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Cover image: Soldiers with the Carl-Gustaf recoilless rifle *(Photo: Saab)*

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FROM THE EDITOR

Ajax is back on track. The British Army is showcasing the armoured fighting vehicle at DSEI in London in September. This follows months of speculation as to whether the vehicle programme would be axed following the identification of noise and vibration problems, which caused injuries to crew members. Trials were halted, and at one point, the Ministry of Defence (MoD) even witheld payments to General Dynamics Land Systems–UK (GDLS-UK) until the problems with the vehicles were resolved.

Everyone involved in the troubled vehicle programme no doubt wants to get on with fielding the vehicle, which is expected to enter service eight years later than originally planned. In the wake of procurement failings such as Ajax, changes are in the pipeline at Defence Equipment & Support (DE&S) — check out our interview with Andy Start, DE&S' CEO on page 10 — and relations between Dstl and DE&S, which, according to the Clive Sheldon Review into Ajax Lessons Learned, were "fractious," have improved. But Sheldon's report reveals some uncomfortable truths about the nature of defence procurement in the UK: A culture that did not escalate safety concerns, or encourage full and frank disclosure, and an "optimism bias" which discouraged junior members of staff from raising issues at a much senior level.

A lot of these issues require a change in organisational culture, but as Stuart Young, former head of the Centre for Defence Acquisition at Cranfield University, points out in his appraisal of the Ajax Lessons Learned Review on page 17, this can be the most difficult aspect to change due to embedded patterns of behaviour. One thing the Ajax saga highlights is that the procurement process itself is often overlooked in the race to acquire the most advanced and capable platforms. The focus is often on the next mission, or the emerging threat landscape, and not on effective and timely acquisition that delivers value for money. But as the near-pear threat becomes ever more apparent as China grows in confidence, militarily, and Russia continues to flex its muscle, our 'broken' system of defence procurement needs to be replaced by one that is more transparent, accountable, and, in the words of DE&S' CEO, "moves at pace."

In this issue, two of our columnists (Professor John Louth from the UK and Australia's Richard Dunley) tackle some of the thorniest issues in defence procurement today. As technology and the threat landscape rapidly evolves, they argue that it is important to understand the risks as well as the opportunities of complex activities.

Has Australia bitten off more than it can chew, with its ambitious recapitalisation of its navy? We're not just talking about the AUKUS mega-project, but also the Hunter Class frigates and Arafura Class Offshore Patrol Vessels. As Dunley points out on page 93, a more "hard-nosed and pragmatic approach to naval procuerment," would reduce risk and ensure equipment gets into the hands of the Royal Australian Navy, while it is still relevant. And as the Ajax programme clearly demonstrates, modifying designs increases risk and blows out costs and timeframes, a price most countries can ill afford against the backdrop of autocratic states increasingly asserting themselves on the world stage and technology evolving at a dizzying pace. ■

Happy reading,

Anita Hawser
Editor

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MAKING A MATERIAL DIFFERENCE

Defence Equipment & Support (DE&S) is one of the most criticised organisations within UK defence. But CEO Andy Start insists defence procurement is making good progress, and that we don't talk enough about the vast scale of programmes that go well.

Andy Start has spent the last 20 years helping organisations in the defence and space sectors transform and grow. But transforming the UK's Defence Equipment & Support (DE&S), the organisation charged with equipping and supporting the UK's Armed Forces, could be his most challenging project to date.

UK defence procurement has copped a lot of flak in recent years with reports from the National Audit Office and the House of Commons Defence Committee, depicting a system that is "overly bureaucratic, ponderous, an inconsistent approach to safety, and adverse to taking individual responsibility."

But Start, who celebrates his one-year anniversary as CEO of DE&S in September, isn't daunted by the criticism levelled at the organisation he leads. Against the backdrop of an increasingly innovative and assertive China, multiple autocratic states asserting themselves on the world stage, and the dramatic pace of change in technology, he understands the need to drive up the responsiveness and availability of the equipment that DE&S provides.

However, he doesn't agree with depictions of defence procurement in the UK as being 'broken'. The House of Commons Defence Committee's (HCDC) report, *It is broke — and it's time to fix it: The UK's defence procurement system*, describes "multiple troubled programmes across the MoD's portfolio," including the Ajax armoured fighting vehicle, delays to the Type 26 GCS' IOC at a cost of £233 million, and spiralling costs associated with the Type 31 frigate programme. But Start says defence procurement in the UK is improving year on year. "At any one time, our organisation manages about 2,600 contracts and 550 programmes, and of those, the vast majority execute. We delivered 98% of the key user requirements and 89% of our contractual milestones to plan. We have saved £6.2 billion out of the Equipment Plan since 2017. So, most programmes are executed well and indeed the level of overspending to budget is around 4%. So, it's only a very small proportion of programmes that are problematic."

He points to the £2.3 billion worth of equipment the UK sent to Ukraine in 2022 and the speed with which DE&S was able to deliver it. "We got our first orders out to Ukraine in 48 hours. Because we already have a network of innovation inside UK defence and close relationships with both the primes and small-and medium-enterprises, we've been able to bring technology through into the Ukraine conflict at an incredible pace. Within DE&S we have a team called the Future Capabilities Group, which has injected a lot of the drone technologies that you see in Ukraine and elsewhere and we're doing the same in the UK context. In defence, we often talk about the big things that are problematic, but we don't talk about the vast scale of things that we do that go well."

Other successes he points to include the acquisition of the Archer 155 as an interim replacement for the 32 AS90 artillery systems the UK gifted to Ukraine's Armed Forces. "We concluded the contract for the Archer in just eight weeks. We're also accelerating ocean surveillance technology by repurposing a commercial surveillance ship as we recognise the increasing threat posed to oil and gas pipelines and underwater sea cables."

Under his predecessors, Sir Bernard Gray, Tony Douglas, and Sir Simon Bollom, Start insists defence acquisition in the UK has progressed in the right direction for the last decade. "At the top end, we're doing big complex mega projects which are historically, in every sector, difficult, because we're pushing the boundaries. It is

DE&S CEO Andy Start in front of Challenger
(Copyright: DE&S)

true to say we can and must do better. But it's not true to say the UK is in any worse position than anyone else."

Responding to criticism from General Sir Patrick Sanders who stated at the RUSI Land Warfare Conference in June that the UK's "procurement record has been poor, and we've allowed our land industrial base to wither," Start says DE&S is getting on with executing the UK's Land Industrial Strategy, starting with Ajax, which he says has turned a corner, with the delivery of 44 Capability Drop 1 vehicles to the Field Army and more than 14,000 collective kilometres racked up during Reliability Growth Trials this year.

With respect to the Boxer armoured vehicle programme, Start says state-of-the-art factories in Telford have been set up by RBSL to build the vehicles. "The first Boxers were delivered to the Millbrook Proving Ground a month ago. It is a phenomenal capability. Challenger 3 is progressing on track, and to augment that the Apache AH-64E, the British Army's new attack helicopter, is being rolled out with all 50 aircraft forecast to be delivered by the end of 2024. Project TIQUILA will also give the army a new drone surveillance capability."

During the Afghanistan and Iraq wars, Starts says the focus was on Urgent Operational Requirements, which meant critical UK defence capability was lost, which it is now in the process of rebuilding. "We need to make a material difference here and invest in the UK supply chain."

DE&S is also embracing what Start describes as the most substantial change in its operating model for a decade. Working with both industry and laterally across defence, a new strategy has been developed for the organisation, which Start says can be summarised in three words: 'today, tomorrow, together'. "Today, we must drive up the responsiveness and the availability of the equipment that we provide. Tomorrow, we need to spin in technology much more quickly, on top of those existing platforms, to enhance the capability and scale of deterrence that we deliver into the world, as well as delivering the long-term programmes that take years or decades. And we've got to do that better together with industry, which is a fundamental part of the defence ecosystem."

> *"There are enormous opportunities to make the system leaner in terms of the flow and the way that we work with industry at greater speed. That's about getting our structures and our processes right. We need to back that up with the right digital tool sets."*

To align with that strategy, Start says DE&S is changing the way it uses different technologies, as well as applying a lot of lean techniques to accelerate speed. "Based on my background of having done nine significant transformations in industry we're taking those best practice techniques to change the way that the DE&S operating model works. As part of that, we've really engaged with industry, with academia and think tanks in identifying what needs to change to produce the concept design for the future of DE&S."

Over the next 12 months, Start says DE&S will change from being an organisation that is organised in vertical stovepipes — land, ships, air and strategic enablers — to one based on "operational excellence" designed to accelerate the speed and flow with which it executes programmes together with industry.

As outlined in the revised Defence Command Paper, Start says there is a recognition within defence that the pace of change is dramatic, and the scale of innovation is greater than at any point in history. "In that context, we've got to put time as a premium in the way that we think about acquisition. And you can see that reflected in the Command Paper with a desire to get to the 80% solution, and then spiral up."

The Defence Command Paper also talks about the need for a new partnership with industry. "We need to manage our relationships in a much more strategic way," says Start. "In the UK, we've brought industry in at high levels of classification early into the acquisition cycle to talk about the threats and how we need to use innovative technologies to be different, rather than just focusing on producing a faster horse and cart."

Having a vision for how DE&S should operate, is one thing. But how do you execute that vision? "The first thing is about creating fundamental structural change so that we ensure everybody who's contributing to the system has a line of sight to the mission and is clear about their role, which is, ultimately, to be the prime of primes," says Start. "We've got to be the integrator of all this defence equipment to be able to create an integrated effect for defence."

While other delivery agents are responsible for submarines and digital, Start says together they must deliver an integrated system that maximises effect and not a whole series of separate stovepipes that fails to create a combined outcome. "There are enormous opportunities to make the system leaner in terms of the flow and the way that we work with industry at greater speed. That's about getting our structures and processes right. We need to back that up with the right digital tool sets, and we're catalysing that through a programme called DX4D, Digital Exploitation for Defence, which recognises at a national level, that digital tool sets

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"We've really engaged with industry, academia and think tanks in identifying what needs to change to produce the concept design for the future of DE&S," says Andy Start, CEO of DE&S *(Copyright: DE&S)*

are having an impact on the operational, capability and acquisition spheres that I lead, and in the underlying business processes and systems across defence."

Three new control centres will be created within DE&S, explains Start, which will have full operating capability by Christmas. "The first of those control rooms allows us, for the first time, to see the availability of all assets — land, air, maritime, Strat Com — across UK defence. The second brings together the overall integrated system capability across defence, which is very complex, but creates an environment where we can make trade-offs between whether it's better to have more digital capability, more hard power, or new more innovative solutions. And then the final control room is aimed at bringing digital twins and digital acquisition techniques to the UK industrial supply chain to allow us to shorten acquisition cycles."

DE&S is developing digital twins for legacy equipment to identify changes that need to be made to improve reliability and availability. "We're also using it to accelerate new programmes both in the maritime domain, but also with programmes like GCAP [Global Combat Air Programme]," says Start. While DE&S already has a "committed workforce," comprising military, veterans, and civil servants, and experts from industry, Start says greater diversity is needed. "We are about 35% female and 65% male. I'd like to see a 50/50 mix. Having done this within multiple organisations before, I know when you achieve greater levels of diversity, you also perform better as an organisation."

Start says he will be proud of his tenure at DE&S, if he leaves the organisation and defence in a place where the workforce feels more aligned to mission, and with greater line of sight. "If I leave an organisation that is passionate, engaged and delivering at pace, and if people look back and say, 'Andy helped us create an organisation better suited to the current environment and one that has the skills to adapt as our adversaries adapt,' then I'll feel I've really done a worthwhile thing." ■

OPINION

PROCURING FOR TOMORROW

Collaboration between the public and private sectors and exacting project management skills are critical to the future of defence alliances such as AUKUS and NATO, and the sourcing of next-generation military capabilities.

By John Louth

For many current and would-be military commanders from this generation and the next, procurement is perceived as an enabler of future force structures or as a support function.

Seemingly, the themes of defence acquisition are not as exciting as the leadership of troops, development of doctrine or management of mission profiles. This is understandable, but misguided. As the refreshed Command Paper from the Ministry of Defence (MoD) makes clear, the notion of defence is now generated through new alliances such as AUKUS, the reinvention of longstanding treaties, like NATO, the criticality of strength and resilience through partnerships and, lastly, the centrality of science and technology to a world in speedy transition.

These four themes are the very essence of acquisition. Even the components and processes of the practice could now be said to be strategic, critical success factors for UK defence itself. This is a sobering thought at a moment when there is a war of aggression in Europe, China is rising to stress-test the existing global order, economic challenges pepper the landscape, and the House of Commons Defence Select Committee reports that UK defence acquisition is 'broken'.

Taking the four themes from above in turn, AUKUS — the trilateral security pact between the US, UK and Australia — is a dish of two principal ingredients. The first relates to the provision of nuclear-powered submarines to Australia. The design, development and manufacture of UK–Australian submarines utilising US-proprietary nuclear propulsion technologies is scheduled for operational delivery in the 2040s.

In the interim, Australia will buy several US Virginia-class submarines, with their sailors training on both US and UK craft. Moreover, from 2027, rotational submarine forces will be based at HMAS Stirling, near Perth in Western Australia, giving a sharp operational focus to these acquisition activities. This is a complicated design and integration suite of interlocking parts, sitting on an investment of billions of dollars. It will be delivered through robust project management disciplines. In fact, the successful generation of capabilities such as these should be seen as an exercise in world-class project management execution.

Logistics critical to risk and aggression response

The second ingredient of AUKUS relates to a shopping list of high-end capabilities such as artificial intelligence, autonomy, quantum technologies, electronic warfare, hypersonics, undersea capabilities and cyber operations. These themes sit heavily upon research and development investments, robust collaborations between the three nations' pan-public and private sectors, and open systems' architectures.

Adding to the necessity for exacting project management competencies, the acquisition of sought AUKUS capabilities now requires speculative research, focused development, the potential adoption and adaptation of commercial off-the-shelf systems, enterprise-wide integration and operational principles and protocols that may well have to span the forces of the three nations and across all operational domains. The challenges are obvious, but the benefits are game-changing and all elements of effective acquisition.

In terms of the reinvigoration of NATO, the Russian invasion of Ukraine has refocused NATO from an out-of-area, expeditionary stance to a clear-eyed gaze on border integrity in Europe and the threats posed by an adversarial major power. The UK policy response has centred on robust political support for Ukraine, supporting and initiating sanctions whilst simultaneously acting as a conduit for resistance and rejection of a corrupt Kremlin narrative of legitimisation.

More pertinently, the UK has provided substantial military aid and training support through standing logistic contracts with the private sector. The efficient and speedy execution of the delivery of military materiel has been hugely significant in supporting Ukraine. This result has been delivered, in part, through the flexibility of the contract for logistical support and transformation between the UK MoD and Leidos, the significance of gain-share


Nato allies help train Ukrainian recruits *(Copyright NATO)*

principles in its execution, and the ability to reshape a back-office function into a strategic enabler for the Western alliance. Once more, an item from the acquisition toolbox — in this case, defence logistics — has proven critical to our response to risk and aggression.

The real-world realities of effective programme management

The emphasis on strength and resilience through strategic partnerships is highlighted by the NATO and AUKUS examples. The argument seems to be that nations are stronger working together, and we can field a greater force when we pool and share capabilities. In this regard, military collaboration through collective training and exchange practices is especially significant. Less well understood but equally critical is the partnership between government(s) and the commercial sector.

Many of the technologies necessary for the next generation of military capabilities are sourced from and housed within the private sector. Integrating the governmental and commercial on-shore and across borders is the magic sauce of effective international collaborations, especially for the technology-rich military capabilities headlined through AUKUS.

This is tricky, as there are clear roles for large, international prime defence contractors, global integrators, and niche technological disruptors. The latter are typically agile and fluid whilst large international corporations and governments tend to be bureaucratic and favour hierarchical systems. Finding common cultures and effective ways of working across such broad ventures is the challenge for the age, captured initially in many a would-be national transformation programme. Defence, as articulated through NATO and AUKUS, must work at pace to transform the defence enterprise through partnered strategic collaborations, perhaps never witnessed before at the scale now desired by policymakers.

To this point, a desire for strategic collaboration must meet the real-world realities of effective programme management. Across major collaborative programmes, we need artefacts such as a single master schedule of activities, a proper understanding of the resourcing necessary for delivery, a fully-mastered sense of the issues and risks that need to be interdicted, and the opportunities that emerge from such a collaboration — operationally, commercially, culturally — and where the critical financial flows fall, and when.

We also need to understand how sensitive the business case is to export sales beyond our own requirements and those of our international partners. Is our own consumption of next-generation capabilities affordable without exports? What does this mean for the potential reform of export controls and the transfer of sensitive technologies and materials, especially those entangled within ITAR, the US defence regulatory regime?

There can be little doubt that scientific and technological advances are transforming defence capabilities. We see it in Ukraine today, in the petri dish of a modern, state-on-state conflict where electronic warfare activities as well as sheets of camouflage shield assets in plain sight. Drones and swarming practices are transforming air power and social media is the new intelligence operative.

In the AUKUS ambition, the importance of autonomy, non-human intelligence and digital decision-making are stated overtly and repeatedly, subtly guiding research, development and investment priorities of industrialists and shareholders. It is, indeed, a world in flux.

There are things to guide us. The centrality of effective programme and project management cannot be overstated. Understanding the issues, risks, and opportunities of complex activities, spanning borders and sectors, will become more important than ever, especially as expanding technologies reshape continually what is possible within programmes.

Accordingly, the expertise of the project manager and risk manager will be highly prized. Secondly, an acquisition practice that has effective programme management at its epicentre will thrive in a world where collaborating partners will all require a single version of the truth to navigate by. Defence acquisition is never broken where effective project management is practised.

Lastly, the management information generated must drive effective decision-making rather than avoidance. Recognising that there are no failing programmes just failures in effective decision-making might prove an important lesson in the transformation of NATO, the making of AUKUS, and in the regeneration of our defence. ■

Professor John Louth *is a strategic adviser to Redstone Risk. He was the Director of Defence, Industries and Society research at the Royal United Services Institute for Defence and Security Studies between 2011 and 2019. John also serves as a specialist adviser to the House of Commons Defence Select Committee, a non-executive Member of the UK Government's Advisory Board to Chief of Defence, People and a senior non-executive director of Subsea Craft.*

CULTURAL CHANGE NEEDED IN LIGHT OF AJAX REVIEW

The most alarming finding from Clive Sheldon's Review into lessons learned from the Ajax armoured vehicle programme, says procurement expert Stuart Young, is the issues relating to organisational culture, which are the most difficult to change.

By Anita Hawser

Clive Sheldon KC describes his Ajax Lessons Learned Review as "required reading for Senior Responsible Owners (SROs) and other senior personnel working on procurement projects for the UK Ministry of Defence."

We sat down with procurement professional Stuart Young, a former head of the Centre for Defence Acquisition at Cranfield University, who boasts more than 20 years of experience in the Royal Navy and Ministry of Defence, including management of major international programmes with the French and US navies, to get his key takeaways from the

General Dynamics factory in Merthyr Tydfil Wales where Ajax (pictured) vehicles are assembled.
(Photo by Edward Low UK MOD © Crown Copyright)

Sheldon Review into the £5.52 billion Ajax armoured vehicle programme, which has been one of the most troubled armoured vehicle procurements in recent history.

Q: What are the biggest lessons that can be drawn from Sheldon's report on Ajax Lessons Learned?

Stuart Young: The biggest lessons are related to the lack of open and honest information flows up the chains of command. Often, the senior people who were best placed to initiate key actions to maintain the project were unaware of many of the key developing issues. This was due to a strong optimism bias, a reluctance to raise issues unless a solution was available and an army 'can-do' attitude which constrained junior personnel in raising issues to a more senior level. The report lists several recommendations related to improving the flow of information and the content and format of reports.

Q: What reforms need to be made to ensure something like this never happens again?

Young: Sheldon proposes 24 recommendations, and it is difficult to argue against any of them. However, underpinning all these recommendations is the need for culture change in the way complex projects are managed across equally complex organisational and reporting structures cutting through civil service, army, and industry culture. Therefore, exceptional leadership is needed to implement the cultural changes required, supported by better education of senior people, particularly at the programme and portfolio levels, and improved resourcing at the programme level. And, as has been frequently recommended elsewhere, longer time in post for key personnel would lead to significant improvements.

Q: What aspects of the Sheldon Review are most concerning?

Young: Of particular concern are those issues which are related to organisational culture, as these tend to be the most deeply embedded and therefore the most difficult to change. These issues include the reluctance to pass bad news up the chain of command, and an underlying optimism bias which tends to emphasise good news whilst hiding or disguising bad news. This was most obvious and concerning when it came to the safety issues related to noise and vibration. Safety concerns were hidden from senior personnel, and only became apparent when those concerns were raised outside the normal chain of command. Action needs to be taken urgently to ensure that this issue is not systemic across other procurement projects.

Stuart Young

Q: Sheldon's report highlighted friction in the relationship between DE&S and the Senior Responsible Owner for Ajax, as well as with Dstl. Is this typical in procurement programmes of Ajax's scale and nature?

Young: Friction between different organisations involved in delivering a challenging programme is almost inevitable. Perhaps this is exacerbated in a military environment where individuals

are rewarded through promotion in competition with their peers.

One solution might be to move the various organisational actors closer together, for example, by embedding Dstl personnel within the DE&S project team. However, this could result in too cosy a relationship where it becomes even more difficult to challenge and raise issues. Therefore, we need to move towards a culture where information is freely shared and available across all the participants, where there is a greater understanding of the roles of the different personnel and organisations involved, and where challenges are both accepted and encouraged as a way of delivering successful project and programme outcomes.

Q: Does the report highlight a problem with the SRO role in procurement programmes?

Young: The SRO role is now well established within the Ministry of Defence, across other industry sectors and internationally. Sheldon's report doesn't raise any fundamental issues with the role of the SRO but it does highlight specific problems in the context of Ajax. A particular problem was the workload imposed on the SRO. At one stage the SRO, in addition to their day job, was also SRO to four major programmes and was supported by inadequate programme-level resources. Complex, high profile, high value and high-risk programmes need to be led by a dedicated, full-time and experienced SRO supported by a fully resourced programme office. This was ultimately recognised within the Ajax programme and a full-time, dedicated SRO was appointed.

There are growing demands for greater alignment of accountability and responsibility in defence procurement, illustrated most recently in the House of Commons Defence Committee report, *It is broke and it's time to fix it – The UK's defence procurement system* published on 11 July 2023. This report develops further Sheldon's themes in relationship to SROs and makes several key recommendations related to improving the skills of the SRO, time in post (a minimum of five years) and the SRO's access to senior personnel, including the CEO of DE&S and the Minister for Defence Procurement.

Q: Does Sheldon's findings support the view of a lack of suitable expertise within DE&S to run complex armoured vehicle programmes?

Young: Sheldon did not identify any specific lack of expertise within DE&S in relation to complex armoured vehicle programmes and noted the hard work and diligence of DE&S personnel. He did note that the DE&S Board had already identified the need to address commercial and project management skills across the organisation. Any shortcomings within DE&S related to the delivery of Ajax were probably explained by the lack of experience and expertise in delivering equipment to the army due to the perceived lack of an Army Equipment Programme over the last few years, apart from Urgent Operational Requirements. Sheldon made no specific recommendations related to DE&S expertise.

Q: How do the failings of the FRES programme, which is the precursor to Ajax, compare with the problems Ajax faced?

Young: The FRES (Future Rapid Effects System) programme was effectively terminated in December 2008 when General Dynamics had its preferred bidder status withdrawn. Underlying reasons for the termination were related to an inability to define the changing requirements and agree an acceptable procurement strategy. Ajax grew out of the Scout variant of FRES and was designed to be based on an off-the-shelf design. However, 1,200 specific requirements meant that the Ajax design was virtually bespoke. It is difficult to make a direct comparison between FRES and Ajax as FRES never progressed to demonstration and manufacture as Ajax has done. The issue of changing requirements is common to both, and highlights Ajax's difficulties in progressing to manufacture, in a desire to maintain delivery targets when requirements are still changing and developing and technical risk remains high.

Q: Should Sheldon have been more explicit in laying the blame for Ajax's problems with certain individuals or organisations?

Young: Sheldon's terms of reference for his report were constrained to looking at leadership, culture and governance issues related to the timely and appropriate elevation of problems to the right level, with a focus on systemic and process issues as well as individual action and inaction. Within these constraints, Sheldon decided that to maximise openness and transparency from individuals interviewed and counter the perception of a witch-hunt, people would not be identified by name and blame would not be attributed.

I consider this to be the right approach; the report appears to have succeeded in encouraging interviewees to be open and honest in their recounting of events and their associated views and feelings. As many of the issues are related to cultural and organisational factors then assigning blame to an individual is probably not appropriate.

However, anyone with insider knowledge could probably easily identify individuals from the roles and timelines laid out in the report and could assign a personal view of blame to an individual. This may have a longer-term impact on an individual's career prospects, although that was not the intention of the report. ■

For more extensive coverage of the Sheldon Review's findings into Ajax and the vehicle programme's recent progress, go to page 32.

Hindustan Aeronautics' Dhruv helicopter onboard India's indigenous aircraft carrier, *INS Vikrant*, during sea trials
(*Photo: Ministry of Defence, GODL-India via Wikimedia Commons*)

INDIA'S PONDEROUS PATH TO SELF-RELIANCE

Can the most populous country in the world transform itself from a net importer of defence equipment to a net exporter?

By Sarosh Bana

Despite having the world's second-largest standing army after China, and the world's fourth-largest defence expenditure after the United States, China and Russia, India's defences have increasingly come into question. Relentless and unprovoked Chinese transgressions across the Line of Actual Control (LAC), the 3,488-km Himalayan border that divides the two nuclear-armed neighbours, has challenged the country's defences.

India has purchased almost $24 billion worth of military hardware over the last five years from countries such as Russia, the US, France, Israel, and Spain, and it has procured even more munitions ever since People's Liberation Army (PLA) troops overran parts of its border Union Territory of Ladakh in May 2020.

The PLA brazenly occupies some border areas where a confrontation between the two sides in June 2020 killed 20 Indian Army soldiers and four Chinese servicemen. India's military establishment was concerned enough by the "collusive threat" held out by China and its ally Pakistan to indoctrinate a two-front war.

Amber Dubey, past partner & India head of Aerospace & Defence at KPMG, says India's ammunition reserves would last only 20 days of a two-front war. "Some estimate them to last much less since the projection of ammunition usage is at best an educated guess," he added. The serious shortfall in defence has in the past been underscored by the Comptroller & Auditor General as well as the Parliamentary Standing Committee on Defence.

NAVIGATING A PATH TO HIGHER LEVELS OF INDIGENISATION

In 2021, India's military expenditure of $76.6 billion ranked it third highest in the world, an increase of 0.9% from 2020 and 33% from 2012, according to data published by the Stockholm International Peace Research Institute (SIPRI). 2022's outlay of $81.4 billion made it the fourth-highest defence spender in the world behind the US, Russia, and China.

In 2021, according to SIPRI data, 64% of capital outlays in the military budget were earmarked for acquisitions of domestically produced arms. The government has reformed policy to encourage indigenous design, development and manufacture of defence equipment in consonance with its overarching Atmanirbhar Bharat (self-reliant India) agenda.

The Indian Ministry of Defence (MoD) has identified 411 "major weapons platforms/systems" under four "Positive Indigenisation Lists," and 3,738 "major line replacement units/sub-systems/assemblies/sub-assemblies/components & spares" exclusively for Defence Public Sector Undertakings (DPSUs) under three more lists, while embargoing their imports from defined timelines.

More than 26,000 defence items are additionally on offer for indigenisation. Junior Defence Minister Ajay Bhatt recently stated before parliament that 7,031 items had been indigenised, "which cater to the domestic and global markets." Other policy reforms include allowing 74% foreign direct investment under the automatic route and a reframed offset policy for attracting investment and transfer of technology from foreign Original Equipment Manufacturers (OEMs) by assigning higher multipliers. Approval has been accorded to 45 companies and joint ventures with foreign OEMs.

At Aero India this February, India's Prime Minister Narendra Modi outlined his ambitions to ramp up Indian defence exports to nearly $5 billion over the next five years. According to Invest India, the country's national investment promotion agency, India's defence exports reached an all-time high of approximately INR 16,000 crore (approximately $1.95 billion) in the 2022-2023 financial year, with the nation now exporting helicopters, naval vessels, aircraft, missiles and armoured vehicles to more than 80 countries globally.

Past exports have included Hindustan Aeronautics (HAL) Dhruv helicopters and the Russia-India venture BrahMos Aerospace is said to be in discussions with Indonesia, Malaysia, and Vietnam regarding new orders for its supersonic cruise missiles.

INDIGENISATION FRAUGHT WITH SETBACKS

On 2 September 2022, India commissioned its first Indigenous Aircraft Carrier (IAC), *INS Vikrant,* which propelled the country into an elite league of nations — comprising the US, China, Russia, the

An Indian Air Force Dhruv helicopter (*Photo: Arpingstone - Public Domain)*

India's Arjun MBT Mk 1A tank on field trials *(Photo by the Defence Research and Development Organisation, GODL-India, Wikimedia*

UK, France, Spain and Italy — with the niche capability to design and build their own aircraft carriers.

While the MoD claims *INS Vikrant* is 76% indigenous, it is powered by four General Electric LM-2500 gas turbines and armed with the Israeli Barak-8 missiles made collaboratively in India. Its radar is an Israeli-made Active Electronically Scanned Array. Recently, the Prime Minister-headed Cabinet Committee on Security opted for 26 Dassault Aviation Rafale-M fighter aircraft for India's indigenous aircraft carrier. The Rafale-M was chosen over Boeing's F/A-18 E/F Super Hornet. At DefExpo 2022, before the selection was made, Boeing India vice president of business development Alain Garcia said, "If the deal goes through, this will be India's first US-based fighter jet." The fighters for both the Indian Air Force (IAF) and Navy are estimated to cost $45 billion. Another deal delayed by the war in Ukraine is for 12 SU-30 MKIs and 21 MiG-29s from Russia, which are proposed to replace ones lost in accidents.

The IAF will operate an air wing comprising 30 mostly imported aircraft, including MiG-29Ks and Kamov-31 airborne early warning helicopters from Russia, and Sikorsky MH-60R multi-mission helicopters, apart from the indigenous Dhruv Advanced Light Helicopters and Tejas Light Combat Aircraft.

However, the 43,000-tonne I*NS Vikrant* will sail without these aircraft as they need to be supported by an Aviation Facility Complex that was to have been supplied by Russia's Nevskoe Design Bureau by year-end. However, its delivery is in doubt as Nevskoe is among the 29 Russian defence entities sanctioned by the US following Russia's invasion of Ukraine.

In March, the Parliamentary Standing Committee on Defence cautioned against any delay in the procurement of these fighter jets, while seeking an early decision on a second Indian aircraft carrier.

According to a 2020 working paper by the Stimson Center, 70% to 85% of India's military platforms are of Russian origin. While indigenisation efforts are aimed at replacing aging Soviet-era equipment, these programmes are often fraught with setbacks and delays. Take India's Futuristic Infantry Combat Vehicle (FICV), which is meant to replace its aging Soviet BMP-IIs that were the bulwark of the Army's Mechanised Infantry since the 1980s and which have long outlived their utility. However, since 2008, political indecision, bureaucratic apathy and frequent changes in procurement practices have impeded the Indian Army's critically required FICV.

According to a 2021 article published by the Observer Research Foundation think tank, the Ministry of Defence also ordered the Indian Army to purchase and integrate 118 Arjun Mark-1A Main Battle Tanks. The Arjun, which weighs more than 68 tonnes, was designed by India's Combat Vehicles Research and Development Establishment (CVRDE) and produced by the Heavy Vehicles Factory (HVF), both based in Chennai. But its heavy weight means it can only be deployed on terrain like roadless deserts.

The country's fighter jet engine project, named Kaveri, failed completely, despite almost $260 million having been lavished on it since it was sanctioned in 1989. This compelled imports from General Electric of its GE-404 and GE-414 engines and a subsequent agreement with French engine maker, Safran Aircraft Engines, for reviving and certifying the Kaveri programme. Kaveri was to power the indigenous Light Combat Aircraft which itself suffered a massive hold-up of more than 16 years.

WILL INDIA REMAIN A NET IMPORTER OF EQUIPMENT?

Despite the ostensible push for "self-reliance," many military analysts and veterans (most Indian defence officials serving or retired are wary of going on the record ever since the Modi government cast a shroud of utmost secrecy over the defence sector, which has only worsened since the alarming developments on India's border with China), feel that India will remain a "net importer" of defence equipment as the requisite infrastructure and competencies are developed. India imports a wide range of defence equipment, from military transport and combat aircraft, helicopters, radars, air defence systems, rockets and missiles to guns, assault rifles and ammunition.

In the period 2018-2022, India was the world's largest importer of major arms, according to SIPRI, with an 11% share of total global arms imports. India's heavy reliance on imports is anticipated to continue, as is the long-delayed programme to acquire 114 combat aircraft for the IAF. A keen contender is Lockheed Martin, whose Super Hercules C-130J aircraft already flies with the IAF. Lockheed Martin's vice president, India, Aeronautics Strategy & Business Development, Michael Kelly, is pitching for the single-engine F-21, saying it is specifically configured for the IAF and "provides unmatched 'Make in India' opportunities."

Defence Minister Singh believes joint ventures have done particularly well for India's defence production and is looking to secure more such investments from major defence companies. Israel is at the forefront, with Israel Aerospace Industries (IAI) having forged several such collaborations. One of them is with DPSU Bharat Electronics for providing lifecycle support for Medium-Range Surface-to-Air Missile (MRSAM) air-defence systems, which are used by all three services in the country. "Through this [joint venture], IAI reiterates its support to the Indian government's vision of Atmanirbhar Bharat," said Bhat, India's Junior Defence Minister.

A BrahMos missile launcher on Republic Day
(Photo: B. M. Meena / Ministry of Defence, Government of India, GODL-India via Wikimedia Commons)

The MRSAMs resemble Israel's Barak-8 missiles, which are being jointly developed by IAI and India's Defence Research Development Organisation under a $2 billion deal signed in 2017. The joint venture with Bharat Electronics follows the opening in New Delhi last October of a subsidiary of IAI, Aerospace Services India. Both these instances "illustrate our support for the government's Atmanirbhar Bharat initiative," IAI president and CEO Boaz Levy asserts. IAI also signed a Memorandum of Understanding at AeroIndia 2023 in February with Pune-based Sagar Defence Engineering to develop autonomous weaponised boat swarms for the Indian Navy.

Another key joint venture, between Tata Advanced Systems and Lockheed Martin, named Tata Lockheed Martin Aerostructures, serves as the single global source of C-130J empennages (tail assemblies) installed on all new Super Hercules C-130J aircraft. To date, 200 such empennages have been manufactured and delivered.

Claiming that India had "made its place despite the monopoly of a few manufacturing companies in the defence sector globally," Prime Minister Modi said the Indian military's decision to buy most of the equipment made within the country underscored the capacity of an Atmanirbhar Bharat.

The situation on the ground, however, markedly belies his claims. Worse, it points to a false complacency that could impede the thrust towards an Atmanirbhar Bharat. ■

ABOUT THE AUTHOR

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MAKING INDIA A NATION OF DEFENCE EXPORTERS

Although India's defence imports still outweigh its exports, Neeraj Gupta, chairman of the Society of Indian Defence Manufacturers (SIDM), says there is still much to celebrate in terms of the country's defence production achievements, and insists that India is becoming more "self-reliant."

When it comes to the creation of Indian national defence champions, MKU Limited, which has armoured more than 3,000 platforms and garnered the trust of 230 forces worldwide, is one of a growing number of Indian defence champions that heralds the country's ambitions to service most of its defence needs domestically. However, that's a big ask for a country that historically, has imported most of its defence equipment.

MKU started out making fibreglass helmets and snow boots for the Indian Army, before moving on to developing more complex hardware such as lightweight composite armour. With a presence in Germany and operational deployments across India and the UAE, MKU's advanced ballistic protection solutions have been deployed on MK41 Sea King helicopters, German CH-53s and UH-1D helicopters. It has also worked with the Swiss and Czech Air Forces and France's Dassault Aviation.

As part of India's Atmanirbhar Bharat (self-reliant India) agenda, the ambition is to create hundreds more companies like MKU, which enjoy export success and help wean India off its overwhelming reliance on defence imports from countries such as Russia, France and the US.

Defence Procurement International sat down with MKU's managing director,

India's indigenous Tejas Light Combat Aircraft showcases the country's expertise in aerospace engineering and manufacturing.
(Photo: Ministry of Defence, GODL-India, via Wikimedia Commons)

Neeraj Gupta, who is also chairman of the Society of Indian Defence Manufacturers (SIDM), to discuss India's indigenisation efforts and the progress the country is making to boost its share of global defence exports.

Q: How successful has India's Atmanirbhar Bharat (self-reliant India) been?

Gupta: India's Atmanirbhar Bharat has shown significant progress. Several defence projects have been initiated by our government, focusing on developing and manufacturing critical defence equipment indigenously. MKU has been actively involved in the production of indigenous defence solutions, particularly in the field of soldier and platform protective equipment, night vision and thermal sighting solutions, armour technologies and advanced materials.

Some successful examples from across the country include the development of the Tejas Light Combat Aircraft, Arjun main battle tanks, BrahMos supersonic cruise missiles and various naval vessels. These contributions have not only showcased India's capabilities in indigenous defence production but have also played a vital role in reducing the country's dependence on foreign imports.

Q: As a net importer of defence equipment from countries like Russia and France, to what extent does India continue to rely heavily on imports for its defence needs?

Gupta: India's defence imports declined by 11% between 2013-2017 and 2018-2022, and this decline was linked to a complex procurement process. We have been a significant importer of defence equipment, including from countries like Russia and France. While efforts are being made to reduce dependency on imports, the country still relies on foreign procurement to meet its defence needs. The government's focus on the Make in India initiative and the Defence Procurement Procedure aims to promote indigenous defence manufacturing and reduce import reliance. Policy reforms such as the Positive Indigenisation Lists, have been introduced to prioritise domestic procurement and incentivise indigenous production. These measures are intended to gradually decrease India's reliance on defence imports.

India is set to spend $33 billion on defence equipment in the financial year 2023. Ninety-nine per cent of this equipment will be sourced from Indian industries.

Q: What impact will the Positive Indigenisation Lists have on reducing India's reliance on defence imports?

Gupta: The Positive Indigenisation Lists play a crucial role in achieving self-reliance in defence manufacturing and reducing our dependence on imports. They contribute to our goal of a turnover of $25 billion in defence manufacturing in the next five years, with an export target of $5 billion worth of military hardware. A roadmap gets created for enhancing domestic production capabilities. By giving preference to indigenous manufacturers, these lists help reduce dependency on foreign suppliers. Overall, these lists are instrumental in reducing India's reliance on defence imports by promoting domestic production, fostering collaboration, and stimulating the growth of our indigenous defence manufacturing sector.

In fact, the recently released list includes 928 strategically important items, such as line replacement units, spares, and components, which will be produced indigenously by public sector units. This complements previous lists that covered major platforms like helicopters, tanks, missiles, and ammunition.

For us at MKU, these lists provide visibility and opportunities for the domestic defence industry to understand the trends and needs of the armed forces. This enables us to develop the necessary research and manufacturing capacity within the country. Collaboration between the private sector, public sector, and research institutions is encouraged, further boosting domestic production capabilities.

Q: Despite these efforts, India's defence imports are still larger than its exports. What more can be done to increase Indian defence companies' share of exports?

Gupta: India's defence exports have reached an unprecedented peak, skyrocketing from Rs. 686 Crore in the financial year 2013-2014 to an estimated Rs. 17,000 crore in 2022-2023, representing a remarkable 23-fold increase. Procurement from foreign countries in 2017-2018 was Rs 30,677.29 crore, while it went up to Rs 38,115.60 crore in 2018-2019 and Rs 40,330.02 crore in 2019-2020. The amount in 2020-2021 was Rs 43,916.37 crore and came down to Rs 40,839.53 crore in 2021-2022.

While imports of defence equipment still outweigh defence exports, I believe that Indian defence companies, including MKU, have made notable progress in capturing export markets. To further increase the share of Indian defence companies' exports, several steps can be taken, including improving quality, reliability, and cost-effectiveness, continued investment in R&D for cutting-edge technologies, government incentives and streamlined export procedures, and partnerships with foreign manufacturers for technology transfers and enhanced product capabilities.

Q: Despite the significant time and money poured into India's fighter jet engine project, Kaveri, the project still has no results. What are some of the challenges in developing an indigenous aero engine?

Gupta: The Kaveri engine project has indeed faced significant challenges.

India has achieved significant milestones in the development of missiles such as the BrahMos supersonic missile *(Photo: Mike1979 Russia, CC BY-SA 3.0, via Wikimedia Commons)*

Honestly, aero engine technology is highly complex and demands expertise in multiple areas. Adequate investment in research and development, as well as testing and validation, is crucial. Collaboration with global partners and access to advanced technologies is also essential. However, the Kaveri project helped us build a strong foundation and expertise in critical technology domains.

India's journey in developing aero engines is a continuous climb, and the progress made through the Kaveri project has set the stage for further growth. The technological advancements achieved will also contribute to the development of higher-thrust engines, such as the Advanced Medium Combat Aircraft (AMCA) class. Despite the challenges, we remain positive about our growth and the potential for indigenous aero engine development in the future.

While the project faced delays and had to rely on imports, it has provided valuable learning experiences. The knowledge and capabilities gained through the Kaveri project have positioned India well for future endeavours. We are now leveraging this expertise by redesigning the engine for other applications like drones. Moreover, the ecosystem for indigenous engine design, development, manufacturing, testing, and qualification has been established within the country.

Q: In 2015, the UK–India Defence and International Security Partnership (DISP) attempted to "intensify" cooperation, but according to some observers, implementation is slow. What can be done to improve or strengthen UK-India defence cooperation?

Gupta: The UK's share of India's defence market is less than 2%, but there is an opportunity to enhance defence and security ties between the two countries. The UK's post-Brexit foreign policy shift towards the Indo-Pacific aligns with India's efforts to engage foreign naval forces as a counterbalance to China. India is re-engaging with the UK, and both countries' Prime Ministers aim to improve bilateral relations. In 2022, India and the UK established a Defence Industry Joint Working Group to enhance cooperation. Both countries are working on collaborative projects to develop new technologies and capabilities as outlined in the UK-India 2030 Roadmap.

Additionally, a partnership has been established for the development of electric propulsion capabilities in India. The roadmap also commits to partnering on India's indigenous combat air programmes, such as the Light Combat Aircraft MkII and AMCA. To further enhance defence cooperation, the suggested steps include enhancing defence dialogues, conducting joint military exercises, promoting technology transfer and collaboration, and encouraging defence-industrial cooperation.

In my opinion, it isn't slow. We have picked up a great pace in strengthening the UK-India defence cooperation. We can further improve this cooperation if both countries consider enhancing defence dialogues, conducting joint military exercises, promoting technology transfer and collaboration, and encouraging defence-industrial cooperation.

Q: How is India looking to diversify its defence supplier base?

Gupta: India has been actively taking measures to diversify its defence supplier base. Some of these measures include expanding defence partnerships with countries like the US, France, Israel, and others to foster defence cooperation. Our country is also encouraging private-sector participation in defence manufacturing and procurement, leveraging the capabilities of domestic private firms under the guidance of the Prime Minister and Defence Minister.

We are focusing on promoting the indigenous defence industry through initiatives like Make in India and the

Positive Indigenisation Lists. Additionally, we are exploring partnerships with new defence suppliers globally, including Europe and Southeast Asia. Strategic alliances and joint ventures with international defence companies for technology transfer and co-development are also part of India's approach. Overall, I believe the goal is to expand defence partnerships, promote indigenous defence manufacturing, and explore new suppliers to diversify defence procurement.

Q: As chairman of SIDM, what are the indigenous defence achievements that you are most proud of?

Gupta: I take immense pride in India's indigenous defence achievements including:

Advanced Missile Systems: India has achieved significant milestones in the development and production of missiles such as Agni, BrahMos, Akash, and Prithvi. These missiles demonstrate India's capabilities in missile technology.

Neeraj Gupta, managing director of MKU and chairman of SIDM
(*Photo: MKU*)

Light Combat Aircraft Tejas: The successful development and production of LCA Tejas, an indigenous multi-role fighter aircraft, showcases India's expertise in aerospace engineering and manufacturing.

Nuclear Submarine Program: *INS Arihant* exemplifies India's ability to design, construct, and operate nuclear-powered submarines, thereby enhancing its maritime security posture.

Border Security Equipment: Indigenous development of surveillance systems, unmanned aerial vehicles (UAVs), and border-fencing technologies contribute to enhancing border security and surveillance capabilities.

Naval Systems: The indigenous development and production of warships, submarines, and sensors, including *INS Vikrant* and Scorpène-class submarines, highlight India's commitment to self-reliance in naval defence.

Smart Innovations at MKU: Ultra-lightweight helmets, body armour systems, night vision, and aiming solutions developed by MKU reflect the changing manufacturing ecosystem in India.

Q: How can the defence procurement process in India be improved?

Gupta: Improving the defence procurement process in India is crucial for ensuring efficiency, transparency, and effective resource utilisation. Potential areas for improvement include streamlining procurement procedures, promoting competition and domestic industry participation, emphasising technology transfers and indigenisation, fostering collaborative partnerships, and investing in capacity building and research. By implementing these measures, India can promote self-reliance in defence manufacturing. ■

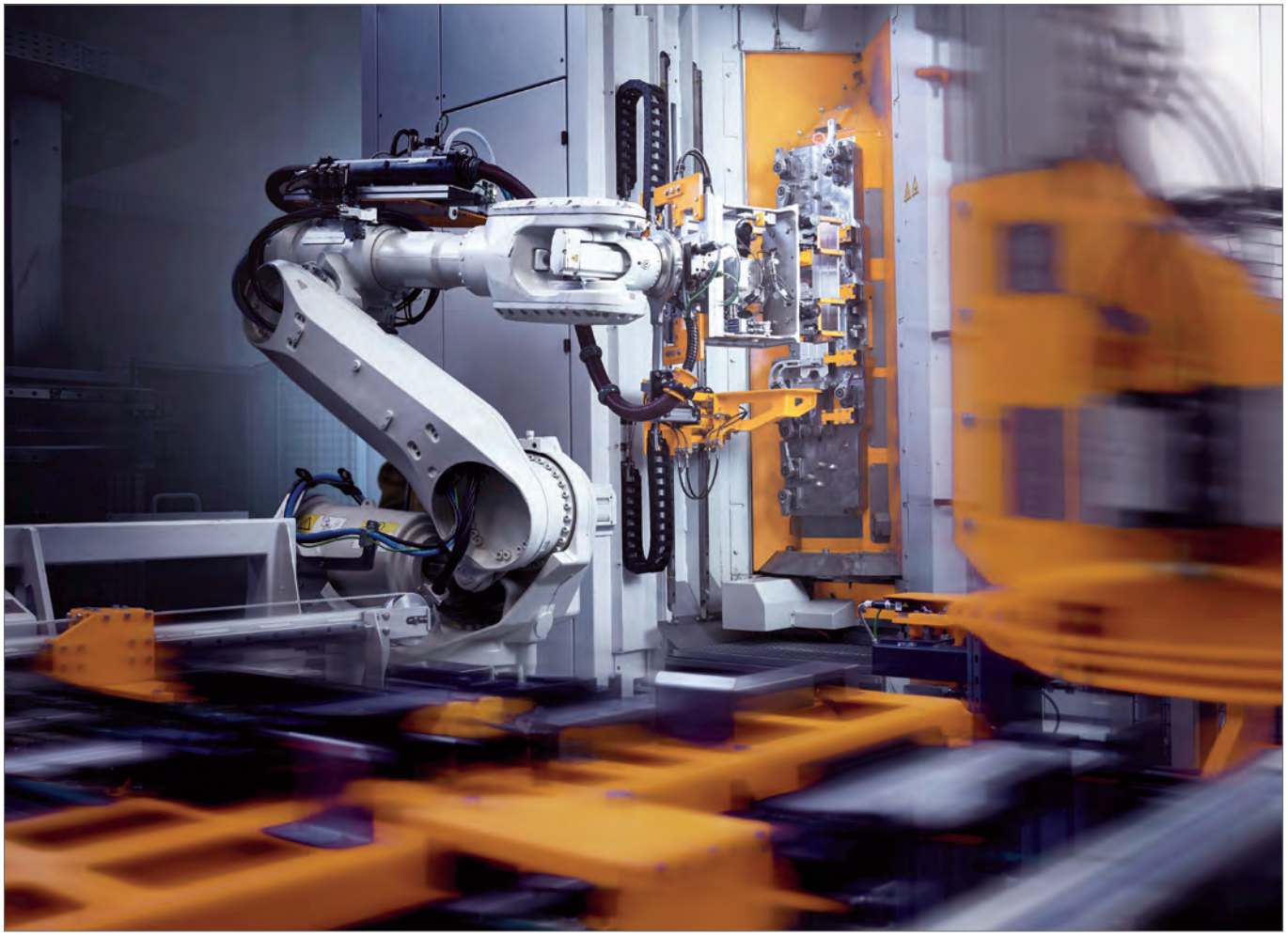
THE NEW TECHNOLOGIES, EQUIPMENT, AND PROCESSES THAT ARE PROPELLING THE DEFENCE INDUSTRY FORWARD

IFS

As autonomous military vehicles now take to the ocean, and space becomes more accessible, new developments from 3D printing to Maritime 4.0 are shaping the future of the battlefield, manufacturing, and space.

Defence forces and A&D manufacturers have become more efficient and asset readiness has increased with new regulatory frameworks allowing for increased data gathering. Matt Medley, Global Industry Director, A&D, IFS, highlights five ways technology is advancing defence support and logistics but warns of the overriding need for cybersecurity to progress in conjunction with new technologies.

Although there are significant macroeconomic and geopolitical hurdles for the defence industry to overcome on the world stage, many defence forces, defence contractors, and A&D manufacturers are already meeting these challenges and looking ahead with new technologies, to reduce the number of



warfighters in danger and stay ahead of hostile forces, ultimately improving military logistics in the process. There are five key areas where technology is powering this growth:

1: LOGISTICS FOOTPRINT OF A&D ORGANISATIONS WILL REDUCE AS 3/4 TURN TO ADDITIVE MANUFACTURING

Military forces are utilising 3D printing to help quickly repair their assets and to design and prototype safety and medical equipment. The design of the world's largest 3D printer by the US military has allowed for advancements to be made in printing runways and bunkers as it's capable of printing parts 30 feet long, 20 feet wide and 12 feet high. This is just the start of the defence industry's additive manufacturing journey as 75% of industry experts expect 3D printing to become a base industry protocol within 10 years.

Conventional methods of acquiring parts from external providers typically take around 25 days, leaving supply lines vulnerable to attacks from hostile forces during this period. The use of 3D printing technology can significantly reduce maintenance wait times and make defence forces more self-sufficient, allowing forces to be deployed in remote areas and reduce their logistical footprint.

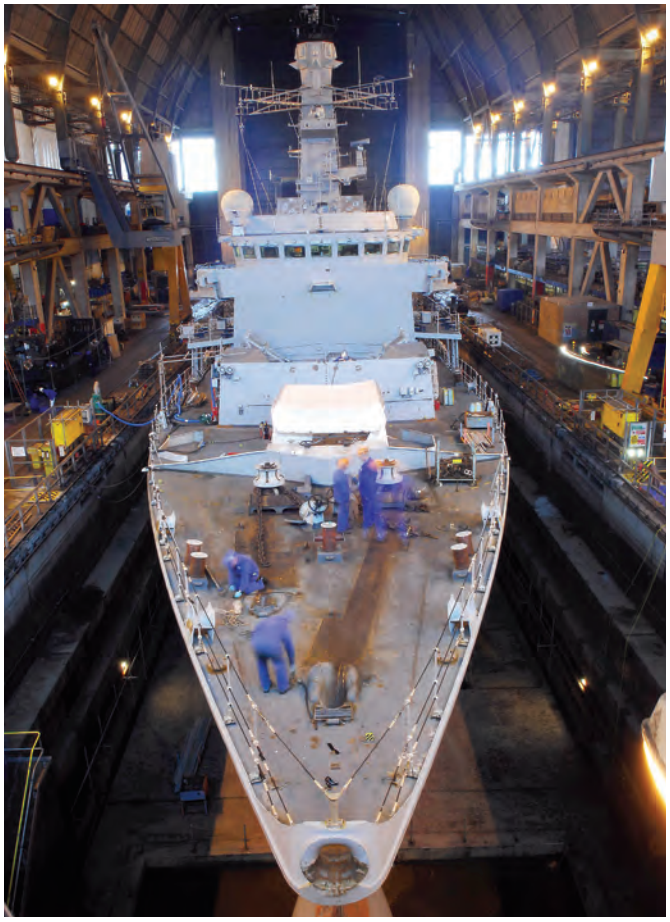
Despite its obvious benefits, additive manufacturing can cause logistical headaches by merging third-party vendor networks and internal additive manufacturing, which are traditionally separate. This integration creates conflicting priorities in ensuring Total Asset Readiness® (TAR), which refers to the readiness and availability of all assets necessary for military operations.

This is where Machine Learning (ML) and Artificial Intelligence (AI) tooling can play a role. AI/ML systems can analyse and optimise the complex logistics decision-making processes associated with additive manufacturing integration. These technologies can assist logistics personnel in making informed decisions about factors such as which parts should be produced internally using 3D printing and which should be procured from external vendors, considering factors like cost, lead time, quality, and availability.

By leveraging AI/ML, defence forces can effectively manage the conflicting priorities of maintaining Total Asset Readiness® while integrating additive manufacturing capabilities. These technologies can help optimise the supply chain, improve decision-making processes, and ensure that the right parts are available at the right time, minimising maintenance wait times, enabling deployment in remote areas, and enhancing self-sufficiency.

2: DIGITAL SHIPYARDS AND MARITIME 4.0 RECEIVE A HELPING HAND FROM NEW INDUSTRY 4.0 TECHNOLOGIES

Industry 4.0 has accelerated the manufacturing industry into



change with new technology and has now moved deeper into A&D manufacturing sectors like shipbuilding. Maritime 4.0 is beginning to show benefits in terms of improved efficiency when designing, manufacturing, and constructing ships with better coordination, clearer operations, and leaner maintenance.

To help with the design and construction of ships, three technologies – Artificial Intelligence (AI), Machine Learning (ML), and Digital Twins – are propelling the development of digital shipyards and Maritime 4.0. Global professional services firm Lloyd's Register sees "the shipbuilding value chain may be empowered to make better decisions and deliver smarter assets by sharing and integrating data from the influx of new Artificial Intelligence (AI) and Machine Learning (ML) based technologies that are now becoming evident in both shipbuilding and operational sectors."

The UK Department for Transport recently invested £206 million to support the net zero aims for emissions within the maritime industry. These Maritime 4.0 technologies will allow for a green maritime future reducing CO_2 pollution and emissions from shipyards but will need the support of cutting-edge software. It will also need to match expected growth. As

shipyards become increasingly digitised, the construction of large-scale assets requires a software system that is tailored to the industry's specific needs and can handle the unique challenges of the construction process at an enterprise level.

3: SHARE OF AUTONOMOUS SHIPS IN TOTAL FLEET WILL INCREASE

The UK Royal Navy recently gained a game-changing Testbed ship with a large surface area for launching UAVs and AUVs that will be tested by NavyX. With a reduced need for room for personnel, there is an area for an operation centre and a meeting room aboard the ship. Importantly, the Testbed Ship will allow the Royal Navy to deploy the MAST-13 AUV, a water-borne drone capable of identifying mines while gathering information on hostile ships. Meanwhile, in parallel developments, the US Navy has unveiled its third unmanned surface vessel 'The Mariner.' The ship is fitted with a government-furnished command and control system, a virtualised Aegis Combat System, and an autonomous navigation system.

The number of warfighters in danger will be reduced with autonomous ships being able to enter areas that were previously too dangerous or inaccessible, to gain key intel. Reduced personnel means ships will also be able to carry bigger payloads, more fuel for extended explorations, and an increased number of surveillance sensors.

The lack of crew members does come with its own maintenance and sustainment challenges, so maintenance controls such as self-monitoring systems and failure projections will be crucial for full mission capabilities and Total Asset Readiness® of autonomous vessels. The broader digital twin ecosystem must connect to onboard self-diagnostics and monitoring systems to plan for maintenance and downtime.

4: AN INCREASED FOCUS ON SPACE-DRIVEN MISSIONS CAUSES THE RACE FOR SPACE TO TAKE OFF

Space is increasingly becoming de-militarised. It is currently used for avoiding and tracking forces, preventing hostile detection, precise attacks on hostile forces, and improved communication. To be able to deal with the increased reliance on space-driven operations by military forces, intergovernmental organisations such as NATO have developed new policies including the "Overarching Space Policy", which sets out the fundamental aspects of the space domain and its importance in preserving the alliance's security and prosperity.

The policy confirms that NATO will address space as a coordinator between members with space-based assets. It also identifies some key functional areas of focus, expressing the need for space systems such as: Intelligence, Surveillance, and Reconnaissance (ISR), space situational awareness, space-based

monitoring of Earth-based domains, satellite communications, position, navigation, timing, and shared early-warning assets.

5: RISE IN DATA BREACHES HEIGHTENS THE IMPORTANCE OF CYBERSECURITY AS DEFENCE INDUSTRY INTRODUCES NEW TECHNOLOGIES

The importance of having a strong underlying cyber security software, cannot be overshadowed by the manufacturing, operational, and military readiness benefits that come with these new technologies. To avoid an attack, the software must be capable of detecting, reporting, and resolving any cyber issues and in the event of a breach, all systems must remain operational.

It's no surprise that Deloitte sees cybersecurity as a pervasive industry theme in its latest Aerospace & Defence industry outlook. As the threat of cyber warfare continues to rise, it is essential that the software used to support military supply chains prioritises cybersecurity. To ensure that the software is effective in detecting and responding to threats, it must undergo rigorous testing prior to implementation.

NEW TECHNOLOGIES CANNOT DOWNPLAY THE IMPORTANCE OF CYBERSECURITY

These new developments look to take A&D manufacturing, defence forces, and defence contractors to the next level—with new manufacturing processes, equipment, and operations. However, the shift to digital technologies requires all advancements to be underpinned by a strong digital backbone, to protect against increased cyber vulnerability. ■

An Ajax armoured fighting vehicle at Lulworth Range (*Photo: UK MOD Crown Copyright 2023)*

AJAX TURNS A PAGE

Many in UK defence will be hoping that the Sheldon Review into Ajax Lessons Learned marks the end of a difficult and troubled chapter in UK armoured vehicle procurement. We digest some of the review's key findings and progress made since it was published.

By Anita Hawser

At DSEI in London in September, the British Army will display the Ajax armoured fighting vehicle. Designed to be a major "game changer" by providing the Army with 24-hour, all-weather persistent surveillance and reconnaissance in an all-digital platform, the armoured vehicle programme has been one of the most troubled in UK defence procurement history. After excessive noise and vibration problems in the vehicle were identified, which caused injuries to crew members, trials were halted and payments to the main contractor, General Dynamics Land Systems UK, withheld. At one point, it looked like the vehicle programme might even be cancelled.

However, a "workable solution" was eventually found to the vehicle's noise and vibration problems, and in June this year the Field Army resumed training on Ajax, which features a suite of cutting-edge sensors, enhanced 40 mm cannon, modular armour and improved cross-country range and mobility.

The worse now seems to be behind the troubled £5.52 billion Ajax programme, which is scheduled to enter service in 2025, eight years later than originally planned. But Clive Sheldon KC's *Report of the Armoured Cavalry Programme – Ajax Lessons Learned Review*, published in May this year, makes for some uncomfortable reading. While all concerned — the Army, Defence Equipment & Support (DE&S), the UK Ministry of Defenc, and General Dynamics Land Systems-UK (GDLS-UK) — are no doubt keen to put this troubled chapter behind them, it is worth reflecting on some of the key findings in the Sheldon Review, which highlights things that can go wrong with programmes of this scale and complexity.

STRUCTURAL, CULTURAL AND LEADERSHIP ISSUES

Unlike the Haddon-Cave QC report regarding the loss of the Nimrod XV230 over Afghanistan in 2006, which came to

a view on where the blame lay, Sheldon concluded that the Ajax programme's failures could not be laid at the feet of any one individual or group of individuals.

However, it highlighted "numerous missed opportunities," and problems with scheduling, technical and safety issues, which were not elevated in a timely and appropriate manner. "Reporting was at times lacking, or unclear, or overly optimistic," the review states, which meant senior personnel and Ministers were surprised to discover in late 2020 and early 2021 that the programme was at much greater risk than they had appreciated.

The Sheldon Review also highlighted structural, cultural and leadership issues, which led to the failure to appreciate, escalate, and resolve problems with the vehicle much sooner. Different entities — Dstl, DE&S and the Senior Responsible Owner (SRO) for Ajax — appeared to be working at cross-purposes to one another. At times, Sheldon says the relationship between different entities was "fractious," and involved the guarding of territory.

"This was seen most clearly in the relationship between DE&S and Dstl. Although Dstl's subject-matter experts were well regarded, the technical and safety concerns they raised were often not resolved to their satisfaction. It was also seen in the relationship between DE&S and the SRO. There was evidence that DE&S "misappreciated" the fundamental importance of the SRO position, and significant concerns and issues were discussed and decided within the DE&S chain of command without input from the SRO."

The SRO on Ajax had to split their time between the Armoured Cavalry Programme and several other roles; and had limited ability to influence, let alone control, the equipment project, says the Sheldon Review. Brigadier (Ret'd) Ben Barry OBE, Senior Fellow for Land Warfare at the International Institute for

Ajax being trialled in Sweden (*Photo by Jack Eckersley UK MoD Crown Copyright 2021)*

Strategic Studies (IISS), says a desire to get stuff done is well entrenched within British military culture, but clearly, the way the Ajax programme was managed could have been considerably improved. "The SROs for Ajax were diverted by doing other jobs," he says.

According to the Sheldon Review, DE&S discouraged Dstl from sharing their concerns on a range of technical issues directly with the Capability Safety team. Dstl, which provided expert technical advice on various aspects of the Ajax vehicles, reportedly tracked 136 'concerns', only four of which were related to noise and vibration.

In a commentary, *The British Army's Greek Tragedy,* published in July 2021, Dr Jack Watling of the Royal United Services Institute (RUSI) says a subsequent investigation following the loss of hearing by crews trialling the platforms concluded that the noise issue with Ajax arose from the integration of the Bowman headsets for the crew radios, which were picking up engine noise, amplifying it as the vehicle accelerated, and putting the sound directly into the crews' ears.

Noise and vibration concerns with Ajax first surfaced in late spring or summer 2020. But neither the SRO, DLE and Chief of Materiel (Land) who were aware in general terms of the problems, nor the Army's Director Capability ("DCap") "understood that noise or vibration posed a significant risk to the programme over and above other safety hazards identified, or that crews may potentially have been harmed in trials because of noise and vibration, until autumn 2020," says the Sheldon Review. It was only then that DCap became aware that crews had reportedly been injured by noise and vibration in the ATDU trials. The Minister for Defence Procurement was only informed on 13 November 2020.

With respect to the emerging concerns around noise and vibration, Sheldon writes: "Not only was there a failure to escalate those concerns properly, but it took a considerable amount of time before anyone looked at the matter strategically and asked what was really going on."

Trials at ATDU recommenced in March 2021 under a new Safety Advice Letter. In April 2021, the Commanding Officer ATDU became increasingly concerned about the safety of crews following further reports of injuries. In June 2021 he sent DCap a draft brief stating that he was no longer content to hold the risk for the safety of trials involving extended periods of driving; this was the first time that the risk was formally elevated through the Duty Holding chain. On 25 June 2021, in response to a report by Millbrook Proving Ground on their further vibration testing, the SRO again halted trials.

WAS AJAX FLAWED FROM THE OUTSET?

In addition to noise and vibration problems, other issues were identified, including problems with the hulls for Ajax. "Quality control is understood to be especially poor throughout the first 100 hulls manufactured in Spain, but the issue has not been entirely eliminated in subsequent batches," Watling of RUSI wrote. "Problems have included sections being inconsistent lengths, the sides of the hull not being parallel, and substandard welding."

GDLUK repaired hulls that were manufactured to an unsatisfactory quality. But Barry says it seems a bit strange that a world-leading armoured vehicle company, like GDLS, delivered vehicles that didn't perform properly. "Now, if you talk to General Dynamics, they will say on the noise and vibration they met the requirement, but the army noise-cancelling headsets didn't perform as well as they should have done," he says. "But it's difficult to go through the [Sheldon] report without feeling that a number of Ajax armoured vehicles that were delivered failed to meet the requirement." GDLS-UK did not respond to requests for comment about the findings of the Sheldon Review.

Compared with Ajax, Barry says the introduction of other army vehicles into service — Warrior, and the Combat Vehicle Reconnaissance (Tracked) family, the FV101 Scorpion, and Scimitar — went remarkably well. "Those vehicles went on to be adopted by a lot of other armies, and lots of CVR(T) were sold for export," he says. "That shows that British industry has produced armoured vehicles that have been effortlessly introduced into service by the Army. So, a key question is, what was the problem with Ajax?"

A March 2022 National Audit Office report on Ajax concluded that the MoD's and GDLS-UK's approach was flawed from the outset as they did not fully understand the scale or complexity of the programme. Although Ajax's design is based on an existing platform (ASCOD), the NAO said the Department's requirements, in effect, made it a bespoke technology, with around 1,200 capability requirements.

"However, the Department and GDLS-UK did not fully understand some components' specifications or how they would be integrated onto the Ajax vehicle," nor did they understand the scale of work or technical challenge, resulting in insufficient contingency in the programme schedule. Despite negotiating a contract reset, which resolved some technical issues with Ajax, the NAO said the reset added complexity with multiple build standards and vehicles from early capability drops having to be upgraded.

A House of Commons Defence Committee report, *Obsolescent and outgunned*, on the British Army's armoured vehicle capability published in 2021, which heard evidence from GDLS-UK, suggested that delays to the delivery of the first batch of Ajax vehicles in May 2020 were due to challenges with the integration of the 40 mm weapon system mandated by the MoD. Barry says the same weapon system is used by the French Army on its Jaguar armoured reconnaissance and combat vehicle. "As far as I know, the gun is working perfectly well on the Jaguar," he says.

In his review, Sheldon refers to "an optimism bias towards Ajax," and people working in "silos" which inhibited sharing, understanding and escalation of information. The review identified a need for greater information sharing, trust, and collaboration between MoD entities and made 24 formal recommendations, which include:

- DE&S and Dstl fostering "a more collaborative approach"
- Greater collaborative working and direct communication between Dstl and the Frontline Command Customer on equipment projects
- "Full, frank and timely disclosure" to the SRO of all relevant information that is relevant to the Defence Line of Development
- All personnel working in a programme should escalate safety concerns where there are 'seeds of doubt' about a matter, even if not fully evidenced
- Individuals involved in programmes should routinely be challenged, and challenge themselves, on "optimism bias."

Ajax at DSEI 2015 (*Photo by Richard Watt MoD/Crown Copyright)*

In a statement to Parliament in June, the Minister for Defence Procurement, James Cartlidge, said that it had accepted the findings of the Sheldon report, and most of its 24 formal recommendations, with 15 accepted and nine Accepted in Principle.

While many of the behaviours highlighted in the Sheldon report are far from ideal, Cartlidge said in many cases they had already been recognised and acted on, specifically on the Armoured Cavalry Programme, as well as across the department. "Where work is not already underway to implement a recommendation, we commit to making the necessary changes at pace," he said.

Since the review was published in May, it is reported that openness, communication, and collaboration between SROs, Dstl and DE&S delivery teams has improved. Lessons are also being learned on how to work best with industrial partners. Dstl is actively involved in assuring resolutions to noise and vibration and with wider technical assurance of the delivery of the Ajax platforms. The SRO is copied in on all regular reports that Dstl provides to the DE&S delivery team.

The number of SROs for Army programmes has increased with the SRO for the Armoured Cavalry Programme devoting all their time now to delivering Ajax. A new Programmes Directorate led by a Major General has also been set up to improve governance and transparency, not only in terms of monitoring each programme's progress, but providing greater insight into risks, challenges, and complexities, so support can be provided when needed.

SROs will be given access to the data DE&S delivery teams use to manage a project, including risks, schedule performance and cost performance. Work is underway to implement a strengthened and consistent acquisition and safety policy approach on SRO accountability, and structures are being put in place to ensure that pace is not put ahead of safety. "Always proceed with a sense of urgency, but applying a dose of cold, hard pragmatism in assessing technical complexity underpinned by a robust and resourced schedule," the outgoing CEO of DE&S Sir Simon Bollom observed in an article for Desider. "Binding all this together is trust and collaboration with our customers and defence suppliers."

Earlier this year, the MoD resumed payments to GDLS-UK for delivery of all 589 Ajax vehicles. Cartlidge says the programme remains within its originally approved budget. Forty-four vehicles at Capability Drop 1 have been delivered to the British Army, while Capability Drop 3 vehicles are manufactured in South Wales. Reliability Growth Trials have resumed at Bovington Camp where soldiers are training on Ajax. However, the Warrior IFV will remain in Armoured Cavalry units until new concepts and capabilities are introduced into service throughout the decade. ■

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GERMANY'S LIGHT AIRBORNE UTILITY TERRAIN VEHICLE

What Germany's LL UTV lacks in weight it more than makes up for in speed and capabilities, with a new configuration presented at Enforce TAC 2023 in Nuremberg featuring a Minigun for fighting UAVs, and a loitering weapon system.

By Ralph Zwilling

Special Operations Capable airborne troops of 2nd Company, 31st Airborne Regiment engage targets from their LL UTV during the Taurus Rising exercise in April 2023 (*Photos by Ralph Zwilling*)

The German Army's Light Airborne Utility Terrain Vehicle (LL UTV) is a typical compromise between weight and protection. To ensure high tactical mobility, the focus was put on transport speed and the lowest possible weight. As a result, ballistic protection elements were largely dispensed with. For this reason, the vehicle is currently only used by special forces and special operations forces in the field. There are no plans to use the LL UTV in regular units.

On 30 November 2020, the Bundeswehr's Information Technology and In-Service Support (BAAINBw) and Rainer Dieterich concluded a contract for the possible delivery of 148 LL UTVs using the Polaris MRZR D4, which is designed to rapidly concentrate and disperse forces by providing assault and raid capabilities. Rainer Dieterich holds the sole distribution rights for Polaris Defense vehicles in Germany, Austria and Switzerland. The Bundeswehr received the first 65 MRZR D4 vehicles in 2021. The second construction lot of vehicles should be ordered next year.

The vehicles were handed over to the special forces as well as the Special Operations Capable airborne troops, the airborne special platoons of the two airborne regiments, the forces of the Air Force's Object Protection Regiment or the support forces of the special forces of the army and navy.

Originally, the Bundeswehr sought a framework contract with a term of seven years for the manufacture and delivery of a maximum of 148 LL-UTV unprotected, four-seater vehicles with high off-road mobility and airborne capability, together with an installation kit to accommodate a weapon launcher provided by the customer, as well as further on-board equipment, special toolkits and initial spare parts.

VERSATILE AND EASILY TRANSPORTABLE

The Military RZR (MRZR), often referred to by troops as the M Razor, was introduced in 2012. A year later, the vehicle was selected by US Special Operations Command (USSOCOM) under the Light Tactical All-Terrain Vehicle (LLATV) programme. The MRZR is available as either a two or four-seater (MRZR D2 and MRZR D4). In 2015, USSOCOM procured approximately 2,000 MRZR D2s and D4s for special operations forces. Today, the MRZR is used in various variants by military and police special forces in 30 countries, including the German Federal Police's GSG 9.

Designed as a light tactical all-terrain vehicle for special operations and light infantry forces, the MRZR is based on the proven civilian RZR vehicle platform. Since more than 90% of the parts installed in the MRZR are also used in the commercial off-road vehicles of Polaris Industries, recourse to the company's worldwide spare parts supply and service network facilitates the maintenance of vehicles in the field.

The original MRZRs for USSOCOM were equipped with 65 kW/88 hp two-cylinder gasoline engines with 875 cc displacement. However, these engines were not suitable for the Single Fuel Policy and could not be operated with the standard military fuel of the US armed forces. As a result, Polaris developed a diesel engine and turbocharger variant which it unveiled in 2016. This new propulsion system meant that the logistical effort required to deploy the vehicles was significantly reduced and their range increased.

The German LL UTV is versatile and can be used for the transport of personnel and material, the recovery of material in a landing zone or for transporting wounded soldiers over short distances. It can also be easily deployed with transport aircraft and helicopters. Its low silhouette, lightweight, extreme off-road mobility, and ability to be airlifted and loaded make the LL UTV an ideal vehicle for the Bundeswehr's specialised forces and special forces. In its basic configuration

At the German Infantry School in Hammelburg, this MRZR D4 is armed with an EOS R150 RWS and Diehl Defence's Libelle loitering weapon system (*Photo: Ralph Zwilling*)

it offers space for up to four soldiers and their equipment. Optionally, two additional rear-facing seats, two wound stretchers or even a single seat and a wound stretcher can be mounted on the cargo bed. With a length of 3.7 m, a width of 1.5 m and a height of 1.8 m, the LL UTV is extremely capable off-road and can also handle high slope angles. It has a wheelbase of 2.72 m and a ground clearance of 30.5 cm. The massive roll bar can be easily folded down by the crew without tools, allowing the vehicle height to be reduced to 1.52 m for transport as an internal load in aircraft or amphibious vehicles. If required, a fabric cover with MOLLE loops can be attached to the roll bar as a roof.

The RWS 150 made by Electro Optic Systems armed with a Dillon Aero M134D mini-gun (*Photo: Ralph Zwilling*)

FROM OFFROAD TO SMALL UAV DEFENCE VEHICLE

The two infrared headlights at the front of the vehicle allow the driver, with night-vision goggles, to safely drive the LL UTV even in complete darkness so it can move undetected by the enemy. A Polaris HD 3500 recovery winch is integrated into the front of the LL UTV. This has a pulling force of two tons and can be used for self-recovery or for recovering another vehicle. At the front right of the vehicle is a connection socket for the cable remote control, with which the recovery winch can be operated at a safe distance from the vehicle.

The water-cooled three-cylinder four-stroke SOHC Kohler diesel engine with turbocharger has a displacement of 933 cm³ and an output of 40 kW/54 hp, which is transmitted to a continuously variable automatic transmission. The LL UTV has a total permissible weight of 1,633 kg and allows the transport of a payload of up to 677 kg. The fuel tank capacity is 35.9 litres.

Equipped with smooth power steering, the vehicle has permanent rear-wheel drive and selectable all-wheel drive. A dual A-arm suspension with stabilisers is used at the front, while the rear suspension is based on a trailing arm chassis with stabilisers. The needle shock absorbers are from Walker Evans Racing. The tubeless Obor Cornelius ATV tyres feature tread blocks aligned as a bridge pattern at an angle for good traction on any terrain. The hydraulically actuated disc brake system has dual-piston calipers on the two front wheels and single-piston calipers on the two rear wheels.

However, the LL UTV is suitable for more than just transporting people. At Enforce TAC 2023 in Nuremberg, Diehl Defence and Diederich Engineering Systems presented a new concept of a highly mobile small UAV defence vehicle. Based on the MRZR D4, the vehicle carries a remotely operated R150 stabilised weapon station from Australian manufacturer Electro Optic Systems, which is operated from the rear fighting compartment. The weapon station is equipped with day/night optics and a radar for reconnaissance, target tracking and firing. The armament scaffolded is a 7.62 mm x 51 machine gun from Dillon Europe, introduced into the Bundeswehr as the MG 6.

The European version of the electrically powered Dillon Aero M134D Minigun fires up to 3,000 rounds per minute from its six tubes and has an effective range of up to 1,200 meters. This makes it suitable for fighting UAVs, but also for ground combat. Six canisters of Diehl Defence's Libelle loitering weapons are carried on the rear of the vehicle.

The loitering weapon is lifted out of the canister for take off and flies to the programmed target area with its two counter-rotating, electrically driven propellers. The flight time to the target can be extended by up to 25 minutes. Above the target, the submunition is ejected and uses its own sensors to seek out the target and engage it from above with projectile-forming charges. The technology used is derived from the SMArt artillery munition for which Diehl manufactures the active component. ■

ABOUT THE AUTHOR

Ralph Zwilling is a freelance journalist and photographer. He is best known for his knowledge about the Stryker Interim Armoured Vehicle and often photographs US Army Europe and other NATO training exercises.

Challenger 2 tanks at Exercise Winter camp
(Photo: UK MOD Crown Copyright 2023)

APEX PREDATOR OR DIMINISHING POWER?

Do tanks still have a place in modern warfare? Their inherent weaknesses demonstrated on battlefields in Ukraine, the Second Nagorno-Karabakh War, and the Battle of Al-Bab in Syria, would suggest not. Or is it just down to how these weapon systems were employed?

Peter Antill

Before the war in Ukraine, the tank, which is a ground force's primary offensive weapon — although it is also effective defensively — appeared to be in decline. While in 2020, the UK's Defence Secretary Ben Wallace was forced to deny the British Army was scrapping all its tanks, in the end, the Ministry of Defence decided to only upgrade 148 of the remaining 227 Challenger 2 tanks to the Challenger 3 standard.

The US and European countries argued whether they should send tanks to Ukraine. Ultimately, they ended up sending some of their best battle tanks — the Leopard 2, the M1 Abrams, and a handful of Challenger 2s. The war in Ukraine also saw neighbouring countries like Poland invest heavily in South Korean and US tanks. The tank, it seems, isn't going anywhere.

Tanks first saw action in the First World War and were originally termed "land ships," but called 'tanks' (as in water tanks) while they were being built to disguise their true purpose. But they really came into prominence during the Second World

US M1A1 Abrams tanks bound for Ukraine (US Army photo by Spc. Christian Carrillo)

War, thanks in part to the success of the German Blitzkrieg, tanks have become a mainstay of many 20th and 21st-century armies and are an important component of combined arms warfare.

Their deployment probably reached its zenith during the 1980s when, during the latter stages of the Cold War, NATO and the Warsaw Pact deployed tens of thousands of tanks across the Iron Curtain in Europe. However, events in recent years have led to questions as to whether the tank still has a place in modern warfare.

Such events have included:

The Battle of Al-Bab: This took place between November 2016 and February 2017 when the Turkish Army and its allies were battling ISIL for control of the city. It was part of a wider campaign started in August codenamed Operation Euphrates Shield which aimed to clear ISIL militants from a 5,000 square km area of Syria. In December 2016, there were reports that ISIL had captured, damaged, or destroyed 10 Turkish Leopard 2A4 tanks and one M60A3 tank, a few with IEDs, but mainly with anti-tank missiles, possibly using either 9K111 Fagot or 9K113 Konkus missiles, captured from either the Syrian or Iraqi Army.[1]

During the Second Nagorno-Karabakh War in 2021, Armenia lost some 255 tanks, many to the (now infamous) Turkish-made TB2 drone.[2]

In February 2022, Russia launched a conventional invasion of its neighbour, Ukraine, aiming to subjugate it within a matter of weeks, with armoured forces advancing into the country along several axes. Some 18 months later, the conflict continues with Russia failing in its overall objective — its offensive has become bogged down and having been put on the defensive, Ukraine is gradually chipping away at the territory captured with a counteroffensive of its own.

Russian equipment losses, especially tanks, have been high. By the end of May 2023, it was estimated that the Russian Army had lost around 2,000 tanks (although the real figure could be higher still), most of them from Russia's current active tank fleet, such as the T-90, T-72B3 and T-80BV.[3] This has led some commentators[4] to question whether the tank (and indeed many other large pieces of military equipment, such as aircraft carriers and fighter jets) have a place in 21st-century warfare, reinforced by the notable decisions by both the Belgian Army and US Marine Corps to divest themselves of their tanks.

IS IT TOO SOON TO WRITE THE TANK OFF?

It is argued that in the ongoing

competition between offence and defence, the pendulum has once again swung in favour of defence and that cheaper technologies that can be produced in their thousands, such as drones, anti-tank, anti-ship and anti-aircraft missiles (both man-portable and vehicle-mounted) have reached such a level of sophistication and lethality that it will force a change as to how war is conducted because of the diminishing power of the heavy and expensive unit of military power, its role challenged by nimbler, easier-to-use — and, crucially, cheaper — systems. Tanks, fighter jets, and warships are being pushed into obsolescence, giving way to new tools of conflict. In the process, we see the very nature of combat change.[5]

However, others argue that it is too soon to write the tank off and for that matter draw sweeping conclusions from a conflict that hasn't finished, much of which happens outside the reporting of open sources. Conditions which prevailed in the early phases of the Russo-Ukrainian War may not necessarily be relevant to the later stages or indeed to the conduct of future conflicts. Therefore, apparent weaknesses with weapon systems may be due to how they were employed rather than an inherent weakness of the hardware itself.

The available data from Ukraine indicates that tanks are still very much an important component of modern combined arms forces — why else would the Ukrainians be so desperate to have their losses replaced with initially Soviet-era tanks, and then later with Western armour, and the Russians replacing their losses with tanks from depots across the Russian Federation, even using older models such as T-62s and T-55s?[6]

The Russian Army's initial problems came from emphasising speed and above all, secrecy. Expecting little resistance, the Russians made few preparations to conduct a coherent combined arms operation which would have required careful planning and coordination between all ground, air, and naval forces. The ground units simply drove towards their objectives unprepared for a fight. They, therefore, conducted this opening stage completely contrary to military doctrine and past practice. In addition, tanks are among the most logistically intensive pieces of hardware to support, needing regular maintenance and spare parts to keep them operational, as well as fuel and ammunition to keep them combat effective.

Because of the emphasis on security, there was little time to properly organise logistics support, especially at the tank battalion and regimental levels. Therefore, the high number of tanks lost, damaged, or destroyed is due to a lack of warning and preparation time, a poor strategy that exacerbated logistics problems, a failure to follow established doctrine and employ combined arms tactics and too many axes of advance which could not support each other.

Especially telling was the lack of infantry to help protect the tanks from infantry with handheld anti-tank weapons. Russia had chosen to reduce the strength of the BMP-equipped motor rifle battalions from 460 troops to 345, plus many of those that were deployed were only at two-thirds to three-quarters strength anyway, so there was clearly not enough infantry, especially when fighting in urban areas.[7]

As for the loss of the Turkish Leopard 2A4 tanks in the Battle of Al-Bab, it is believed that the tanks were operating without infantry support, the crews did not realise they were within ATGM range, the tanks were at rest with their flanks facing the enemy (the Leopard 2A4 has relatively weak side armour as it was designed to fight in Europe with the enemy advancing towards it) and once under fire, the crews panicked and took cover allowing the insurgents to bombard them with missiles without returning fire, redeploying the tanks or generating a smoke screen.[8]

In the Second Nagorno-Karabakh War, most of Armenia's losses occurred after Azerbaijan reportedly destroyed 60% of Armenia's air defences and 40% of its artillery in the first hour of the

The Leopard 2A4 has relatively weak side armour as it was designed to fight in Europe with the enemy advancing towards it (*Copyright: Rheinmetall)*

war, effectively obtaining air superiority allowing it to effectively use its tanks while denying Armenia the ability to use theirs.[9]

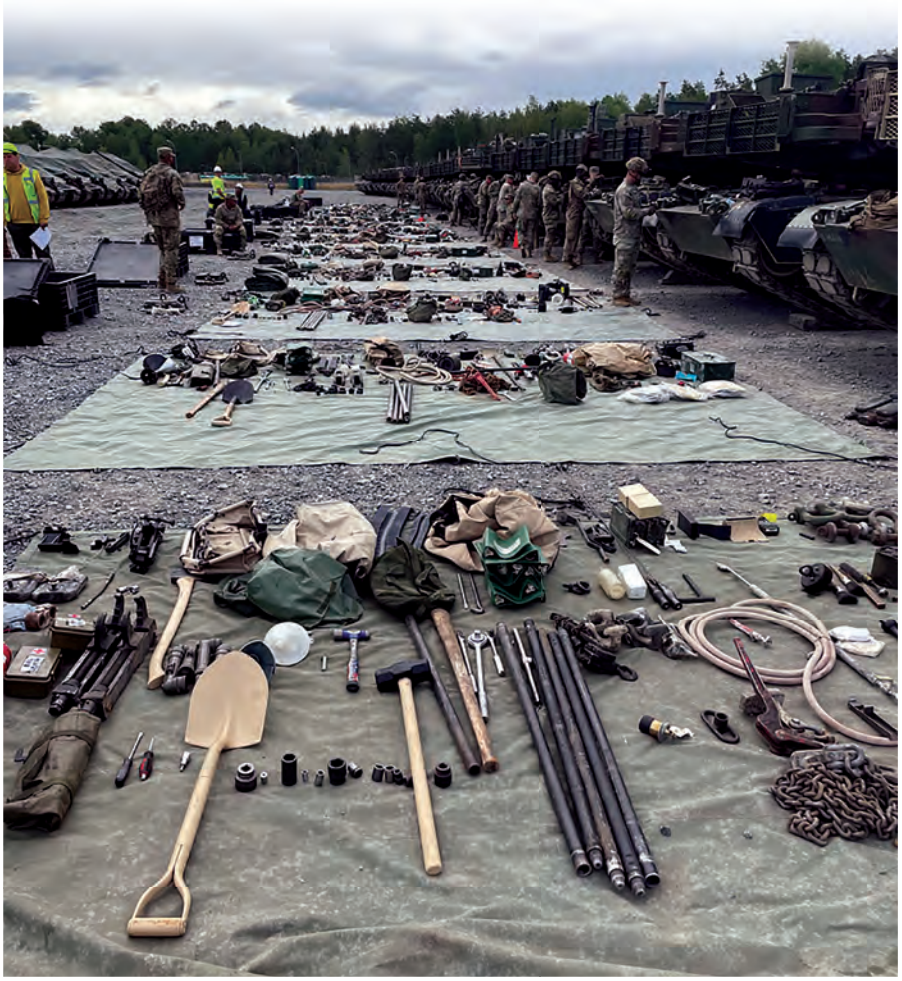
Such discussions, however, are not new — almost from the day of their introduction, there has been a debate about the tanks' utility. As a weapon system (or a weapons platform, depending on your viewpoint), they are difficult to build, hard to operate and maintain, let alone deploy and when they are, relatively vulnerable. They are far from the "perfect package" that they are sometimes portrayed as. Apparently, even Lt. Col. J. F. C. Fuller came to realise the limits of the tank during the 1917 Ypres offensive and following the end of the First World War, only Britain and France stayed in the field with the USSR entering (and Germany re-entering) much later.[10]

The UK Ministry of Defence (MOD) has contracted Rheinmetall BAE Systems Land (RBSL) to upgrade 148 of the 227 Challenger 2 MBTs currently in service (although it is estimated only some 150-160 are still useable) to Challenger 3 standard, which includes several major upgrades:[11]

- A new 120 mm smoothbore gun which uses the most advanced globally available ammunition
- A new suite of sights providing tank commanders with enhanced day and night targeting abilities
- A new armour solution
- An active protection system
- A turret that can be fitted to the tanks of allies and global partners
- Significantly improved mobility through an upgraded engine and new hydro-gas suspension.

However, the Challenger 3 will only be in service until around 2040, so what then? Regardless of whether the UK opts for another MBT or not, the following three factors need to be considered when looking at future procurement options:[12]

The Totality of the Battlefield: The modern battlefield has similarities to the Second World War. Tanks acting in the open with little or no support that are caught by aerial or artillery assets are unlikely to survive. The key to success on the modern battlefield is not any one piece of equipment or technology, a tank or otherwise, but the speed and organisation of a complete (combined arms) force with adequate logistics and intelligence support arriving at the right moment to influence the battle. This means that any future discussion over procurement options must include not only the British Army, but the entire UK Armed Forces to present a complete, cohesive combined arms force able to influence the outcome, backed by the political will to act.



A long line of M1 Abrams tanks and secondary equipment being inventoried in Germany (*Photo by Maj. Leonard Weschler*)

The Totality of Technology: With technology advancing at a rapid pace, there are reasons to believe that the tank no longer holds its place as the "apex predator" on today's battlefield. The purpose of the tank is to use its unique combination of firepower, mobility, and protection to deliver an aggressive mobile shock to an enemy and then exploit the enemy's resultant loss of initiative.

Of these strengths, firepower has kept pace, with 130 mm guns and integrated anti-tank guided missiles (ATGMs) likely to be adopted in future, but protection and mobility have lagged. Current and future conflicts will be fought in more complex terrain, including cities, where a threat could come from almost any direction. This means tanks have become

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more vulnerable, not only due to the increasing lethality of anti-tank weapons (which can increasingly be directed to attack the sides, rear or top surfaces where the armour is weaker) but also due to the degradation of tanks' mobility. In general, engines have not been upgraded to maintain the original power-to-weight ratio, which has had an impact on the force's overall agility and tactical manoeuvrability. It also impacts the tank's reliability and therefore its maintenance and logistics footprint. On the positive side, promising developments in advanced armour packages, reactive armour, active defence systems, advanced situational awareness, and sensor systems, close in defence weapon systems and active/adaptive camouflage offer hope.

The Totality of Society: Not only has the battlefield changed but society and economics have changed too. The UK no longer has a global empire it can call on to support a large, technologically advanced standing army. Instead, it spends around 2% of its GDP on defence and must increasing rely on foreign designs and technology obtained through its collaboration with allies due to large portions of its defence industrial base having disappeared since the end of the Cold War.

In addition, there seems to be little public appetite for increased defence spending (although that could well have changed since the start of the war in Ukraine), with most looking to spend more on domestic priorities such as Social Services, the NHS and policing after a decade of austerity, Covid-19 and Brexit. Finally, falling recruitment figures mean the Army is struggling to maintain current manpower levels. Keeping a fleet that is overly large for what you need takes a disproportionate amount of the defence budget and manpower (both of which are already in short supply) to man, operate and maintain.

The tank remains a credible piece of military hardware, and while some modern conflicts have shown their vulnerabilities, it has been a result of how they were deployed, used, and supported which has caused problems, rather than any inherent weakness of the platform itself.

Currently, very little can match the tank's unique balance of mobility, firepower, and protection. But to make full use of those abilities it must be part of a comprehensive combined arms force, supported by adequate intelligence and logistics. While a couple of forces have decided to dispense with them, many others are looking to upgrade their tank fleets, for example, Lithuania and Italy.[13] ■

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Peter Antill graduated from Staffordshire University in 1993 with a BA (Hons) in International Relations and gained a MSc Strategic Studies from Aberystwyth in 1995 and a PGCE (Post-Compulsory Education) from Oxford Brookes in 2005. He worked at Cranfield University at Shrivenham from June 2009 to 2019, creating a defence acquisition body of knowledge.

FOOTNOTES

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WHY ISRAEL IS INCREASINGLY ALARMED ABOUT IRAN'S WEAPON SYSTEMS

Israeli experts claim that Iran is building a "terror empire" comprising armed UAVs, hypersonic and long-range ballistic missiles. Its naval ambitions are also being boosted by Russia.

By Arie Egozi

One effect of the war in Ukraine is clear and worrying, according to Israeli defence experts, who claim the war is helping Iran build a relatively advanced defence industry. At this point, the armed Shahed unmanned aerial vehicles (UAVs) Iran has supplied to Russia are the most well-known product, but there are likely to be others very soon.

While Iran continues to deny that it has supplied any sides in the war in Ukraine with weapons, including drones, Israeli experts claim that the UAVs Iran is shipping to Russia, include hundreds of different types. With no effective air force, the Iranians have built a large UAV industry to give them other means of attacking targets in Israel and the Gulf. According to Israeli sources, the Iranian UAV industry was developed using imported parts bought in various nations by several "straw" companies to bypass international sanctions. Tal Inbar, an Israeli defence expert, points to the Ababil 5, an Iranian UAV which is approximately five meters long and has a wingspan of seven meters. The Ababil 5 was displayed during the Iranian Army Day parade last April. One, according to the Tehran Times, featured "two diamond rocket launchers under the wing."

Unlike the heavy industry required to produce armoured platforms and ballistic missiles, one Israeli expert says UAVs frequently rely on civilian components

A Shahed UAV (*Photo: Twitter*)

Home-grown drones delivered to the Iranian Army (*Photo: Iranian Ministry of Defence*)

that can be obtained even online. As a result, the Iranian UAV industry has expanded quickly.

IRANIAN UAV FACTORIES IN OTHER COUNTRIES

Dr. Moredchai Kedar, an Israeli expert on Middle East issues says that the Iranians are continuing to build what he brands a "terror empire." "The international sanctions do not allow them to export weapon systems, so they have decided to establish assembly and production lines in different countries. They send their experts, and they manage to use available technologies to manufacture weapons that Tehran is then exporting to its allies around the world."

Some of the weapon systems used by the Houthis, Iran's proxy in Yemen, are being assembled in the country. This local operation began with simple items like land mines, but in recent months the scope of local assembly and production has increased.

In May 2017, the Iranian press reported on the inauguration ceremony of a UAV factory built In Tajikistan. According to Israeli defence sources, this plant is currently producing older models of the Iranian Ababail UAV.

On May 28, 2022, Iran unveiled an underground UAV base at an undisclosed location. Among various types of drones and munitions, a new, small, air-launched cruise missile was also observed. The new cruise missile is carried by an Iranian copy of the US Predator Remotely Piloted Air System. After supplying large numbers of armed UAVs to Russia, Tehran is negotiating the establishment of a UAV factory in Russia. The US and Israel are closely following the capabilities of Iran's UAV industry, which has been boosted in recent months by the money it earned from Moscow for the armed Shahed UAVs used in Ukraine. According to international media reports, Israel is fighting a battle against the spread of Iranian UAVs and missiles by bombing shipments of them bound for Lebanon, where Iran's proxy, Hezbollah, is likely to deploy them. It is also attacking UAV sites on Iranian soil.

IRAN'S HOMEGROWN HYPERSONIC MISSILE

While Iran's military nuclear programme has garnered the most attention from Israeli intelligence sources, in recent months its achievements in developing long-range ballistic missiles and now hypersonic missiles, have been placed on higher priority. A senior commander of the Islamic Revolutionary Guards Corps (IRGC) recently announced that Iran had succeeded in developing a missile. "[with] great velocity and manoeuvre both in and

out of the Earth's atmosphere." Amir Ali Hajizadeh, the IRGC Aerospace Division chief, told reporters, "The new missile can pass through all missile defence systems, and I don't think that the technology capable of intercepting it will be achieved in the decades to come. It can target the enemy's anti-missile systems, and its production marks a huge generational leap in the development of a new generation of missiles." The hypersonic missile can fly at more than five times the speed of sound.

Israeli intelligence is trying to confirm whether Iran's declaration about its success in developing a hypersonic ballistic missile is true. At the same time, Israel is taking measures to prepare for the new threat. These preparations are classified but it can be said that they focus on early detection and very advanced interception systems. "Many eyes in the skies watch for every little sign that can indicate the level of threats from these two weapon systems," a senior defence source connected to the missile defence operation in Israel told *Defence Procurement International.*

With the US, Israel has accelerated the development and deployment of the Arrow-4, a new version of its air defence system. An Israeli expert who talked on condition of anonymity, says that unlike ballistic missiles it is impossible to predict the hit point of a hypersonic missile. That makes the interception of such missiles more complicated and should therefore involve a mix of interceptors, which are under development.

Iran's homegrown hypersonic missile is said to be more advanced than its Sejil medium-range ballistic missile, which is the country's first option to respond to any Israeli aggression. The Iranians boasted that the Sejil can reach Tel Aviv in less than seven minutes if it is launched from Natanz. However, the hypersonic missile, which is much more advanced than the Sejil, can reach Tel Aviv in less than four minutes from Iran's western regions.

In May 2023, Iran unveiled a new long-range ballistic missile, the fourth generation of its Khorramshahr ballistic missile under the name Khaibar, which has a range of 2,000 km (1,243 miles) and a warhead that weighs 1,500 kg (3,300 lb).

In 2014, Israel Defence Forces intercepted an Iranian weapons shipment to Gaza (*Photo: IDF*)

In November 2022, the Commander of the Aerospace Force of the IRGC, Brigadier General Amir-Ali Hajizadeh announced that hypersonic missiles are now in the hands of his force. According to Inbar, an Israeli defence analyst, since Iran already developed a ballistic missile that was declared as "hypersonic" (the "Shahid Haj Qassem") with a declared re-entry speed of Mach 12, and already demonstrated skipping capabilities in several missiles re-entry vehicles, the most plausible assumption is that the new system is a true Hypersonic Glide Vehicle (HGV). "The assessed hypothesis is that the new missile will have the shape like the known systems of China's DF-17 or North Korea's HGV, both hypersonic missiles," says Inbar.

Inbar says a HGV is not a "wonder weapon" and it could be intercepted. However, soon, it will pose a significant challenge for active defences — both in detection, tracking and kinetic encounter and interception. "HGV systems challenge most missile defence systems because they are hard to detect and track due to their depressed trajectories," he explains. "Unlike ballistic trajectory, this is an unpredicted flight path. Usually, high maneuverability during reentry. "

According to Ari Heistein and Elisha Stoin, researchers from the Israeli Institute for National Security Studies, it is possible that in the future the Houthis will permit Iran's IRGC forces to launch advanced Iranian cruise missiles, UAVs, or ballistic missiles from Yemeni territory. "This could occur in a scenario in which Tehran seeks to strike Israel while distancing itself from the attack and minimising potential blowback," they say.

Israeli defence sources say that the potential launch of Iranian-made ballistic or hypersonic missiles from Yemen makes the operational cooperation between the Israeli Defence Force and US troops in the Gulf area, "ultra-important."

IRAN'S NAVAL AMBITIONS BOOSTED BY RUSSIA

The close cooperation between Moscow and Tehran is not just confined to UAVs. Observers say it could also enhance Iran's naval capabilities. Israeli defence sources say Russia will help Iran build a fleet of combat vessels. Russian defence policy gives priority to the development of advanced frigates. The most popular is the Admiral Grigorovich class, which is classified as a "general purpose" surface combat vessel.

"The Iranians hoped that China would help them build a navy, but the Chinese were not in a hurry to share their maritime technologies," says Eliezer Marom, a former commander of the Israeli Navy. "The war in Ukraine opened a new option to acquire the needed combat vessels from Russia."

Iran's maritime aspirations became clear some years ago when its officials for the first time pointed to plans to establish a naval station in Syria to be able to support Hezbollah without having to rely on air or land convoys through Syria, Iraq, or Turkey. The plan included opening another naval station in Yemen, through which Iran will be able to pose a threat at the Red Sea's entrance and potentially impede ship traffic heading towards the Suez Canal and the Gulf of Eilat.

These two naval stations were not officially established, but in recent years the Iranian naval plan has become even more ambitious to potentially include expanding beyond its territorial waters. According to Iranian Navy Commander Rear Adm. Shahram Irani, Iranian naval units are now present in the Indian Ocean, the Atlantic Ocean as well as the Pacific, and are safeguarding merchant containers and oil tankers during their missions in international waters.

Iran is also building relations with Venezuela, with Israeli intelligence concluding that the latter may allow Iranian naval forces to use its ports in the future — giving Iran a naval base to operate out of in the Americas. Israeli naval expert Shaul Chorev says that the plan to create an Iranian naval presence in the Western hemisphere is largely an effort to "poke a finger in the West's eye."

Pictures of what are believed to be Iranian Shahed drones in Kyiv *(Source: Twitter)*

Chorev, who is a former deputy chief of the Israeli Navy, noted that the Iranian plan to expand the presence of its navy became clear in 2021 when they participated in an exercise with the Russian fleet and two of their ships arrived at Saint Petersburg. The growing "friendship" between Moscow and Tehran is a boost for Iran's defence industry, which has many countries, including Israel, worried and watching developments very closely. ■

ABOUT THE AUTHOR

Arie Egozi is an Israeli-based journalist who has worked as an aerospace and defence correspondent for Israel's largest daily, *Yedioth Ahronot* and foreign defence publications such as *Flight International*, *Aviation Week* and *Breaking Defense*.

ALL TERRAIN C-RAM PERFORMANCE

IAI

The conflict in Eastern Europe continues to demonstrate the supremacy of precision targeted artillery and mortar fire supported by the efficient, real-time target acquisition capabilities afforded by UAVs and drones. The ability to quickly close the firing loop using these small, difficult to counter, aerial reconnaissance and targeting tools has made the threat of indirect fire more dangerous than ever. The potential damage is further exacerbated when mobile forces must operate in difficult terrain, where ingress routes are often limited and the enemy is able to focus on choke points and obstacles, natural or engineered.

To counter precision targeted rocket, artillery, and mortar fire as well as the range of aerial threats — from manned and unmanned attack aircraft through to surveillance, reconnaissance, and targeting drones — it is imperative that maneuvering forces have the integral ability to detect and classify the relevant threats. They must be able to anticipate incoming fire and quickly direct accurate counterfire to destroy or disrupt the threatening batteries. They must also be able to detect the dangerous presence of UAVs and drones, which are instrumental in target detection and fire control, and which can also serve as guided weapons in their own right. There is only one single

ELTA ELM 2311 C-MMR Compact Multi-Mission Radar (*Photo: IAI ELTA*)

sensor that can provide a solution to this range of requirements — a modern, multi-mission C-RAM radar system.

But the ability to deliver the necessary capabilities and performance in a compact, highly mobile package is not a trivial endeavour. In response to this challenge the innovative sensors and systems subsidiary of Israel Aerospace Industries, ELTA Systems Ltd., has leveraged its 60-year legacy in radar system design and development and its unique know-how as a pioneer in active electronically scanned array (AESA) technology to offer the ELM-2311 C-MMR, a compact, high performance multi-mission Doppler radar system. Based on the successful MMR family of radars, with over 170 systems in service worldwide and the key sensor in the well-known Iron Dome system, C-MMR delivers effective C-RAM and air defence capabilities.

ATM MMR2 *(Photo: IAI ELTA)*

Small and light enough for deployment from a single 6X6 or 8X8 armoured fighting vehicle and operated by only two crew members, this versatile radar system is able to escort manoeuvering forces in challenging terrain and provide an array of capabilities that necessitate the deployment of multiple radar types in past legacy solutions. In fact, C-MMR has been designed to contend with extreme weather and geography, including the special challenges imposed by alpine warfare — lightning, wind gusts, falling rocks, avalanches, ice, extreme cold, and crevasses.

C-MMR operates in two main modes: Weapons Locating System (WLS) and Air Defence (AD). In WLS mode the radar detects incoming mortar rounds, artillery shells, rockets and missiles. It calculates impact and launch points (IP and LP), performing Hostile Weapons Location (HWL) in real time while concurrently providing friendly fire ranging (FFR) to facilitate highly accurate counter-battery fire for an immediate and effective response. In fact, a single C-MMR can simultaneously support up to 10, modern, long-range artillery batteries. The highly accurate radar is also able to support fire control of counter-RAM weapons systems. In AD mode, the radar detects and classifies all types of airborne targets, including UAVs, generating a real-time Air Situation Picture (ASP).

C-MMR provides ranges of up 100 km in the WLR role and 250 km in the AD role. It is capable of detecting and tracking hundreds of targets simultaneously and features advanced signal processing for better performance in heavy clutter and noisy targets, target classification, and the detection of very low elevation targets. It also features advanced ECCM capabilities. Moreover, high redundancy, graceful degradation, and high reliability/availability ensure the systems' dependability.

Various radars claim to answer C-RAM mission requirements and offer multi-mission capability. From Elta's perspective, which is based on years of operational and professional experience acquired through the experience of Israel Defense Force units and extensive development efforts, the full definition of C-RAM must include the simultaneous capability to both accurately pinpoint the source of enemy fire while at the same time correcting friendly fire in order to ensure quick and efficient target destruction. In order to claim genuine full multi-mission C-RAM capability, both missions must be performed in parallel without the need to switch between detection and ranging modes.

C-MMR radar provides a combination of performance and mobility that gives manoeuvering forces a defensive edge against airborne platforms and incoming artillery, rocket and missile fire; as well as an offensive edge, with their ability to direct highly accurate fire. Moreover, the radar was developed considering the threat of small and medium-sized unmanned aerial vehicles (UAVs) on the battlefield.

Operationally proven and ready for deployment in extreme terrain, this radar offers a cost-effective solution for force protection and friendly fire direction, even in the most challenging operational conditions. ■

THE CONNECTED BATTLESPACE

Collins Aerospace, an RTX business

Graham Davenport, marketing director, Mission Systems for Collins Aerospace, talks about the importance of the Connected Battlespace and how it is helping customers with solutions needed to sense, make sense, and act on information gathered across multiple warfighting domains in highly contested environments.

Q: What are some of the main drivers for more joined-up multi-domain communications on the battlefield?

A: The current threat environment is driving a new consideration by our customers in terms of how they conduct their military operations, as is the transition back to Large Scale Combat Operations (LSCO) against a peer or near-peer adversary that combines and synchronises effects from multiple domains — with particular emphasis on how command, control, and communication are conducted across the air, land, sea, cyber and space domains.

The UK Ministry of Defence (MOD) response to this threat is the Multi-Domain Integration (Change Programme), a mindset in which UK and allied military forces seamlessly connect in highly contested environments through secure, distributed networks that collect, analyse and quickly process mission information and data to accelerate decision making. In the US, the Department of Defense (DoD) calls this Combined Joint All-Domain Command and Control (CJADC2).

Q: How much progress has been made so far in terms of allied forces seamlessly connecting on the battlefield?

A: This is an ongoing and complex challenge that is being addressed through multiple, incremental steps. Operational progress is being made all the time but our experimentations at major military exercises are helping customers understand the real potential and mission requirements our solutions can address.

U.S. Air Force Vice Chief of Staff Gen. David Allvin and Royal Australian Air Force Deputy Chief of Air Force, Air Vice-Marshal Glen Braz tour a KC-135 Stratotanker during the Air Senior National Representatives (ASNR) Forum at Joint Base Elmendorf-Richardson, Alaska, May 16, 2023. The Collins Aerospace team integrated and demonstrated on a KC-135 a highly mature, resilient networking gateway enhanced with autonomous routing technologies that bridged disparate line-of-sight and beyond-line-of-sight networks across multiple security levels. *(Photo U.S. Air Force)*

A KC-135 Stratotanker assigned to the 151st Air Refueling Wing takes off during exercise Northern Edge 23-2 at Kadena Air Base, Japan, July 12, 2023. Collins Aerospace partnered with the Utah Air National Guard 151st ARW to test new connectivity and BMC2 solutions through an ongoing Cooperative Research and Development Agreement. *(Photo U.S. Air Force)*

Our dedicated experimentation and demonstration team has significant experience in rapid experimentation and the transition of technical readiness level capabilities into deployment.

RTX business teams from Collins Aerospace and Raytheon recently participated in Northern Edge 23, a joint force exercise with active involvement across all US DoD services and multinational partners. Using cross-domain solutions, advanced AI-enabled communications, and intelligent gateway technology, the company connected partners from the Five Eyes Alliance and others to a larger, joint force data network to shorten decision-making timelines from hours to minutes for military commanders and operators.

In the UK we have supported exercises such as Joint Warrior, Vulcanex and Joint Viking. Recent experiments have included the use of the Intelligent Gateway providing legacy waveform translation, cross-domain solutions bridging multiple networks and data sources, a tactical cloud-enabled computing environment and resilient autonomous networking along with intelligent sensing, and the command and control of autonomous air and ground platforms, sensors, and effectors. Many of these activities require our company to collaborate not only with the customer but also with local industry integrating third party hardware, software, waveforms, or algorithms.

Q: What are some of the biggest challenges forces face in enabling more joined-up multi-domain communications — land, air, sea, space — on the battlefield?

A: The biggest challenge is trying to connect legacy platforms, systems and networks, with current and future capability. Although open architectures and the adoption of industry standards is definitely the way forward there is still some work to be done on retro-integration to ensure interoperability with legacy capability.

One of our primary accomplishments from Northern Edge included a successful demonstration of new directional communications technology. It tested how currently disadvantaged assets within threat areas could receive updated tasking and provide actionable information. Integrating technology like this on legacy platforms can increase their survivability and operational relevance in highly contested environments.

Q: How do you ensure persistent multi-domain communications in a highly contested/congested environment with GPS denial and jamming?

A: There are two approaches here, the first one involves Primary, Alternate, Contingent and Emergency (PACE) bearers and networks to ensure that if a specific part of the spectrum is being denied then the operator has other options. This along with War Reserve Modes (WARM), will protect the communication modes we rely on during the early stages of a potential conflict.

Secondly, the wider adoption of digital command and control. Voice communication is slow and exposes the user to the threat of discovery through adversary electromagnetic warfare. Combining digital C2 with Resilient Autonomous Networking provides the capability to integrate individual networking services into a whole, across a variety of domains and operational theatres, both military and commercial, for the next generation of resilience, reliability, and robustness.

Q: What are some of the key data and security challenges around sharing data across multiple domains?

A: There is an acknowledgement across our customers that in order to achieve seamless sharing of information we need to transition to data-centric security — much of the information held today is classified due to the classification of the system within which it resides. Therefore, until there is an efficient, effective, and accredited method of labelling, tagging, or identifying the classification of the data it will be difficult to transition to data-centric security solutions, and again there is a vast amount of legacy data that would need to be considered.

Q: How are RTX and Collins Aerospace reorganising themselves to address these challenges and deliver on the multi-domain Command and Control vision?

A: RTX recognises that the current landscape has unique challenges — transitioning from years of counterinsurgency/ counter-terrorist operations in multiple theatres where the

difference in military power was stark. Customers are now preparing and posturing for Large Scale Combat Operations (LSCO) against a peer adversary in a highly congested and contested environment. Many customers are undertaking digital transformation programmes that will require data exchange between legacy, current and future platforms to support operations by delivering a combined response in a multi-domain, joint, coalition, or multinational environment.

In response, RTX has launched a strategic initiative called Connected Battlespace to help customers with solutions needed to sense, make sense, and act on information gathered in highly contested environments. To meet these needs, RTX has structured four platform-flexible capability enablers to mature, integrate, and deliver solutions that meet customer demand. These enablers are: Intelligent Sensing, Resilient Networks, Battle Management Command & Control, and Advanced Effector Systems.

Our recently announced restructuring allocates these four technology areas between two business units: with Raytheon providing the sense and act part, and Collins Aerospace the "make sense" element, through resilient networking and battle management command and control, and resilient navigation systems. Advanced battle management systems, communications and cross-domain solutions are included in Collins' portfolio.


Graham Davenport

Q: What are the key technologies for enabling the Connected Battlespace?

A: High-fidelity physics-based modelling and emulation, including communications and networking, resilient navigation, integrated mission solutions and live virtual constructive simulation.

This work supports mission engineering and operations analysis capabilities which enable analysis of the ability of current and emerging operational and system capabilities across RTX's platform-flexible enablers to achieve desired operational effects across security, service, and even national domain boundaries.

Q: What existing technologies versus new innovations will be leveraged?

A: Existing technologies and platforms have their limits, but they are key building blocks to be connected, enhanced or replaced in the future.

The new technologies we are exploring are integrated wideband Beyond Line of Sight capability and directional communications for disadvantaged platforms. These capabilities show how assets within threat areas can receive updated tasking and provide actionable information back to the joint force.

We're also looking at artificial intelligence and machine learning software that can securely orchestrate sensors through machine-to-machine communications, enabling the creation of rich geolocated, multi-intelligence data packages that can provide enhanced threat awareness across multiple platforms and domains to subscribed users and decision-makers at strategic and tactical levels. ■


U.S. Air Force and U.S. Marine Corps service members aboard the KC-135 Stratotanker check satellite connections using the Collins Intelligent Gateway connectivity solution combined with Battlespace Command and Control Center Air Battle Management hardware/software during a distributed tactical C2 experiment at exercise Northern Edge 23-2. *(Photo U.S. Air Force)*

The Carl-Gustaf M4 fitted with the new FCD 558 (Copyright: Saab)

LONG LIVE THE CARL-GUSTAF®

In service for more than 80 years, the "slayer of Russian tanks in Ukraine" has enjoyed considerable longevity. So, what is the secret behind the man-portable recoilless rifle's continued success?

By Peter Antill and Anita Hawser

Russia's invasion of Ukraine has renewed worldwide interest in both man-portable anti-tank and anti-aircraft weapons, especially as these weapons have played a significant role in thwarting Russian advances.

Some estimates (as of mid-November 2022) place Russian tank losses at between 1,400 and 1,500 vehicles[1], leading some analysts to question the future of the tank itself. Such "prophecies of doom" however, need to be read with caution as in reality it is the Russian Army's problems with leadership and troop morale that have generated around half of these losses, due to soldiers abandoning their equipment.[2]

Nevertheless, the performance of man-portable shoulder-fired systems like the Carl-Gustaf recoilless rifle in Ukraine has earned it the moniker, "The slayer of Russian tanks," following claims from the Ukrainian Ministry of Defence (MoD) that the weapon system had destroyed two Russian T-90M main battle tanks (MBTs). One video, shared on Twitter, shows Kharkiv Territorial Defence fighters eliminating a T-90M "Breakthrough" tank near Stary Saltiv with a Carl-Gustaf. "We thank the Swedish people and the King for their help," the post read.

Fresh from the battlefields of Ukraine, it is perhaps no coincidence that the British Army, which first adopted the Carl-Gustaf towards the end of the 1960s in its M2 variant as an infantry anti-tank capability, but later replaced it with the Light Anti-armour Weapon 80, started looking again at the system. That interest manifested into an order worth £4.6million, from the UK's Defence Equipment & Support for the delivery of Carl-Gustaf M4s to replace the Anti-Structure Munitions the UK sent to support Ukraine against the Russian invasion.

Remarking on the acquisition, Major General James Bowder, the British Army's Director of Futures said: "The procurement of the Carl-Gustaf M4 will provide a versatile, potent, and proven capability to our close combat forces; it will defeat a range of threats on the modern

The FCD 558 communicates with the HE 448 round using a protocol called Firebolt® to determine the best trajectory for the round.
(Copyrighht: Saab)

battlefield, further enhancing our lethality."

"The fact that the British Army is reintroducing the Carl-Gustaf into service after having phased it out once, is evidence of how well we have adapted the Carl-Gustaf system to the contemporary threat," says Michael Höglund, head of the Ground Combat Dynamics business unit at Saab in Sweden. Saab has had both NATO and non-NATO members as customers for its ground combat weapons, including the Carl-Gustaf, for decades. But Höglund told *Defence Procurement International* the war in Ukraine had made nations around the world look more closely at investing in their defence capabilities.

The latest version of the Carl-Gustaf, the M4, is significantly lighter than earlier iterations and can be paired with intelligent sighting systems which increase the chances of a successful engagement. In addition to the flexible range of legacy ammunition the Carl-Gustaf is known for, which can handle a multitude of scenarios on the battlefield — destroying an armoured vehicle or structure, or illuminating the battlefield during night-time operations — the M4 is also compatible with programmable rounds.

Officially launched in 2014, the M4 weighs in at 6.6kg (15lbs) and has a length of 950 mm (37in). Not long after its launch, Saab conducted a live-fire demonstration at the British Army's Close Combat Symposium at West Lavington on 20 July 2016.[3] Since then, the M4 has been ordered by many different countries, entering service with the Swedish Army in 2018. Today, a total of 15 countries, including the US, Australia, Estonia and Latvia, have acquired the M4. The latest country to procure the system is India, which has used the Carl-Gustaf since 1976. Furthermore, Saab announced in September 2022 that it is building a facility in India to produce the weapon system as well as export components to users around the world, the first such facility outside Sweden.[4] "The Indian facility is progressing as planned and we aim to have production up and running by next year," says Höglund.

Another long-standing customer of the Carl-Gustaf is the US Army, where the reloadable, multi-purpose system has been in service since 1990. In 2018, the Army announced it would acquire the latest version of the weapon, the Carl-Gustaf M4. The US Department of

A HISTORY OF THE CARL-GUSTAF

The Carl-Gustaf 84 mm man-portable, shoulder-fired, recoilless rifle was initially developed by Hugo Abramson and Harald Jentzen of the Royal Swedish Army Materiel Administration in 1946. It was based on an earlier model (the Carl-Gustaf 20 mm recoilless rifle) and inspired by the success of man-portable anti-tank weapons in World War II such as the Panzerschreck and Bazooka.

Entering service in Sweden in 1948, initial production was undertaken at the Carl-Gustaf factory in Eskilstuna, which at the time was run by the state agency, Försvarets Fabriksverk (FFV). FFV continued to develop the weapon for both the domestic and international markets and was eventually merged into Saab Bofors Dynamics, which currently handles system development and export.

EARLY VARIANTS OF THE CARL-GUSTAF INCLUDE:

- **M1** – Fulfilling the same anti-tank role as the American Bazooka, German Panzerschreck and British PIAT, the main difference between these weapons and the Carl-Gustaf is that the Carl-Gustaf's barrel is rifled imparting spin to stabilise the round in flight, as opposed to the use of fins. Also, the use of a recoilless firing system allows Carl-Gustaf's ammunition to hold considerably more propellant and achieve higher velocities (290 m/s compared to around 105 m/s for the Panzerschreck and Bazooka, and 75 m/s for the PIAT) resulting in better accuracy at increased range.[5]

- **M2** – The M2 was introduced in 1964 as an improved, lighter, shorter version of the M1 for the export market, however, it quickly replaced the M1 across the globe. The M2 was in UK service from the late 1970s until the early 1990s as the L14A1 84 mm Carl-Gustaf Recoilless Rifle (aka the "Charlie G"), which was replaced by the LAW 80.

An M1 Carl-Gustaf recoilless rifle (*Photo by Soldatnytt from Oslo, Norway (CC BY 2.0 via Wikimedia Commons)*

Carl-Gustaf M3 (Photo: Jorchr *(CC BY-SA 3.0 via Wikimedia Commons)*

- **M3** – Introduced into Swedish service in 1986, the M3 was even lighter, replacing the forged steel barrel with a thin metal tube (with the rifling), strengthened by a carbon-fibre outer sleeve. The external parts were also replaced by plastic and aluminium components. The export version was introduced in 1991 and used in various roles (including anti-armour and bunker-busting) by many forces worldwide, including the British SAS.

- **M3 in US Service** – In the late 1980s, the US Rangers (aka 75th Ranger Regiment) needed to replace their M67 Recoilless Rifles. A market survey by ARDEC in 1987 suggested that the M3 Carl-Gustaf was the most suitable weapon to fulfil the Ranger Anti-Armour Weapon System (RAAWS) requirement and so it was selected in September 1988. A subsequent review of the manufacturer-supplied data suggested that the weapon did not meet US Army requirements, but fatigue tests done by Benét Laboratories showed that while the manufacturer's recommended life for the weapon was 500 rounds, the bores of two test weapons showed no sign of fatigue until 2,360 rounds.

M3E1 MAAWS version of the M4 *(Photo: US Army via Wikimedia Commons)*

At this point, the Navy Seals became interested in the weapon and the programme became a joint procurement, changing its name to the Multi-Role, Anti-Armour/Anti-Personnel Weapon System (MAAWS).[6] The Rangers found that the weapon was best employed by a two-man team with one soldier acting as the gunner and carrying the recoilless rifle, while the other acts as a spotter and carries additional rounds. The weapon system can fire a variety of rounds including high explosive (HE, 441/441B), high explosive anti-tank (HEAT/751), high explosive anti-tank – rocket assisted projectile (HEAT-RAP/551), high explosive dual purpose (HEDP/502), smoke (SMK/469) and anti-structure munition (ASM/509).

Defense completed testing of the M4 in Autumn 2017 and it was designated the M3E1 Multi-purpose Anti-Armor Anti-personnel Weapon System (MAAWS). The US Army then approved a requirement for 1,111 M3E1 weapon systems to be deployed using an Urgent Material Release as part of the portfolio for the Product Manager, Crew Served Weapons (PE CSW) acquisition team. In November 2017, the US Marine Corps announced its intention to acquire 1,200 units, enough to equip one in each infantry squad, with deployment starting in mid-2021.[7]

The USMC is also considering acquiring the MAAWS to replace the Mk. 153 Shoulder-Launched Multi-Purpose Assault Weapon (SMAW) in its combat engineer squads as it has a greater range of ammunition and an effective range of 1,000m, twice that of the SMAW. In May 2022, the US Army MAAWS Program Office awarded Saab a $16 million contract for Carl-Gustaf M4 recoilless rifles. The order includes deliveries of weapons for both the Army and the US Marine Corps.

"This order will make soldiers and Marines more agile thanks to the reduced weight and increased capability compared to the previous version currently in operational use," said Erik Smith, President and CEO of Saab in the US. "Additionally, it will increase interoperability across services, alliances, and partnerships, with so many already fielding the Carl-Gustaf M4."

The US Army started fielding M3 MAAWs weapon systems with regular units in Afghanistan in late 2012 as they were being engaged by RPGs out to 900 m, while their small arms and light support weapons had ranges of around 600 m. The M3 could airburst troops in defilade out to 1,250 m or use High Explosive rounds out to 1,300 m.

Interestingly, although US Special Operations Forces had used the M3 since the early 1990s, US Army light infantry unit commanders in Afghanistan had to submit operational needs statements to get the weapon. The M3 became an official "Program of Record" in the regular Army in 2014, and a conditional materiel release was authorised in late 2015 to equip all brigade combat teams with one M3 launcher per infantry platoon.[8]

While the M3 boasted increased effectiveness, its 9.5kg (21lbs) weight was a significant burden to troops carrying it. In March 2013, US Special Operations Command (SOCOM) issued a call for a kit to reduce both its weight and overall length, without compromising its ruggedness or performance. Thankfully, Saab had already started work on the M4 version, which had limited reductions in the expected barrel life, no increase in recoil and could fire a newly developed high explosive munition with a range of 1,500 m if fired using a fire control system.

WHY THE CARL-GUSTAF CONTINUES TO REMAIN RELEVANT

Two developments that will undoubtedly keep the weapon system up to date and generate export orders are a new programmable munition known as the HE 448, along with a new Fire Control Device designated FCD 558. The two communicate using a protocol called Firebolt® to determine the best trajectory for the round. Both were showcased at a live fire event near Karlskoga, Sweden from May 3-4, 2022, which was attended by representatives from more than 30 countries.[9]

By introducing the Firebolt communication, the sighting system obtains crucial information from the ammunition, such as ammunition type and temperature, Höglund explains. "This information, together with information from the sight such as ambient temperature and

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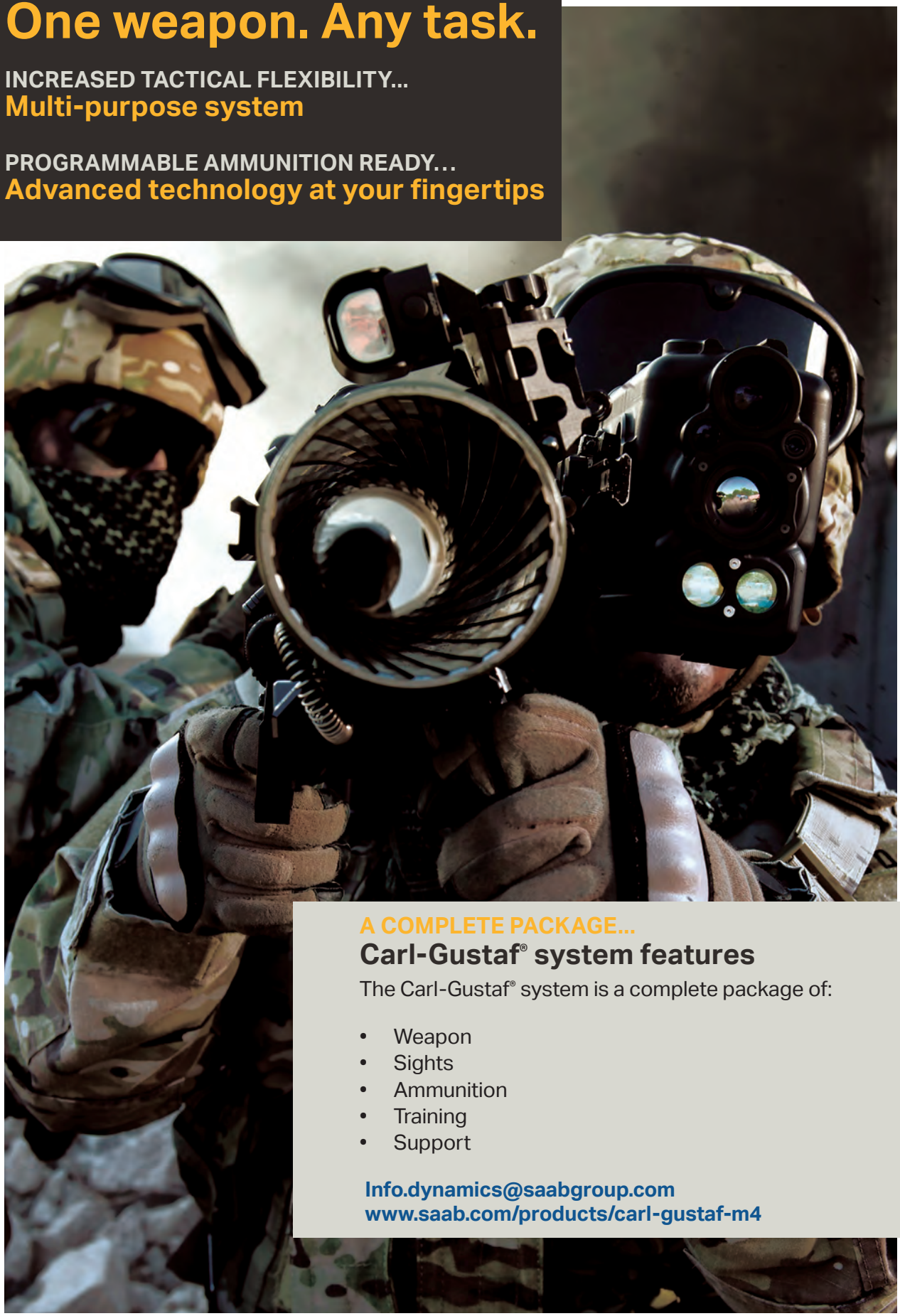

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pressure, is used to do a very accurate ballistic calculation. The user benefit is an improved probability of hit, less user input from the soldier (no need for manual adjustments/corrections) and faster engagement times. The communication interface is also used to programme rounds (in the barrel) with what we call the defeat mode, such as airburst and airburst distance."

In July, Saab received an order from the Australian Department of Defence for the supply of additional Carl-Gustaf M4 weapons fitted with the new FCD 558. The FCD and programmable round, which can be used against unprotected troops, troops in defilade, and soft-skin targets, including vehicles, were developed based on feedback from users. Saab Customer Service Representative Petter Grabbe said a common request among users was for a high-explosive round with a better ability to defeat body armour, which can reduce the effectiveness of fragmentation rounds. The 800 steel balls in the HE 441 round were replaced with 4,000 tungsten pellets in the HE 448, which increase the fragment density and the probability of striking vulnerable areas on enemy combatants. When combined with the FCD558, the new HE round allows for the engagement of targets at much longer ranges.

Höglund says the development of the Carl-Gustaf has always been user-focused, and introductions of new capabilities are a result of listening to customers and their needs. "That's probably the main reason for its continued success." As customer needs evolve, he says there is always room for further improvements. While some such as further weight reduction are always desired, Höglund says Saab also needs to guarantee robustness and reliability. "We believe the Carl-Gustaf M4 offers a perfect combination between robustness and being lightweight."

The war in Ukraine has also highlighted the need to safeguard forces against unmanned threats. While there are no firm requests for the Carl-Gustaf to be used to defend against the threat posed by drones, Höglund says it is constantly monitoring what is happening in the unmanned land and air domains. Saab is also working closely with suppliers of intelligent sighting systems for the M4. Currently, the Aimpoint FCS13 is qualified for the Carl-Gustaf and qualification is ongoing for the Senop AFCD Ti thermal imager and day sight.

"We continuously explore the sighting market for new and improved capabilities and take action if we see a benefit for the Carl-Gustaf system and the end user," Höglund says. Saab is also currently working on new ammunition capabilities for the Carl-Gustaf, spanning from improved anti-tank to multi-purpose, including Confined Space variants.

"We will continue to add capability to the Carl-Gustaf to keep one step ahead of the evolving threat," says Höglund. "The Carl-Gustaf capability road map stretches well beyond 2030, so plenty of new capability will be made available for existing and new customers over the next decade." ■

ABOUT THE AUTHORS

Anita Hawser is the Editor of *Defence Procurement International* and **Peter Antill** is a writer and military historian, whose interest lies in examining defence procurement and logistics within the realm of military history.

FOOTNOTES

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DIGITALISATION OF MORTAR SYSTEMS

Hirtenberger Defence Systems is a worldwide active developer, manufacturer and provider of mortar systems. The product range, consisting of mortar ammunition, weapon systems, auxiliary field equipment, aiming and sighting systems and solutions for the digitisation of mortar systems illustrates the variety of technologies and know-how.

The conduct of battle has always been determined by the factors of forces, space and time. The challenge of future battles in the context of national and alliance defence are similarly challenging for many modern armed forces and are presented as follows: In principle, a fight against a peer opponent must be assumed. Furthermore, based on experience from the Ukraine conflict, it must be assumed that wars or conflicts can arise without long warning times. The reality for the commander is likely to be as follows:

- Overstretched spaces must be held or taken with the limited strength and resources available
- Operations are conducted on a "glass battlefield." Receiving information, reliable transmission and the processing of all incoming data is therefore of crucial importance
- Digitisation of the battlefield requires good Communications, Command and Control (C2) systems, and Battle Management Systems (BMS), and requires redundancy in the event of disruptions. In view of the austerity measures taken by many armed forces, due to Covid-19, modernisation projects, and maintaining operational readiness, this can only succeed if, in addition to weapons effectiveness, systems are efficient.

Hirtenberger 81 mm M8 System with MDAS (Mortar Digital Aiming System)

Hirtenberger 60 mm M6 C Commando Mortar System with GRAM System (Grid Aiming Mode)

SYSTEMS READY FOR USE TO INCREASE THE COMBAT EFFECTIVENESS OF MORTARS

Hirtenberger Defense Systems (HDS) manufactures cost-efficient mortar systems, that will increase combat effectiveness. These systems are provided in all common NATO calibres.

GRID AIMING MODE — GRAM

Hirtenberger introduced the GRAM electronic aiming device to the market in 2017. It now has additional functions. This device is scalable and increases the combat effectiveness of all common 60 mm mortars, including the commando mortar variant. With a weight of only 900 g, the GRAM system combines several sensors for determining the position of the barrel in space and has a wireless interface for communication with the fire control computer.

Attached to the barrel by means of a clamp, the integrated position sensors enable the lateral and vertical inclination of the barrel to be determined more precisely than classic levels. GRAM allows 60 mm mortars to be aimed and fired digitally, this enables fire orders to be executed quickly, as orders are transmitted seamlessly from the observer to the mortar using radio data transmission, negating errors in voice transmission.

The potential of GRAM is not exhausted as the use of the weapon no longer depends on visually aligning the mortar and target, other methods of using the system are also conceivable. The use of the commando mortar, in conjunction with the GRAM, is no longer limited to direct aiming. with the electronic aiming device, a commando mortar can fire indirectly from behind cover and as precisely as a 60 mm bipod mortar. The digitisation of mortar systems is achieved by connecting to existing fire control, command and weapon deployment systems via standardised interfaces. This means that the mortar can be used not only with battle management systems, but also with simulation systems to process trainers based on VBS.

REQUIREMENTS FOR FUTURE MORTAR SYSTEMS

Infantry mortar fire support plays an important role in such scenarios as they can be deployed quickly, with comparatively small forces, a small logistical footprint, and can quickly cover large areas. However, in order to make this contribution to combat operations, future mortar systems must meet several criteria. Survivability, speed of action and the ability to integrate into the digital battle space must be significantly improved in many armed forces.

Additionally, it is also important to increase the effectiveness of the weapon systems - in terms of accuracy, range - and to simplify the training of operators. Since the requirements described already exist today due to ongoing operations, there is not much time left for the development of new systems with inherent risks due to the development of such systems, which are sometimes difficult to control, throughout the entire development phase until they are ready for use.

To equip Android-based smartphones, Hirtenberger has developed a GRAM app, which expands the Android device into a complete fire control computer and makes the overall system even more cost-efficient, as there is no need to purchase additional IT hardware. Communication with the GRAM takes place via a Bluetooth connection, the target data can also be transferred directly from the target locating device to the app via Bluetooth at close range, if this connection is not available data entry can be done manually.

MORTAR DIGITAL AIMING SOLUTION — MDAS

The MDAS is a digital aiming device for 81 mm and 120 mm mortars. The setting up and aiming of bipod mortars can be carried out using this system independently of aiming circles or sights and also without connections to the Global Navigation Satellite Systems (GNSS).

The MDAS weighs less than 12 kilograms and consists of two hardware components. These consist of a navigation system-independent, gyroscope-based sensor package including a battery unit and a display, which is attached to the mortar in place of a sight and shows the orientation of the weapon system. MDAS is ready for serial production and is currently being tested in a Central European country.

The concept behind MDAS offers several advantages:

- It works independently of the weapon system and can increase the combat value of the mortar systems in use as a retrofit, and therefore integrate the mortar systems into the BMS. This simplifies both the management and the use of the systems.
- Furthermore, digitisation enables a significantly faster transmission of target information than voice. Depending on the stability of the data connection, transmission errors are eliminated, and this allows faster target engagement. MDAS simplifies the tasks of the fire unit, aiming with a digital display is easier to learn and operate in comparison to a conventional optic sight. As a result, training is easier and faster, and the unit size required for firing can be reduced. The freed-up personnel, who are still required to transport the weapon system for combat purposes, can then be used for other tasks.

Using MDAS independently of the navigation system also allows it to be used in a scenario determined by electronic combat. MDAS allows the mortar, where necessary and appropriate, to continue to be used in the conventional manner with sight and aiming posts. ■

Hirtenberger 120 mm M12 System

THE UPS AND DOWNS OF LOITERING MUNITIONS

Loitering Munitions can deliver precise and lethal effects at longer ranges. But while these nascent systems offer many advantages to traditional artillery, tactics, techniques and procedures, are still being developed.

By Peter Ong

UVision-Hero (Photo courtesy of UVision)

A key component of the US Marine Corps (USMC) reinventing itself under Commandant David H. Berger's Force Design 2030 consists of Loitering Munitions (LM) for long-range precision fires. Still in the nascent development stages, Loitering Munitions offer both advantages and disadvantages for the USMC, as explained by the Marines and the RAND Corporation.

In the Winter 2022/2023 issue of *Defence Procurement International*, Mark Cancian from the Center for Strategic and International Studies and Dakota Wood from the Heritage Foundation provided analysis as to whether LMs could replace tanks and their tactical use on the battlefield. Cancian's conclusion was that LMs are so new to the US Marines (and the war in Ukraine) that their "tactics, techniques, and procedures don't really exist yet although the war in Ukraine provides an opportunity to develop them."

Jeff Tomczak, Deputy Director of the Science & Technology Division at the Marine Corps Warfighting Laboratory, says a common Department of Defense definition of a LM is a type of unmanned aerial vehicle designed to engage beyond line-of-sight targets with a payload. Loitering munitions are often portable, and many are meant to provide ground units such as infantry with a guided precision munition. They are equipped with high-resolution electro-optical and infrared cameras that enable the operator to locate, surveil, and guide the vehicle to its target.

"A defining characteristic of loitering munitions is the ability to `loiter' in the air for an extended period before striking, giving the operator time to decide when and what to strike," says Tomczak. The

Marine Corps has experimented with loitering munitions for more than a decade. "These experiments are currently focused on what's possible now and based on analysing current technology — what's possible eventually and how soon?" says Tomczak. The motivation for researching the deployment of LMs was borne out of a need for distributed Marines to have a lethal capability that allowed them to maintain a low signature.

"Loitering munitions provide the Marine Corps with a way of increasing and distributing lethality across smaller, dispersed elements in keeping with their new operational concepts of Expeditionary Advanced Base Operations and stand-in forces," explains J.D. Williams, a senior defence researcher at RAND and a retired Marine Corps Colonel. As demonstrated in Azerbaijan and Ukraine, Williams says LMs can deliver precise and lethal effects at increased range against high-value targets while avoiding some of the disadvantages of traditional fire systems like artillery and aircraft.

"For the Marine Corps, this means enabling units down to platoon and even squad level, to effectively engage a variety of targets beyond the range of direct-fire weapons, thus increasing the impact of these units on the battlefield and complicating an adversary's efforts to defend and protect its assets." However, effective fires from LMs are not a complete substitute for tank and traditional artillery fire, says Williams. But in circumstances such as those envisioned in the USMC concepts, they can provide an effective alternative.

OVER-THE-HORIZON TARGETING

He also disclosed some downsides to LMs. "Disadvantages for the Marine Corps include the ability to provide targeting for the LMs, the ability to concentrate fires to achieve mass when needed, providing mobility for the LM launchers, increased technical complexity required in the force, and costs. These disadvantages are likely to prove manageable as LMs are brought into the inventory and the force gains experience in employing them."

US Marines test the newest ground-based air defence system, the Light Marine Air Defense Integration System *(Photo by Sgt. Servante Coba, USMC)*

Regarding tactics, training, and procedures, Williams envisages that small units will have to become proficient in over-the-horizon targeting to gain full advantage from LMs. The Marine Corps envisage targeting coming from an enhanced ISR capability encompassing a family of unmanned systems and from sensors on the LMs themselves.

In some situations, small units will require the capability to mass fire from LMs or "swarm" them. Disbursed Marine units are likely to have only limited numbers of systems in each element, so it will be essential to be able to network the kill chain to concentrate the effects of multiple LMs when needed, says Williams. On the other hand, the precision of LMs should reduce the numbers required to generate effects on targets.

Similar considerations apply to mobility: small, dispersed units will not be able to move many LMs in each unit. The Marine Corps is initially deploying its LMs on wheeled armoured vehicles which can carry packages of LMs. "I would expect that similar multi-pod launchers will be developed for smaller tactical vehicles in the future, providing greater numbers spread across the battlefield," says Williams.

Incorporation of LMs into small infantry units or infantry-fires hybrid units will increase the technical skills required to employ these systems at a lower level. But Williams says there is also a good bit of automation built into LM's systems and the skills required to use them should not be significantly greater than those required to operate other modern equipment.

COSTS ARE LIKELY TO GO DOWN

Cost is always a factor in bringing new capabilities into service. This is especially true for the Marine Corps which operates on a much smaller relative budget than the other services. Williams says costs for the Marine Corps should be manageable when considering divestment of other systems

Marine Air Defense Integrated System (MADIS) on an armoured JLTV consists of a 30 mm autocannon, a pod for four Stinger missiles, FLIR turrets, and RADA radars. *(Photo-USNI NEws)*

like tanks and some of its tube artillery. "While LM costs are greater than the current family of infantry weapons, you also get a greater effect," he explains. "The cost comparison with the targets they are engaging (tanks for example) is strongly in favour of LMs. LM costs are also likely to go down over time, as well."

Williams also offered a glimpse at possible tactics. He says Marine Corps LM usage is likely to be similar in traditional land operations if or when the Marine Corps is called upon in that role. But the biggest difference is that the Marine Corps wants to deploy LMs to engage maritime targets in support of the Navy-Marine Corps concept of Distributed Maritime Operations. Small marine elements operating from expeditionary advance bases on key littoral terrain will use LMs to engage naval surface targets that are attempting to control the sea.

The Marine Corps is exploring using an unmanned surface vessel (small, fast patrol boats) as an LM platform, providing increased range to find and engage maritime targets. "While LMs are unlikely to be able to sink a ship by themselves, they can inflict damage on critical systems like radars and electronics," says Williams.

LOITERING MUNITIONS AND USMC TANK DIVESTMENT

At the WEST 2023 conference in February, General Eric Smith, Assistant Commandant of the Marine Corps, cited a few reasons aas to why the Marines are divesting of legacy systems such as tanks and some towed tube artillery. "When you can kill a tank at 90 kilometers (with organic precision fires), why do I want to bring a tank to kill a tank at four kilometers? The fuel, all the maintenance that comes with that, we cannot afford to move that [USMC M1A1 tanks]."

General Smith said that towed artillery is not mobile compared to HIMARS and that the best towed artillery units require seven minutes from "shoot-to-scoot." "You don't have seven minutes with loitering [munition] drones up there waiting to kill you," he said.

While the Marine Corps should explore the full spectrum of LM capabilities, Williams says its best investments for the near term are the more mature smaller, mobile, short and medium-range offensive systems. "Some attention should be paid to countering adversary UAS and LMs, especially if the countermeasures can be light, mobile, and relatively cheap. But the concept of distributed, mobile forces with small signatures as envisioned in the USMC operating concepts offers some reasonable measure of passive defence without having to invest heavily in active countermeasures."

The USMC is investing in counter-UAS and LM vehicles, which it refers to as the Light Marine Air Defense Integrated System (LMADIS). The Polaris MRZR LMADIS carries only electronic jammers whereas the Joint Light Tactical Vehicle MADIS has kinetic "hard-kill" weapons (a 30 mm cannon and four Stinger anti-aircraft missiles).

"As technology advances, the potential for strategic LMs should be considered [such as the Hero-1250], especially in the long-range anti-ship role," says Williams. "But fielding strategic land-attack long-range precision fires is generally outside the Marine Corps mission set," he says. ■

ABOUT THE AUTHOR

Peter Ong is a US-based writer who contributes to a number of leading defence titles.

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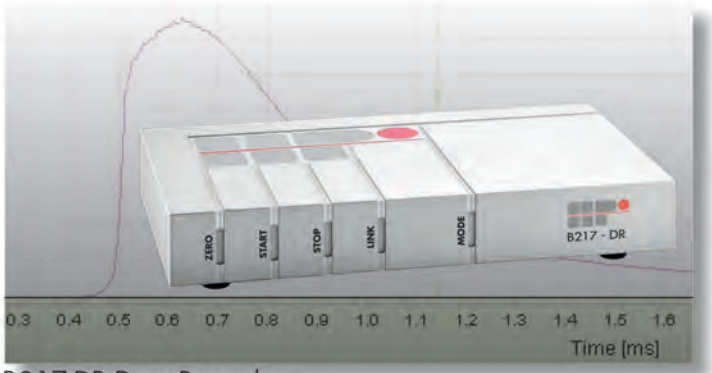

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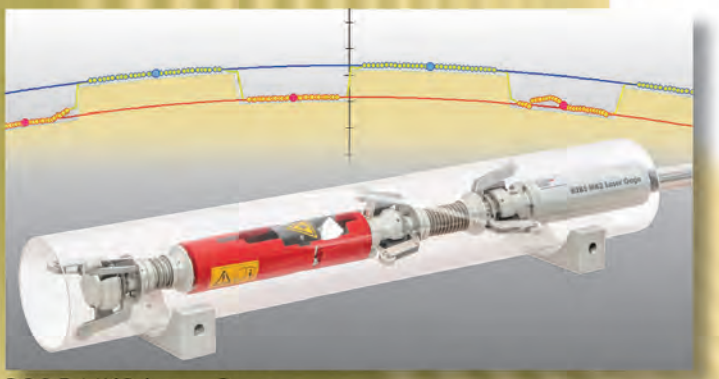
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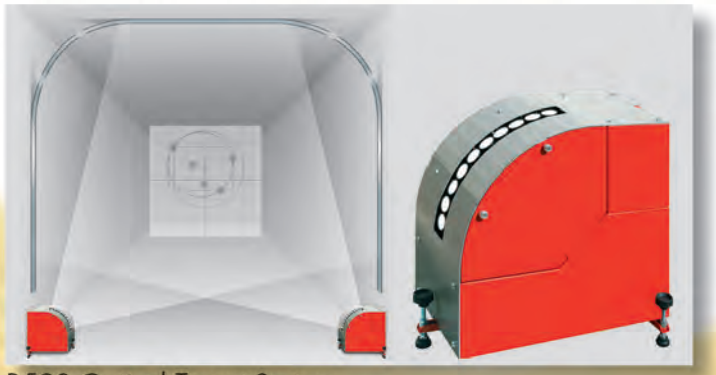
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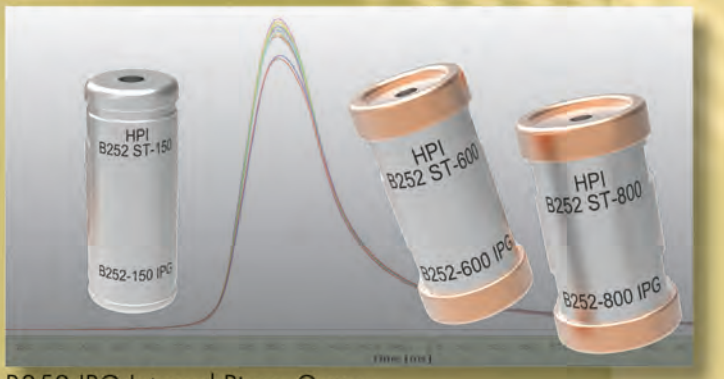

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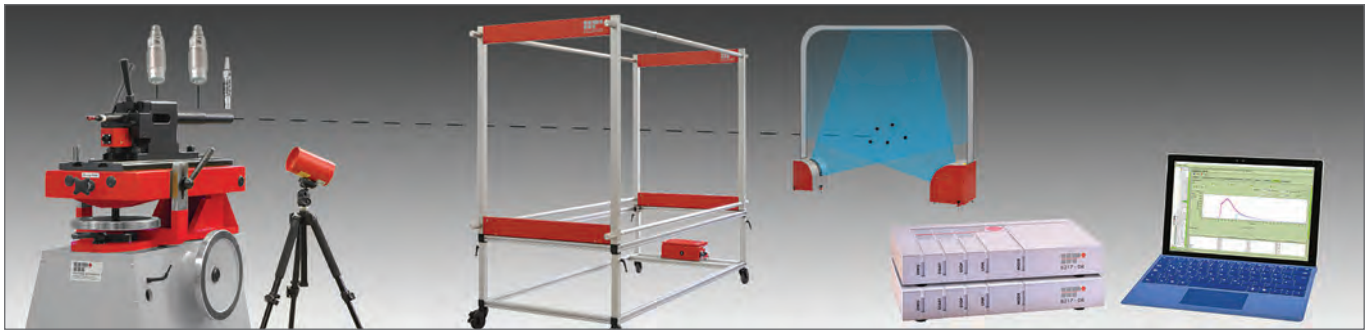

HPI, based in Graz/AUSTRIA, was founded in 1996, and is a leading supplier of Ballistic Measuring Equipment for interior, exterior and terminal ballistic applications and test equipment for testing protection material.

HPI High Pressure Instrumentation was established in 1996 after the withdrawal of a famous Austrian company in ballistics. A legal buy-out took place by three ex-employees who now make up the company's Board of Directors, which have extensive experience in ballistics.

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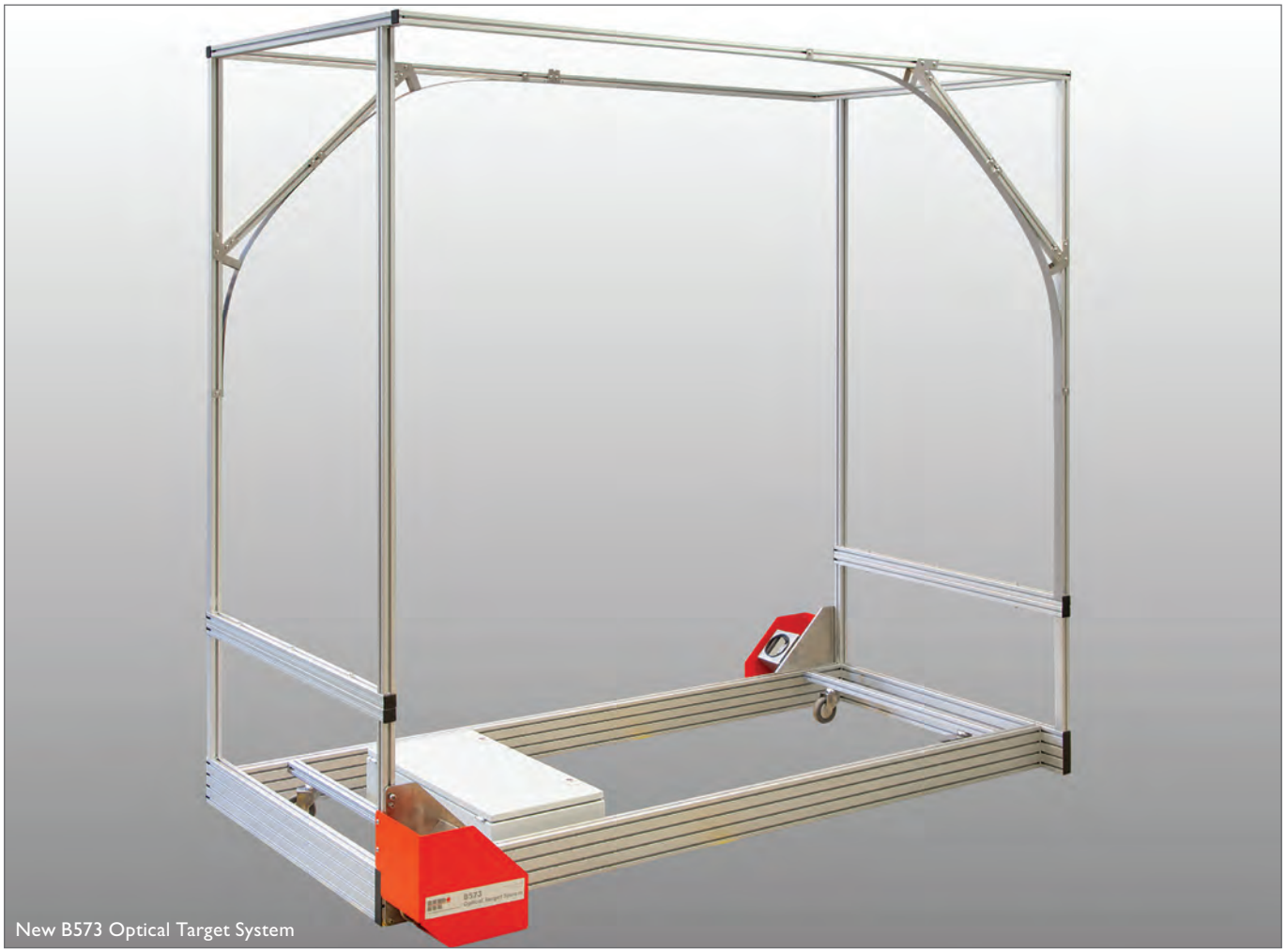
New B573 Optical Target System

NEW B573 OPTICAL TARGET SYSTEM

The B573 Optical Target System can be used in the calibre range 4 mm to 20 mm (40 mm Low Velocity) in R&D, quality control and acceptance tests. It is designed for use in indoor shooting ranges, but can also be used outdoors or in covered facilities under dry conditions.

The B573 Optical Target System operates with two cameras with an integrated illumination unit and a reflecting foil. It allows shot position determination and velocity recording of small and medium calibres. The effective Target sensor area (1.7 sqm) is permanently monitored by two high-speed line scan cameras placed on the lower corner.

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THE TOUGHEST OF TOUGHBOOKS

Panasonic's latest TOUGHBOOK for defence and security is ruggedness at its most extreme.

By Anita Hawser

Panasonic Connect Europe goes to great lengths to ensure that its TOUGHBOOK 40 notebook, which is billed "as the toughest of TOUGHBOOKS," lives up to its name. Panasonic says the 14" notebook is the only Windows-based product to contain a complete IP66 rating for water and dust protection. The device meets some of the most rugged testing standards — MIL-STD 810H and MIL-STD-461F — for drops, vibration, altitude, and extreme weather conditions.

TOUGHBOOK 40
(Photo by Panasonic)

The TOUGHBOOK 40 allows operators to access mission-critical information in the most hostile and demanding environments *(Photo by Panasonic)*

TOUGHBOOK 40 customisation and testing at Panasonic's European Mobile Solutions Division in Cardiff *(Photo by Anita Hawser)*

At its European Mobile Solutions Division in Cardiff where TOUGHBOOK base units are customised, tested, and qualified, the notebook is put through a rigorous testing regime — drop tested (the TOUGHBOOK 40 can withstand drops of up to 180 cm), exposed to dust, water, shake and bake testing, thermal shock (-40 degrees Celsius to +80 degrees Celsius), knocks, vibrations. Practically the only thing they haven't done is drive a tank over it but give it time.

The tough exterior is matched by a tough interior — Windows 11 Secured Core PC, limiting the risk of even highly advanced cyber-attacks, according to Panasonic. A quick-release OPAL Solid State Drive means you can take your sensitive data easily with you on the move. The TOUGHBOOK 40 is also certified for use with quick-release NATO-approved VIASAT self-encrypting secure drives.

"This is the next step in extending our partnership with Viasat to offer the highest-level security drives across the TOUGHBOOK range," said Jon Tucker, general manager Engineering, Product & Mobility Solutions at Panasonic Mobile Solutions Business Division. "With the current geopolitical tensions across Europe and beyond, the demand for this type of highly secure, rugged and modular flexible device is growing every day."

User authentication on board the TOUGHBOOK includes a smart card and fingerprint reader. With military-grade security and communications, the TOUGHBOOk 40 is designed to allow operators to access mission-critical information in the most hostile and demanding environments. It even features a Concealed Mode, which automatically switches off the notebook's light and electronic transmissions.

The notebook features seven expansion areas, which can be quickly and easily modified to suit a range of different mission requirements.

Positioned as a more flexible and cost-effective alternative to other rugged-tablet devices for defence and security customers, the rugged notebook supports a range of connectivity options, including 5G, GPS Galileo, mobile antennas, and eSIM.

Battery life is impressive with one battery lasting for 18 hours. Two batteries can be "hot swapped" for 36 hours of uninterrupted operation. In addition to being carried on foot, the TOUGHBOOK 40 can also be mounted to military armoured vehicles using custom-designed rugged vehicle docks and mounts.

The TOUGHBOOK 40's battery life, screen resolution and flexible configuration, make for a compelling proposition for defence and security customers, says Panasonic.

The device features a discrete GPU and Intel Iris Xe graphics and is powerful enough to support even the most resource-hungry software such as mapping applications. It can also run battlefield communication software and applications for forward headquarters, and support video feeds from unmanned devices such as drones.

Built with longevity and easy maintainability in mind, the Toughbook 40 features hot-swappable connectors. Panasonic also provides seven to 10 years of product support.

Several major European defence forces are believed to be testing the new TOUGHBOOK 40, which will be displayed on Panasonic's stand at DSEI 2023 from 12-15 September at the Excel Centre in London. ■

STREAMLIGHT: 50 YEARS OF BRILLIANT THINKING®

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Streamlight Inc.

Streamlight® Inc., a leading provider of high-performance lighting and weapon light/laser sighting devices, is this year marking 50 years of manufacturing high-quality flashlight products. Since its founding in 1973, it has grown from a small company with a single product to a global manufacturer of a broad range of high-performance lights for tactical and military personnel.

A pioneer in the development of rechargeable flashlights, lanterns, and LED lighting, the company is known for its expert engineering approach to creating lighting products that feature extraordinary brightness while also offering high value and durability.

Stinger LED

Rechargeability

Streamlight's first full-size, rechargeable duty light, the SL-20, was introduced in the mid-1970s. It was the first model in this family that used a halogen bulb and a rechargeable nickel metal cadmium battery to make it up to seven times brighter than torches that were powered by disposable batteries. Featuring a 20,000-candlepower output, it quickly became the standard for law enforcement personnel, who appreciated its longer run time as well as the cost-saving benefits of not having to replace batteries.

With the concept for a more compact and rechargeable design, the Streamlight Stinger® was introduced. It was created to deliver the optimal balance of performance and value with long run times. Today's Stinger LED flashlights feature high lumen outputs and innovations such as dual switches, TEN-TAP® programming, and productivity-enhancing features, making them among the most popular tactical torches in the world. For example, the ergonomically designed Stinger® 2020 uses a high-power LED to produce 2,000 lumens and an innovative SL-B26® USB-rechargeable battery pack to provide convenient charging on the go.

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Beginning with the TLR-1®, Streamlight's first aluminium gun-mounted light for full-size guns, the TLR family has grown exponentially to include a full line of TLR products to fit long guns, full-frame, compact and subcompact pistols. The intensely bright TLR-1 HL® is a leading choice among military and law enforcement with its wide peripheral beam.

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The first light/laser combinations of their kind for compact and subcompact pistols, the TLR-6® & TLR-7® were designed to maximise visibility and long-range targeting capability in a variety of tactical applications. Ultra-compact and extremely lightweight, these lights are made to attach to the trigger guard of a wide variety of handguns. Their low-profile design prevents snagging and a safe-off feature locks them so they cannot be turned on accidentally.

Sidewinder® Series

Streamlight's Sidewinder® Series is renowned for having the most versatile military lights in the world. The varied lights in the series are a modern representation of the evolution of military flashlights, offering lightweight right-angle solutions that are compact and allow for multiple hands-free options and colour LEDs at different outputs. The original Sidewinder® LED features a 185° tilting head and offers an easy selection of lighting modes when in the field. The series also includes the Sidewinder Compact® II, which was designed so that the entire body rotates 185° for easy aiming of light, with an unbreakable, scratch-resistant lens.


Sidewinder® LED

The newest product to the family, the Sidewinder Stalk®, is a multi-function military helmet light system featuring multiple colour LEDs, an Identification Friend or Foe (IFF) beacon, a strobe function, and a flexible stalk for aiming light where it is needed. Its versatility reduces the amount of gear needed in the field, and with its multi-fuel capability, it's the ultimate configurable tactical light.

ProTac® 2.0 Series

For blazing brightness without sacrificing run time, Streamlight's new rechargeable ProTac® 2.0 Series has a lot to offer. Whether it's handheld, hands-free, or weapon-mounted, users get 2,000 super-bright lumens from these USB rechargeable lights. All are powered by Streamlight's SL-B50® USB Li-Ion battery pack that charges via USB-C cord inside or outside of the light. With TEN-TAP® programming, multiple lighting modes, and run times of up to 25 hours (based on model), the series offers the reliability needed when in the field.

"At Streamlight, we have always taken pride in designing and manufacturing lighting products that make our customers' jobs easier, improve their productivity, and keep them safe in trying conditions," said Streamlight President and CEO Ray Sharrah. "As we celebrate 50 years of operation, we pledge to continue to leverage the latest advances in LED and battery technologies to produce ever brighter, more useful lighting tools, while still maintaining our same high-quality standards." ■

BREAKING AWAY FROM SILOED THINKING

Against the backdrop of the war in Ukraine, the focus at DSEI 2023 shifts to better-integrated forces across all warfighting domains and leveraging new and innovative digital technologies that enable the warfighter to outstrip near-peer threats.

DSEI 2021 *(MOD/Crown Copyright 2021)*

DSEI 2023 is shaping up to be the largest-ever gathering in the event's 24-year history, with visitor numbers expected to shatter records set in 2019.

Achieving an integrated force is the overarching theme for this year's show, and while DSEI continues to attract some of the biggest names in defence, increasingly, non-traditional companies from outside the sector see it as an opportunity to exhibit their novel digital technologies and applications for defence.

Air Vice Marshal (Ret'd) Gary Waterfall, one of the event's advisors, sat down with *Defence Procurement International* to preview some of the most exciting developments at this year's show.

Q: What are some of the key themes or trends to watch out for at DSEI 2023?

A: The major change since DSEI 2021 is unquestionably the war in Ukraine. The brutal and illegal invasion by Russia has focused minds on how to deter, and if necessary, defeat, a peer/near-peer adversary to maintain our hard-won freedoms; this is now front of mind in terms of how allies think about warfare.

Similarly, the need to continue a programme of transferring military equipment to President Zelenskyy's forces will continue for some time to come; this transfer of technology and their innovative employment is remarkable to see and serves as a lesson in innovation to Western forces.

DSEI is a global event, but as it is based in the UK it will have a significant UK Ministry of Defence (MOD) presence. The UK can be proud to be one of the largest donors to Ukraine having committed £2.3 billion in military assistance in 2022 and pledging to match that assistance in 2023.

DSEI always attracts the biggest brands in the defence industry, but increasingly there are also many companies coming from outside of the defence enterprise either exhibiting for the first time or returning, bringing novel applications of their technology into the sector. Returning exhibitors include household names such as Fujitsu, CGI, DXC Technology, Panasonic, and Dell.

Q: "Achieving an Integrated Force" is the overarching theme for this year's show. Why is this theme so important?

A: Integration at a national level across the frontline commands, and across the levers of power — both hard and soft — is essential to create a credible deterrence. "Multi-domain operations" was the underlying theme of DSEI 2021, and "Achieving an integrated force" is this year's focus. The most effective fighting forces are those that can integrate best across all environments. But it's more than that — it includes integration from the supply chain, SMEs, and large primes alongside the UK government — and all set in an international context. A hackneyed phrase — but together the component parts are much more powerful than the individual sum.

DSEI is a key learning platform and a way to bring together people from different branches of the military to share best practices, discuss ideas and scale capabilities from one domain and apply them to others.

This learning from other domains ties in with the overarching theme for DSEI 2023 of "Achieving an Integrated Force". The UK Ministry of Defence and the British Army, Royal Navy, Royal Air Force and UK Strategic Command are working to integrate at all levels and across the five operational domains of Air, Cyber and Electromagnetic Activities (CEMA), Land, Sea and Space. With this, comes the need for industry to mirror this integrated approach, breaking away from domain silos to work in parallel with other domains to deliver integrated solutions across the supplier base.

Q: Given the advances in AI, data analytics, and edge computing, how far off are we from this integrated vision for Command and Control across all five warfighting domains?

A: Achieving nirvana across all domains may never occur. We are in the middle of a digital technology revolution; bright

Slovak Republic company, KONŠTRUKTA Defense, which has supplied several of its self-propelled howitzers to the Ukrainian war effort, will make its debut at DSEI 2023 (*Photo by KONŠTRUKTA Defense*)

ideas swiftly transform into credible capabilities but can be outpaced by future development in months. Moreover, the requirements grow daily as better connectivity and harnessing of AI powered by effective data analytics make it seemingly simpler to deliver additional complexity.

It is a jigsaw puzzle with no corners and no discernible edges. But this is an area where perfection will be the enemy of progress. Setting standards to allow incremental growth and additional capabilities to spawn will see success. However, returning to the show's theme, it all revolves around integration — at a national and international level. It is here where the resultant solution will see the warfighter being able to act with speed and clarity that outstrips any aggressor and fundamentally increases the credibility of international deterrence.

Q: What innovations or platforms are you most excited to see at this year's show?

A: I might be biased as a former RAF pilot, but I am looking forward to key updates on the Global Combat Air Programme (GCAP). GCAP is a trilateral collaboration between the UK, Japan, and Italy to develop the next generation of fighter jet.

Two months ago, the UK MOD awarded a major contract to BAE Systems on behalf of British defence firms, Leonardo UK, MBDA UK and Rolls-Royce, to progress the design and development of this aircraft. Tempest is the UK name for the aircraft in development under GCAP. Team Tempest has been researching and evaluating a host of future combat air system capabilities since 2018 and is continuing to develop the technologies needed to deliver the next-generation combat air capability.

DSEI will also host a panel with all the directors of the GCAP programme from Italy, the UK and Japan. This will be the first time they are appearing in public together and typifies the outstanding content programme at DSEI.

Q: There seems to be a stronger emphasis on future tech and non-traditional defence companies at this year's show. What can defence learn from non-traditional defence companies? Why are they important to the future of defence?

A: Whilst 'defence' and 'security' are in our title, DSEI presents a platform for companies outside the traditional defence sector. The fastest growing area of the event is "Future Tech". Oracle, Sony, IBM, Palantir and Capgemini are all set to feature, demonstrating the broad reach of DSEI beyond its normal defence and industrial base. They will exhibit alongside the traditional defence industry, including all the major manufacturers. Across these future tech companies, two key trends are developments in AI and cyber.

These companies are important to the future of defence to supply fresh ideas about the development of new technologies and to prevent defence from becoming too stagnant or siloed in its thinking.

Q: The war in Ukraine has seen the innovative use of commercial-off-the-shelf drones, USVs and loitering munitions. How will we see some of these lessons from the Ukrainian battlefield reflected in this year's show?

A: You will see across the DSEI floorplate that companies are drawing lessons from the Ukrainian battlefield. There are tactical lessons to be learnt from Ukraine but there will also be equipment that is currently in use on the battlefield physically at DSEI. For example, Slovak Republic company KONŠTRUKTA Defense has supplied several self-propelled howitzers to the Ukrainian war effort. Making its first appearance at DSEI, KONŠTRUKTA will showcase these


Air Vice Marshal (Ret'd) Gary Waterfall

howitzers alongside new products in ammunition and electronic systems.

I am pleased to be able to say that Ukraine will have a pavilion at DSEI 2023, and they will be represented by their state-owned business – Spets Techno Export. Spets Techno Export is a Ukrainian state-owned foreign trade enterprise that makes a significant contribution to the development of defence and strategic industries.

The Ukrainian Pavilion will showcase a prototype of an advanced naval drone, the unmanned surface vessel Magura V5. There will also be two First Person View (FPV) drones on display, namely Drone JET 7 and FPV Drone JET 8.

Q: There is also a Discover SMEs section at this year's show. Why the focus on SMEs?

A: Given the size of DSEI, it can be challenging to discover cutting-edge SMEs working in areas which are relevant to buyers or visitors. In response to this need, the 2023 show will feature a series of discovery trails that highlight international SMEs working on DISruptive TEChnology – DisTec. The DisTec Trails will guide visitors around the exhibition according to their areas of interest.

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A PARADIGM SHIFT IN NAVAL WARFARE

Unmanned surface vehicles are making waves, and as their use by Ukrainian forces against Russian naval assets demonstrates, the element of surprise they provide marks a major turning point in naval Concept of Operations.

By Tayfun Ozberk

As technology advances at a dizzying pace, new sophisticated weapon systems are impacting current naval strategies and tactics. Given the rising costs of maintaining an operational navy, the sustainability of such systems in terms of development and operational costs, as well as ease of deployment, have become paramount.

These are the primary reasons for the growing importance of unmanned surface vehicles (USVs), which offer several advantages in naval warfare in terms of new capabilities and operational dynamics. USVs can be used for mine countermeasures, reconnaissance and patrols in hazardous environments, where the presence of manned ships could entail risk to personnel and more expensive platforms. USVs increase operational flexibility and provide field commanders with the ability to take more risks to accomplish the mission.

Next-generation USVs equipped with advanced sensors, cameras, and communication systems can provide real-time intelligence on enemy activities, vessel movements and maritime traffic, which improves situational awareness and enables more effective decision-making. Equipped with mine detection systems they can autonomously sweep areas for underwater mines, reducing the risk to traditional mine countermeasure vessels and personnel.

USVs can also play a role in ASW operations by deploying underwater sensors, collecting acoustic data, and participating in coordinated efforts to detect and track submarines. They can be fitted with torpedoes and ASW rockets to engage enemy vessels. They also have a key role to play in Anti-Surface Warfare. Navies are working on arming these unmanned platforms with different types

A ULAQ armed USV by ARES Shipyard and Meteksan *(Copyright: Meteksany)*

of missiles. The most significant examples are the US Navy's Ranger USV fitted with containerised SM-6 surface-to-air missiles, and the Turkish Marlin USV, which will be fitted with dozens of Kuzgun surface-to-surface missiles with a range of more than 40 kilometers.

USVs are also well-suited for addressing asymmetric threats, such as pirates, terrorists, or non-state actors, as they can be rapidly deployed and manoeuvred in response to unpredictable situations.

USVS PROVE THEIR EFFECTIVENESS IN RUSSO-UKRAINE WAR

The use of USVs by Ukraine against Russian vessels marks a new chapter in naval warfare. These makeshift vessels have conducted successful kamikaze USV (KUSV) attacks during the war. On October 29 2022, Ukraine targeted naval combatants at the Russian naval base of Sevastopol, using USVs as suicide drones. This attacking style is relatively unfamiliar in naval warfare, although navies have been working on the Concept of Operations (CONOPs) to use these assets as part of manned fleets.

After the first attack, Ukraine increased the range and lethality of the KUSV, and conducted assaults on Novorosisk and several more naval assets in the middle of the Black Sea. While the Russian Black Sea Fleet was able to repel a few attacks with machine guns, the last two attacks on a Ropucha-class tank landing ship and a logistics vessel demonstrated that Russian naval forces couldn't develop a solid countermeasure against the suicide drones.

OSINT analyst, H.I.Sutton, who is an expert in unconventional warfare, says the war in the Black Sea is an important test ground for USVs. "Until the 2022 Ukraine invasion, USVs were a technology without a war," he says. "Consequently, USVs were not generally armed. Now it has become an imperative." Conflicts such as Yemen and the persistent Iranian threat to shipping in the Middle East have also served as an incubator, he adds, but Ukraine has been the turning point.

A Marlin USV conducting an ASW mission at Dynamic Messenger 2023 (*Copyright: NATO*)

Samuel Bendett, a research analyst at the Center for Naval Analyses (CNA), says we are at the beginning of a process where unmanned technology will be incorporated into naval CONOPs. "The Ukraine war is unique," he says, "insofar as the Russian Navy is not very active, which enables Ukrainian USVs to target Russian ships at ports. We are also witnessing a rapid evolution of USV technology by Ukrainians, and a response by the Russian Navy in fielding different types of defences against such capability."

CHANGİNG THE BALANCE

The future of USVs offers many opportunities for improvements and advances in various aspects of design, capabilities, and applications. New weapons and sensors, the ability to operate in a network-centric architecture, coupled with extensive land, air, and space-based surveillance capabilities, are making the frontline increasingly recognisable and transparent.

Artificial intelligence-enabled USVs can interpret complex patterns of information from the vast amount of data they collect, enabling command and control systems to build a comprehensive situational picture. Penetrating behind enemy lines without risk of human casualties, providing effective ISR, and engaging enemy assets will be the critical tasks of next-generation USVs.

Further advancements in artificial intelligence and machine learning will enable USVs to navigate autonomously in complex and dynamic environments. Improved decision-making algorithms will help them avoid collisions, adapt to changing conditions, and optimise route planning. Integrating multiple sensors, such as radar, lidar, sonar, cameras, and communication systems, will enhance the USV's perception, allowing them to gather more comprehensive and accurate data about their surroundings.

USVs can be designed to operate in swarms, working together in a coordinated and distributed manner to accomplish complex tasks. This approach could enhance their capabilities for surveillance, reconnaissance, and other mission types. Developing intuitive and effective human-machine interfaces will enhance operators' ability to control and monitor USVs, making them easier to operate and integrate into existing naval operations.

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"Individually, USVs are unlikely to match the versatility and survivability of crewed warships, but they make up for it by comparatively low cost," says Sutton. "And equally as important, there is a natural willingness to use them in high-risk missions which might otherwise not have taken place." Sutton says the Ukrainian KUSVs can be improved upon and made more stealthy and survivable. "But, in essence, they are already true weaponised USVs," he says.

The future of USVs will likely see a combination of advancements in technology, engineering, and operational strategies that will make these vessels more capable, versatile and valuable assets in a wide range of maritime applications.

As the unmnanned trend becomes more promising, defence companies have started to develop more types of USVs, which have been showcased at recent defence expos. At the NAVDEX 2023 exhibition in the UAE, many types of USVs, including ones produced with 3D printers, were on display. This is a clear sign that USVs will dominate the seas in the near future.

At the IDEF defence exhibition in Turkey in July, visitors felt the impact of the lessons from the Russo–Ukrainian war. Turkey's leading defence companies launched new kamikaze USVs with enhanced ranges, communication capabilities and heavier payloads to increase lethality. Turkish company, Havelsan's semi-submersible KUSV, which dives just before hitting a target to increase damage and survivability of the drone, showed that the future naval scene will become more complicated and risky for combatants.

Bendett believes the lessons learned from the Russian–Ukrainian war will shed light on the future developments of this technology. "The USV dynamic may be different between other naval powers that have active naval activity and manoeuvres during a conflict, but what the current Ukrainian USV use shows is that a relatively low-cost, capable and effective technology is within reach that can stress even established navies, by providing not just attack capability, but ISR as well," he says.

ÇAKA submersible suicide USV by Havelsan at IDEF 2023 (*Credit: Tayfun Ozberk*)

He compares the approach of the major navies, saying, "There is a parallel approach here — major navies like the US and China have been testing different USV/UUV technologies for years, while Ukraine is actually using such technology in combat already. So Ukrainian lessons can be incorporated into USV concepts and tactics undergoing refinement by other countries."

INTEGRATING USVS INTO NAVAL FLEETS

While the development and improving capabilities of USVs are ongoing, navies are embarking on manned-unmanned teaming (MUM-T) exercises, which refers to the coordinated collaboration between manned vehicles (such as aircraft, ground vehicles or vessels) and unmanned systems to achieve mission objectives more effectively and efficiently.

The US Navy executed Unmanned Systems Integrated Battle Problem (UxS IBP) exercises to evaluate the coordinated operation of manned and unmanned units. NATO countries have also conducted Robotic Experimentation and Prototyping using maritime uncrewed systems in the vicinity of Portugal. Last year's Dynamic Messenger exercise had a particular focus on MUM-T. Moreover, the US NAVCENT-led IMX exercises have attached a particular focus on the operation of USVs.

The benefits of USVs — reduced risk, sustained and widespread presence at sea, deterrence, national security impact at lower unit cost, and exceptionally short procurement times — are whetting countries' appetites for USV deployment.

As USVs prove their value in real-time operations and conflict, defence contractors will continue to improve these vessels, which will change the nature of naval warfare. ■

ABOUT THE AUTHOR

Tayfun Ozberk is a Turkish naval analyst who writes for a range of naval titles, including *Naval News*.

A SUBMARINE LIKE NO OTHER

The US Navy's Orca Extra Large Unmanned Underwater Vehicle is delayed and over budget, but the Navy is committed to exploring the robotic submarine's potential for clandestine mine warfare.

By Peter Ong

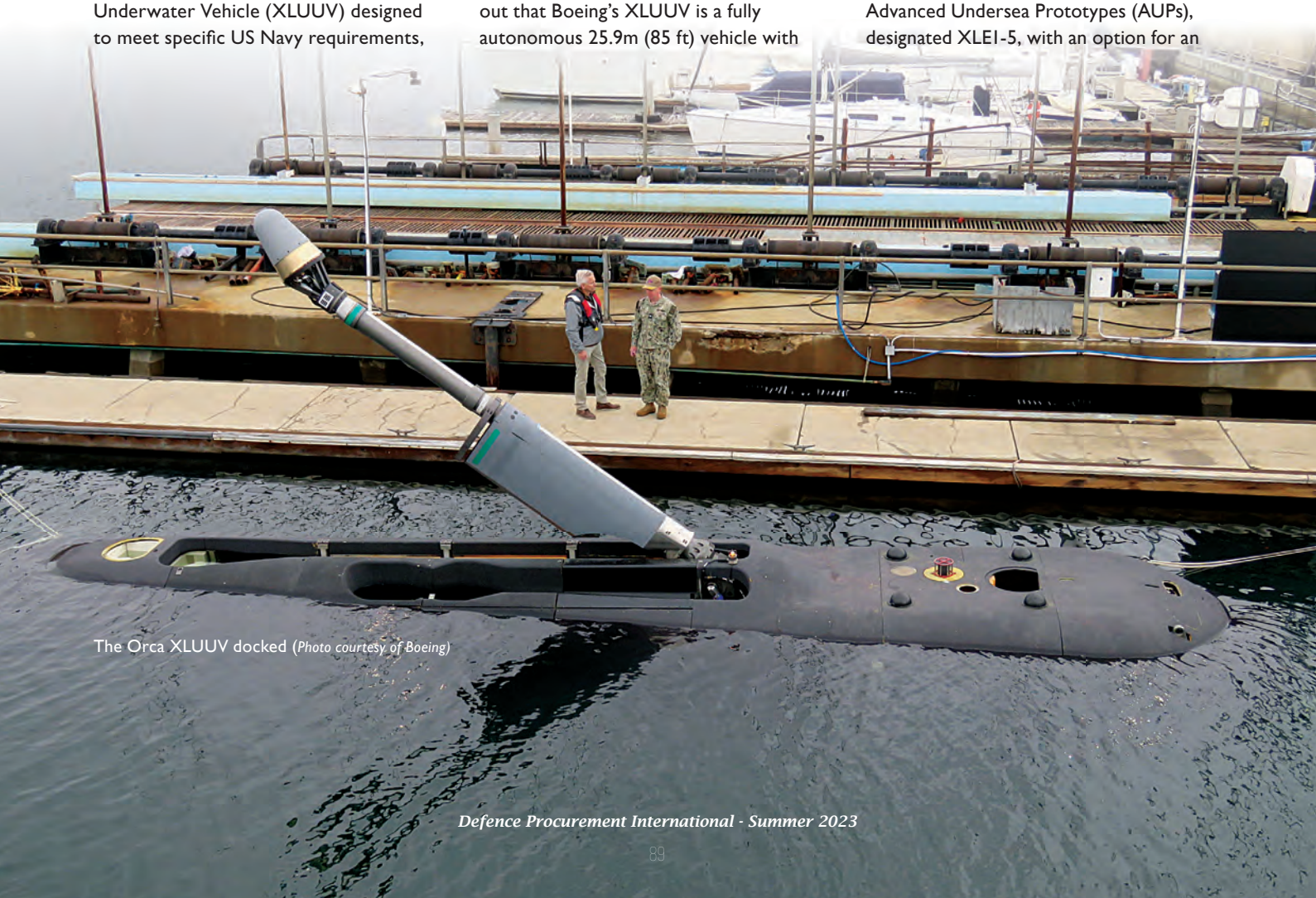
With a focus on protecting sailors from performing dangerous missions, many navies are exploring the potential of uncrewed autonomous vehicles for anti-submarine warfare, ISR and the detection and disposal of sea mines. But one novel programme, led by the US Navy, is looking at the use of "robotic submarines" for laying undersea mines to prevent adversaries from accessing strategic waterways and land entry points.

Aptly named "Orca," which is a variant of Boeing's Extra Large Unmanned Underwater Vehicle (XLUUV) designed to meet specific US Navy requirements, these submarines will change the dynamics of the US Navy's underwater mine warfare with the fielding of autonomous systems that have long endurance and range.

The XLUUV product line emerged from an internally funded programme, which resulted in the Echo Voyager, a Boeing-owned vehicle used for tech development, experimentation, and risk reduction of undersea autonomy. Echo Voyager has more than 10,000 hours at sea.

In terms of capabilities, Ann Stevens, senior director of Maritime Undersea for Boeing's Orca XLUUV Team, points out that Boeing's XLUUV is a fully autonomous 25.9m (85 ft) vehicle with a modular 10.4m (34 ft) payload bay enabling a range of precision undersea missions and applications. In normal operations, the XLUUV departs from a pier with no support vessel required. The baseline vehicle has a 6,500 nm (12,038 kilometers/7,480 miles) range, enabling months-long missions with limited human intervention. "The vehicle is capable of open ocean transit, bottom following, and long-duration moored operations on the seabed," Stevens explains.

In 2017, Boeing won a US Navy competitive contract for five Orca XLUUV Advanced Undersea Prototypes (AUPs), designated XLE1-5, with an option for an



The Orca XLUUV docked (*Photo courtesy of Boeing*)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additional four. "In 2022, a sixth test and training vehicle (XLE0), was contracted to accelerate US Navy tactics, techniques, and procedures training," says Stevens. "The US Navy has a published requirement and budget to continue to acquire XLUUV beyond the AUP programme."

Initially, the Navy planned on the rapid delivery of five XLUUVs with the first vehicle scheduled for delivery by December 2020 and all five vehicles by the end of 2022. However, according to the Government Accountability Office (GAO), the XLUUV effort is at least $242 million or 64% over its original cost estimate and at least three years behind schedule. The COVID-19 pandemic and supply chain issues pushed back delivery and all five vehicles are now scheduled for delivery between February and June 2024.

Stevens says Boeing stood up a new complex industrial base, including manufacturing and assembly lines for large structure modules, new pressure vessels in size, material, and volume, and a complex distributed system of vehicle controls that enables fully autonomous operation for weeks at a time without operator intervention. All this was achieved, she says, during the COVID-19 pandemic, under heavy travel restrictions and global parts and raw material shortages, further exacerbated by the war in Ukraine.

CLANDESTINE SEA MINING

The Orca XLUUV could potentially be used for ISR, ASW, mine countermeasures, and anti-surface warfare, but its ability to secretly lay underwater mines through underbelly "bomb bay doors," is one area being initially explored by the US Navy. The Hammerhead mine, a moored, encapsulated torpedo mine purpose-built to be deployable from XLUUVs, is one example of clandestine undersea mining.

Boeing's XLUUV has an internal payload bay volume of up to 56.6 m3 (1,998 cubic feet) and a payload capacity (dry weight) of up to 7,257 kg (15,998 pounds). The bay provides structure, electrical, and data interfaces to host a wide variety of payloads. In terms of Orca's transportability, Stevens says Boeing's XLUUV is designed to be transported by flatbed trailer (land) and C-17 (air), or given its strategic range, can be self-deployed.

"Boeing's XLUUV is designed to support missions lasting up to 90 days at a time," says Stevens. "The subsequent maintenance periods are dependent on the specific Concept of Operations and mission profiles that our customers choose to employ; however, maintainability was a key driver in the overall vehicle design."

Beyond its use by the US Navy, Boeing is also exploring Orca's export potential. "As maritime security challenges continue to threaten the global economy, there is broad and growing interest in the application of advanced autonomy, capacity, and strategic range to advance undersea warfare," says Stevens. "Boeing's XLUUV team is in discussions with multiple allies that recognize the significance of a mature autonomous solution designed to meet the most robust naval combat requirements."

While submarine technology is a sensitive domain, Stevens says Boeing works closely with US government partners to ensure that these capabilities are exportable to key allies. ■

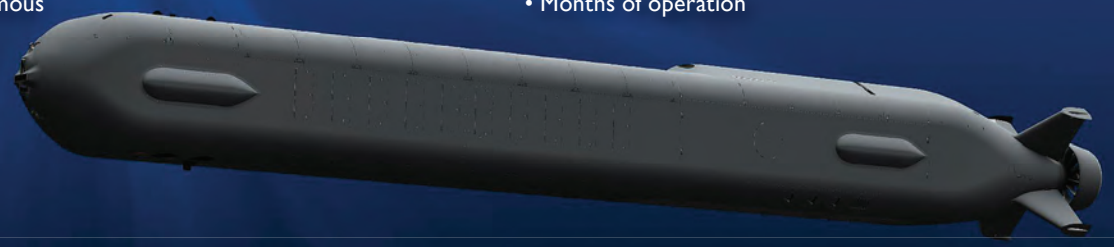
ABOUT THE AUTHOR

Peter Ong is a US-based writer who contributes to a number of leading defence titles.

XLUUV SPECIFICATIONS AND PERFORMANCE

Host Ship Independent
- Swims from port
- Fully autonomous

Long Endurance/Range
- 6,500 nm range (one fuel module and diesel-electric hybrid)
- Months of operation



A fully autonomous vehicle featuring:
- Weight in Air: 50 tons (45,360 kg)
- Envelope (no payload): 51 ft x 8.5 ft x 8.5 ft (15.5 m x 2.6 m x 2.6 m)
- Envelope (with a 34 ft payload section): 85 ft (25.9 m)
- Maximum Depth: 11,000 ft (3,000 m)
- Maximum Speed: 8.0 kts (14.8 km/hr)
- Minimum Speed: 2.5 kts (4.63 km/hr)
- Optimal Speed: 2.5 - 3 kts (4.6 – 5.6 km/hr)
- Range between recharges: ~150 nm (~280 km) at nominal speed" (Diesel-electric hybrid—the XLUUV surfaces and runs its diesel generator to recharge the batteries driving the propeller).

Artist's conception of the Boeing Orca XLUUV (*Image courtesy of Boeing)*

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OPINION

NAVIGATING TROUBLED WATERS

Australia is embarking on the greatest re-capitalisation of its navy, but has it bitten off more than it can chew with multiple mega projects and other resource-intensive builds?

By Richard Dunley

The announcement of the AUKUS optimal pathway in March with the first generation of nuclear submarines to be built in the UK and Australia, based on a British design, has driven widespread discussion within Australia and beyond about how the deal can deliver the required nuclear-powered submarine capability.

However, the focus on AUKUS has tended to distract attention away from other very substantial naval construction projects already underway in Australia, most notably that of the Hunter Class frigates. The AUKUS announcement, together with the challenging strategic circumstances facing Australia, have also led to a wider reconsideration of the future balance and make-up of the Australian fleet coming out of the recently released Defence Strategic Review.

Taken together these factors mean that it is a time of almost unprecedented activity and opportunity in terms of Australian naval procurement, but also one of significant risk given the scale of the projects and the limitations of capacity across government, navy, and industry.

By any criteria, AUKUS is a mega-project. With a cost in the region of 0.15% of the country's GDP and lasting at least three decades, this is a huge undertaking. The government has been very open with the scale of the challenge, presenting it as a "whole of nation opportunity," and highlighting the need for uplift across areas from industry to education and academia. On a more immediate, if prosaic level, the recent establishment of the Australian Submarine Agency, whose staff is expected to reach 680 by the end of 2024, gives an indication of the scale of the organisational challenge.

Hunter Class frigates could be axed

The AUKUS focus has distracted attention away from the other Australian naval procurement mega-project, the construction of nine Hunter Class frigates based on the BAE Systems Global Combat Ship design. This project has been dogged by questions of design immaturity, increases in weight, escalation in cost, and doubts over the original procurement requirements. The project is now significantly behind schedule, and it appears likely that the government will soon take the decision to reduce the number of hulls, if not axe the programme completely.

One thing that is common to both the Hunter Class project and Australia's lengthy efforts to acquire a future submarine capability is the decision to go with procurement options that maximise return in terms of both capability and domestic industry involvement. These decisions have naturally brought higher risk. In contrast, efforts during previous construction cycles tried to balance out more and less risky projects, most notably with the acquisition of the Collins Class submarines and Anzac Class frigates.

The implications of this approach were brought out very clearly in a recent Australian National Audit Office (ANAO) report on the Hunter Class, which highlighted how many of the issues facing the project stemmed from the decision to go with a comparatively immature design. Seeking to maximise capability and domestic industry involvement does not only have implications in terms of the potential for delays and cost overruns, but it also places additional strain on Australia's limited resources. The same ANAO report noted that a lack of suitable skills and expertise had been a perennial issue for the Hunter Class project, something that will have only been compounded by the almost insatiable appetite of AUKUS.

> ***By any criteria, AUKUS is a mega-project. With a cost in the region of 0.15% of the country's GDP and lasting at least three decades, this is a huge undertaking.***

Further, very significant decisions related to Australian naval construction are expected in the coming months. The Defence Strategic

Review (DSR), ordered by the incoming Labor government last year, has clearly set out the requirement for a shift from a balanced force to one focused on high-intensity conflict with a peer rival. It has also highlighted the loss of warning time, and the need to get capabilities into service quickly. Precisely what this means in terms of naval procurement is unclear, as the review opted to recommend a further review of the surface fleet instead of making its own recommendations.

Multiple risky and resource-intensive projects

Most analysts and commentators have focused on the need to enhance lethality, and in particular increase the number of missile tubes the Royal Australian Navy can put to sea. The rather cryptic remarks in the DSR and from Defence Minister, Richard Marles, about the growth in the number of smaller surface vessels may also indicate the intention to shift towards an approach like the US Navy's concept of Distributed Maritime Operations. It appears likely that the surface fleet review will recommend a reduction in the numbers of Arafura Class Offshore Patrol Vessels and/or Hunter Class frigates to acquire further destroyer capability and a new class of smaller corvettes.

The desire to enhance lethality and increase the pace with which new capabilities are brought into service is sensible. However, seeking to achieve both at the same time may prove problematic. Given the fact that the Hunter and Arafura projects have been in train for several years, any cuts to them with the aim of increasing lethality will likely mean even longer delays before the new capability hits the water. This, in turn, would have major implications for the upgrade programmes for the existing vessels, most notably the Anzac Class Transition Capability Assurance Program (TransCap). Similarly, adding additional projects to the already extensive list of Australian naval construction and maintenance programmes will further dilute the already limited pool of resources and expertise.

Ultimately, much of this comes down to a question of risk. Concerns over Australia's strategic situation have driven the procurement decision-making process, leading to a focus on acquiring the most advanced and capable platforms. At the same time, domestic political concerns, combined with a desire for a sovereign capability, have led to decisions to build in Australia, and prioritise Australian industry contributions.

All these decisions make sense when viewed in isolation, however, the layering of multiple risky and resource-intensive projects on top of each other creates the real possibility that the Australian government and industry will simply lack the resources necessary to successfully see them all through to a conclusion. No matter how bad the strategic situation is,

US President Joe Biden greets British PM Rishi Sunk and Australian PM Anthony Albanese *(DoD Photo by Chad McNeeley)*

Australia will always be better served by a vessel in the water than one which merely exists on paper.

This means that there is a very strong case for the surface fleet review to focus on de-risking any new projects to the greatest extent possible. In its most extreme form, this could be a decision not to pursue a new platform and instead to make more limited changes to the programmes already in progress. Other options include limiting requirements for Australian industry contribution for any new projects, and possibly even taking the decision to build the vessels overseas. Such decisions would have significant political costs, but they would help reduce risks and allow Australian industry to focus on the challenges involved in delivering AUKUS.

Change of mindset needed

A further option could be the adoption of a military off-the-shelf design with very limited 'Australianisation'. Australia has learnt through hard experience that modification of designs dramatically increases risk and makes cost and timeframe blowouts far more likely. The adoption of a tried and tested design for any new vessels would help mitigate this. It would, however, run up against the perennial problem that few other nations have Australia's peculiar mix of geography and strategic requirements.

Australia is currently embarking upon arguably the greatest-ever recapitalisation of its navy and is doing so in the face of a deteriorating strategic situation. Policymakers need to think carefully about how they can provide the Royal Australian Navy with the best capability possible given the nation's limited resources and to do so within a timeframe that ensures it will be relevant. Achieving this will, however, require a change in mindset.

The government can no longer simply default to selecting the options which are the most capable on paper but also the riskiest. Australia needs a hard-nosed and pragmatic approach to its upcoming naval procurement decisions to ensure that they are deliverable within the necessary timeframes and budgets and get equipment into the hands of the sailors of the Royal Australian Navy, as soon as possible. ■

Dr Richard Dunley *is a senior lecturer in history at the School of Humanities and Social Sciences (HASS), UNSW Canberra. His research interests include British history and defence studies.*


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IS YOUR BRAND BATTLE READY?

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History has shown that forming a clear strategy with finely tuned tactics will usually win the day. Obvious, you might say, but why haven't we all learnt lessons from the past?

Back in the early nineteenth century, the French and Spanish Navies joined forces to help carry out Napoleon Bonaparte's plan to invade Britain. Their mission was to take control of The Channel – an arm of the Atlantic Ocean that separates southern England from northern France, thus providing safe passage to the French Army.

This allied fleet, under the command of the French Admiral, Pierre-Charles Villeneuve, began its voyage in single file heading north from southern Spain on 18 October 1805. It soon encountered the British fleet under the leadership of Lord Nelson. In anticipation of the threat, Nelson had assembled his fleet along the southwest coast of Spain, off Cape Trafalgar and was lying in wait.

Warships of the time were designed for the naval tactic known as the line of battle - two parallel columns of opposing warships manoeuvring to exchange fire along their broadsides. Typically, in

conflicts such as this, the opponent with more firing cannons had the advantage. The alliance fleet included the 136-gun Santissima Trinidad, the largest ship in the world.

Recognising that he was outnumbered, Nelson sailed his fleet in two squadrons sailing perpendicular to the enemy's line, hoping to break it into pieces to address this imbalance.

The plan proved to overwhelm the centre and rear sections of the enemy's fleet. Soon after dawn, Nelson's two-column attack split the French/Spanish fleet into three parts, successfully piercing the enemy line and firing cannons into the bow and stern of enemy ships as they passed between them.

The ensuing fierce battle resulted in 22 allied ships being lost, while the British lost none.

Can parallels be drawn between this historic event and a modern-day brand? One observation would be that if Admiral Nelson were to have considered himself as a brand and pondered over his core values back in the day, then one could imagine they would be along the lines of: courageous, reliable, leading, strategic, entrepreneurial, honest, faithful, dutiful, experienced, opportunistic etc.

Nelson's image would have been backed up by his inspirational leadership qualities, grasp of strategy, and opportunistic tactics which brought about several decisive British naval victories. His officers and crew had great faith in his decisions and were literally 'on board' with the direction that he gave and the values that he portrayed.

Like with all good brands, Nelson engaged with his followers, and they felt loyal, rewarded and proud of their association with him.

In comparison, even though Villeneuve knew of Nelson's likely tactics, his officers were not trusted to break the conventional line of battle for fear they could not make rational decisions on their own and needed to be signalled with instructions. He was personally uncertain how the battle would unfold and nervous about what the eventual consequences might be.

Nelson's strategy was clear and focused. He wanted to dominate the Channel and conquer the impending invaders once and for all. He knew that the conventional single line of engagement approach often led to fleets engaging in a mixed mêlée of chaotic inconclusive battles without a clear winner or allowing the losing side to minimise its losses, so this wasn't an option. He needed to somehow develop tactics that would allow the fleet to lock ships together and capture the enemy by boarding and fighting hand-to-hand to the end. He saw this as the only way to an outright win.

Establishing tactics for a brand can only be achieved if the strategy is in place. Nelson demonstrated how focused tactics can be once the strategy, goals and objectives have real clarity.

Gaining clarity around your brand:

- **A goal is a broad primary outcome** — Protect Britain from invaders
- **A strategy is the approach you take to achieve a goal** — Dominate the Channel by sea
- **An objective is a measurable step you take to achieve a strategy** — Defeat the French/Spanish Navies once and for all
- **A tactic is a tool you use in pursuing an objective associated with a strategy**
  1. Let the enemy come to me
  2. Take them by surprise
  3. Approach the enemy side on in two columns

Comparing the above to conventional brand tactics, it is clear to see how Nelson's fields could be substituted. For instance, the tactics for a military hardware manufacturer would typically be replaced with several marketing channels that would formulate an integrated mixture of social media, PR, on-page and online planning.

Winston Churchill once said, "The farther back you can look, the farther forward you are likely to see." All things considered, it's difficult to understand why so many companies carry out day-to-day tactical planning without any clear goals, strategy, or objectives at all, let alone having generated buy-in with key stakeholders.

To those companies, I ask the question 'do you have a Nelson-style strategy, or do you fall into the Villeneuve camp of thinking?' ■

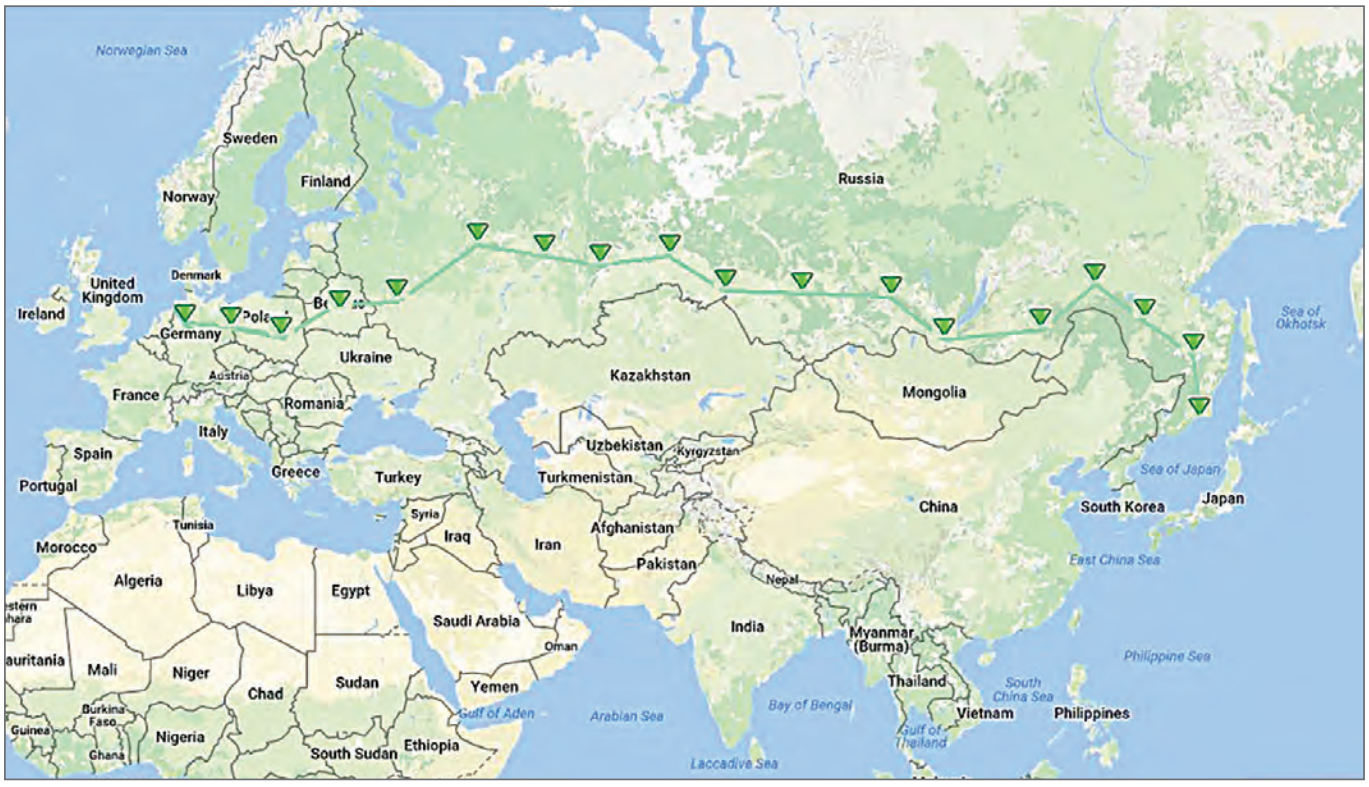
THE MOST SOPHISTICATED TRACKING SECURITY FOR GLOBAL SUPPLY CHAINS

Zenatek

In military supply chains, tracking regulation and security fall under the control of military logistic departments and authorities.

One might assume that these authorities provide cargo monitoring at its best. Unfortunately, there is evidence to suggest that this assumption is not warranted. There are military deployments in which tens of thousands of containers or pallets per year remain unaccounted for, without a proper e-tracking system. Such waste or misplacement of costly resources is bad enough, especially if the resources represent depreciating or perishable assets. Much more importantly, the troops involved may suffer the consequences of improper tracking and may not be as well protected or as well fed as they should be.

Obviously, improperly tracked or missing containers hold not only food items and supplies necessary to sustain the troops and keep them healthy, but also equipment and material, including vehicles, air conditioners, earth moving equipment, and more. It is not unusual for key shipments to arrive late, or to miss transshipment. They may even be untraceable in ports and countries suffering critical logistics issues themselves. Moreover, some transporters have been known to hide their problems, keeping missing containers in certain port yards or other "off-the-grid" facilities. Such transporters are not always happy that clients may want to monitor and analyze the whole transport process to be sure their money has been well spent. There is also the problem of frequent overcharging of demurrage fees to clients.



Tracking of goods equipment from Europe to Russia

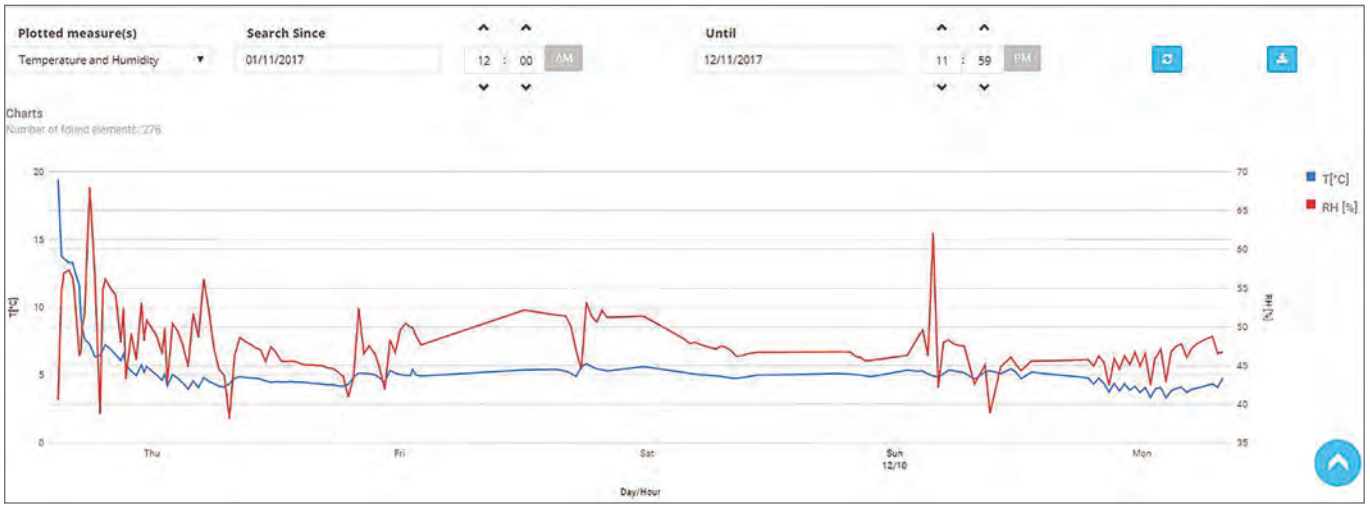


Chart of temperature and humidity related to a transport of ammunition

With modern, technologically advanced real-time monitoring provided by Zenatek Tracking Service (ZTS), these problems can be eliminated quickly and efficiently. Our service is very reasonable and cost-effective, and we have a proven track record of excellence in the field. Today, we track goods globally and have recently expanded our service, extending it to a much broader range of goods without sacrificing the discretion our client's demand.

ZTS was designed with an eye to maintaining strict cost control. Our primary aim was to develop a rock-solid goods tracking system that would remain affordable while meeting the needs of our service's end users. We have created a system that is intentionally simple and stable, based on user-friendly web-based software. For practical purposes, it is not necessary to verify the location or positioning of the goods every 30 minutes. Nor is it necessary to implement overstated monitoring requirements that increase battery costs and may lead to the hardware device being returned to the sender. However, it is critically important to have the capacity to determine and trace all shipments' routes, and to receive immediate alert notices when something unexpected or unpleasant happens to a shipment. These alerts are sent by Zenatek's web-based system via e-mail to any computer, smartphone or other device assigned by the client.

To provide an accurate geographical position for a monitored shipment at any point, the ZTS tracking device may use its internal GPS, which is compatible with the GPS/Glonass standard and is also Galileo-ready. Alternatively, it can leverage information from mobile network cellular towers. The user can remotely configure all of the system's communication parameters, even after a shipment has departed the loading point.

ZTS can also store a container's packing list, password-protected, in the web-based application, together with lading documents and health certificates, thereby enabling the receiver to trace the shipment's contents and route with a mere finger-click on a tablet. The ZTS device will also trigger alarms when a reefer container's internal temperature and humidity deviates from a predetermined level set by the client. It then alerts the user when the temperature and humidity return to the required level. Additionally, it will alert the user if flammable goods within a container are approaching the point of ignition, or if a container's doors or a pallet's seals are subjected to tampering. It will similarly alert the user if a container or pallet is turned on its side, capsized or involved in a destructive incident.

The ZTS device has geo-fencing capability. This means that if a trailer or container is placed in a new location or moved to another part of the current port, the device will wake up and alert the user. The device also provides geo-coded proof-of-delivery information to the client, who can then rest secure in the knowledge that the shipment has reached its destination, and that there has been no unauthorized opening of a container's doors or tampering with a pallet. The device conforms to international regulations, including FCC and EU standards, not to mention that it is also HERO compliant.

Other currently available tracking technologies do not fare well in performance comparisons with ZTS, and some of those products can be very expensive. In fact, some operate based on monthly fees, or payments per communication received by the client, or both. Zenatek, on the other hand, designed and manufactured ZTS with affordability in mind. ZTS devices need not be retrieved at destination points because all traced route and shipment information is in the system and has already been transmitted – the devices may be used on a "one-way" basis. This eliminates all costs associated with unit and data recovery

tasks, such as recovery personnel costs, and unit forwarding, reconfiguring, and restocking. These aspects of ZTS in particular make it ideal for military logistics applications.

Pallets may be transported and tracked in containers; they may be transferred to train or truck, and then reloaded into containers based on any intermodal chain. ZTS will track accurately and provide status reports throughout, monitoring for any damage, tampering, interference, or deviations.

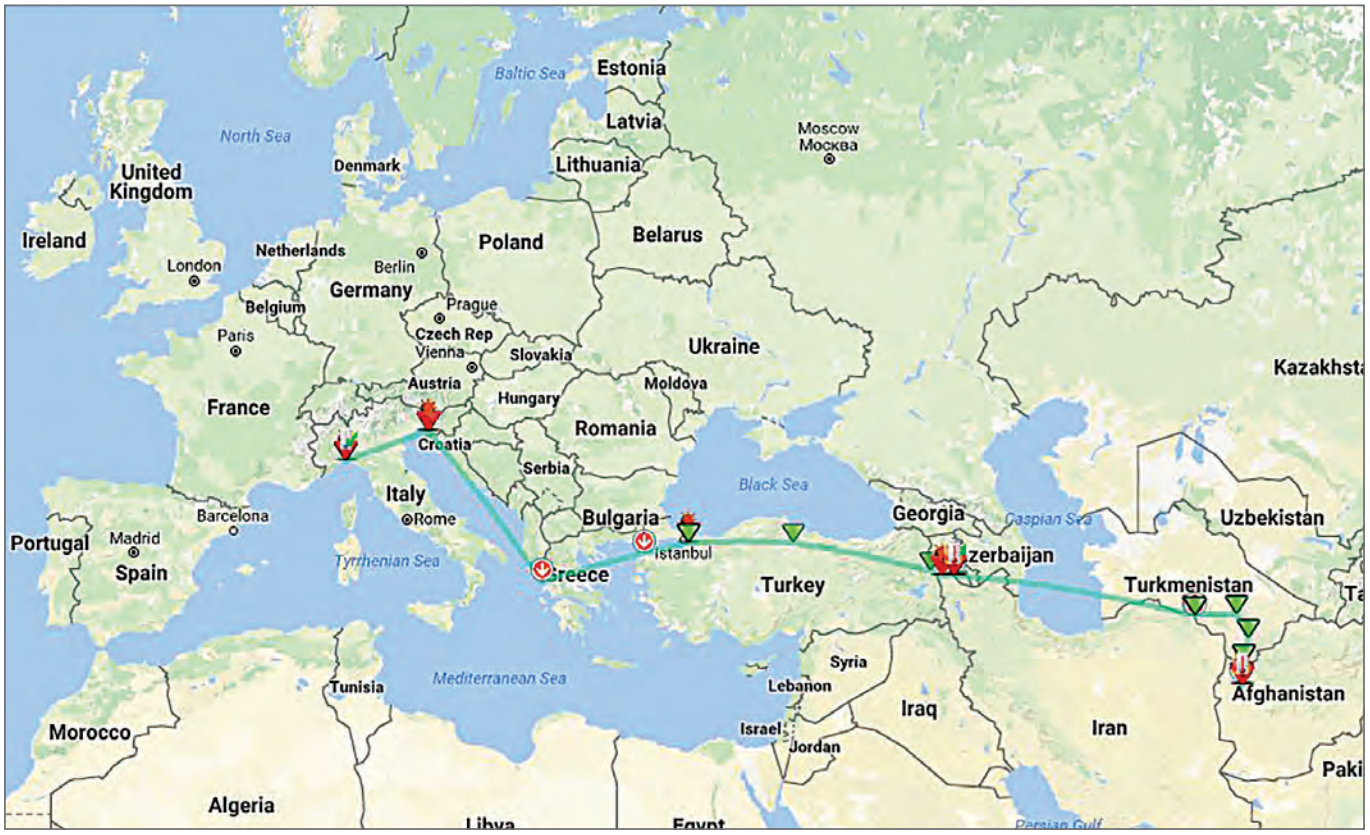
Real-time status updates and event alerts allow users to respond quickly to changes and emergencies. ZTS affords users the possibility of prompt, effective damage control, even to the extent of rerouting an entire shipment if necessary. The benefits are obvious, particularly with respect to time-sensitive or temperature-sensitive shipments.

Users can also elect to provide receivers with access to ZTS web-based applications, so that they are equally informed as to a shipment's status and current location. Clients can predetermine the range of the information to be made available; they may change access to and frequency of status updates for any or all of the available information. All data is contained within an encrypted data stream for full security, maximum confidentiality, and protection.

Today, one of the mostly frequently used tracking technologies is RFID (Radio Frequency Identification). Unfortunately, RFID technology depends on the acquisition of a costly infrastructure of porticos and hardware at fixed sites, or unreliable hand-held transceivers that need constant maintenance. In fact, an RFID device could, at least theoretically, be manipulated to form part of a weapon (for instance, as a triggering device) designed to attack a specific shipment.

ZTS leaves RFID technology and its associated problems and expenses behind. With ZTS, clients now have access to a one-price solution that includes all costs associated with the technologies and services provided.

We live in a world that seems increasingly insecure, and there are those who would resort to violence in their attempts to disrupt international civil and military supply chains. The threat of terror attacks targeting global logistics through vulnerable transport systems can never be eliminated, but it can certainly be reduced. The continuing use of unchecked and unmonitored containers, pallets, trailers, and rail cars, when viewed in combination with current business practices in many congested ports, represents a hidden but very real danger. With Zenatek service these potential threats can be seriously reduced. ■



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