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Front cover: Boeing is displaying a new iteration of its CRVS visual technology at I/ITSEC 2016. (Photo: Boeing)

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Trevor Nash, Editor

Pipe down

It's an often-quoted term and one that is frequently abused – the 'training pipeline' is a concept to which many refer, but few truly understand.

A pipeline is a method of seamlessly moving resources, be they fluids or people, from one point to another. When 'training' precedes 'pipeline', the process becomes slightly more complicated, but the fundamental action – moving things from one place to another – remains the same.

Unlike fluids, the training pipeline is not about physical transfer but more about a cognitive and skill-based process that changes the knowledge, skills and attitude of an individual. The term refers to taking an individual or group of individuals from one state to another – in other words transforming them from an input standard to an output standard.

In military terms, this output is inexorably linked to an operational requirement or need. For example, if the nation operates a fleet of 500 main battle tanks, the crewing of those tanks – gunner, loader, driver and commander – needs to be multiplied by 500, plus allowances for wastage, illness, postings, the maintenance of a reserve and perhaps the addition of an agreed percentage as a contingency factor.

Resource hungry

Individuals entering the training pipeline must be at a given standard or entry level and the output must achieve set training objectives that are assessed through testing and evaluation. Not rocket science, but in between input and output, countless resources are required to achieve the training goals. In the example of tank crews, these include the provision of trained instructors, classrooms, accommodation, virtual and live training equipment, ranges and manuals that are all based on a thorough training needs analysis process.

These resources are clearly tied to the expected throughput of the training pipeline. If throughput rapidly increases or decreases, resources can be over-stretched or wasted. This was exemplified in 2011, when the RAF sacked 170 pilot trainees following on from fleet reductions as a result of the 2010 Strategic Defence and Security Review. Overnight, this sudden decision created a training pipeline whose resources were too great for the new requirements and therefore wasteful.

The RAF appears to have balanced its aircrew manpower requirements with its current fleet plans. However, the Royal Navy is facing its own staffing crisis caused by making many of its personnel redundant, but then having to respond to a political decision to operate both new carriers instead of just one.

A service such as the Royal Navy cannot simply expand overnight. It requires different skills and experience at various levels to remain balanced. Training is a long-term process and the pipeline cannot simply be turned on or off.

Efficiency failing

The other issue is failing to correlate specific training devices with throughput. The recently published US Government Accountability Office report entitled 'Efforts to Adjust Training Requirements Should Consider the Use of Virtual Training Devices' focuses on this problem. On the surface, the report encourages the use of virtual devices but also highlights that the US Army needs to improve its strategy for their efficient use.

Examining the usage of eight virtual trainers, the report stated that these devices were only used for 20.56% of their total available time. Some, notably the Common Driver Trainer Mine Resistant Ambush Protected Vehicle Simulator had a usage rate of 1.3%.

The case of the RAF and the RN highlights the danger of political decisions impacting training. The same has occurred in the US, with the impasse between Congress and the White House that led to sequestration and the USAF being forced to reduce training and stand down operational squadrons. This led to a pilot shortage, notably in the F-16 community, something the USAF has only now started to address.

Interim training units are being established from F-16 aircraft based at Hill AFB in Utah, at two of the four current F-16 training locations, and it is planned to spin-off these assets to form formal training units at permanent locations in the US. The USAF is currently evaluating a number of potential air bases for this new training task and a decision is expected later this year.

Training is not just about simulators – it needs to be based on a robust analysis and methodology. ■

In the next issue

- Motion capture and eye tracking
- Visual database development
- Serious games
- US S&T programme update

Boeing launches latest version of CRVS

Boeing has launched the latest version of its CRVS to provide 20/20 acuity throughout a 360° FoV using JVC D-ILA projectors. (Photo: Boeing)

No stranger to providing high-end visual systems, notably its Visual Integrated Display System that was developed in the 1990s, Boeing launched its Constant Resolution Visual System (CRVS) in 2012.

Since its launch, the system has been adopted widely by the US as well as in Australia and Saudi Arabia. 'By 2009, the technology had advanced to where a clean-sheet design was required to capitalise on advancements that had been made in COTS projector technology... particularly evidenced in the wide 16x9 format, high-definition digital projectors that had been developed for the digital cinema and professional markets,' Harry Streid, technical fellow at Boeing, told *MTSN*.

'The shape of the screen allows a standard projector lens to map pixels relative to the eye-point, such that all of the pixels appear the same size to the viewer, thus providing constant resolution,' he explained. This is enhanced through a 'high-contrast and high-acuity' screen coating.

Like the original CRVS system, Boeing is maintaining its long-standing relationship with JVC, which will be supplying Direct-Drive Image Light Amplifier (D-ILA) projectors for its latest variant, but the new CRVS brings a number of advantages over its predecessor.

'In addition to being the first 360° FoV visual system to provide truly eye-limited resolution, [the new] 20/20 CRVS operates with 120Hz update rate [that] completely eliminates flicker as well as temporal aliasing, and minimises motion blur, even at high motion rates,' said Streid.

'Motion blur is further reduced by proprietary light modulation techniques, made possible by the solid-state laser light source. This reduces operating costs and provides better consistency and uniformity of brightness and colour versus the arc lamp sources used in modern simulators today.'

Asked about edge blending and colour balance, Streid explained to *MTSN* about the eight-projector system, and said that the 'CRVS advanced screen design results in no need for edge blending, while colour balance between projectors is maintained by a fully automated alignment system'.

20/20 CRVS certainly promises great potential and in addition to new customers, Streid said that current CRVS users can 'upgrade to 20/20 resolution by simply swapping out current projectors with [the] new projector technology'.

The better the resolution, the less chance of eye fatigue or simulator sickness, and in theory at least, this improved environment should provide enhanced training transfer. 20/20 CRVS is sure to draw the crowds to the Boeing booth at I/ITSEC 2016.

By Trevor Nash, St Louis

RDE hopes KC-390 training will become intercontinental

Rheinmetall Defence Electronics hopes its exclusive framework contract from Embraer will result in orders for more than just the first simulator. Rheinmetall was awarded the contract in March 2016 to deliver training equipment for the Brazilian aircraft manufacturer's KC-390 twin-jet medium-range tactical transport. The contract covers full flight simulators, cockpit procedure trainers and cargo trainers for the KC-390.

Embraer expects to receive the certification of the KC-390 by the end of 2017. Deliveries of the 28 KC-390s ordered by the Brazilian Air Force are planned to stretch over ten years, starting from the first half of 2018. Five more countries have placed options for 60 aircraft and several more have expressed interest, according to Stefan Klaes, senior sales manager of flight simulation at Rheinmetall.

Klaes said deliveries of the first training systems – a full flight simulator, cockpit procedure trainer and cargo handling trainer – for the Brazilian Air Force are scheduled for 2018/2019. He expects the first simulator to be located in Brazil, so it could also be used by Argentina and Portugal. Klaes also mentioned the possibility of another simulator being located in Asia for KC-390 customers there.

He said that KC-390 operators will be offered Rheinmetall training equipment as an option, adding that all devices will be listed in Embraer's training catalogue. Klaes said the KC-390 framework contract takes a similar approach to Rheinmetall's contract with Airbus for the A400M cargo handling training system.

He described a 'very good business outlook', with orders for over 100 KC-390s in the next ten years requiring more training equipment and the typical operational lifetime of such an aircraft exceeding 30 years, for which continuation training is needed. Regular updates and modifications to the aircraft will have to be incorporated into the devices, he added. He saw further opportunities in the maintenance and operation of training devices and if the KC-390 is transferred to the civilian market.

By Nicholas Fiorenza, Berlin

Farewell QF-4, hello QF-16

The USAF has used the last of its QF-4 aerial targets and now has a fleet of QF-16s as replacements. The aircraft can be flown with a pilot for certain missions or pilotless when acting as targets. (Photo: USAF)

The re-use of redundant fighter aircraft to act as full-scale aerial targets (FSAT) has a certain symmetry with the hunter becoming the hunted. In August, the USAF conducted its last FSAT mission using a QF-4 target – a modified F-4 Phantom.

Operated by Detachment 1 of the 82nd Aerial Targets Squadron (ATRS) from Holloman AFB, New Mexico, the last QF-4 was engaged and destroyed by an F-35 Lightning II from the F-35 Integrated Test Fleet at Edwards AFB. The QF-4 programme was operated and managed by BAE Systems, but as the stock of Phantoms dwindled, and surplus but more capable F-16 Fighting Falcons became available, Boeing secured a contract to convert the latter type into the QF-16.

The QF-16 is an FSAT that has been modified to be flown with a pilot in the cockpit for training and also without a pilot as a target for live missile testing. The 82nd ATRS received its first QF-16 in September 2014.

On 23 September 2016, Air Combat Command declared initial operational capability for its QF-16 FSAT and the USAF now has 15 currently available for test and training activities. The QF-16s are assigned to Tyndall AFB in Florida and flown by the 82nd ATRS, the only FSAT unit in the USAF.

The QF-16 marks the introduction of fourth-generation fighter capabilities in the aerial target mission. It maintains all of the inherent capabilities of the baseline F-16 Fighting Falcon including supersonic flight, the ability to deploy various countermeasures and 9g manoeuvrability.

'This leap forward in airframe capabilities, combined with advanced electronic pods, will allow us to properly test and evaluate our fifth-generation aircraft and weapons,' said Lt Col Matthew Garrison, the 82nd ATRS commander.

By Trevor Nash, London

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Iqarus opens Hereford training centre

Aberdeen-based Iqarus Intelligent Health Solutions has opened a new training centre offering realistic environment medical training solutions. The company, which has a legacy of providing such training to the offshore industry, has built this new resource to offer training to medical and evacuation teams, including the military, in realistic environments.

'Our specialty is instilling the best of Western care into remote and difficult environments,' explained Ged Healy, executive director. 'We train those who are working in environments whereby they are under constant threat. They have little or no access to backup and are either under immediate hostile threat or are simply working in an area lacking health infrastructure.

'Staff working in these environments are, by the nature of the work, operating in high-stress, high-pressure environments, and what we are aiming to do with our Hereford training centre is to replicate the environments and situations that medics are going to face in order for them to train in realistic conditions.'

The new Hereford centre is spacious and includes two standard classrooms along with 745m² of specialist training simulation rooms and scenes. The capability includes training in desert, jungle, woodland and arctic environments and the facility incorporates dedicated 'environment' rooms for each of these climatic regions.

The centre incorporates collapsed building structures, two-storey houses for rescue training, water rooms, a road traffic collision simulation area and Middle Eastern and European street simulations. There are gold command operations control rooms available for exercise staff who have the responsibility of coordinating the incident.

Overhead UAVs, state-of-the-art cameras and a two-way intercom system allow the user to be on scene dealing with a casualty without an instructor present in the room, adding to fidelity. To continue with dynamic training, the centre has a 4D high-fidelity immersive simulation room which can incorporate any environment at the customer's request.

'We can offer bespoke training to individual customer requirements and are talking closely with a number of militaries about what we can offer their medical teams,' explained Healy. 'We have the benefit of being able to offer immersive and realistic training in a range of hostile environments within a central location. Additionally, we have the capacity to deliver courses in Afghanistan, Kenya and Iraq and can provide lesson packs in numerous languages.'

Embedded within the centre is a dedicated coordination management team allowing effective and efficient tracking of students, certification requirements, audits and care throughout the training cycle and beyond.

By Sarah-Jane Prew, Hereford

Force-on-force training enabled by EST II

Meggitt Training Systems has started deliveries of the US Army's Engagement Skills Trainer (EST) II and used the recent AUSA exhibition in Washington, DC to promote the system to prospective customers.

Awarded a $99 million contract in June 2014 – although progress was initially delayed by a protest – Meggitt has begun deliveries of more than 890 EST II systems to army locations around the world. After completing the project's system verification test, EST II was formally certified as the army's programme of record for small-arms training.

Speaking to *MTSN* at AUSA, company representatives said the system would now train soldiers in 3D marksmanship, collective and judgmental video scenarios, with each mode providing critical training based on the skill level of the soldier or unit.

In addition to training up to 15 soldiers in marksmanship skills, EST II provides automatic coaching, a tablet interface, enhanced graphics and compatibility with existing army simulated weapons.

Darren Shavers, liaison officer at Meggitt Training Systems, said a key element of the EST II upgrade was the use of the CryEngine game engine, designed by German developer Crytek. 'We have upgraded the different modes of training. Before, there was a static eye point which only allowed defensive marksmanship, and we changed it by using the Crytek [gaming engine] for the marksmanship, which gave people higher fidelity on the images,' he explained.

'This also gave you the moving eye point – so in addition to regular simulation where you can move the target towards the shooter, now you can simulate the shooter moving to the target. That's one big thing that Crytek brought the training, that ability to do that.'

This enhancement enables group training in confined environments, giving each squad member a realistic representation of the battlefield and allowing soldiers to move within the scenario.

Winn Hines, director of virtual systems programs at Meggitt Training Systems, said the company had looked 'across the spectrum of what was available' and settled on CryEngine as providing the 'most realistic 3D perspective for the shooters'.

'In a gaming engine, typically there's a single-shooter perspective, which means the eye point is in the centre of the screen. But if you have five shooters, you don't want the eye point to be in the centre of the screen for the shooter who is on the right or the left. So, we perspectively render the eye point to where the shooter is standing.'

By Tony Skinner, Washington, DC

VT MÄK releases VR-Engage

VR-Engage offers a number of simulation opportunities for training dismounted soldiers, vehicle crews and pilots of rotary- and fixed-wing aircraft. (Photo: VT MÄK)

Best known for developing software for LVC simulation, VT MÄK's COTS solutions have historically been designed to assist customers to train, plan, analyse, experiment, prototype and demonstrate.

This strategy has recently been enhanced with the announcement that the company has released a new virtual simulation product called VR-Engage. Developed for use in training simulations or laboratory experimentation, VR-Engage allows users to play the role of a first-person character, a ground vehicle driver, gunner or commander or the pilot of a fixed-wing aircraft or helicopter.

At the core of the new product is VT MÄK's VR-Forces simulation engine, VR-Vantage's 3D graphics and a network interoperability capability provided using VR-Link technology.

According to the company, VR Vantage features a high-fidelity vehicle physics model, a library of air and ground vehicles and DI-Guy human characters. Secure radio and voice communications can take place using DIS/HLA protocols.

The company said that the new product 'is ready to use out of the box. It can be deployed as a trainee simulator, as a role player station, an instructor aid, a desktop simulation game or even as a VR headset experience.' Natively compliant with DIS and HLA, VR-Engage can be used in multi-player classroom environments, and can integrate with existing simulation applications and third-party SAF/CGFs. When VR-Engage is used in conjunction with VR-Forces and other company products, the 'additional benefits of a common system architecture' can be achieved, said VT MÄK.

'We're thrilled to add VR-Engage to our line-up of COTS products,' said Dan Schimmel, CEO. 'Our global customer base of system integrators in the training and simulation market has been building virtual simulators directly on top of VR-Vantage and VR-Forces for quite some time.

'By providing an integrated but extensible virtual simulator application, we give them the best of both worlds – game-quality immersive simulation combined with open architecture. Customers can reduce their time to implementation while still enjoying the flexibility to customise and control key aspects of the system.'

By Trevor Nash, London

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As companies, procurement officials and users prepare to decamp to Orlando for the annual I/ITSEC event, *MTSN* takes a look at the US simulation and training industry's capabilities. As more and more military users adopt these technologies, both to improve training and save money, the market remains buoyant. **By Miles Quartermain**

Flexible thinking

The US defence budget amounted to $597 billion in 2015. This represents very nearly half of the aggregate budgets of the top ten global spenders on defence, according to the 2016 factsheet released by the Stockholm International Peace Research Institute. The same source indicates that this spending level represents a commitment of 3.3% of GDP.

This figure is well above the global average of 2.3% and significantly higher than any other member of the top ten, except Saudi Arabia, for which available figures include spending on public security, and Russia, for which accurate numbers are notoriously difficult to obtain.

Against this assessment of the US as the world's largest defence spending power, several other factors have to be considered to determine the health, scope, capabilities and likely future development of the defence and security S&T industry.

In the run-up to I/ITSEC in Orlando this year, at which the almost 500 exhibiting companies are likely to be dominated by US entities exhibiting in their front yard, *MTSN* looks at the shape of the market and the response being made by industry, considers some of the challenges it faces, the innovation it brings to the party and the manner in which future growth is being planned.

Protecting the future

Perhaps the most obvious recent change in the status quo, as far as the political leadership that helps shape the market environment to which industry must

Boeing is continually developing its training offering to match improvements in aircraft technology. Shown here is the latest iteration of the F-15, featuring a large multi-function glass cockpit. (Photo: Trevor Nash)

PLW Modelworks is a US company that specialises in creating detailed urban models. Shown here is the company's rendition of Honolulu. (Image: PLW Modelworks)

inevitably react is concerned, lies in an accelerated change of emphasis.

Thinking has moved away from purely military concerns to embrace wider societal issues. The Modelling and Simulation Congressional Caucus Leadership Summit, which took place in Chesapeake Bay, Virginia, in March 2016, had an agenda dominated by two themes – 'Vulnerabilities and Infrastructure: Protecting Our Children's Future' and 'Cyber Security: Protecting Our Nation's Future'.

Both sessions attracted passionate discourse on the dire necessity of leveraging US expertise and capability in S&T to broaden the defensive approach to protection of society-wide assets – not simply military installations or facilities. That sends a clear and unmistakable message to the industrial component of the community. Innovation, flexibility, agility and 'thinking outside the box' are not only sensible approaches to 'marketing the differential' and maintaining or growing market share, they have become an essential prerequisite to addressing the evolving needs of the rapidly changing market.

What effect do such messages have on the market? James Robb, president of the National Training and Simulation Association – organiser of I/ITSEC – in reviewing the success of the 2015 conference and exhibition late last year, was in no doubt that the future is simultaneously challenging, changing and holds significant promise.

'The world remains a very dynamic and dangerous place... our nation's economies, communications, social structures and critical infrastructure are being attacked in virtual ways and S&T capability must adapt and adjust to those trends,' stated Robb. 'With this in mind, we are expanding the scope of I/ITSEC to include S&T related to defending the transportation, energy, manufacturing, business and education domains. The demand for integration of LVC training, gaming and analysis into our core workforce skillsets has never been more important... We are 16 years into the "simulation century" and the future for S&T is very bright.'

With a background of requirements change – even cultural change, as the expansion of the threat envelope has been transformational in necessitating fresh approaches – the industry itself is changing and adapting. This becomes readily apparent when talking to companies large and small across the industrial landscape – companies with different areas of expertise, different attitudes to marketing, technological innovation and future growth, and companies with widely varying views of what these changes mean for them.

'At the macro level, it really feels right now like the market is stable, but stagnant,' said Dan Brockway, VP of marketing for VT MÄK in Cambridge, Massachusetts. He believes there are issues pertaining to the dynamics of the market that are unique to the world of defence and security.

'Technology in the wider world has accelerated at a truly remarkable pace – it is difficult sometimes to understand why the [defence and security market] develops so slowly by comparison,' he told *MTSN*.

As a software company that delivers off-the-shelf modelling and simulation solutions to a broad community of interest, VT MÄK is a good example of the type of company that takes pains to innovate where feasible, but sometimes finds that process difficult to manage. Not because of any internal shortcoming, but because of the sometimes ponderous manner in which the procurement and acquisition system works.

Specialist market

In the commercial market, Brockway pointed out that the economies of scale and volume make it possible for technologies to be discarded and replaced *in toto*. 'That factor drives innovation. It makes it entirely possible to harness widespread innovation – that's feasible when the prospect is that we can build a solution once and deliver it many, many times to a broad customer base,' he said.

By contrast, the defence and security market demands customised, role-specific solutions that have not traditionally lent themselves to being exploited in a high-volume sense, even for the largest national market in the world. Although that may be changing – in line with the alternative views expressed below – this dichotomy presents companies at every level of the S&T supply chain with a considerable challenge. How to innovate, exploit and leverage technological advances at the same time as gaining an acceptable return on the levels of internal investment required to fund that innovation.

One solution, in Brockway's view, is to insert capability and innovation incrementally. Since the preference of the end user is to maximise usage of legacy systems (against an acquisition process background that still makes it difficult to entirely replace a system rapidly and efficiently), why not do exactly that? And in doing so, leverage experience and best practice from the commercial world that has not only succeeded in delivering capability but has successfully transformed the market dynamics at the same time.

'Look at the self-drive car issue,' he said. 'From a starting point in which there was huge resistance to the concept, the automotive industry has developed trusted autonomous components and systems, ▶

injecting them gradually until the only thing left to replace is the human being. Self-drive cars are an imminent reality, and that is because attitudes have been transformed as a result of innovation and the intelligent application of technology.'

That does not mean the defence and security market does not innovate – quite the opposite. Brockway believes that the industry did something 25 years ago that was 'little short of brilliant'. The decision to focus on networking systems – creating an operational environment in which heterogeneous systems interact and collaborate to the benefit of the user – has had a transformational effect.

S&T has not been slow to capitalise on this decision, and the US market in particular abounds with examples of networked training solutions, empowering distributed mission operations for tactical training and collective or crew training for applications ranging from platoon-level tank gunnery to aircraft maintenance.

To a degree, the current focus on incrementally upgrading existing solutions speaks directly to the self-drive car analogy. Full flight simulators – a market in which the likes of FlightSafety International and CAE excel – require significant investment and no little planning to maximise return for the user. They represent considerable capital expenditure and therefore wholesale replacement of a fleet of simulators is rarely contemplated. Making them easier and more cost-effective to operate, however, is an entirely different solution to be considered.

Upgrading the visual environment, for example, to enhance the fidelity and realism of the trainee's 'out of the window' view, can contribute dramatically to training efficiency at a fraction of the cost of replacing the entire simulator.

CAE is a much larger company than VT MÄK, although both have a global footprint. Chris Stellwag, director of marketing communications for the former's defence and security business area, views the US market from a slightly different perspective.

'It is pretty buoyant at the moment and the general feeling going forward is one of optimism,' he told *MTSN*. 'In practice, there is a continued increase in interest in moving training to the synthetic environment. We constantly seek to change the syllabus where it makes sense, driven by the imperatives for efficiencies in operation and increasing long-term cost benefits. And we can do that because advances in technology allow us to do so.'

Service model

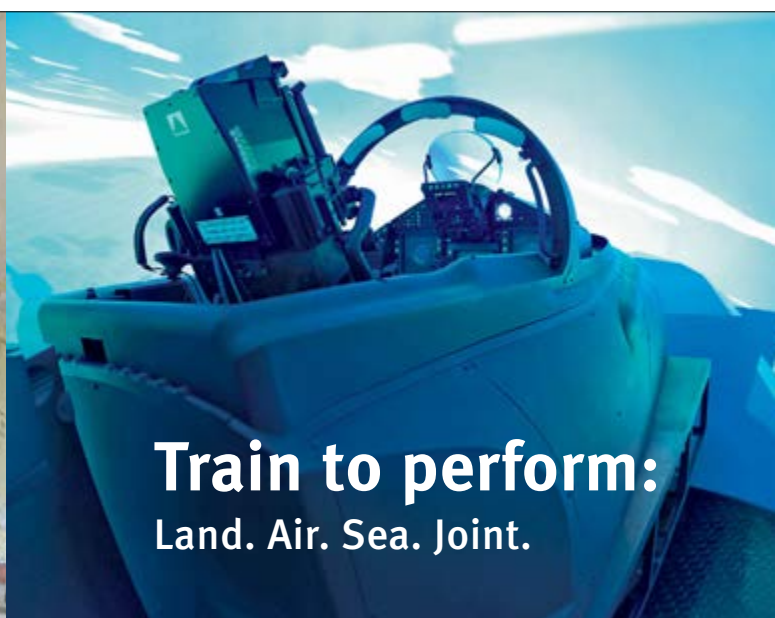
There is a distinct acceleration, in CAE's view, in the willingness of the US DoD to look at service delivery models of acquisition, rather than traditional capital expenditure models. The USN appears to be close to making a decision as to whether to adopt a service delivery model for its *ab initio* helicopter training.

Sources close to the programme indicate that careful consideration is being given to a contractor-owned, contractor-operated solution, in which an industry partner will be required to deliver trained pilots rather than a suite of equipment. Included in the contractor responsibilities would be the provision of a fleet of training aircraft, which observers estimate at between 75 and 80 airframes. CAE emphasises that such an approach to a major training requirement not only reduces risk to the end user, it allows uniformed personnel to be dedicated to operational rather than training tasks, reduces wear and tear on customer-owned assets and – above all – reduces total costs.

More importantly perhaps, from an industry perspective, this model allows contractors to innovate and leverage best practice and other non-military models of contract execution. 'One of the sometimes intangible but very real benefits is being able to exploit the institutional knowledge resident in the [civilian] instructors, who more often than not remain in their positions for much longer than a uniformed trainer who may be in his or her assignment for two or three years,' Stellwag pointed out.

CAE USA deals not only with the domestic DoD market but is also the company's 'go to' implementation unit for all contracts awarded under the US FMS system. For example, it is CAE USA that is executing the FMS contracts recently signed with Joint Aviation Command in the UAE.

The company will deliver a Level 7 equivalent flight training device for the NorthStar Aviation 407MRH, a multirole variant of the Bell 407GX designed for light

Cubic Defense is involved in a wide range of S&T activities encompassing the LVC domain, including its MILES laser-based tactical engagement system. (Photo: Cubic Defense)

attack, close air support and ISR missions. The simulator, along with a suite of desktop training devices and brief/debrief systems, will be delivered to the UAE during 2017. A year later, CAE USA will supply a full flight simulator for the Armed Black Hawk helicopter, featuring a six-DoF motion system, a vibration platform and an 'extreme' FoV display system.

Although there is an apparent disagreement in their views of the US market (and therefore the appropriate industry response) between VT MÄK and CAE, both are valid. To a certain extent, this is due to the large scale and varied nature of the market for S&T for domestic armed forces and security authorities.

It is also due, in part, to the increasingly global nature of the US market itself. VT MÄK delivers technology – not equipment. As such, its customers, many of whom are OEMs rather than end users, integrate the software into solutions destined for foreign operators.

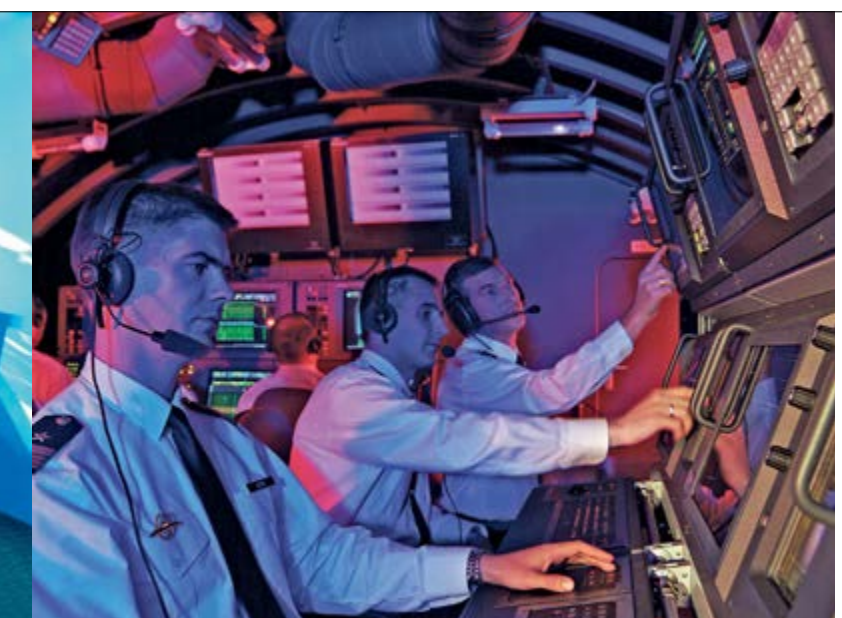
'We have been addressing the international market directly for over 20 years,' Brockway said. 'But we are in this market together with the large-scale integrators – they need technology insertion for their solutions and we can provide that. The net result for us is that a significant portion of our revenue comes from the international market via US OEMs.'

That, perhaps, is proof positive of one of the most far-reaching changes to have affected the US market in the last two decades. Not even the mighty domestic defence industrial base can operate in isolation any longer. Since the days of the 'two-way street' under the Reagan arms build-up in the 1980s, the industrial landscape in the US has changed – some would say beyond all recognition.

Continuing growth

Established companies such as CAE, Boeing and Lockheed Martin have invested considerably in establishing and nurturing capability overseas, not only providing solutions but also technology transfer and expertise to burgeoning foreign defence capabilities. Companies whose names are watchwords in the US defence industry, such as BAE Systems, have a multinational character, addressing national and regional markets through a complex web of subsidiary companies, consortia and joint ventures.

Buoyancy in the international market addressed via the US is one issue. The growth of a more advanced, technologically savvy domestic market is just as important, however. Meggitt Training Systems, part of a UK-based international conglomerate ▶



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with expertise across a wide range of defence and aviation specialties, is a case in point. It has recently cemented an already considerable position in the provision to US forces of engagement skills trainers for small arms and – increasingly – heavier weapon systems. In doing so it has brought to bear the innovation necessary to achieve continuing growth in an increasingly competitive environment.

'The fundamental challenge for us lies in the realism angle,' said Winn Hines, director of virtual systems sales for Meggitt. 'The constant demand from the user is for solutions that offer more and more lifelike environments for individual and collective training. Our approach to this is to innovate wherever we can – in issues ranging from untethered weapons to multiple shooter perspective correction.'

In 2014, Meggitt won a $99 million five-year contract to provide the US Army's programme of record for the next generation of small arms training simulation systems. The Engagement Skills Trainer II (EST II) will be delivered to army, National Guard and reserve forces worldwide, with over 890 units to be delivered over time. A more recent $15.6 million second delivery order brings the total number of systems to be delivered to over 1,000.

EST II will provide training for both new recruits and experienced troops in marksmanship, collective scenarios and judgemental video scenarios, each mode offering critical training based on the assessed skill levels of the individual soldier or unit. Using 3D marksmanship, automatic coaching, a tablet interface, enhanced graphics and compatibility with existing army simulated weapons, the system provides a flexible, adaptable and efficient methodology for instructors to ensure skills are learned and become persistent.

Alongside the EST II win, last year Meggitt unveiled FATS100e, which it describes as 'an evolutionary step forward from previous virtual reality solutions'. An extension of its renowned FATS M100 system and representing a significant expansion in capability, FATS100e introduces features such as Crytek-based 3D lanes, automatic coaching and VBS3-based collective training. Automatic coaching has never before been available in the small arms training market and collective capability is new to the VBS3 environment, according to the company.

VT MÄK provides a range of different software solutions to the S&T community. The majority of the company's sales are to system integrators. (Image: VT MÄK)

Pursuing his theme of enhanced realism being the overriding priority among many of his systems' users, Hines pointed out that 'the demand is now growing horizontally as well, for a wider range of weapons'. In addition to small arms and personal weapons, ranging from pistols to automatic rifles, Meggitt's systems are now being called upon to replicate the performance of armament such as .50cal machine guns, MK19 automatic grenade launchers, anti-tank and anti-structure weapons such as the AT4 and Carl-Gustaf and even indirect fire weapons and 'call for fire' capabilities.

'Enhancing the fidelity of the 3D renderings and untethering the full range of simulated weapons means that we can now provide a credible and comfortable perspective for each individual in a collective training scenario, rather than a "single shooter" perspective as in most game-engine-derived systems,' says Haines. That means individuals are more fully absorbed in the training environment, with the consequence that lessons learned are more profound and last longer than in a situation in which the 'willing suspension of disbelief' is required.

Sanguine on the domestic prospects for Meggitt's suite of engagement skills trainers, Hines sees reason for optimism in foreign markets also. 'Our two big [domestic] wins have certainly stimulated a great deal of interest in EST II type solutions and in FATS100e,' he told *MTSN*.

Multitude of views

As might be expected in such a large community – current estimates put the US S&T industry at approximately 580 individual companies – there is a very broad range of opinions regarding the current and future states of its health.

The views expressed above are neither diametrically opposed nor mutually exclusive. Rather, they highlight one of the industry's great strengths – its diversity and variety, with large-scale integrators dependent to a degree on the innovative technologies that so often stem from the smaller companies in the supply chain, while smaller entities leverage the marketing channels and global reach of their larger brethren. It is a symbiotic relationship, for the most part, in which every party stands to benefit.

A market as complex as the US inevitably gives rise to an industrial base that is multi-faceted, composed of contributing organisations of all shapes, sizes and capabilities. As described in the previous issue, there is a coalescence in the US industry around the 'I-4 Corridor' in central Florida (see *MTSN* Sep-Oct 2016, p8).

Government, industry and academia have gathered there in order to benefit from a closer working relationship and to make the research, development, test, evaluation, manufacture and deployment processes more efficient and affordable. That, if anything, should become the enduring watchword of the US defence and security S&T industry. Visitors to I/ITSEC in Orlando will be able to establish for themselves whether the industry is living up to expectations. *MTSN*, however, has little doubt. ■

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BACK IN FASHION?

The British Army uses the Raytheon Command and Staff Trainer at two sites in the UK and one in Germany. (Photo: Raytheon UK)

In recent years, military forces have concentrated on counter-insurgency operations but with troop withdrawals from Iraq and Afghanistan, capabilities have been refocused. More nations are looking again to high-intensity operations and the use of constructive training systems to help them prepare for such engagements. **By Alan Dron**

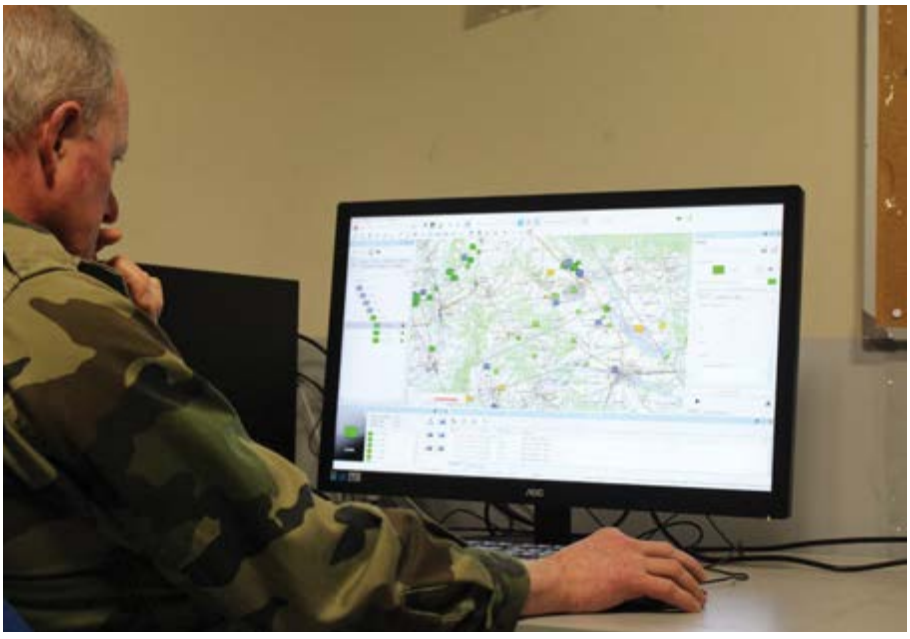
Is constructive training's time coming around again? As one of the early computer-based solutions for training the commanders of large formations, it has been overshadowed recently by more games-based products, particularly given the emphasis on small-unit actions in theatres such as Afghanistan.

However, a combination of factors – notably the ability to tweak constructive training's technology to make it more suitable for units down to company, platoon or even squad level – is sparking renewed interest in a regime that is relatively economical in both up-front cost and staffing requirements.

Casting off

'As Afghanistan starts to fade, constructive training's original remit of providing the ability to practise moving large numbers of personnel and machines around a battlefield or wider theatre is gaining strength again,' said Raytheon Systems' Rob Rowbotham, lead for the three sites that operate the company's Command and Staff Trainer (CAST) – Warminster and Catterick in the UK and Sennelager in Germany.

Until recently, CAST had been used to train staff for operations in the Afghan theatre. 'Now we're going back to general warfighting. People coming into CAST today didn't do it before Afghanistan. They don't know how the military used to fight.' ▶



A French Army staff officer using the MASA Sword constructive training system. Sword is in service with 13 armies including those of Brazil, Colombia, France, New Zealand and Peru. (Photo: Trevor Nash)

CAST is contracted to provide 225 training days a year and can train up to 300 people per exercise, which can last from one day up to three weeks. In addition, CAST is also used to support exercises conducted away from the three fixed sites, such as *Arcade Fusion* and *Iron Resolve*.

High-level training is also carried out by US company Engility. Its collective – or team – training forms the environment 'where you train top-level commanders, from the admiral and general down the command chain', notes director of training and learning solutions, Michael Finnern. 'We've done that for almost 30 years for the ▶

DUTCH EXPERIENCE

One of the more modern examples of constructive training can be found at the Royal Netherlands Army base at Amersfoort, where an Elbit system was installed in 2012. The Netherlands Command Staff Trainer (CST) became operational in 2014, and by autumn 2016 had completed its tenth exercise.

'We use the system only for brigade and battalion staff exercises,' explained commanding officer of the CST, Capt Thijs Hein. 'The exercises take several weeks because there's also a planning phase for the training audience. A couple of weeks beforehand, they come to my simulator, they give their plans to their lower units and those units – in turn – make their plans. That will be the starting situation in the simulator.

'The exercise usually starts on a Sunday or Monday and lasts four or five days,' he continued. 'Everything is possible; normally we take eight hours' simulator time and after that there's an extended evaluation period and planning for the next day. However, next week [late September], for the first time we're trying to simulate a 32-hour continuous event.'

Constructive training may not involve the physical exertion of live exercises, but is nevertheless tiring. Participants have to manage their sleep rhythms and certain staff involved in the exercise have to be double- or even triple-headed so that the need to take breaks does not hamper the exercise, as they are not the primary training audience.

'On our last two exercises, we had an airmobile battalion and a foreign paratroop battalion. We give primary simulation time to three Dutch brigades and seven manoeuvre (infantry or cavalry) battalions. After that, we can host combat support battalions, or foreign units.'

However, some units from other European nations have had to skip planned exercises because of the terrorist threat in their countries. Belgium, for example, has deployed substantial numbers of troops around Brussels in the wake of the attack on the city's airport earlier in 2016.

Those units who do have the time to make their way to Amersfoort, however, use the simulator to practise the kinetic phases of a battle – attack, defence and what Hein calls 'hasty defence'.

'Sometimes we do a half-day or complete day of stabilisation operations, but the simulator isn't very well suited for that. It's mostly used for combat. Most of the Dutch and foreign units focus on their internal procedures and rehearse before going on a real mission.

'Typically, Dutch brigade HQs only train twice a year, which isn't very much. With the CST, it forces them to think, because it gives them a lot of injects. Any action can be repeated in the simulator, so you can learn from your mistakes.

'The command post is just a normal command post and is not connected to the simulator, but they pass their orders by normal communications channels to lower control groups in the training audience that are connected to it.

'Another big benefit of the simulator is that we're able to build units as they are in the real world. We ask them for their real ORBATS, but units can ask for different factors [to be included]. One battalion entering a village wanted to do it with and without fire support. We also had a mechanised brigade moving to a motorised brigade and they wanted to see what vehicles they should choose. They tried the exercise with four-wheel drive and six-wheel drive vehicles.'

Other nationalities can ask for the characteristics of their own equipment to be programmed in to the simulator. A Belgian unit 'brought' their own materiel, rather than using Dutch equipment.

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USN in the live-virtual-constructive environment.' Engility's systems work at executive level so that flag officer staff can practise how to work together in a variety of operational situations.

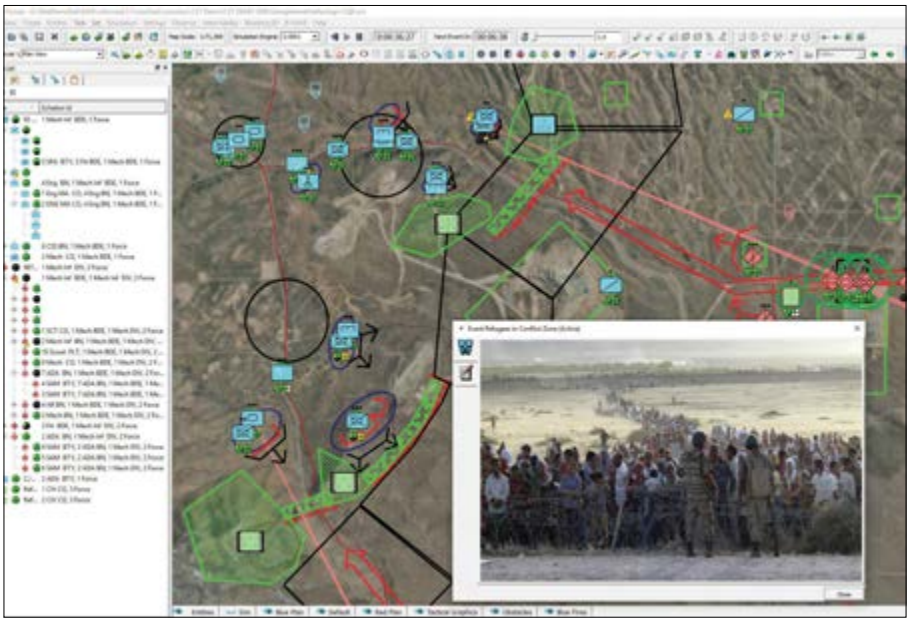
'We also provide constructive training for foreign forces,' explained Finnern. 'We do two to four of these fleet synthetic training exercises a year. These are quite large and include a number of coalition forces, such as Australia, Singapore and South Korea. Normally, they're at their home stations and the exercises can last from four days to two weeks.'

These are particularly valuable for USN carrier strike groups as they prepare to depart on missions. Such training requirements mean that the constructive market is growing.

'Today we have a strong position in France where we provide all levels of constructive training, from brigade and battalion level down to platoon level,' said Vincent Megaides, strategy director for training and simulation at Thales. The company also has further interests in Europe. It is in foreign nations that Thales sees opportunities in the future. 'We want to expand in the export market, where we believe there's growth to capture.'

Constructive training is permeating down to the platoon level because there are 'new training requirements for more interoperability and connectivity between the training systems, between nations or at the coalition level', Megaides said.

There is also a transition to multiple-level training, allowing other participants such as special forces and UAV crews to participate simultaneously in the same exercise. This new level also includes training of officers at platoon level and instructing crews on complex vehicle systems.



A screen grab showing VT MÄK's Command & Staff Training product. Real video is used to enhance feedback for the trainee. (Image: VT MÄK)

Finnern also sees market growth. 'Because of budget pressure, readiness is a large concern with all the services. There's more and more of a demand for [constructive training] than ever before.'

Improved systems

Constructive simulation has evolved considerably over the years. Raytheon's CAST originated more than two decades ago and was originally managed by moving large carpet-tile-like panels around a floor with sticks.

'CAST has progressed so much,' said Rowbotham. 'It started with a single simulation – the Advanced Battlefield Computer System (ABACUS), a constructive simulation, but what we've done is to build on other simulations around the outside to enhance the exercise.

'When an exercise is taking place, the battlegroup HQ has no vision of the simulator at all. They use only the C4I that they would use in the field, for example, satellite communications or a combat net radio system.'

The simulators are operated by 'lower controllers', or 'lowcons', who feed inputs of factors such as mortars, machine guns or air support into the HQ. The lowcons effectively act as the HQ's eyes and ears during the exercise.

'Lowcons are the people who will normally be fighting on the ground – section commanders and platoon sergeants,' Rowbotham continued. 'They're the ones that control the systems. The more you stimulate them, the more you stimulate the HQ.

'ABACUS is the constructive simulation and uses 2D maps. It is used in conjunction with VBS2 which is used as a first-person shooter game for the detailed information. If you move an icon in ABACUS, it will move in VBS2 and be reflected in the unit's C4I systems.

'Our engineers build the scenario for the military. We ask them for their start states – equipment, manpower, weapons, ammunition and fuel – and we build that into a database for them along with maps.

'Every unit in the UK army has a 12-month training cycle and in that time, they'll come through CAST twice. The first time is to show them how to use the simulator. The second time will be nearer to the operational cycle, so they will know more about what they have to do. Each exercise lasts for two weeks. We give them a week to set up and the second week is when they actually exercise,' Rowbotham concluded.

ABACUS and most other constructive systems use traditional red and blue forces, but in addition, ABACUS allows for green and yellow forces to be inserted. This added level of complexity emerged from the Afghan campaign, where elements such as local militias (green) or unknown forces (yellow) were present. These could be aligned with the red or blue or could 'change sides' – a not uncommon phenomenon in Afghanistan.

Multiple factions

Lockheed Martin's primary product for constructive ground combat training, WARSIM, similarly allows multiple factions to be portrayed in a way that mimics modern warfare, explained Tim James, UK business development director with the company's rotary and mission systems division. It allows 'patterns of life' features to be built into scenarios, together with a political dimension, such as the use of social media, which has become an increasingly important background factor in areas such as propaganda. 'WARSIM looks at a lot of the "softer" aspects of warfare,' he said.

CAE's well-established GESI command and staff trainer is used by seven European armies, the largest of which is Germany. A steady flow of enhancement contracts from the country's armed forces has covered improving the ability to create tactical symbols using templates and enhanced after-action review capabilities.

Through 2015, Germany funded a major software enhancement of the system, including a new overall architecture and functional/feature enhancements, such as improved logistical and medical models as well as the portrayal of CBRN.

Most of the companies contacted by *MTSN* believed there would be – or already has been – a greater emphasis on the use of constructive training for much smaller units than has previously been the case.

Among the factors contributing to this development, said Megaides, is the increasing complexity and range of ▶

The CAE GESI constructive training system being used by the German Army as part of a brigade exercise. (Photo: CAE)

systems deployed at every level of the armed forces. This means there is a strong need to train even junior officers in areas such as C2 and C4I systems, and constructive training fits that role.

'There will be a greater emphasis on lower levels of command, adding more functionality. Increasingly they also have to take in new requirements such as working with special forces, UAVs and joint operations or other allied forces.

'The latest generation of our commander training systems has been deployed in France since the end of 2013 and it's now in full deployment. The feedback we have is

MIX AND MATCH

UK simulation and training consultancy NSC operates the Joint Exercise Toolkit (JET), a selection of simulation products and services that it offers to organisations such as the Joint Services Command and Staff College (JSCSC).

The constructive simulation component of JET, said NSC business development manager Nev MacMillan, is the Joint Operational Command and Staff Training System (JOCASTS), which is a theatre-level constructive simulation, able to simulate large, formation-level entities – hundreds or even thousands of vehicles and platforms in the maritime, land and air domains.

'For higher tactical simulation we have CONTACT, which is a predominantly land forces constructive simulation for use at brigade level in a divisional context, but can come down to battle group level at a brigade context,' he explained.

NSC focuses very much on 'training delivery' in its wider context, much more than being just a technology provider, said MacMillan. Both JOCASTS and CONTACT have been around for some time, the latter in various guises, having evolved out of a previous tool, URBAT, that was used for urban training. Given its background, it simulates operations in complex urban and littoral environments well, something many in-service constructive simulators struggle to do, said MacMillan. JET has been used by the JSCSC and by several Middle East staff colleges.

The use of constructive simulation is on the rise, he said. In discussions with predominantly army customers he has noticed greater interest, notably from the field army. NSC has undertaken capability demonstration work for clients around some of its existing contracts to deliver training at unit level although those requirements have not yet evolved into specific contracts.

The field army's growing interest in constructive training 'is interesting, because it's not something you see at ITEC or I/ITSEC, where the emphasis is generally on virtual simulation', said MacMillan.

'Constructive simulation could be described as old technology, but it's still relevant. It's horses for courses – it works very well at higher levels. You don't need to have a lot of soldiers running around. It [also] works at lower levels, when your main interface is via a flat-panel display in your armoured vehicle or even on a map in your HQ and most of your information is coming from your screen.

'Arguably, that type of simulation is viable at company command level [because] young majors and captains are having to deal with quite a diverse suite of equipment and capabilities that they haven't had to deal with in the past.'

From discussions to which he has been privy, MacMillan believes that there is interest in pushing constructive simulation down to the British Army's company and platoon levels. That would mark a revival of interest after a period in which high-fidelity virtual simulations have predominated. 'I think constructive has been the Cinderella simulation, while the focus has been on virtual during events such as [Operation] *Herrick*. It's not received the attention it might have.

'That's partly because it's a tool that was designed and built ten or more years ago. It works perfectly well and it doesn't need a great deal of updates and maintenance. But obviously, it doesn't look "Gucci". Constructive simulation, just showing a screen with some icons moving around, isn't as interesting to display at a trade show. But there remains a demand for constructive – it's cheap to run, cheap to amend and doesn't require a lot of user training. Nor do you need a user to have fine motor skills to operate a character as you would in a virtual simulation.'

really positive, because it's used to instruct the commanders at all levels and it can be connected to a live system.'

CAE said that after years of reduced budgets, the market is picking up pace again, although funding remains lower than in previous years. Customers are also increasingly conscious of manpower requirements for constructive systems such as GESI and want it to be capable of ever-more complex scenarios but with fewer operators.

The company discerns several trends including the re-use of the same applications or software for different training audiences such as military command and staff training, or officer training at academies.

Requirement shift

Meanwhile, MASA's well-established Sword system, which is traditionally used by brigade and division command post staff to practise operating in large-scale conflicts or stabilisation operations, is developing to meet the evolving marketplace. Sword can be customised to an individual nation's needs, with a version for the Brazilian Army taking 18 months to develop to match that force's equipment and doctrine, together with all the factors it needed to prepare its own missions and exercises.

More recently, a contract with the Bangladeshi Army was signed in 2014, with customisation starting in 2015 and ending in April this year. MASA is developing a new battalion-level version that it hopes will be ready in time for I/ITSEC in December.

Another company that has seen constructive training move down through the echelons is VT MÄK. 'We've seen constructive simulation changing from divisional to battalion level,' explained Dan Brockway, VP of marketing. 'When it's used at those levels, there's a fidelity requirement shift. At higher levels, nobody is worried if an individual vehicle went through an obstacle or how it went round a corner, but at lower echelons, fidelity needs to go up, it needs to have more advanced behaviours.

'In the past couple of years we've integrated two different pieces of technology. We've added first-person character simulation so we have the ability to have high-fidelity behaviour, and we've taken some concepts from a product called Ecosim. It works at the squad level and uses behaviour where the operator can control the leader.

'Vehicles can move around and engage or interact with one another,' he continued. 'Those entities need to go around corners properly and interact with the environment at a high level of fidelity. We've also seen some customers want to make hybrids, to work at a higher level for most of the entities but have specific things you want to have at entity level. You can take first-person control for missions where artificial intelligence isn't enough. An entity that has a plan to go down a road and into a city could have a change of script and have it go down a different road.'

Brockway said that the company was planning to announce a new product at I/ITSEC. 'We haven't worked out all the details, but essentially it's a product that... will allow people to assume a computer identity and jump inside and be the pilot or gunner or tank commander.'

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The UK MoD has undergone a number of reorganisations as it battles to do more with less. These recent reshuffles, powered by the Strategic Defence and Security Reviews (SDSRs) of 2010 and 2015, have been the catalyst for increased joint and expeditionary operational planning.

This new focus has resulted in the creation of Joint Force Command (JFC) in 2012. JFC oversaw Exercise *Joint Venture 2016 (JV16)*, which the MoD said 'was the highest priority UK national training and assurance event in 2016'.

JFC provides the foundation and supporting framework for operations by ensuring joint capabilities, such as medical services, training, intelligence, information systems and cyber operations, are developed and managed, as well as testing operational HQs for overseas operations. To operate successfully, it needs to conduct robust exercises.

JV16 was held at RAF St Mawgan, Cornwall, and featured around 1,200 personnel plus 400 supporting staff. The exercise took place on 1-10 July, and was preceded by a four-day preparation phase.

Involving all facets of the British armed forces, *JV16* also included a number of government departments to exercise, test and review higher HQs' planning and execution processes and procedures at the operational level of war.

As well as the military element to the exercise, *JV16* was facilitated by the JFC's Joint Warfare Support Team (JWST) that is led by Systems Consultants Services (SCS) and a number of supporting companies. This heavy industry involvement exemplifies the 'whole force' approach that was highlighted in SDSR 2015, whereby civilian support staff and the military become fully integrated to achieve set goals.

JV16 was centred on an operation in the Middle East commanded by JFC's Standing Joint Force HQ. This organisation is now a two-star command following SDSR 2015, and has five components – air, land, sea, special forces and logistics.

'*JV16* emphasises the UK's new expeditionary approach using full-spectrum effects,' said Dick Forsythe, deputy director of training support at SCS. 'Warfare is not just about bombs and bullets but consideration must be given to a whole raft of other factors contained within hybrid warfare.'

JV16 was an extremely complex exercise that saw SCS and its industry partners providing exercise design, planning and delivery. SCS also ran the master events list, managed government-furnished equipment and oversaw logistic support to enable the exercise to take place.

One important member of the SCS team was US company Cole Engineering Services, which provides the simulation. Its system is based on the USMC's Marine Air Ground Task Force Tactical Warfare Simulation (MTWS).

'This simulation is important to us but it is not the be-all and end-all,' explained SCS's Kevin Baldwin, team leader of JWST at JFC's HQ in Northwood. 'MTWS is used to feed the exercise and create a picture for the exercising cells, but there are a number of other inputs that must be taken into account before decisions are taken.'

Several companies reported that there is increasing interest in using constructive training for cooperating with non-military organisations to rehearse plans for crisis management. This can involve linking constructive systems to government software.

MASA's marketing and communications manager Amandine Pinget reports that the Peruvian Army has adapted Sword to prepare for civil emergencies or natural disasters while, closer to home, MASA has developed a simulation of floods in Paris.

Lockheed Martin has noticed a trend among customers to look for open systems that move away from the traditional 'stovepipe' approach where live, virtual and constructive elements operate in isolation, said James. 'The customer is saying that he wants to access the constructive simulation tool set in his virtual and live simulations. They're moving away from live, virtual and constructive silos and blending all three.' ■

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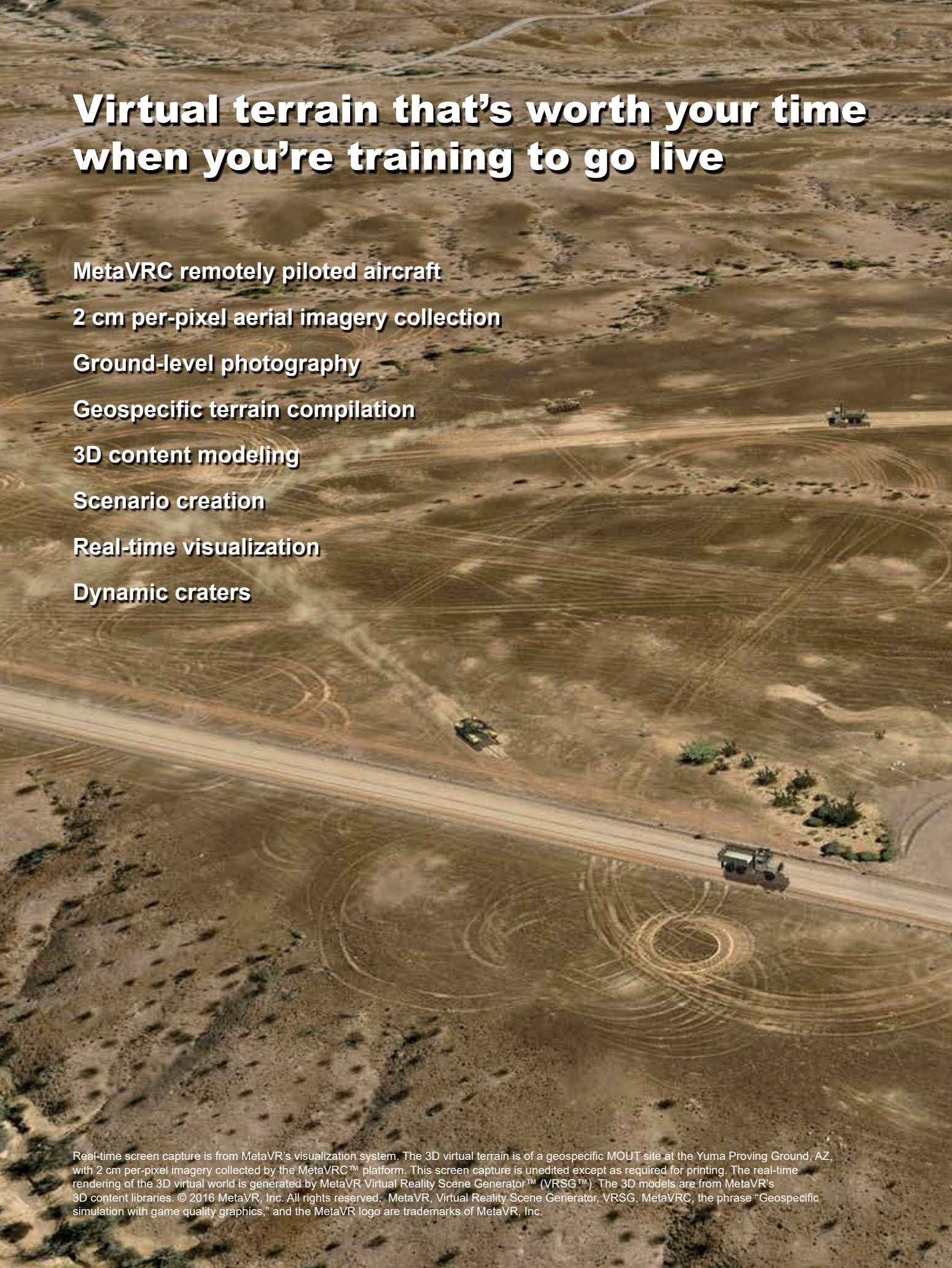

Real-time screen capture is from MetaVR's visualization system. The 3D virtual terrain is of a geospecific MOUT site at the Yuma Proving Ground, AZ, with 2 cm per-pixel imagery collected by the MetaVRC™ platform. This screen capture is unedited except as required for printing. The real-time rendering of the 3D virtual world is generated by MetaVR Virtual Reality Scene Generator™ (VRSG™). The 3D models are from MetaVR's 3D content libraries. © 2016 MetaVR, Inc. All rights reserved. MetaVR, Virtual Reality Scene Generator, VRSG, MetaVRC, the phrase "Geospecific simulation with game quality graphics," and the MetaVR logo are trademarks of MetaVR, Inc.


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REFRESH RATES

CAE is currently in the process of conducting a technical refresh programme on the US Navy's MH-60R and MH-60S simulator fleet. (Photo: CAE)

The market for simulator updates and upgrades is massive and it is not only platform OEMs that are benefiting, as many smaller suppliers that provide projectors, software and more are also involved.

By Trevor Nash

On the surface at least, many might consider the simulator upgrade business as a small element of the overall market. In fact, the provision of upgrades, updates or technical refreshes, form the lion's share of the global training market.

Unsurprisingly, given the greater use of virtual training devices in the air sector, the majority of these activities are centred on flight simulation. Flight training devices are upgraded and updated on a regular basis to keep the device concurrent with the real platform. Updates generally refer to the platform's software systems, and upgrades focus on the training device's components, such as the image generator or motion platform.

Regular revisions

Given the fast pace of technical development in areas such as image generation and display technology, it is hardly surprising that such systems have to be replaced on a relatively regular basis. Younger pilots of the X-Box generation demand fidelity at least as good as what they see at home, and on the realism front visual systems need to have high levels of acuity.

Updates usually flow from the platform's OEM and, in theory, should be present in the simulator before the actual aircraft. A recent example of such an update concerns the Systems Configuration Set (SCS) for the US Navy and USMC's F/A-18E/F and EA-18G training devices.

Under the terms of this $9.6 million programme, L-3 Link Simulation and Training will bring the training devices to the same concurrency level as the aircraft. The SCS will be delivered to the fleet as an integrated software package that provides updates to the mission computer, sensors and human-aircraft interaction.

Such updates are not all about aircrew training devices. Link has also just been brought under contract to undertake an engineering change proposal to 'resolve obsolescence issues associated with the maintenance training system multi-function display unit, the aircrew training system main power cabinet and the small computer system interface' of the B-2 aircraft. This $8.9 million contract was awarded by the USAF Life Cycle Management Center at Wright-Patterson AFB in Ohio.

Meanwhile, Boeing has been awarded a $13 million contract modification to a previously awarded contract for F-15C and F-15E mission training centres. The company will update the F-15C and F-15E training devices with Mission Package 16 to provide compliance with combat air force distributed mission operation standards updates.

Awarded over a period of five days, the three updates described above indicate how manufacturers of training devices can benefit from supplying the initial training devices for a programme and then reaping the upgrade work that follows. As well as the sale price of these devices, they also provide a long-term revenue stream.

Technical refresh

A case in point concerns the US Navy's latest maritime patrol aircraft, the Boeing P-8A Poseidon. Although only recently entering service, next year will see an RfP issued to undertake a device technical refresh for ten operational flight trainers, eight weapons tactics trainers, three part task trainers, the P-8A Training System Support Center and a number of so-called 'electronic classrooms'. All of the equipment is located at NAS Jacksonville, Florida, and the award is expected in FY2018.

The procurement is expected to cost around $78 million. In addition, a production concurrency upgrade (PCU) for the P-8A valued at $100 million is expected to be let in December. Both of these contracts will be good news for Boeing and its sub-contractor CAE.

But what factors drive these upgrades? *MTSN* spoke to CAE's VP of strategy and business development, Chuck Morant, who said that 'challenging fiscal constraints' are key, but at the same time 'defence forces must still be prepared and mission-ready, so most are looking to simulation-based training to save money and cost-effectively maintain readiness'.

He said: 'One of the quickest and most efficient methods for militaries to expand the use of simulation-based training is to look at technology upgrades and updates to their existing training systems to bring additional capacity or capability.'

He added that maintaining concurrency between the simulator and platform is 'critical' and that 'technology refresh [helps] improve simulator performance and simplifies maintenance'. Other key factors were adding new capabilities to enable a broader range of training to take place and managing obsolescence.

Rotary refinements

Staying in the US, CAE is currently working on the US Navy's MH-60R/S Tech Refresh programme. This was awarded as a base contract with options, and will see the company undertake a number of major updates and upgrades to the navy's suite of MH-60S and MH-60R training systems, including tactical operational flight trainers (TOFTs) and weapons tactics trainers (WTTs) located at NAS Jacksonville, Naval Station (NS) Mayport, NAS North Island and NS Norfolk.

Some of the updates and upgrades to be developed include delivering a common hardware/software baseline for more than 20 MH-60 Seahawk training devices, extending the visual field of view on existing MH-60S OFTs, and converting an existing SH-60B helicopter simulator to an MH-60R TOFT.

This programme is also good news for Esterline Treality, which is providing the ▶

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It is not just flight simulators that need to be upgraded. Aero Simulation has recently secured a contract to replace PLCs on the US Navy's fire fighter trainer located at Great Lakes, Illinois. (Photo: ASI)

extended-field-of-view displays, and Barco, supplier of the F-35 DLP projectors.

The MH-60R/S upgrade is being undertaken largely to improve the fidelity of the training devices to allow the US Navy to meet its avowed aim of taking more training time out of the aircraft and into the simulator.

Ray Duquette, CAE USA's general manager, said: 'The enhancements we make to the MH-60 Seahawk training systems will ultimately help the navy provide higher fidelity and more cost-effective training to its MH-60 fleet squadrons.'

Other active upgrade programmes currently being undertaken by the company include a digital automatic flight control system installation at RAF Benson for the service's Medium Support Helicopter Aircrew Training Facility for two Chinook HC6A helicopters; while in New Zealand, host computer, sensor, instructor operating station and tactical environment simulation software upgrades – including a CDB-compliant Medallion 6000 image generator – are being undertaken on the New Zealand Defence Force's SH-2G Super Seasprite simulator.

Platform protection

Upgrades are not always about making a single simulator more capable, however, a situation highlighted with the KC-135.

Referring to the KC-135 Aircrew Training System programme where CAE is the prime contractor, Morant stated: 'Our primary responsibility is providing the classroom and simulator instruction to the 3,700-plus aircrews – pilots and boom operators – that go through the KC-135 training programme annually. The US Air Force has put more training into the simulators and training devices on the KC-135, in part to save wear and tear on an ageing platform. This has allowed CAE to perform a range of simulator upgrades on the KC-135 training devices, especially over the past five years.

'Currently we are upgrading a range of KC-135 aircrew training devices for use on the United States Air Force's Distributed Training Center Network (DTCN) as part of a programme called the Mobility Air Force Distributed Mission Operations (MAF DMO). With the ability to connect the various KC-135 training devices to the Distributed Training Center Network, the USAF will have increased capability for virtual air refuelling and air refuelling formation training over a secure network.'

Stalling simulation

Making devices more realistic is a key requirement if more training is to be undertaken in the virtual world, but it is not all about visual systems or networking. In the US, Bihrle Applied Research has developed StallBox, which enables a significant expansion of the simulator's flight model, specifically in and around the stall.

'StallBox was developed in response to the industry need to extend the training envelope of existing transport category simulators to include the stall and post-stall flight regime... and in the commercial sector to also meet the FAA's March 2016, 14 CFR Part 60 Change 2 requirements for enhanced stall models and instructor displays for upset prevention and recovery training [UPRT],' explained Brian Wachter, Bihrle's VP of corporate development.

The other benefit of the product is that it can also support installation of software to expand the flight envelope without interfering with the main host computer.

'The StallBox computer, which hosts the new math models, is connected to the existing simulator host system via Ethernet or other communication protocol,' explained Wachter. 'A minimal code change is required to the existing host system to establish the interface with StallBox. When the flight conditions approach the limits of the valid training envelope of the baseline simulator, the StallBox is invoked and blending algorithms on the StallBox provide a seamless transition from the baseline aerodynamics model to the new/enhanced aerodynamics model hosted on the StallBox.'

The company is developing a range of models for commercial aircraft and StallBox is already in service with Alaska Airlines for UPRT. The system has also been integrated with Boeing's P-8A Poseidon simulators.

'Most simulators can be modified to establish this interface,' explained Wachter. 'The simulator owner needs to have the authority and ability to make the change to the host software to establish the interface to the StallBox. The models to be hosted on the StallBox will depend on the specific training requirements. Bihrle currently offers several stall models – for example, for the Boeing 737 and Airbus 330 – and we are building a library of stall models for most types of commercial transport aircraft. Custom model development can also be conducted.'

Innovative approach

Bihrle's approach with StallBox can be viewed as applying innovative technologies to the upgrade process to squeeze more fidelity from the simulator. The same can be said of Serious Simulations and its Zero Drift Machine Gun Tracking System (ZDMGTS), Zero Frame Latency Wireless Video Formatter (ZFLWVF) and HMD products. The former is being incorporated into the US Army's Virtual Clearance Training System (VCTS) upgrade that is being conducted by FAAC.

ZDMGTS enables the VCTS machine gun to be fired with an extremely high degree of accuracy and zero drift. Drift is an issue whereby the virtual machine gun begins to move itself, or 'drift', virtually, without any physical movement or stimulus, necessitating recalibrations during training. The drift issue is not uncommon in simulators, and is created by a number of mounting and sensor technologies as well as environmental conditions.

'We were glad to provide the army with a solid solution for a vexing problem, so that soldiers will be uninterrupted by simulator drift issues and can be more fully ▶

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immersed in their combat training,' said Christopher Chambers, CEO of Serious Simulations. 'In this project, we also decided to track deflection and elevation of the gun mount, rather than the gun itself, thereby making weapon change-outs realistic and simple, with no impact on tracking sensors.'

As seen above, upgrades are not all about flight simulation. Aero Simulation (ASI) has recently secured a contract to upgrade the US Navy's Recruit Fire Fighting Trainer. Awarded by the Naval Air Warfare Center Training Systems Division, the Programmable Logic Controller (PLC) Update Program is designed to enhance the trainer that is used by the navy's Recruit Training Command in Great Lakes, Illinois.

Recruits use the system during basic training to learn how to escape from smoke-filled compartments, open and close watertight doors, use self-contained breathing apparatus, carry fire hoses and fight fires. The replacement of the obsolete PLCs will provide improved training through improved reliability and maintainability.

'ASI is pleased to continue to support the navy fire fighting training by adding this new programme to our current Surface Warfare Fire Fighting Trainer update work,' said Michael McCarthy, ASI's president. 'This programme ensures new sailors continue to learn the skills necessary should a disaster ever happen aboard their ship by enhancing the reliability and maintainability of their training device. We're excited to continue our work developing great training solutions in partnership with the navy and look forward to our successful upgrades of these important devices.'

Upgrade path

Although frequently manufacturing new synthetic training devices, ASI has built a strong reputation for conducting simulator upgrades. In May, the company won the USAF's T-1A Ground-Based Training System (GBTS) Contractor Logistics Support (CLS) and TSSC programme to support 16 OFTs and 14 avionics part task trainers.

'The programme requires a team of highly skilled technicians to maintain the complex training devices at each location,' said Dan Deschnow, VP/director of programme management at ASI. 'The ASI team will also have personnel at Randolph AFB and NAS Pensacola to provide training system hardware and software updates, concurrency management and obsolescence analysis as part of the TSSC.'

Another company with this particular skill set is Quadrant Simulation Systems. Typical activities include visual upgrades, the replacement of older hydraulic motion platforms with electric systems, adding avionics simulation such as TCAS, re-hosting and adding enhanced flight and engine models. In addition, Quadrant also undertakes simulator relocations. In February this year, for example, the company completed the move of 18 FFS devices to a new training centre for British Airways.

Serious Simulations' 130° horizontal FoV HMD can be used to upgrade a number of different types of simulators, from door gunner trainers to dismounted infantry devices. (Photo: Serious Simulations)

Legacy updates

On the military front, the company has now completed the first of two legacy Rediffusion Simulation hydraulic motion system removals and replacement with a new Moog electric motion system on a US Navy simulator.

Quadrant said: 'The programme scope consists of the mechanical design and manufacturing of the mounting adaptor plates and access bridge modifications required as well as the site tasks to remove the hydraulic systems and install the Moog electric systems. Quadrant also provided engineering support to commission the electrical system interface with the simulator.'

The first system, located on the West Coast, went back into training service on schedule, with the second system, located on the East Coast, due to be completed later in 2016.

Turning again to ground systems, one of the growing areas of virtual simulation over recent years has been virtual small arms trainers (VSATs). One of the major providers of such systems is Meggitt Training Systems. Upgrades form a significant part of its business model.

'Meggitt Training Systems has a very healthy mix of both upgrades and new system orders,' explained Winn Hines, director of virtual systems sales. 'We have received orders from our existing customers for both upgrades to existing equipment, as well as orders for new training capabilities and weapon simulators. All of this has been mixed with orders from new customers for both simulators and weapons.'

Reaping the rewards

According to Hines, an upgrade will normally allow customers to reap 'the benefits of greater realism, faster performance and efficiency in system operation, [as well as] updating older technology with new hardware'. Upgrades can also lead to improved availability and may also provide greater operational training.

He said: 'Customers generally look to upgrade components such as PCs and projectors, thereby keeping up with the latest in visual display technology and graphics software, while at the same time maximising the investment in their simulated weapons inventory. This type of upgrade may also include the addition of tablet capabilities and enhancements to the user interface.

'Canada, the UK, Australia and the US Marine Corps have placed orders with the company to upgrade or perform "tech refreshes" on their existing systems.'

Although it is difficult to quantify the simulator upgrade market, the cases highlighted above indicate that the market is an active one. From CAE's point of view, the market is also an important one.

'CAE certainly believes that the simulator upgrade and update market will continue to grow over the next five to ten years,' said Morant. 'Demand from military customers to accomplish more training in a virtual environment, continued pressure on capital procurement budgets, and the rapid pace of simulation technology developments all point to growth in the simulator upgrade market.' ■

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Crackly volts

As many of the world's military forces get back up to speed with the need to train for high-intensity operations, EW is back on the training agenda, whether it is on land, at sea or in the air. **By Grant Turnbull**

For over a decade, Western forces have focused efforts on counter-insurgency warfare and fighting an enemy that, although arming itself only with basic weapons and equipment, is still a deadly force.

Training has largely been based around how to operate in built-up areas, while attempting to counter opponents who often blend in with the population and avoid a traditional force-on-force confrontation using weapons such as IEDs.

Now, with major involvement in Iraq and Afghanistan all but over, and the belligerence of old foes such as Russia increasing, the focus has once again shifted to potential conflicts with near-peer aggressors. The next enemy could possess integrated air defence networks, armoured vehicles with passive and active protection, encrypted communications and a host of other equipment that the Taliban and many rebel groups would never have access to.

Powerful capabilities

The conflicts in Ukraine and Syria have opened many eyes to the significant capabilities Russia can still bring to the battlefield, which have been shown to significantly weaken an opposing force. One of those areas where the country has seemingly excelled on the front line is EW, thanks to significant investment after the 2008 Russo-Georgian war. Russian EW equipment and tactics have on many occasions rendered Ukraine's unmanned

Modern warships require combat centre crews to be fully trained to allow the ship to function in an EW environment. (Photo: Crown Copyright/UK MoD)

The UK MoD has contracted Cobham Aviation to provide airborne EW for the Royal Navy and RAF. Different pods containing specific jamming frequencies may be fitted to the company's fleet of Falcon 20 aircraft. (Photo: Crown Copyright/UK MoD)

vehicles, air defence radars and C2 networks practically unusable.

With Western forces now using more of the EM spectrum than ever before – whether on land, at sea or in the air – they are particularly vulnerable to this electronic attack threat. At the same time, Russia has also been busy developing its own EW countermeasures, produced to ensure that if a country attempts similar jamming or signal identification/localisation, this can be identified and effectively dealt with.

For this reason, there is once again a significant focus on training and educating military personnel on the topic of EW. But what are the fundamentals of EW? How can it be used defensively and offensively? How can it be recognised and, ultimately, defeated?

Fighting an adversary in the electronic domain will not only require superior equipment, but also better and more proficient EW operators who can utilise the technology to its maximum effect.

Exercise plan

Major exercises involving coalition forces such as NATO, including the recent *Anakonda 16* held in Poland, now integrate some kind of EW training element.

As part of *Anakonda 16*, soldiers from the US Army's 5th Battalion, 7th Air Defense Artillery Regiment and the Polish 3rd SAM Brigade were tasked with locating US Navy aircraft. The aircraft, however, were carrying electronic jamming equipment, which was also boosted by Polish ground-based EW nodes. The training allowed operators to develop and enhance tactics, techniques and procedures in a significantly degraded electronic environment.

Recent wars have allowed EW to become a much more appreciated and understood domain and capability, according to Troy Phillips, director of business development at UK-based consultancy EW Solutions.

'Prior to recent conflicts, EW people were misunderstood because their work went on in the background; now EW people are well known, they've had good success in providing a force multiplication against asymmetric threats,' he said. 'So it's a well-known capability.'

This is especially true for the land domain, where the importance of EW has grown in recent years. Ground forces are now being trained on, and exposed more readily to, EW equipment and tactics, including jamming, communications geolocation and ECM – both offensive and defensive. Most infantrymen deployed to Afghanistan would have carried a man-portable ECM at some point, a method of jamming radio-controlled IEDs. Service personnel are also trained on the dangers of being 'geo-tagged' when using social media at home and abroad.

New experiences

The increase in potential cyber threats and cyber vulnerabilities in military systems also adds an additional and growing dimension to EW training, something not experienced before in the domain. The US, for instance, has begun to group cyber and EW capabilities – defensive and offensive – into an evolving concept it calls Cyber Electromagnetic Activities (CEMA). Dedicated CEMA teams are currently integrating with armoured brigade combat teams and taking part in major exercises.

It is a challenging and rapidly changing environment, even for modern militaries that already have long-standing EW schools and technologies, and it is yet more difficult for emerging nations that do not have high-end EW technology and a little institutional knowledge of the domain.

'EW is an expensive commodity, therefore it's not something you refresh every year... so it's about getting things right at the procurement phase, but also that longer-term investment in the people and staff to grow the capability,' said Phillips.

Advances in technology also means that EW systems are getting cheaper, smaller and more lightweight. The latter means that training can now become more mobile, not having to rely on fixed installations and bulky equipment.

Restrictions apply

But herein lies one of the challenges of EW training – any training activity that involves the interception and/or interference with electronic signals (as EW so often does) is heavily restricted, particularly near built-up areas, and requires a considerable amount of pre-approvals from the relevant authorities and agencies.

GPS and RF jamming, for example, will have a considerable effect, not only on the civilian population going about their daily lives, but on other sectors reliant on the technology for business operations.

'Generically, there are two elements of EW – offensive and defensive,' said Phillips. 'One is active, intrusive and aggressive and the other is passive. Both of those areas, wherever you are in the world, come with a big chunk of legislation, so you can't go around listening to communications illegally. You have to be cognisant of the rules and regulations and laws of the area that you are doing your training in.

'Your ability to use simulation and not through-the-air signals for both offensive and defensive activities is fundamentally important if you don't want to go to prison,' he added. ▶

In the US, transmitting jamming signals near public airwaves requires military, Federal Communications Commission or Federal Aviation Administration approval. Once permission is granted, jamming is sometimes limited to late night and early morning hours. Across the pond, the UK's communications watchdog Ofcom is usually notified of any electronic jamming exercise that is planned, with a notice put up on its website.

Another challenge is that in order for an EW operator to become competent, they must be able to deal with multiple threats simultaneously, often with different electromagnetic signatures. This requires a 'target-rich' environment that cannot be replicated easily with today's limited resources. Ultimately, along with legislation concerns, it means that any exercise involving EW capabilities is difficult to plan logistically and takes up crucial resources at a time when militaries are already strained.

A potential training alternative to real open-air jamming is what's known as a 'direct inject jamming'. The direct inject jammers are small devices that are installed between a vehicle's antennas and a radio transceiver, which can then be programmed to digitally produce different kinds of jamming signals when cued by a member of a training team. Squad members will experience the same effects as if they were being subjected to open-air jamming.

Soft approach

Another solution which does not require open-air emission of RF signals is software-based simulation.

British company MASS has developed software for training purposes that can emulate a target-rich RF environment, without any signals being emitted. Stuart Willumsen, a training delivery manager at MASS who has over 30 years' experience with the British Army in EW and SIGINT roles, said that in his experience taking a regiment on exercise can be a time-consuming and labour-intensive process. Not only that, but you also have to throw into the mix that equipment is not always working as it should.

'Then you have to think about a target-rich environment, because otherwise how do you test and evaluate the people that are going through that period of training? Now we have to think about target vehicles, we have to think about RF, offsetting all that with anything else that is happening in the area, and trying to mimic systems that we are not allowed to utilise in that specific area, there's all sorts of problems that go with it.'

Real-world training lasting just two or three hours could translate into four to five days of preparation. That challenge has spurred MASS to look at developing – with its team of developers, engineers and former military operators – an in-house software solution that would simulate a dense RF environment, with no over-the-air signals, and that could be utilised instantly as well as be put on a USB memory stick and be used in a networked classroom environment.

'We wanted it on a map, so when we actually intercept something or collect something – whether it is radar, voice, data – that signal has a location, an actual grid reference that comes up with it. That allows the analyst to be plotting this onto maps and give the supervisor a good idea of what is happening on the ground, in the air, or whatever the scenario might be,' said Willumsen.

Wider qualifications

MASS offers a number of training options for EW, including a one-day course that introduces students to the basic concepts, all the way up to delivery of a master's degree in partnership with the University of Lincoln's School of Computer Science. The company opened a new training centre in Lincoln in 2012, a renovated 3,600ft² building that incorporates a host of new technologies for students.

MASS emphasises that the training is technology-agnostic, and its main focus is how to become a more efficient and effective operator, rather than someone who just knows how to turn on and turn off a specific system.

'What we try and do, where possible, is hit all these different styles of learning, by utilising the classroom environment to do formal tutoring or theory training... then we move through to simulation and emulation. So that we can actually underpin this theory, by allowing the students to go further and, where possible, we will always run real-world, scenario-based training,' said Willumsen.

'After about ten minutes, the students think they are in Afghanistan, or Central Africa, or wherever the scenario is based, because they get so engrossed in what's happening,' said Shaun Vickers,

Textron Systems specialises in the provision of EW equipment designed for testing and training. Shown here is one of the company's portable range threat simulation systems. (Photo: Textron Systems)

a former RAF Tornado F3 navigator and now an EW business development manager with MASS.

Holistic view

MASS, along with other industry players, is keen for more militaries to adopt a holistic, tactical thinking approach to EW training, over the silo method that many countries currently take by training their personnel on specific equipment.

'How do you contribute to the whole intelligence and mission data cycle? You need to know the impact you're having and you need to know why you're doing it and the effect you're going to have on others,' said Vickers.

It is a blend of both tactics and technology, according to Phillips. 'If you don't get that blend right and you have undertrained people that don't understand the capability of their equipment, or the capability of the threat, or what the target is – then even the best equipment will operate at a low percentage of its capacity. You can have mediocre equipment and get a lot more out of it with a trained operator that understands the threat or target that they are looking at.

'Our thought is that, the foundation of an EW operator is a good understanding of the electromagnetic spectrum, radio frequencies and the theory behind that,' he continued. 'There's an element of physics, propagation, mathematics, frequencies, wavelengths and skill, which underpins anyone that wants to be involved in EW. There's that theoretical side and on top of that there is the application side, which can be generic or system-specific.'

In the classroom

Most customers want a tactical EW suite, but many do not understand that that also requires a classroom trainer, said Eddie Hicks, a senior business development director in DRS Technologies' Advanced ISR business.

He told *MTSN*: 'What we have found is it's really better if they buy a classroom trainer first, because then the actual users of the equipment will have some concept of what electronic warfare is, basic concepts of how to use the system, and then when they actually get the system in-country it's much easier for them to operate.'

A training system would be delivered in six months, while the full capability would likely take around a year and a half, meaning that operators could begin the training process several months before the new capability arrives.

DRS Technologies has developed the Electronic Warfare Training System (EWTS), primarily used for training students to practise direction-finding COMINT. ELINT simulation is also offered as an optional add-on feature. Instructors are given tools that allow them to create realistic scenarios by geographically placing friendly and hostile emitters as well as direction-finding and other electronic surveillance and electronic attack assets. EWTS can also utilise real RF energy. ▶

Hicks cited Gulf Cooperation Council and Eastern European countries as keen proponents of the classroom-based training approach.

He explained: 'When they are coming up with new requirements they seem to have a more overall view of electronic warfare. When you see a requirement for a land EW system come out, they are also talking about classroom training, they are also talking about cyber security, they are trying to cover it in a much more broader way than the other countries we talk to.'

Another example of a desktop trainer system is the T-25 Simulator for Electronic Combat Training (SECT), used by the USAF to train its combat system operators (CSOs). The T-25 utilises off-the-shelf computer equipment, and can simulate the entire electromagnetic combat spectrum, from surveillance to electronic attack. The CSO is part of an aircrew and can be responsible for navigation, weapon systems and EW.

No substitute?

Clearly, however, there is still no substitute for utilising the real equipment that would be used on the battlefield. There are times, for example, when militaries want to use authentic RF energy against flying aircraft, to simulate different threat systems in a real-world environment. One such example of this technology is Textron Systems Electronic Systems' Portable Range Threat Simulator (PRTS), which utilises a Model 527 emitter to generate complex signals and scenarios, which could look like those used by potential adversaries.

The PRTS provides valuable training by enabling realistic threat engagement scenarios such as search, track and launch to be simulated.

'It simulates enemy radar systems, so that the aircrews can be trained to recognise the symbology, recognise the validity of the threat and perform whatever the tactics are relative to that threat,' said Byron Green, VP of business development at Textron Systems Electronic Systems.

He added that these can be low-power examples for training helicopter crews flying at low altitude, or more powerful RF emitters used for training of fast-jet pilots at high altitude.

Battlefield communications become impossible unless robust ECM measures have been put into place. (Photo: Crown Copyright/UK MoD)

Originating from its ESL Defence facility in Hamble, England, the company also develops products that can simulate a missile launch, triggering an aircraft's hostile fire indicator system to warn the pilots. The company's Mallina product is a medium/long-range EO system that emits a signal that alerts a UV-based (solar blind) missile warning system such as the AN/AAR-47. This can be used independently or as an adjunct to the PRTS. IR and laser variants are also available.

'The RF systems will be interacting with radar warning receivers in the aircraft,' said Green. 'But the infrared or UV plume simulators, or hostile fire simulators, they are interacting with the missile warning systems in the aircraft. So they are designed to teach the aircrew threat recognition and tactics for weapons such as shoulder-fired infrared missiles. While the others are designed to teach aircrew recognition and tactics for radar-guided anti-aircraft missiles.'

The company even produces a Man-portable Aircraft Survivability Trainer (MAST), which replicates the visual effects of an IR-based MANPAD weapon to train aircrew against this threat using the platform's aircraft survivability equipment.

Devices such as the Model 527 can be used to test self-protection equipment, ensuring it is functional and working as designed. The Model 527 has been selected as the preferred technology for pre-flight testing of F-35 EW systems and has also been chosen for the KC-46A tanker, where it will test the operational status of installed EW and radar warning receiver systems.

Similar solution

Textron Systems offers similar solutions to test and validate ECM equipment on ground vehicles.

Model 527 threats can be derived from Textron Systems' Advanced Architecture Phase, Amplitude and Time Simulator (A2PAT) or Lab Joint Service Electronic Combat Systems Tester (JSECSTTM), allowing vertical integration of data for test events.

A2PATS is a direct-port simulator that is designed to verify that US and allied EW systems can properly locate, identify and defend against threats, whether on the ground or in the air.

'We are having a tremendous amount of success in the market place with these new, extremely high fidelity, extremely dense, extremely reactive physics-based RF simulators,' said Green. 'You don't actually have to take the aircraft up and fly it around, or the ship system and float it around. You can actually embed this in a synthetic environment, and when I say synthetic environment, I don't mean like a video game, this is real life, honest to goodness, RF energy.'

As warfare becomes more electronic – with 'digitisation' often the buzz word across industry – the threat from hostile forces that want to interfere and disrupt these systems will increase. Having more personnel on the battlefield, not just the trained EW specialists, who can recognise when an electronic attack is taking place and know how to take action against it, will ultimately be a battle winner during future conflict. Training will be a key part of that, ensuring personnel are proficient before they come up against a well-equipped foe that is also proficient in utilising the electromagnetic spectrum. ■

Marines exit the MAET while submerged. (Photo: USMC)

Escape clause

As the reliability of rotary-wing systems, particularly their powerplants, has increased over the years, aircraft ditchings have declined. Despite this, military crews must be ready for any eventuality and so psychological preparation and physical underwater escape training are crucial. **By Sarah-Jane Prew.**

Underwater escape is a familiar part of the training regime for all helicopter crews who fly over water. In addition, military passengers who regularly travel in these conditions are also required to undertake such training.

Underwater escape or egress training is a unique requirement for over-water operations because the risks involved are equally unique. When a helicopter is involved in a controlled crash into water, the chances of survival are theoretically good. Helicopters are designed, particularly when equipped with flotation devices, to stay afloat for some time or at least sink slowly, giving occupants the chance to escape. However, it is highly likely that any real incident will be a situation involving underwater escape. Sadly, the survival rate is not as high as it could be.

Those finding themselves trapped in a submerged aircraft face a number of challenges. The shock of being involved in the incident, even if no injuries have been sustained, and the sudden immersion effect of being plunged into cold water are immediate concerns. Next to mitigate is the disorientation effect, as the survivor is now likely to be upside down; then the distance from the exit; the darkness resulting from being underwater; and the location and utilisation of exits in extreme conditions. The stifling effect of being underwater must be also be taken into account.

Over the years, most countries have introduced requirements for all crew and passengers, such as the wearing of immersion suits and aviation life jackets and, more recently, the use of emergency breathing systems to give vital seconds of air supply to those trying to escape.

Psychological conditioning

Due to the nature of a helicopter crash into water, the difficulties of escape and the stresses involved, understanding the psychology behind how training can ▶

improve performance in an emergency situation is vital. The suddenness of the situation makes it hard for people to cope with what has happened to them. Someone who is ill-equipped mentally and physically is going to find that struggle all the greater.

Fear is one of the first emotions that will take over, often to a point where one is unable to act. This is the point at which a person realises that they are in a dangerous predicament and the implications start to dawn on them. At this point, stress is felt by the body, which can have a negative impact on thought patterns and actions. People with particularly poor coping mechanisms can suffer very adverse reactions to stress.

It is known from studying aircraft evacuations that passengers often become immobile in their seats and do not obey the commands of the crew to evacuate. This 'freezing', called behavioural inaction, leads to passengers being unable to help themselves. Those who survive will be the ones who can return to cognitive function quickly, and who can tune their minds to taking advantage of every opportunity.

Conditioning and training are important. They help an individual to experience a 'bad' situation in a safe environment. Even a low level of conditioning can make them understand a scenario they might end up in. It will give them a comprehension of the threat, how they may feel and what they can do to help themselves. Critically, this reduces the shock factor if such a thing were to happen for real, minimising the chances of behavioural inaction and psychogenic death. The latter is defined by psychologist John Leach as 'a biological process that takes place as in natural death, but it is triggered at a premature stage in the person's life when they are under duress'.

The brain can only process so much information and work at a certain speed. It reacts quickly each day to familiar events. When something unexpected happens, the brain needs time to process its new surroundings, and is limited as to how much new information it can absorb and how quickly. It has a model created of day-to-day life, so it can respond almost automatically in common scenarios. In a new situation, there is no model so has to create one, but in an emergency, there is not enough time. This leaves a person relying on a cerebellum that is using an inadequate mental model for the situation at hand.

The UK MoD conducts its tri-service HUET training at RNAS Yeovilton. Plans are under way to open a new three-pool facility at the base in 2018. (Photo: Babcock International)

Training allows that model to be built – at least partially – by the brain, so that when the 'real' event happens, it can use the model to initiate action rather than starting from scratch. The more developed the model, ie the more training and conditioning that has taken place, the more complete it will be. Conditioning, preparation and training can help take away some of the stress and make an individual more prepared to cope in adversity, leading to a better maintenance of cognitive function.

Spending sense

Underwater escape training has developed widely in past years in response to both individual incidents and research. A review of 234 USN ditchings from 1963 to 1975, involving 1,093 occupants, found that those having undertaken effective training in underwater egress will have a 91% chance of survival as opposed to a 66% chance for those without such training.

'If a nation's military spends millions on training a helicopter pilot and that pilot flies over water, it is only good sense to train them to survive a water ditching,' explained David Comeau, COO of Falck Safety Services, Canada, which is contracted to undertake training for the Canadian forces' rotary-wing crews.

'This is especially true since research tells us that most helicopter ditchings into water are survivable. The high fatality rate is due to lack of training on how to egress a flooded, upside-down helicopter. In other words, most crew members aren't killed on impact, they drown because they are disorientated and lose their exit location.

'Military underwater escape training involves the concept of "actual versus perceived risk" and the trainee may feel the training is risky and unpleasant, suffering with water up the nose, holding their breath or using an underwater breathing apparatus,' he continued. 'That's OK, as the real event is also stressful and it is all part of the conditioning. We want to introduce elements of increasing stress, referred to as graded stress inoculation, to help the trainee perform appropriately in the real event. However, in terms of actual risk, the simulator has instructors inside with the trainees, emergency seat belt releases and the ability to pull the complete simulator out of the water, so the actual risk is very low.'

James Walker, the Royal Navy Underwater Escape Training Unit's chief instructor at RNAS Yeovilton, where the UK military carries out its tri-service dunker training, discussed other benefits to underwater escape rehearsal.

'In the military, so many lives have been lost by helicopters going into the sea. Back in the 1950s and right through to the mid-80s, the UK was one of the biggest operators of aircraft carriers in the world and our military were engaged in extensive maritime operations, inevitably leading to

aircraft ditchings. Once underwater escape training was brought in, the survival rate improved. It was staggering to see how the confidence gained though training helped people cope in such stressful situations.

'Another often unseen but hugely life-saving benefit of underwater escape trainers is the ability to test kit and scenarios in a safe environment before putting troops in potentially dangerous situations. We are often involved with testing new kit or procedures but very often, problems just become apparent through regular training and we are able to share this information and help reduce problems that have come to light in a "safe" environment, thus saving lives should a real emergency occur.'

Close replication

As helicopters have developed, so too have underwater escape trainers. There are a myriad of devices that are in service around the world, ranging from generic shells that are open either end with holes for exits, to type-specific replications with actual exit mechanisms. Attack helicopters that carry a heavy armament do not carry flotation devices, so will sink like a stone if they ditch. In order to train for this, Canadian company Survival Systems has designed a trainer that is effectively a submersible trolley that can deep-ditch.

'At Falck, we encourage aircrew to train in simulators that closely replicate the aircraft types, the fuselage and interior of the aircraft they fly in, to build that familiarity that can be relied upon during an emergency,' explained Comeau.

'Our Modular Egress Training Simulator offers functional replicas of cockpit and cabin configurations, exit mechanisms that feel like the real thing in terms of resistance, exit lighting and communication cords that can be "jammed" so the pilot has to either break the connection or remove the helmet. Probably the biggest advancement in underwater escape training has been the introduction of breathing apparatus, giving the trainee a better option than trying to egress on breath hold.'

Walker agreed about type-specific training: 'Generic training is just not good enough.' In September 1997, Lt Cdr Paul Haywood, as the Royal Navy's then fleet survival officer, produced a paper called 'Helicopter Underwater Escape Training [HUET] Realism and Fidelity in Training', supporting the introduction of specific modular training. It followed a survey of RN aircrew and the results were very blunt. They were confident in their ability and preparedness to egress safely from the dunker – however, they felt this did not translate into either their confidence or ability to evacuate safely from an aircraft in a real ditching.

'Our dunker training in the early days used a generic cabin with simple and basic exits. This training did not specifically teach operation of existing jettison systems or representative exit usage. It did not teach life jacket usage. All that had to change to cover aircraft and equipment-specific training that ▶

involves real experiences and real sensations. That is the only way to equip someone to the point where the likelihood of panic in an emergency is reduced.'

Falck offers a one-day basic course for aircrew that involves a morning in the classroom reviewing case studies, hazards, equipment, crew roles, preparation and procedures. Students study preparation in the event of a ditching and egress – how to abandon the helicopter on the surface if it doesn't roll over and how to evacuate underwater. The afternoon session takes place in the pool and starts with surface abandonment into a life raft.

'At Falck, we use a simulation theatre to deliver the HUET course, so we employ wind and waves as well as darkness,' said Comeau. 'We progress the training so a pilot or rear crew member will start in the trainer on their own and will evacuate from their nearest exit. Next they must locate and use exits further away, then evacuate with other crew members in the trainer at the same time. Finally, they will practise egress with the use of breathing systems.'

Warsash Maritime Academy, an integral part of Southampton Solent University in the UK, offers training to the Merchant Navy, the Royal Fleet Auxiliary and those working in the offshore oil and gas sectors. It has access to one of only a handful of underwater escape trainers in the UK, at Andark in nearby Swanwick. This facility offers climatic control, darkness and a wave machine, but the dunker is fairly generic.

The USMC undertakes its underwater egress survival training at Camp Lejeune, North Carolina. It usually takes place in three phases and starts with classroom training. In the pool, marines begin with shallow water egress training (SWET) in equipment designed specifically for the task. The SWET trainer is a small, enclosed chair with buoys for flotation that represents the cockpit of an aircraft. The student will sit in it and can be flipped upside down in the water, allowing them to practise escaping by pushing through a side window.

Following this, the marines then progress to the deep end of the pool. The Modular Amphibious Egress Trainer (MAET) is capable of seating a number of personnel at any one time, sinking them into the water and turning them upside down. Participants start by evacuating the submerged simulator off the air from their last normal breath before moving on to using breathing apparatus. They also conduct scenarios where they are in full kit and have to jettison this before egress, and sit in different positions within the simulator so they are always in a fresh location, relative to the exits, to enhance training.

A USAF pilot undergoes training using a SWET device. (Photo: USAF)

Confidence tricks

All three military services in the UK carry out training at Yeovilton in a facility operated by Babcock on behalf of the Royal Navy. Aircrew who fly military operations are required to undertake underwater escape training with emergency escape breathing apparatus every two years, while those operating in a non-maritime role carry out training every three years.

In addition, it became regulation in January 2016 for all passengers in military rotary-wing aircraft who undertake dunker training to return for regular refresher courses. If considered a regular passenger they are required to train every three years, including with the use of breathing equipment. If they are considered a less frequent passenger, they train every five years and are not required to train on breathing equipment.

Students begin with confidence building and by learning how to use the breathing equipment, first in the classroom and then practically in shallow water at the corner of the pool. Following this they undertake four 'hold your breath' scenarios in the dunker. The first is a submerged but upright exit.

'We do not train for a surface egress,' explained Walker. 'Most military operations tend to be low-level and along with the difficulties of buoyancy support invariably lead to a higher chance of an inverted and submerged scenario post any ditching.

'Following a submerged upright egress they do an inverted scenario which is then followed by the same but in "twilight". Finally, they do a completely dark inverted exercise. Once the four "hold your breath" scenarios are complete, students then carry out two more exercises, this time with the breathing apparatus. The first is a submerged but upright scenario and the second is with the cabin partially inverted.

'One of the most important things about training is that we observe the participants' confidence,' Walker said. 'We are tasked with sending these individuals back to their units with "confidence and ability". It is not sufficient that they are able to escape our HUET modules in training with us but that this translates into the confidence needed to help them escape from their own aircraft.'

RNAS Yeovilton is looking forward to a new and enhanced underwater escape facility that will be open early in 2018. Work has already begun – the new pool will be similar in size to the existing one but will be 1m deeper, taking the depth to 5m. It will also be cold water, requiring all crews to use immersion suits for training.

There will be two additional pools. 'We need to have a warm water pool for breathing apparatus training so we can introduce students to the environment gradually, avoiding the stress that can be caused with cold water immersion,' explained Walker. 'This is also where our biggest increase in training is going to come from, so it makes sense to have a dedicated facility for it.'

There are plans for a third pool for survival training that can be climatically controlled with blackout, rain, wind and a wave capability equalling that of a Force 6 gale. The pool will have a 1m freeboard.

In terms of equipment, there will be a large cabin to take 14 people, fitted with a cockpit. It is likely this will be a Merlin 3/Chinook replica. 'The dynamic changes considerably when you fill a cabin with people, rather than conducting one-on-one training,' said Walker. 'Suddenly the participants have to worry about where everyone else is and whether they will hinder their egress in an emergency. It is very valuable training to put a group together in such a trainer.'

For new-generation HUET modules, there is an aspiration to see several bespoke and some interchangeable modules from large Chinook and Merlin representations, down to the smaller Wildcat along with the already existing Apache and Viking modules.

There will be space for eight trainers, which gives the scope to expand the capabilities to suit the emerging equipment purchases of the military in years to come. The proposals for these new trainers are currently being put out to tender.

USMC troops take part in HUET training using the MAET at Camp Lejeune. (Photo: USMC)

Muscle memory

With recent advances in helicopter safety, better flotation devices, improved kit and comprehensive training on emergency breathing systems, survival rates for those operating in a maritime environment are much improved. However, nothing detracts from the essential nature of underwater escape training and the confidence it can give personnel.

The experience in itself can be very frightening and stressful and may, potentially, reduce confidence in an underwater escape. For this reason, it is important that a regular structure of courses takes place to ensure that the aim of giving confidence is achieved. The student must feel satisfied and competent about the training to be confident that they have a chance of survival in a real emergency.

Knowledge of escape procedures is not enough – the student must develop the muscle memory in order to increase the possibility of being able to replicate the action in a real emergency. In such an incident, additional negative factors are present and a student's ability to have the confidence that they can escape will be the single best determinant of success. Regular and relevant training are the keys to survival. ■

In the case of MQ-1/9 simulation, the gap between the virtual and real environment is almost zero, as pilots and sensor operators use the same human-machine interface as the real platform. (Photo: USAF)

VIRTUAL REVOLUTION

With new technologies creating ever more realistic virtual training environments, militaries are conducting increasing amounts of training in this domain. It would appear that the live-synthetic argument has shifted towards the virtual. This is mainly due to increased fidelity and lower cost, but there are other benefits. **By Peter Mathews**

Virtual training is a key component of how the military conducts its operational preparation. The pendulum that is the live-virtual or live-synthetic balance seems to have swung towards the virtual domain, but does that mean that the 'eternal question' has been fully answered?

According to a paper entitled 'Live Virtual Constructive Training Blend Optimisation Study', delivered by BAE Systems, Quintec and QinetiQ to NATO in 2011, 'the complexity of this question has so many facets that makes it difficult to answer, not the least of which is the balance of what? Pure total cost reduction, the best training outcomes, or simply the answer that meets economic drivers. The introduction of blended technologies in live and synthetic environments requires us to shift our attention to the live, virtual, constructive [LVC] balance and to develop a methodology to assist decision-makers in procuring effective training mixes.'

So it would appear that the eternal question remains unanswered. However, it is clear that military pilots are flying fewer hours in the aircraft and more in the simulator, and there are some good reasons for that.

With a Eurofighter Typhoon costing around $84,000 an hour to fly, the purely economic factor becomes an imperative, especially in this period of cash-strapped

defence budgets. Add to this the issue of wear and tear on the platform, the low availability of ranges combined with the cost of firing real weapons, and the overall availability of aircraft due to operational deployments, and the case for synthetic training becomes compelling.

Pressure point

The other factor that promotes the increased use of the simulator is the old adage that 'the cockpit makes a poor classroom'. That statement is inherently true, and the benefits of simulation include a learning environment where training can be made scalable, repeatable and measurable. The synthetic environment can also replicate many different assets, such as air-to-air-refuelling tankers, airborne early warning and control platforms, suppression of enemy air defence support and other fast jets, including enemy aircraft, which would be extremely costly or impossible to recreate in the real world. Importantly, this synthetically hostile environment becomes totally benign when rendered virtually.

If the pendulum swings back to the live argument for the moment, there are clearly elements that cannot easily be simulated. The synthetic environment is benign – no positive or negative 'g' forces, no psychological or physiological pressures, no decisional issues that are shaped by the thought: 'If I mess this up, I will die.' This therefore drives the question of how much negative training is present in the virtual environment?

However, this pendulum theory is not really a suitable analogy when discussing the live-virtual/synthetic balance. Indeed, the very term is far too linear and two-dimensional, a point recognised by Elbit Systems.

'Our approach is not to consider the live and virtual as separate elements but to view them as a blended environment,' explained Reuven Alon, VP of fixed-wing solutions at the company. 'We use embedded training, networking to link ground-based simulators with real aircraft, and technologies such as our Targo helmet display system, to display virtual images to the pilot in a real aircraft. This approach provides an all-encompassing training environment.'

Targo is an interesting system that is referred to by the company as a helmet-mounted avionics (HMA) device. This technology has been used to provide solutions for training pilots to fly modern fast-jet combat aircraft or advanced trainers.

Elbit said that Targo is designed to cover 'all stages of the mission, from planning to debriefing', and that the system 'assures a dramatic improvement on the ground and [for] in-flight training. In the planning stage, Targo facilitates [the] creation of detailed mission mapping, including navigation, threats, symbols, in-flight simulation, advisory data and more with its dedicated Targo SkyPlan. The rehearsal stage is comprehensively covered, allowing trainees to experience every moment of the mission with the on-helmet Targo Sim.

'Trainees debriefing with Targo's embedded air combat manoeuvring instrumentation helmet feature allows... debriefs [without the need to integrate with computers or ground stations]. The system also enables the review of the performance of single or multiple aircraft with flight recording and debriefing capabilities, complete with aircraft audio and helmet video.'

Shortening the gap

One of the company's major achievements has been the development of embedded training systems that are exemplified on aircraft such as the USN's T-45C, the BAE Systems Hawk AJT and the Leonardo M-346. In the case of the latter, Elbit is part of the Leonardo/Raytheon team competing for the USAF's T-X programme.

Embedded training creates a virtual environment for pilots flying real aircraft. Threats, friendly and enemy aircraft, as well as data links and EW information, are either simulated or stimulated on board the aircraft. Elbit refers to such systems as embedded virtual avionics (EVA).

The company says that its EVA system 'is being delivered on board trainer, fighter and rotary-wing aircraft, with each being configured with an emphasis on the specific trainee/operational pilot's requirements. EVA can be installed on basic or advanced trainer aircraft, transforming the platform into a virtual advanced fighter while maintaining the hourly costs of a trainer.

> ***"Our approach is not to consider the live and virtual as separate elements but to view them as a blended environment."***

'The embedded training system virtual avionics suite is designed to shorten the training gap which exists today between trainer and modern fighter aircraft, and allows the trainees to operate advanced systems, such as virtual radar, optical sensors and EW systems, as well as virtual air-to-air and air-to-ground weapons. The embedded training system is manufactured in a minimal-integration single-LRU configuration, thus reducing aircraft integration costs.'

In short, airborne virtual technologies are helping to download many of the training tasks associated with high-performance fast-jet operational types onto the less costly training aircraft.

Technology is certainly pushing the envelope as far as virtual simulation is concerned and it is clear that the blended approach is gaining traction. In an ideal world, simulators need to talk to each other. Unfortunately, despite the concept of common standards, most military forces have a broad swathe of different technologies within their synthetic training equipment holdings. To achieve commonality requires forethought and determination, something that the Royal Canadian Air Force (RCAF) is now pursuing through its RCAF Simulation Strategy 2025 study.

The service's vision is that 'by 2025, the RCAF will have a simulation-focused training system which skilfully leverages LVC domains within a networked common synthetic environment. This system will optimise the means by which RCAF aviators achieve and maintain readiness, fully exploiting advances in both technology and training methodologies, to deliver world-class capabilities for the full spectrum of operations.' ▶

One major provider of embedded training systems is Elbit. Its approach offers virtual capabilities in a live environment. Shown here is the company's Targo helmet, operating in day and night scenarios. (Photo: Elbit Systems)

It is interesting to note that the core component of this strategy is a 'networked common synthetic environment'. The RCAF wants to achieve more effective training by providing flexibility, a holistic environment and increased collective training opportunities, as well as providing more efficient instruction – notably reducing training time but at the same time making it more capable – and freeing up resources that are currently used to achieve and maintain readiness.

'Analysis shows that the availability of a CH-149 Cormorant simulator in Canada will reduce the length of the Cormorant first officer initial course from 16 weeks to ten weeks,' it stated in the Executive Summary to the RCAF strategy document. 'Aircraft simulator operating costs are generally one-fifth of the operating cost of an aircraft, and the inclusion of multiple simulators in a synthetic environment, while preserving the aircraft for operations, makes training more available to all RCAF personnel.

'High-risk manoeuvres or sequences can be trained in a simulator to a high level of proficiency. Joint and collective training events, traditionally limited in frequency by their complex and cost-prohibitive nature, could be conducted in the synthetic environment if the RCAF ensures its training systems can interconnect with Canadian Armed Forces and allied training systems. Modelling and simulation directly enables experimentation and concept development. The rationalisation of service delivery will ensure the maximum numbers of RCAF personnel are available for operations. Finally, reducing the amount of live-fly required to achieve and maintain readiness will reduce the carbon footprint of the RCAF today and in the future.'

Back to basics

It is clear that the RCAF has a vision and is putting in place a 'deliberate and phased' plan to achieve its goal by 2025, which is both 'achievable and quantifiable'. To meld together current and future training technologies, the air force is adopting a process that it calls training systems integration. For this to be a success, it will go back to basics to access all of its current and future training using a systems approach to the matrix.

In theory at least, the RCAF has formulated a well thought-out plan of action that sees the adoption of an organisation-wide training management information system, and a common visual database that are all controlled through a distributed mission operations centre (DMOC).

The RCAF is adopting a 'spend to save' strategy. The briefing document has stated that 'the full cost of implementing the strategy is estimated at $414 million, with the potential for $1.52 billion in savings over 20 years, above and beyond the sustainment cost of the system.'

The key to success for the RCAF Simulation Strategy 2025 is to have a robust staff and engineering system to see the project through. Continuity is the key, and personnel need to be in place to see the project through and not be posted on short cycles.

In the UK, the RAF is pursuing a similar project. The Defence Operational Training Capability (Air), or DOTC(A) requirement 'will present frontline operators with the opportunity to enter the synthetic battlespace from their own operating bases to exercise with other users in realistic joint operations, free from the constraints and limitations of many live training serials. In this way, synthetic training will be used smartly to augment rather than replace live events, helping to ensure that our forces retain the capability, competency and readiness levels demanded of them.'

It is hoped that DOTC(A) will eventually link together with DOTC Land and Maritime to create a defence-wide virtual training domain for the UK forces. It remains to be seen whether this vision will be realised.

Virtual exercise

The RCAF and RAF are both looking to increase the integration of current and future virtual training systems. In the US, this aspiration is reflected every year in the *Coalition Virtual Flag* (CVF) exercises that network simulators in the US and throughout the world. CVF clearly shows the opportunities that are available in terms of networking virtual simulators and also integrating live and constructive assets.

CVF is overseen by the USAF's 705th Combat Training Squadron, part of the DMOC that is located at Kirtland AFB in New Mexico. The mission of the centre 'is to develop, integrate and deliver DMOC capabilities and training to prepare warfighters for combat in joint and coalition environments through exercises, training, tactics, techniques and procedures – warfighter readiness, testing, experimentation, tactical to operational-bridged events and standards development.'

In effect, DMOC is the USAF's nexus for distributed combat training exercises,

experimentation and testing. Supported by Lockheed Martin, which provides software development, exercise support and infrastructure, the DMOC architecture 'integrates virtual and constructive simulations across various networks to support a synthetic battlespace that models weapons and C2 and ISR systems. Lockheed Martin has supported the DMOC for three decades, facilitating a number of training exercises each year for US and coalition forces.'

As well as USAF units, *CVF 2016* drew together the USMC's 3rd Marine Aircraft Wing, the Royal Australian Air Force's (RAAF) 285 Squadron and the RCAF's 426 Squadron among many others. In what was claimed to be one the world's largest virtual air combat exercises, CAE provided contractor support to both the RAAF and RCAF participants.

'These kinds of distributed mission training exercises, often involving both live and virtual assets, are becoming more critical as militaries and coalition partners look to cost-effectively prepare for operations and maintain readiness,' said Gene Colabatistto, CAE's group president of defence and security. 'CAE brings a great deal of expertise and experience as a training systems integrator to help enable defence forces to conduct distributed mission operations and increasingly leverage more virtual training as part of these exercises.'

From the RCAF perspective, 426 Squadron flew a CAE-built CC-130J full-mission simulator as part of the exercise where it had responsibility for performing a range of tactical ground support missions, including the insertion of special operations forces assets. The company's computer-generated forces software was used to create numerous enemy virtual threats, such as Su-27 fighters and ground-based surface-to-air missiles, as well as a range of friendly forces. In total, CAE's simulation software provided more than 2,000 computer-generated constructive and virtual entities in the synthetic environment.

'Our participation in *CVF* was highly relevant and proved that these type of distributed virtual exercises provide valuable tactical training at the basic and advanced levels,' said Capt Jason Danyluk, a CC-130J pilot and the *CVF* mission lead for the RCAF. 'We look forward to our continued participation in *CVF* exercises, and exploring the various training opportunities this level of simulation can provide to the RCAF and our allies.'

In Australia, the RAAF flew its CAE C-130J full-flight mission simulator that had been networked with a Virtual Simulation Systems-built C-130J tactical airlift crew trainer (TACT), both located at RAAF Base Richmond in New South Wales. CAE supported the integration, networking and testing of the FFMS and TACT into the *CVF* exercise, the latter being supported by Calytrix, TitanIM and VSS.

Every year, the USAF DMOC hosts *Coalition Virtual Flag*, an exercise linking live and virtual assets from across the world. Shown here is a C-130J FFMS from 285 Squadron, RAAF. (Photo: RAAF)

'This is our second year participating in *CVF* and we continue to learn a lot of lessons and overcome various technical challenges to improve the immersive quality of the training,' said Wg Cdr Jason Baldock, OC 285 Squadron, RAAF. 'A big step forward this year was linking the C-130J tactical airlift crew trainer with the C-130J full-mission simulator so that the entire C-130J crew could be immersed in the same training environment.'

Although *CVF* is important, the exercise is not merely a case of plug and play. The involvement of industry indicates that a lot of technical preparation is required before the exercise can take place.

Sci-fi systems

Technology continues to move forward at such a pace that projects such as those envisaged by the RCAF and RAF might never be able to catch up with the availability of what are now emerging technologies. For example, the next iteration of synthetic training is likely to see the use of blended reality (the rapid conversion of real-world objects into 2D or 3D models) and augmented reality (where real objects are enhanced or augmented with computer-generated imagery). A simple example of the latter is Pokémon Go.

Although these technologies are not yet mature enough for military training applications, the Star Trek Holodeck is no longer a thing of wonder or ridicule – depending on one's Trekkie credentials. Blending and augmentation will take virtual training to new levels.

Perhaps the virtual/live balance question will never be answered satisfactorily, but it is clear that more and more training is being conducted in the simulator and activity that is conducted in the air frequently features the use of synthetics. Without wishing to sound too cynical, we all hope that cost is not the major driver in the equation, and that outcomes dictate the ratio of virtual training being undertaken. ■

Survival in the skies

At Dobbins Air Reserve Base in Georgia, the ambitious Aeromedical Simulation Training and Education Center is revolutionising the way in which crews train for their demanding and life-saving roles.

By Beth Maundrill

The ultimate aim for Dobbins Air Reserve Base (ARB) in Atlanta, Georgia, is to be a centre of excellence for aeromedical evacuation (AE) training, with crews from all over the nation assembling to attain proficiency. Dobbins is home to the 94th Airlift Wing and is the first regional training and simulation centre devoted to the sustainment and development of AE skills.

'The long-range plan is to have three regional training sites, with Dobbins serving as the centre of excellence which will guide the others,' said Lt Col Chad Corliss, deputy commander of the 94th aeromedical evacuation squadron. 'This means having at least eight more [training] devices.'

Dobbins recently accepted a bespoke C-130E/H AE training system (AETS) and has the delivery of KC-135 and C-17 AETS devices from training and simulation specialist CAE to look forward to in 2017. Both the KC-135 and the C-17 trainers cost around $3 million each. The benefits of the AETS are the provision of realistic lighting, intercom systems, breathable air stations, realistic mounting points for stretchers and equipment as well as the ability to simulate a range of faults and emergencies, including fires.

The funding for the training systems, including the C-130, has an interesting history. 'It was a bit of a surprise for us because we were in the middle of sequestration when HQ Air Force came back to us and said: "We like this concept of the C-130 simulator, we have got the initial money,"' said Corliss. 'We used operations and maintenance dollars from

Patient simulators are supplied by CAE and include iStan, Caesar and METIMan. (Photos: CAE)

Aeromedical personnel conduct a full life support exercise in the C-130J simulator at Dobbins ARB in Georgia.

within the reserves, which is why the reserves own this thing.

'So we had this excess of money, which we took to HQ and said that we would like to re-programme this money into acquisition dollars to support this training,' he added. This request was then approved by the air force.

Increasing survival

The C-130 training system, which is set to reach full operational capability by March 2017, is to be mounted onto a new electric motion platform to provide additional fidelity to crews using in the device. The platform has been designed by E2M Technologies and will provide six-degrees-of-freedom (DOF) movement. The C-17 and KC-135 training systems will receive three DOF high-fidelity motion systems when they are installed at the ARB.

'This gives us greater reliability, greater responsiveness, less maintenance and a greater time between failure rate,' said Corliss. The motion element of the training system came after the initial requirements were set out, and was approved by the USAF with a cost of around $1 million. All of this training equipment is predicated on increasing soldier survivability rates on the battlefield and is therefore given high priority.

The USAF is the executive agent for all patient movement DoD-wide and since the beginning of operations in Iraq in 2001, a total of 320,275 patient movements have occurred and are ongoing.

For Corliss, the main aim is to decrease the 'died of wounds' rate. He pointed out that during the Vietnam and Korean wars, these rates were around 24-25%. During the first Gulf War and the first few years of the second, this did not improve, sitting at 24%. However, the numbers have improved dramatically, and in the past four and a half years, the US services have maintained a 98% survival rate.

'That means a less than 2% "died of wounds" rate – that is unheard of in modern combat,' said Corliss. 'I was asked if I think the C-130 AETS is going to let us get below 2%. Well, I want it to. We want to chase that 0% figure. I don't think that is going to happen, but what I don't want is it to go back to that 24% figure.'

He noted that survival in the combat zone is multi-faceted and is influenced by the improvement of medical care, superior body armour, the use of the tourniquet, the immediate application of fluids and the fast movement of people. The training received by AE personnel stretches from point of injury to medical evacuation, continuing on to air evacuation and then to fully equipped hospitals.

'We have learned a lot in over ten years of combat. What we do not want during our next conflict is having new nurses and new medics coming in, not knowing what we have learned and having to learn it all over again,' Corliss said.

The simulator is not just about the device itself but also encompasses the curriculum which is currently being developed by CAE. It is widely accepted that simulation reduces errors and maintains proficiency, as military and commercial flight applications have shown over the years. 'The medical world is just getting into that, but we are a little behind,' said Corliss, 'We know that [simulation] can improve patient safety.'

Hands-on experience

The simulator allows the AE team to conduct reproducible, standardised and validated scenarios. Currently, much clinical training is carried out through 'experience by chance'. 'We don't want to have that. We want to guarantee that every crew member that comes through this facility will get the opportunity to put their hands on and go through each one of those experiences,' explained Corliss

To facilitate this, alongside the AETS there are various high-fidelity patient simulators at Dobbins ARB. These include eight iStan patient simulations, provided by CAE, which are able to bleed, change blood pressure, heart rate and other clinical signs. There are also seven METIMan simulations and one Caesar, also from CAE, among a long list of other patient simulator products, including those from Gaumard.

Next on the agenda is the acquisition of a military dog to join the patient simulator family. This is likely to be acquired outside of CAE, as the company confessed a military dog is not yet part of its patient simulator portfolio.

'One of these misconceptions is that this is going to become a replacement for live training – it's not. We still train and we still fly,' explained Corliss.

However, the cost of training can be significantly reduced when the C-130, KC-135 and C-17 AETS are fully fielded, as this will remove the need for a live, costly aircraft to be launched to undertake training as frequently as it was in the past. It will also reduce the personnel costs. To operate the simulator, three individuals are needed compared with 12 to get a live mission off the ground, previously.

The future for AE training appears to know no limits. The new simulator assets are currently making their way into the USAF's inventory, and the next stage could be to move this onto rotary training units. The USMC has used the MV-22 as a medical evacuation asset and the UK has used a CH-47 as part of the RAF Medical Emergency Response Team.

'I love the MV-22 working as a tactical evacuation platform, working in a joint environment,' said Corliss. 'The challenge I see right now is that it is primarily a marine asset. The air force does have some but not inside the mobility world. So will it come? Very likely, as at the same time we are looking at more helicopters and previously we had never even talked about them... I do think the MV-22 could be down the road.' He added that although the air force does not own UH-60 Black Hawks, it has trained AE crews on them.

Corliss has had discussions with the US Army aeromedical school in Fort Rucker about the use of Black Hawks as an AE aircraft. 'Right now, they are training on a static Black Hawk, [but] they would certainly like to see one that goes on motion, too,' he added. ■

Founded in 1988, the National Training and Simulation Association aims to foster communication between training agencies regarding the industry's requirements, procurement issues and policies. Trevor Nash talks to its president, **RAdm James Robb, USN (Retd)**, about the future for simulation and training in the US.

Vital asset

The US has the largest military simulation and training (S&T) industry in the world and is the key provider to the US and many overseas markets. Robb believes that due to modern threats from 'state and non-state sponsored terrorism, cyber and other threats to critical infrastructure and the need to maintain, enhance and redirect capabilities to meet near-peer challenges', training capability has become a 'vital national asset'.

He said: 'The service leadership is recognising the value of moving more training into virtual worlds to capture the benefits of increasing simulation fidelity, adaptability, security and affordability. All this is good news for the military training industry, which is now estimated to be worth at least $9 billion. The S&T industry is the focal point of high technology and virtual-world capability. The key now is to get the government customer to move as fast as industry.'

Key partners

As with any relationship, there is always room for improvement. As far as training is concerned, the relationship between industry and the user is vital and the annual I/ITSEC event helps to foster this partnership.

'We now see a desire by the services to increase the percentage of time that individuals and units train in synthetic environments, so the demand for live/virtual/constructive [LVC] training capabilities is robust,' said Robb. 'Industry is leaning forward to help government assess requirements and quickly field or modify systems to meet their needs. As part of renewed dedication to supporting larger exercises within virtual environments, the needs and challenges associated with networking simulations and live entities together have come to the forefront.'

An example of this close relationship can be seen at this year's I/ITSEC, where 'the National Training and Simulation Association [NTSA] will field the second iteration of Operation *Blended Warrior*', explained Robb. 'This live demonstration will bring 55 industry and government LVC capabilities together into a single scenario-based war game. The operation is a showcase of industry and the government working together in a developmental and execution environment.'

Emphasising the importance of I/ITSEC, Robb told *MTSN*: '[The conference] is increasing emphasis on new and innovative ways to use current and future systems to improve training. We are working to better align industry research and development with near-term emerging requirements. The S&T industry includes some of the most innovative and savvy individuals on the planet, and I/ITSEC has become the place where new capabilities are being fielded at a record pace.'

Team work

The relationship between services and industry is not all plain sailing and Robb highlighted the challenge for the government in the assimilation of new technologies. He felt that procurement was too slow to accommodate this rapid rate of technological change. NTSA is dedicated to improving the working relationship between the two, especially as new challenges, such as cyber warfare, are now present.

'The Pentagon's "Third Offset" strategy emphasises the need for autonomous deep-learning machines and systems that support analysis,' Robb added. 'It also predicts increasing human-machine collaboration, decision-support and teaming. You can't fight a cyber war at the speed of humans. This focus on man-machine teaming will have profound implications for the training industry as a whole.'

As to the future of S&T technologies, Robb is clear. 'The value of virtual, augmented and mixed reality systems has become obvious to government leadership not only for force training, but for education,' he told *MTSN*.

'All the services are moving quickly to bring their individual training and performance measuring capabilities into the digital age. We can cut time-to-train down significantly, while at the same time reduce training requirements by making systems more intuitive or through the insertion of artificial intelligence into platforms and systems.'

Turning again to I/ITSEC, Robb said the event 'is doing extremely well and growing', and will allow the military to 'both communicate their requirements to industry and to be exposed to leading edge concepts and technology'. ■

NTSA

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