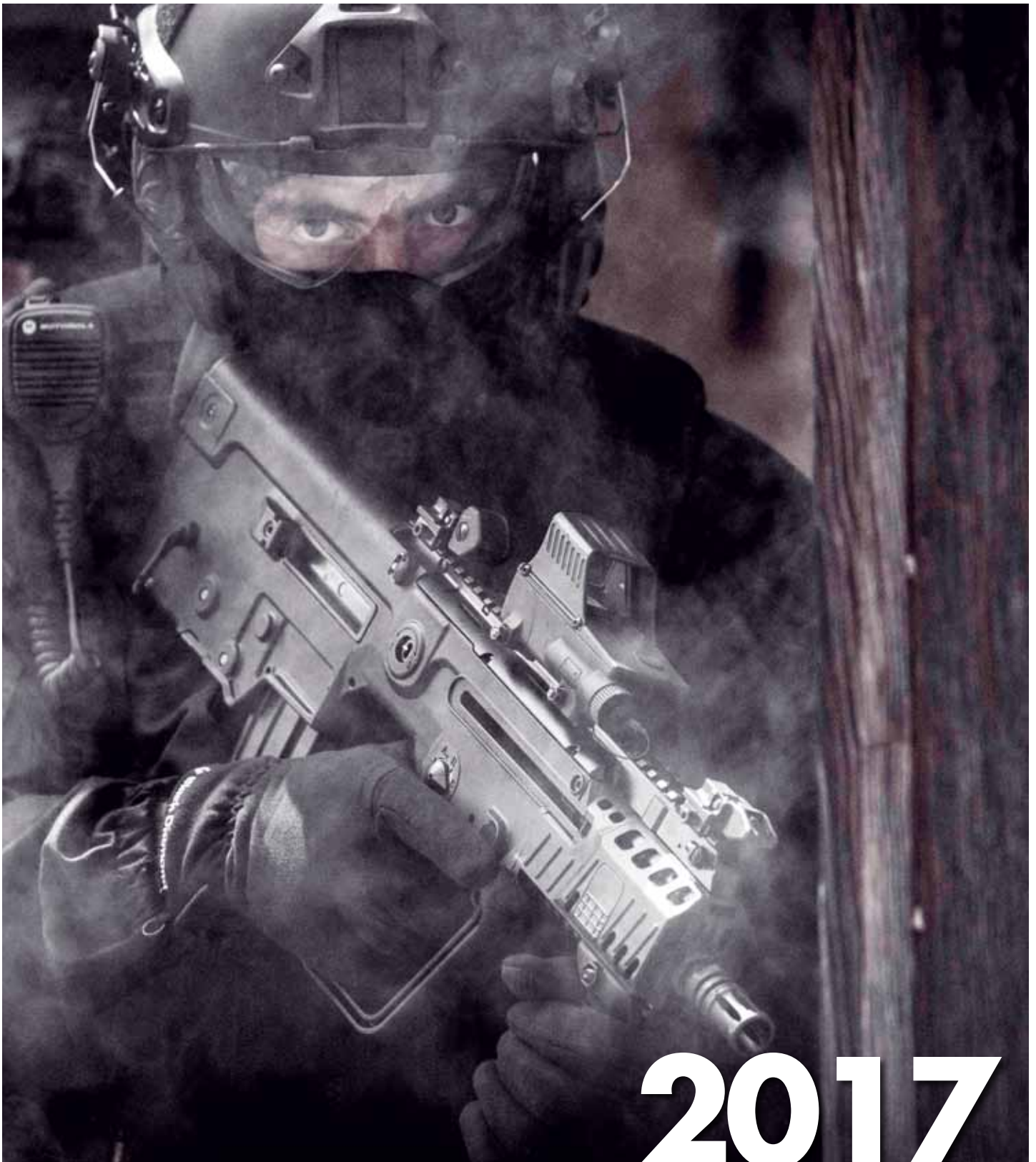


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During the siege of Sarajevo between 1992 and 1995, the 'Dragon of Bosnia' street had been nicknamed 'Sniper alley' as Bosnian Serb gunmen shot people at random.



CITIES IN CONFLICT

One could argue that the strategic importance of cities in a conflict is not a new concept. Historically, cities were used for protection by the population that lived within their walls, while fighting took place outside the city walls, or on its ramparts.

Dr. Alix Valenti

Once the attacking army had succeeded in destroying the city walls, or once the population had surrendered after years of famine and disease caused by siege, the enemy walked into the city, took what they wanted or needed and then either destroyed the place, or moved on anew as part of their overall campaign. A number of historic battles contributed to the common belief that military operations against cities form an intrinsic part of grand strategy; notable examples include the Fall of Constantinople which was captured from the Byzantine Empire by the Ottoman Empire on 29th May 1453, the siege of Sebastopol that lasted one year (1854 to 1855) during the Crimean war when the allied powers of France, the Ottoman Empire, Sardinia and the United Kingdom captured the city, located in the southeast of Russia. During the 20th Century, the Siege of Sarajevo, the capital of Bosnia and Herzegovina by the Bosnian Serb Army lasted from 5th April 1992 until 29th February 1996 (see below).

Frédéric Chamaud and Colonel Pierre Santoni in their book *L'Ultime Champ de Bataille: Combattre et Vaincre en Ville* ("The Ultimate Battlefield: Fighting and Winning in the City") published in 2016 wrote that: "Cities have been surrounded, bombarded, starved,

then pillaged and destroyed ... but in almost every case, the city was not a battleground." It is only on the doorstep of the Second World War, during the Spanish Civil War from 1936 to 1939, that the battleground moved into the city centre: during the Battle of Madrid, which raged from 8th November 1936 until 28th March 1939, when the city held by Republican forces was besieged by the Nationalist armies of General Francisco Franco.

MOVING OUTSIDE IN

Gen. Franco believed that taking Madrid would only be a matter of days, and would send a powerful message to adversaries and international allies (notably Germany and Italy) alike. His armies made their first assault on the Republican bastion on 29th October 1936. However, far better prepared for manoeuvre in open spaces rather than in city streets, the Nationalists were repeatedly pushed back and contained for the next three years by the Republican forces that used the capital's geography to their advantage. Madrid eventually fell in 1939, but it was more the result of the Republicans' general defeat across the country, rather than a Nationalist operational victory. The city retained a powerful symbolism throughout the civil war: between 1936 and 1939 it exemplified Republican resistance, whereas in 1939 it became a symbol of

Nationalist victory and power: "Following on from the Spanish Civil War, the city became a key battleground because it represented the centre of power," said Col. Santoni in an interview with *Armada* who, in addition to co-authoring *L'Ultime Champ de Bataille*, was the French Army's commanding officer for its *Centre d'Entraînement en Zone Urbaine* (Urban Zone Training Centre) located in north-east France between 2012 and 2014. A number of decisive battles took place in cities during the Second World War, including the Germans' defeat at the hands of the Red Army in Stalingrad (now Volgograd) in southeast Russia on 2nd February 1943, and during the siege of Budapest when the city was liberated by the Red Army and its Romanian Allies from German and Hungarian forces after a siege lasting from 29th December 1944 until 13th February 1945. Perhaps most famously, during the Second World War, the Red Army administered the *coup de grace* to Germany's Nazi regime during the Battle of Berlin fought between 16th April and 2nd May 1945.

Nevertheless, while during the Second World War cities had mainly become battlegrounds for national belligerents, a new trend emerged with the wave of wars of independence and civil wars, which took place between the 1960s and 1980s following the break-up of the colonial empires of Belgium, France, the



Today military forces are often involved in a number of MOUT scenarios, such as US combat operations in the Iraqi city of Mosul in 2003.

Netherlands, Portugal and the United Kingdom after the end of the Second World War, and the Cold War struggles between the Soviet Union-led communist and US-led Western blocs. According to Col. Santoni: “during (these) wars of independence that took place in Africa and Asia, Western armies faced a new enemy that had understood that knowledge of one’s city was a key advantage against an enemy with better capabilities.”

According to *L’Ultime Champ de Bataille*, the overt US intervention in the Vietnam War between 1965 and 1975 has a notable example of this trend; the Battle of Huế in central Vietnam between January and March 1968. On 31st January 1968 the city, which was defended by the US Army and Marine Corps (USMC), and the South Vietnamese Army of the Republic of Vietnam (ARVN), fell to the Viet Cong (VC) insurgent organisation, and their North Vietnamese People’s Army of Vietnam (PAV) allies, in a surprise attack during the Tet Offensive; a large offensive launched by the VC and PAV on 30th January 1968 against ARVN and US forces. Within hours, the VC had occupied all the key buildings in the city, such as government buildings and places of worship, and had raised their flag. It took the US Army, the ARVN and the USMC three months to reclaim the city for two reasons: Firstly, there was an initial reluctance from the US and ARVN to destroy some of the buildings the VC were hiding in, including Buddhist temples and the city’s Imperial Palace. This allowed the VC to continue re-supplying their forces and to stand their ground. Secondly, while the VC displayed great determination and strong organisational skills, including the establishment of defensive perimeters around their areas, US forces and the ARVN faced coordination issues: The nature of fighting in the city required different battalions to attack from different axes, therefore complicating communication between them and thus necessitating

more autonomy for each battalion. It was only when they regrouped and secured the support of heavy artillery and aviation units that they succeeded in eliminating their VC and ARVN adversaries and reclaiming the city.

The lessons learned from Huế and other battles fought by the US following the Second World War were reflected in the development of the *Field Manual for Military Operations on Urbanised Terrain* (MOUT) for the US Army in August 1979. Its introduction stated that: “Urban combat operations may be conducted in order to capitalise on the strategic or tactical advantages which possession or control of a particular urban area gives or to deny these advantages to the enemy.” Much like the symbolism of Madrid during the Spanish Civil War or the Battle of Berlin (*see above*) what happens in the city: “may yield decisive psychological advantages that frequently determine the success or failure of the larger conflict,” the manual continues.

I SOLDIERS AND CITIES

The end of the Cold War in 1991 marked a new turning point for the city in the context of war. Countries whose independence was fought and gained during this epoch thanks to the support of their US or Soviet allies were suddenly left to fend for themselves, characterised by weak political institutions while struggling to face the economic insecurities arguably caused by the onset of globalisation’s strong market driven economy. Thus, as this discussion will illustrate, cities not only became the spaces where globalisation met with local expectations and desires; they also progressively became the main sites for elements of civil society contesting and confronting the institutional powers which were failing those expectations and desires.

The 1990s thus saw a wave of new wars where cities became the theatres of bloody conflicts between economically and/or po-

litically disenfranchised population elements and contested power holders. In this context, the post-Cold War era has seen military operations, as discussed below, increasingly including Western interventions intended to halt conflicts and enforce conditions conducive to peace and post-conflict reconstruction. These new missions have encompassed a whole new set of challenges for military operations, particularly regarding cities. The first major example of such a trend was witnessed in Bosnia and Herzegovina, notably during the Siege of Sarajevo.

Space is insufficient here to provide a detailed discussion of the factors behind the break-up of Yugoslavia in the late 1980s and early 1990s. Nevertheless, broadly speaking, demands for more regional autonomy amongst Yugoslavia’s ethnically diverse population, coupled with dissatisfaction towards the government in Belgrade from some elements of the Yugoslav polity precipitated the country’s gradual disintegration. Part and parcel of this disintegration was the Bosnian War, which commenced on 6th April 1992 and which pitted the Republic of Bosnia and Herzegovina, Croatia and the Croatian Community of Herzegovina against the Republika Srpska, Yugoslav armed forces and the Republic of Serbian Krajina. The war that ravaged Bosnia and Herzegovina until December 1995 is perhaps most infamous for returning mass graves, ethnic cleansing and concentration camps to Europe fifty years after the end of the Second World War. It is also remembered for the siege by Republika Srpska forces of its capital, Sarajevo, which continued for three years, ending only in September 1995 following the commencement of Operation DELIBERATE FORCE by the North Atlantic Treaty Organisation (NATO) on 30th August 1995; during which air strikes were performed by NATO combat aircraft against Republika Srpska forces to

undermine the latter's military capability.

During the three and a half years siege, one particular thoroughfare, *Zmaja od Bosne* ('Dragon of Bosnia') Street, in Sarajevo became known as 'Sniper Alley': A wide street in the centre of the city, Sniper Alley saw Bosnian Serb gunmen positioned on top of buildings regularly shooting unsuspecting victims picked at random, not only civilians, but also UN (United Nations) peacekeepers deployed from 1992 to Croatia, and Bosnia and Herzegovina from the UN Protection Force (UNPROFOR). Amongst other duties, UNPROFOR had the task of protecting so-called Safe Havens in both areas established to protect civilians, of which Sarajevo was one.

According to Col. Santoni: "conflicts in the city last far longer than they used to in open spaces, not only because the new rules of engagement dictate that the population should be protected at all costs, but also because the urban environment, with all the opportunities for surprise attacks it provides to the 'local fighters', balances out the advantages of today's technologies available to Western armies." They also require a balancing act for intervening in a conflict, according to *L'Ultime Champs de Bataille*: "units (engaged in urban combat) must be able to master the entire spectrum of operations, from non-lethal anti-riot action to gun fights against (insurgents)." Current military operations involving the Iraqi armed forces, al-

lied militias, Iraqi Kurdistan and US-led international forces dubbed Operation QADIMUM YA NAYNAWA ('We Are Coming Nineveh'; a reference to the Nineveh Governorate, an Iraqi province on the outskirts of Mosul) which commenced on 16th October 2016 to liberate the northern Iraqi city of Mosul from the Islamic State of Iraq and Syria (ISIS) insurgent movement, exemplify these complexities.

I MOUT MANUALS

The UN's Department of Economic and Social Affairs, in its 2014 revised publication *World Urbanisation Prospects*, stated: "The planet has gone through a process of rapid urbanisation over the past six decades ... In 2014, 54 percent of the world's population (was) urban. The urban population is expected to continue to grow, so that by 2050, the world will be one-third rural (34 percent) and two-thirds urban (66 percent), roughly the reverse of the global rural-urban population distribution of the mid-twentieth century." As cities continue to grow and represent centres of struggle for economic, political and cultural power, they will continue to be a key determinant in each and every conflict that ensues from these struggles.

General Alain Bouquin, Thales' army advisor, says that: "Now there are four scenarios for military involvement in cities: support to national security forces, such as the presence

of 10000 French military personnel on national territory since (the ISIS acts of political violence) perpetrated in Paris in 2015; control of an urban area, such as the (French Army) peacekeeping mission in Gao, southern Mali; counter-insurgency external operations, such as (UN) operations in Mogadishu, Somalia, in 1993; and, the reclaiming of a city from the adversary, such as what is currently happening in Mosul." NATO nomenclature refers to these operations as Fighting in Built-Up Areas and its report *Urban Operations in the Year 2020*, published in 2003, defined them as: "those military and other activities in an area of operation, where significant defining characteristics are man-made structures, associated urban infrastructures and non-combatant populations." In the US, these operations are referred to as Military Operations in Urban Terrain (MOUT), and the Marine Corps' doctrinal guidance document *Military Operations in Urbanised Terrain* published in May 2016, defines them as: "all military actions planned and conducted on a topographical complex and its adjacent terrain where man-made construction is the dominant feature. It includes combat in cities, which is that portion of MOUT involving house-to-house and street-by-street fighting in towns and cities." For the purpose of this publication, the term 'MOUT' has been chosen as an arguably more comprehensive concept.

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FIGHTING IN THE CANYONS

The key characteristic of MOUT (Military Operations in Urban Terrain) is that urban terrain, in all its complexities, has altered the balance of power as victory no longer necessarily belongs to the belligerent with the most deadly and technologically-advanced capabilities.

According to Colonel Pierre Santoni, the French Army's former commanding officer for its *Centre d'Entraînement en Zone Urbaine* (Urban Zone Training Centre) located in northeast France, intrinsic to prevailing in MOUT is, first and foremost, a matter of having or acquiring as deep an understanding of the urban environment as possible. As such, a determined insurgent group which knows the urban environment really well will be able to fight on equal footing with soldiers equipped with the best capabilities but little knowledge of the terrain.

After spending decades decreasing their military personnel, a study by the consultancy firm Roland Berger published in 2015 stated that over the past decade NATO (North Atlantic Treaty Organisation) personnel levels had dropped by one third. Western armies engaging in MOUT are coming to terms with the fact that: "Aside from technology, the number and quality of combatants and (commanders) will also be deciding factors (in MOUT)," as stated in Frédéric Chamaud's and Col. Santoni's 2016 book *L'Ultime Champ de Bataille: Combattre et Vaincre en Ville* ("The Ultimate Battlefield: Fighting and Winning in the City"). Adequate training and careful strategic and tactical planning is therefore intrinsic to increasing the chances of success during MOUT.

I TUNNEL EFFECT

The first key characteristic of the urban environment is the fact that it is very closed-up. The multitude of streets, small alleyways, street corners and high-rise buildings provide many possibilities for an ambush by an adversary. This can be very disorienting for a soldier that does not know the area well or whom has not been prepared for it. An essay published in 2012 in the French magazine *Histoire et Stratégie* (History and Strategy) entitled *Les Trois Caractéristiques des Opérations Urbaines* (The Three Characteristics of Urban Operations) explained that: "The sense of isolation incurred by the presence of buildings limits units' movements, channelling them into streets and other passages, allowing the adversary in a defensive position to predict to a certain extent their movements."

In their book, Mr. Chamaud and Col. Santoni call this "the tunnel effect," arguing that "streets kill." The 'tunnel effect' has a particularly strong psychological effect on individual soldiers, who suddenly feel that they could be an easy target at any moment. The operational consequences of a soldier that tires more quickly, due to the stressful environment, are key concerns to take into account in training as well as during the operational and tactical preparation for a MOUT action.

Finally, it is often the case that the streets are too small to facilitate the manoeuvring of

armoured vehicles, making it more difficult for the infantry to rely on the support of these vehicles for additional protection. Indeed, the firepower normally afforded by these vehicles facilitates the targeting and elimination of the adversary in the *locale* surrounding the units. Without such support, the same units are even more exposed to potential threats and surprise attacks. Nevertheless, contemporary rules of engagement which have, since the end of the Cold War, required NATO to minimise civilian casualties and damage to civilian infrastructure can also restrict the application of such force during MOUT.

I 3D VISION

MOUT actions are further complicated by the three-dimensionality of the urban environment. It is no longer only a matter of what individual soldiers can see in their field of vision, but it is also, and perhaps even more importantly, a matter of what lies within, above or beneath a building. As the experience of Sarajevo (see preceding article) revealed, snipers can hide anywhere in an urban environment, starting from behind a window all the way up to the rooftop of a building. Similarly, adversaries can hide in the numerous underground passages such as sewage systems and underground transportation that comprise the fabric of the urban environment.

The equipment currently at the disposal of many armies around the world is yet unable to fully assist soldiers in the task of preparing for such complex environments. Maps, which soldiers learn to use during their training, are only bi-dimensional. They do not provide any information regarding the height of buildings surrounding the street a unit intends to take, for example, nor do they offer a reading of the potential presence of underground passages. Yet, underground passages quickly become a key asset for those who know of their existence. As indicated in the US Marine Corps' doctrinal publication *Military Operations on Urbanised Terrain* published in May 2016: "Both attacker and defender can use subterranean avenues to manoeuvre to the rear or the flanks of an enemy. These avenues also facilitate the conduct of ambushes, counterattacks and infiltrations." For instance, during the Battle of Aachen, which occurred in and around the German city of Aachen in the west of the country fought between 2nd October 1944 and 21st October 1944, German troops regularly used underground passages to appear behind US soldiers and engage them without difficulty. Such tunnels can also be used for



Cities are complex environments including different areas presenting different urban fabrics, and at the French Army's CENZUB installation, the village of Jeoffrecourt includes a core periphery.

Alix Valenti



Alix Valenti

MOUT incurs more wounded than military operations in open spaces, and during their training soldiers learn to evacuate casualties quickly and efficiently.

the storage of ammunition, thus creating a significant advantage against opposing forces which may face significant logistical challenges in this regard when trying to re-supply their forces conventionally during MOUT.

ROTA

Unlike cities in the pre-industrialised world, today's urban areas are complex environments consisting of a combination of different areas. The city core, which is common to all urban areas, varies in its fabric according to countries' levels of development and architectural history, but is similar across the globe in that it is very dense. The commercial ribbons are the city streets that are predominantly lined with shops, restaurants and businesses. Although, again, this varies from county to country, commercial ribbons are usually built around wider streets in order to allow large influxes of people and to facilitate the circulation of delivery vehicles. Beyond the city core lies the core periphery which consists of streets, of varying widths, lined predominantly with residential buildings. Outside the core periphery is the residential sprawl which often takes the form of vast poor and very dense areas in developing countries, whereas in a developed country this sprawl can simply represent a series of new residential developments built to accommodate a rising population. Last but not least, the outlying industrial areas generally consist of clusters of industrial buildings.

According to the Marine Corps' MOUT doctrinal guidance cited above: "each of the urban area's regions has distinctive characteristics that may weigh heavily in planning for MOUT." Dense areas, such as city cores, are generally more prone to provoking the 'tunnel effect' (see above), and are much more complicated to access for support platforms such as main battle tanks and armoured vehicles. Commercial ribbons, core periphery and residential sprawl are more conducive to the circulation of these vehicles, and can often represent ideal avenues for approaching the city core and progressively securing an urban space. Outlying industrial areas, however, can become a substantial problem due to the fact that they often include buildings with dangerous materials such as chemicals or gas. The risks represented by these outlying industrial areas are known as 'Risks Other Than Attacks' (ROTA), according to the essay *Les Trois Caracteristiques des Operations Urbaines* (see above).

OPERATIONAL ISSUES

At the operational level, the characteristics of the urban environment outlined above have one key consequence: MOUT implies combined arms manoeuvre. A number of confidential sources whom spoke to *Armada* during the preparation of this article highlighted some important considerations to this end. Arguably, the most common form of combined arms manoeuvre involves the close cooperation of infantry and armour. The use of main battle tanks and armoured vehicles in a city, provided there are no restrictions to their circulation (such as street width or bridge weight limits), provides the infantry with an assault weapon to be used against buildings or strong points where adversaries are known to be hiding. However, Col. Santoni warned in an interview with *Armada* that: "armoured vehicles and tanks need protection in urban areas." Their field of vision is limited to the ground, and the unit inside cannot afford to come out of the vehicle to see what is going on. As such, these vehicles are vulnerable to munitions coming from any angle in the city, as well as to any threats emanating from underground passages. Thus, the role of the infantry is to protect these vehicles. Key to this partnership is the quality of the communications between the vehicle and their



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During an exercise at the CENZUB: armoured vehicles provide the infantry with an assault weapon while the infantry provides mutual protection for the vehicle.



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MOUT requires armies to maintain strong autonomy as small units will need to divide to clear urban areas, and at the CENZUB soldiers learn to work in small groups.

accompanying dismounted infantry unit: the latter needs to be able to quickly and efficiently communicate to the former precise coordinates for the direction of fires.

During MOUT, combined arms manoeuvre may also include aviation. Close Air Support (CAS) provides infantry and armour with additional striking power where vehicles cannot reach, or where it is too dangerous for infantry to venture. This requires highly trained Joint Terminal Air Controllers (JTACs) that communicate with the different units to direct aerial fires.

Operationally, any MOUT planning needs to carefully outline a plan regarding logistics. Before entering potentially confined urban zones, it is vital to determine at least one route that can be easily protected for use as a logistics corridor, as well as to facilitate the evacuation of wounded and the regular rotation of assault units. The evacuation of wounded troops is indeed also key to successful MOUT because, as a French military source said: "MOUT operations incur more dead and wounded than operations in any other terrain, therefore being able to evacuate and treat wounded soldiers as efficiently as possible means they can quickly go back to the battlefield; failure to do so means fighting in one of the most complex environments with a dwindling army".

Finally MOUT are demanding in terms of personnel and require that commanders at all echelons be well trained to work separately and to coordinate combined arms manoeuvre. When attempting to stabilise the situation in, or when reclaiming, a city armies can no longer work in big formations; rather the nature of the environment dictates that they divide into smaller units in order to approach from different axes and spread to secure dif-

ferent buildings and areas. As indicated by the French military source: "The degree of autonomy imposed by the numerous micro-theatres of the battleground will result in squad, platoon and company commanders being left to make decisions for themselves."

I TACTICAL IMPLICATIONS

At the tactical level securing a city is extremely time, and ammunition, consuming. The possibility of a new threat in every new street, corner and building means that units moving into a city have to go through these buildings one-by-one, and secure them floor-by-floor and room-by-room. According to Sean Page, senior associate at Avascent, a consultancy based in Washington DC: "Individual soldiers need to learn how to move in a city environment, where threats are all around and tactical options are very limited; as a result, going through compounds rather than streets is generally safer." This translates into a large number of rounds being expended either against the adversary or in the room where there is a suspicion that an adversary might be present to ensure that it is cleared.

The chaos of MOUT also has the potential to incur casualties in the midst of operations, whether they are friendly forces or civilians. This requires that, to the extent possible, the organisation of MOUT also includes evacuating civilians as fast as possible prior to commencing operations. The rules of engagement for military operations have become very strict regarding civilian casualties. The Marine Corps' MOUT doctrinal guidance requires: "Minimising civilian casualties and/or collateral destruction in order to: avoid alienation of the local population; reduce the risk of adverse world or domestic opinion; preserving facilities for

future use; and, preserving cultural facilities and grounds." Similarly, the chaos of MOUT places a premium on detecting and identifying friendly forces. While this is usually done through the development of new technologies such as Blue Force Tracking (BFT) which depicts friendly (Blue) and hostile (Red) forces, the past decade has seen a proliferation of BFT systems such as those offered by ViaSat namely its Blue Force Tracking-2 system used by the US Army and Marine Corps; Elbit Systems, which is fulfilling the Australian Army's BGC3 BFT requirement and Thales which provides a BFT capability as an integral part of its NORMANS (Norwegian Modular Arctic Network Soldier) infantry soldier system which is currently equipping the Norwegian Army. Nevertheless, the three-dimensional characteristic of urban environments remains particularly difficult to represent on handheld or vehicle-mounted BFT devices. As Gen. Bouquin asked: "how do BFT devices cope with showing friendly forces present on different floors in a building?"

Last but not least, tactical communications, which are key to any military operation, can be disrupted in urban environments. Both Very High Frequency (VHF) and Ultra High Frequency (UHF) communications, which use a frequency band of 30 megahertz to three gigahertz, are limited to line of site ranges. So called 'Urban Canyons' where streets are flanked by high rise buildings can block line-of-sight radio transmissions employed by VHF and UHF radios. Inside buildings, such radios can have their transmissions limited by the thickness of walls or floors, while a crowded electromagnetic spectrum, which may also include radio and television stations, civilian radio communications (such as those used by taxis or the emergency services) not to mention cell phone traffic, may also have an adverse effect on the ability of VHF and UHF tactical radios to work as desired. Nevertheless, mobile *ad hoc* networking, by which tactical radio transmissions 'hop' from one transceiver, within the transmitting radio's line-of-sight to another until reaching the transmissions' intended recipient, in much the same way as a frog jumps from one lily pad to another across a pond, provide one means of meeting the communications challenges presented by the urban canyon. Similarly, the advent of the US armed forces' Mobile User Objective System (MUOS), a UHF satellite communications constellation being developed by Lockheed Martin on behalf of the US Navy, provides a means by which UHF radio transmissions can be transmitted into space to bounce off one of the four MUOS spacecraft in geostationary orbit to reach their recipients; once again avoiding the physical restrictions imposed by the urban canyon. That said, despite some of the potential communications solutions offered for MOUT, writ large, commanders still need to have a very high level of autonomy during operations, as well as trust in the original planning of their MOUT action, while individual soldiers need to trust both direct orders and their instincts.

PREPARING FOR BATTLE

Alongside their reliance on ever-improving technology, individual soldiers need to be trained in an environment where the vast majority of the fighting takes place in built up areas with actions often occurring at squad, or even individual levels.



The Centre of Medina Wasl, a mock Iraqi village used to train troops for MOUT at the US Army's National Training Centre.

As Frédéric Chamaud and Colonel Pierre Santoni indicated in their book *L'Ultime Champ de Bataille: Combattre et Vaincre en Ville* ('The Ultimate Battlefield: Fighting and Winning in the City'), published in 2016, MOUT requires: "shooting with an individual or collective weapon, loading ammunition under fire, moving as a group, applying safeguard procedures for parking in hostile areas, applying first aid procedures and calling for fires from Close Air Support (CAS) and artillery."

In the course of the second half of the twentieth century, a number of countries have built MOUT training sites. First amongst these was the United Kingdom which, during the conflict in Northern Ireland between 1969 and 2006, built a number of villages replicating the operational conditions the British Army met in Northern Irish villages, towns and cities. Based in different locations, such as Folkestone (southeast England), Seenelager (western Germany) and Ballykinler (southern Northern Ireland), the training grounds were regularly updated to reflect the constantly changing conditions of fighting on the ground, including significant changes in the landscape and the latest weapons and ambushing techniques used by insurgents. Today, the British Army trains primarily for MOUT at the Copehill Down Village, part of the Urban Operations Wing of the British Army Land Warfare Centre, in Warminster southwest England.

Other MOUT training centres exist for the *Heer* (German Army) at Hammelburg in south-central Germany, at the Urban Warfare Training Centre at the Israeli Defence Force base of Ze'elim, southern Israel, for the Singaporean Army at the Murai Urban Training Facility, and for the *Ejército de Tierra* (Spanish Army) at the *Paracuellos de Jarama Centro de Instrucción de Combate en Terreno Urbano*

(Paracuellos de Jarama Urban Combat Training Centre) in Spain, to name but a few.

I US MOUT TRAINING

The US has two main training locations for MOUT: the Joint Readiness Training Centre (JRTC) at Fort Polk, Louisiana; and, the National Training Centre (NTC) at Fort Irwin, California. According to Sean Page, a senior associate at Avascent, a consultancy based in Washington DC: "military forces undergo training in one of these two centres if they are required to deploy overseas in missions that will include MOUT."

The JTRC focuses primarily on preparing light infantry brigade task forces for low-to-mid-intensity combat, that is, mostly peace-keeping exercises. Exercises for infantry brigades may be done as a rotation or Mission Rehearsal Exercises (MREs). While MREs are shorter than rotations, respectively running for twelve and 18 days, they include most of the scenarios that are confronted by brigades participating in full rotations. A rotation generally has three phases: an insertion and counter-insurgency operation; defence in response to an insurgent attack; and an attack into a state-of-the-art MOUT complex. The scenarios are conceived to prepare soldiers for as many of the potential difficulties that they could encounter on the ground as possible. This is particularly the case regarding scenarios where they may need to work closely with civilians, and as such number of scenarios that involve dealing with evacuations of civilians, gathering intelligence from civilians, and dealing with civilians that are sympathetic to the adversary force are rehearsed. On this point, Mr. Page adds: "one of the most difficult tasks when carrying out MOUT operations is dealing with a population speaking a foreign language, so in order for soldiers to be prepared for this eventual-ity, interpreters are also part of the scenario

while role players posing as civilians pretend they do not speak English."

The exercises also aim to train infantry brigades to plan and undertake combined arms manoeuvre in the urban context. As such, mechanised and armour units, special operations forces, US Air Force Air Combat Command units, US Navy elements and US Marine Aviation and Marine Air Naval Gunfire Liaison Company units are regularly involved. Observers/Controllers, who are part of the JRTC staff, follow the exercises closely to provide support to unit chiefs and help them improve their abilities to plan, coordinate and respond to unforeseen challenges. After Action Reviews (AARs) and exercise conclusion reviews are performed at the end of each operational phase.

The NTC's mission, according to its website, is to: "prepare (US Army) Brigade Combat Teams (BCTs) and other units for combat." The NTC includes several mock villages, modelled on towns and villages in Afghanistan and Iraq. Similar to the JRTC, a rotation at the NTC lasts 18 days and includes a number of scenarios intended to prepare the BCTs for the worst possible case scenarios during MOUT, such as the detonation of Improvised Explosive Devices (IEDs), rocket attacks and suicide bombings. It also includes situations that involve crowd control, interacting with locals who do not speak English and providing aid as well as ensuring evacuation of civilians and armed combatants.

Mr. Page indicated that the types of scenario as well as the choice of the specific environment for the exercises are at the discretion of the BCT commander, depending on the mission they will deploy for. In terms of capabilities, he indicated that BCTs and infantry brigades undergoing training at the JRTC or NTC generally bring as much *materiel* as they can themselves including not only individual soldier equipment but also helicopters. Main Battle Tanks (MBTs) and armoured vehicles, on the other hand, are provided by the centre: "these used to be transported by the units on training via railway, however it proved too time consuming and too costly, so it was decided it would make more sense to have them ready at the centres," adds Mr. Page.

I FRENCH MOUT TRAINING

Away from the United States, France's MOUT training site is located at Sissonne in north-east France. Following the deployment of the *Armée de Terre* (French Army) to theatres in Afghanistan; Bosnia and Herzegovina; and Mali, where it regularly experienced MOUT, the military training ground of Sis-



US DOD

The US Army's National Training Centre includes a number of reproductions of different villages modeled on Iraqi and Afghan urban areas.

sonne opened its *Centre d'Entraînement aux Actions en Zone Urbaine* (CENZUB/Urban Zone Action Training Centre) in 2004. The CENZUB includes Beauséjour; a reproduction of a village with low-income settlements and a defensive hamlet; an urban area firing range where soldiers can exercise in confined environments as individuals or in group formations and the Jeoffrécourt urban complex.

Jeoffrécourt, the construction of which began in 2008 and was completed in 2012, is the reproduction of an urban environment designed for 5000 inhabitants. It includes four different environments: an outlying industrial area with a recycling centre, a supermarket and other industrial buildings; a core periphery area, with a nursery, a hospital and a fitness centre, as well as seven storey residential buildings set up around a wide street reminiscent of the infamous 'sniper alley' in Sarajevo during the Bosnian War: *see the first article in this compendium for a discussion of Sarajevo as a case study for MOUT*. Also to be found at Jeoffrécourt is a residential sprawl and the city core, with a mosque, a city hall and a few narrow streets. The urban area includes other features meant to reproduce some of the challenges soldiers are likely to encounter in urban environments such as a small river over which two bridges have been built, with only one able to withstand the weight of an MBT or armoured vehicle, and a sewage system to simulate the challenges posed during MOUT by underground passageways.

A rotation at the CENZUB lasts two weeks: "the first week, the company on rotation, whether infantry, cavalry, artillery or engineers, takes both lectures on MOUT doctrine and workshops to learn specific tactics, such as how to deal with IEDs for instance," says Lieutenant Charlotte (French military policy allows only a single name for individual personnel to be used by the media), a communications officer at the CENZUB: "During the second week, the simulation exercise begins at Jeoffrécourt," Lt. Charlotte continued. On the first day, Monday, the company begins by preparing the manoeuvre on a large reproduction of the city on the ground. This is meant to recreate the conditions for preparing a manoeuvre on the battlefield. They then move to Jeoffrécourt and begin their

first manoeuvre: launching an attack on the city, which is meant to last until Tuesday evening. On Wednesday, the company deals with a stabilisation scenario, which includes a tripartite meeting in the town hall between international forces and the two civilian groups at war with each other, as well as a riot erupting in the city, which the company is then tasked to contain. On Thursday, the company faces a counter-attack from insurgent forces attempting to reclaim the city and is meant to stand its ground defending the city.

The CENZUB has a permanent staff of approximately 400 people, both civil and military, who role-play during these exercises: "Depending on the scenario of the day, the staff can play the adversary force (FORAD), whether as military forces, insurgents or civilians," continues Lt. Charlotte. There are also instructors on the ground and in the CENZUB operation centre, who follow the exercises very closely to provide detailed feedback at the end of each day, and a film crew, which records the most complicated manoeuvres, or scenarios where the instructors have informed them beforehand that the company will meet unexpected obstacles. At the end of each day, company commanders



Alix Valentini

During training at the CENZUB, the FÉLIN system is equipped with sensors in order to detect fire and simulate injuries.

sit down with the instructors for their AARs.

During training at the CENZUB, French soldiers are equipped with the Safran Defence Electronics/Sagem FÉLIN (*Fantassin à Équipement et Liaisons Intégrés/Integrated Infantry Equipment and Communications ensemble*), and their GIAT/Nexter FAMAS-F1 5.56mm assault rifle, as they would be during a mission. The FÉLIN system is equipped with a Cassidian/Airbus STC-AL (*Simulateur de Tir et Combat Armes Legeres/Shooting and Light Arms Simulator*): with the helmet and the vest covered with laser light sensors that react when hit by lasers equipping the opposing forces' weapons for the purpose of the exercise. The exercises are performed without live ammunition, however in order to simulate the firing noise, the FAMAS-F1s shoot blanks. The aim is to accustom soldiers to the noise of shooting in confined spaces, and the stress that can come with it. Moreover, in a similar fashion to MOUT training in the US (*see above*), French Army companies coming to train at the CENZUB bring their own equipment which can include *Aviation Légère de l'Armée de Terre* (French Army Light Aviation) reconnaissance helicopters such as the *Aérospatiale/Airbus Helicopters SA-342 Gazelle* or the *Eurocopter/Airbus Helicopters EC-665HAP/HAD Tigre* attack helicopter. Unmanned Aerial Vehicles (UAVs) such as the French Army's Cassidian/Airbus Survey Copter and Tracker UAVs, can also be included in the CENZUB training exercises.

The CENZUB, on the other hand, equips the FORAD with old French Army vehicles such as the GIAT/Nexter VAB four-wheel drive armoured personnel carrier, the GIAT/Nexter AMX-10P amphibious infantry fighting vehicle (being retrieved from the French Army) and GIAT/Nexter AMX-30 family MBTs.

Captain Martin, an instructor at the CENZUB, says that the exercises: "are meant to replicate as many of the conditions that the soldiers are likely to encounter as possible." This includes not only potential conditions and scenarios, but also how they deal as a squad, platoon or company with their casualties. Indeed, the FELIN training system built around the STC-AL is also equipped with a screen which informs the soldiers when they have been hit and lightly injured, seriously injured or have died. In the latter case, they either lie on the floor for five minutes waiting to be evacuated by their comrades, or remove their helmet to signify that they are dead and should be left behind: "The evacuation of armed combatants is a key determining factor for the tempo and success of an operation," continues Capt. Martin: "ultimately, exercises at the CENZUB are developed to prepare commanders for combined arms manoeuvre and to coordinate large companies in complex environments," he concludes.

VIRTUAL MOUT

Conducting live training is expensive and companies only have a limited amount of time available to prepare for their deployment in MOUT training centres. Military



French Army

At the CENZUB, the Jeoffrécourt village includes an outlying industrial area, a core periphery area, a residential sprawl and a city core.



MetaVR

MetaVR has produced numerous computer-based MOUT training systems, including a virtual representation of the MOUT training site at Camp Pendleton.

training, however, remains an ongoing task as adversaries evolve their tactics, and as new technologies make tactics that worked yesterday redundant tomorrow. Moreover, not all combined-arms scenarios can be replicated within the confines of a MOUT training ground. It is particularly difficult, for instance, to train JTACs (Joint Terminal Attack Controllers), whom form a vital part of the provision of CAS, in places such as the JRTC, NTC or CENZUB. Nevertheless, advances in virtual training technology over the past decade have had a significant impact in this sense.

MOUT requires tactics that not only demand sharp soldiers reflexes, but also necessitate a lot of ammunition. It would be far too costly to train individual soldiers with live rounds regularly on MOUT training sites. Meggitt works to fill this gap by providing small arms training systems. Robert Cairns, a manager and training

subject matter expert at Meggitt, explained “We take live weapons and modify them into air-powered simulators, which use heat detection to show where the ‘shot’ hit ... This way soldiers develop quick and accurate reflexive skills through the use of a simulator with unlimited rounds, and have a higher level of preparedness when they arrive at the live training centre.” Meggitt currently has two important programmes ongoing with the US Armed Forces: a \$5.8 million contract with the US Marine Corps’ Systems Command Programme Manager for Training Systems for the Indoor Simulated Marksmanship Trainer (ISMT) system. The company explains that the ISMT is a small arms training programme designed to improve marksmanship through collective and judgmental scenarios. It has been built to include automatic coaching features that allow the instructor to receive immediate feedback on the Marine’s performance, and to provide additional coaching where needed. Under this contract, Meggitt will provide 166 ISMT systems to the USMC with delivery commencing in January 2017.

Meggitt’s second US marksmanship training programme, worth \$99 million, is for the delivery of over 890 Engagement Skills Trainers (EST-II) systems to active US Army, National Guard and Reserve units worldwide. The EST-II, the firm continues, is a small-arms trainer that integrates three-dimensional marksmanship, automatic coaching, a tablet interface

and enhanced graphics with existing simulated weapons. Deliveries began in August 2016 and are scheduled to be completed in April 2018: Heath Shaw, who is also a manager and training subject matter expert at Meggitt, added that: “both systems have been developed to allow as much fidelity to real scenarios as possible thanks to the use of Bohemia Interactive Simulations (BISim) Virtual Battlespace-3 (VBS-3) software.” They are also designed to constantly integrate new weapons.

Regarding VBS-3, Oliver Arup, vice president of product management at BISim, told *Armada* that this: “allows users to experience a highly detailed and complex environment close to what they would experience in the real world; this includes object details such as IED components, wires and switches, which are important elements for military training in today’s urban environments.” Through TerraSim, a BISim subsidiary, the VBS-3 package also allows users to build their own three-dimensional models of buildings from blueprints, thus facilitating pre-deployment training for specific missions, and offers a wide range of weapons and weapon effects: “It supports procedural, physics-based destruction, which allows the user to damage a building in a variety of ways from simple breaching or mouse holes to full destruction of a building,” continues Mr. Arup; “thus allowing the user to train for the knock-on effects of kinetic engagements in an urban environment which might otherwise not be considered.” In 2016, BISim delivered custom terrain software for urban training to the Netherlands Ministry of Defence and the firm’s DayZ Chernarus terrain software, a fictional terrain based on real-world data which includes a variety of urban environments, to the Swedish Armed Forces.

Regarding MOUT training aids, MetaVR is heavily involved in the provision of MOUT computer simulation training systems for the US armed forces. Kristin Blier, a terrain database engineer for MetaVR has lead several of the company’s initiatives to develop virtual MOUT installations, including the firm’s virtual Camp Pendleton MOUT site: “In 2016 we created virtual replicas of two real-world Camp Pendleton MOUT sites with a high degree of realism ... Our goal for this effort was to replicate the Kilo-2 and Combat Town-25 MOUT sites with our 3D terrain building tools to achieve an accurate and geographically specific virtual environment for real-time simulation.” Ms. Blier continued that: “We used publicly sourced videos and photographs as reference. From these reference sources we created geospecific building models with façades from photo textures and full interiors with accurately placed doors and windows. Details such as rocks, poles, vegetation, tires, bleachers and signs were also created from reference photographs to flesh out the environment’s cultural features. The models were all geolocated on our round-earth formatted 3D terrain, which we built from 100mm (3.9 inch/in) overhead imagery and 600mm (23.6in) Lidar (Light Direction and Ranging) data. The result was an immersive replica of the two MOUT sites, suitable for tactical training.”



BISim

The VBS-3 provides a virtual environment that includes a large number of challenges soldiers would encounter in real world scenarios, such as IEDs.

THE SHARPEST TOOLS IN THE SHED

Technology is increasingly assisting the soldier's work in the urban environment. Advances in optronics, Unmanned Aerial Vehicles (UAVs), weaponry and command and control are all playing their part in easing the MOUT burden.

According to General Alain Bouquin, Thales' army advisor: "discussions over tactics and strategy for MOUT (Military Operations in Urban Terrain) have been taking place for quite some time now, however discussions over the adaptation of technologies in order to respond to the specific needs of these operations have only been ongoing for the past ten years." According to him and to Gadi Shamni, a retired Israeli Army Major General who is now head of MOUT activities at Israel Aerospace Industries, this is in part due to the difficulties within armed forces to perform such reflections. Maj. Gen. Shamni argued that: "the military is usually more traditional, and it is not always easy to (introduce) new concepts and ways of doing things, so it is often the case that the industry is ahead of the military when it comes to adapting technologies to new threats."

■ LIGHTER IS EASIER

For Patrick Curlier, vice president of sales and marketing at the optronics and defence division of Safran, the complex environment of MOUT means that soldiers need to have as much freedom of movement as possible. As such: "it is crucial to provide our soldiers with a modular system that can be adapted according to missions and threats and can, therefore, be lighter." To this end, Safran has been equipping the French Army with its FÉLIN (*Fantassin à Equipements et Liaisons Intégrés/Integrated Infantry Soldier Equipment and Communications*). Now in its second incarnation, FELIN is designed for dismounted soldiers and includes a small tablet that connects all the soldier's equipment, including their radio, the transmission of images from optronics systems used by them, their comrades or from external sources such as UAVs, and the GPS (Global Positioning System) geolocation device that transmits the soldier's position: "The latest version has been conceived taking into consideration lessons learned from the recent combat experiences of the French Army," says Yann Gerard, sales manager at Safran's optronics and defence division: "It now includes a number of kits that can be added or removed according to the mission, and the new communications system, integrated by ATOS, networks the (infantry soldier) to their vehicle's battle management system." The second version of FÉLIN has also been made much lighter than the previous one. Safran has delivered over



Safran's latest version of the FELIN includes a new communications system, integrated by ATOS which networks infantry soldiers to their vehicle's battle management system.

20000 of the first incarnation of the FÉLIN system to the French Army.

According to Mr. Curlier, the French Army has also expressed the need for a lighter weapon. For the past forty years, French infantry has been using the GIAT/Nexter FAMAS-F1 5.56mm assault rifle but in September 2016 the French Ministry of Defence announced that the FAMAS-F1 would soon be replaced by the Heckler and Koch HK-416F 5.56mm assault rifle: "The HK-416F is up to 1.5 kilograms/kg (3.3 pounds/lb) lighter than the FAMAS-F1," Mr. Curlier concludes. The French *Direction Générale de l'Armement* (DGA/General Armaments Directorate) procurement agency told *Armada* that the French Army will start receiving the HK-416F in 2017, and that deliveries will span over the next ten years. Over 100,000 weapons will be delivered.

The quest for the development of a lighter infantry weapon and more modularity is also at the heart of Israel Weapons Industries' (IWI) philosophy. Its UZI PRO 9mm submachine gun utilises modern polymers to make the gun lighter than its predecessors, bringing the weight down to 2.3kg (5.1lb) without its magazine (compared to the 3.6kg/7.9lb of the FAMAS-F1): "The UZI PRO Submachine Gun is perfectly designed and adapted for urban operations and the urban environment," says Marcelo Rubín, IWI's vice president of marketing and sales: "Its compact size and advanced accuracy enable the soldier to successfully operate in a crowded area. Moreover, the UZI PRO features a quick fitting suppres-

sor to avoid arousing suspicion when used in a residential area." The firm's X-95 Tavor 5.56mm weapon has been designed by IWI to combine the roles of an assault rifle, a carbine and submachine gun. As indicated in the company's *brochure*: "the X95 is manufactured out of high strength impact modified polymer, providing a strong but light weapon and incorporates advanced technology that allows the conversion among ... different calibres within minutes."

■ WEAPONS OF CHOICE

The close proximity of soldier's comrades, plus obscured fields-of-view caused by buildings can heighten the risk of so-called blue-on-blue friendly fire accidents during MOUT. According to a French military source: "accidents involving friendly fire happen in pretty much each and every operation." It is therefore absolutely necessary to ensure that, amongst their capabilities, armies can count on weapons that are as precise as possible, or can be used to empty buildings without risking civilian life or contributing to fratricide.

Gen. Bouquin indicated that Thales is working towards meeting these challenges. In his opinion: "it is important to have weapons with reduced lethality that can however be used to neutralise the adversary, or missiles with the capability to change course at the last minute if new information has arrived that would indicate potential casualties." Thales is currently working on its Reptile laser, a device aimed at helping special

Forces remove obstacles (by cutting fences or drilling holes) without causing further damages to the surroundings. It is also developing a portable electromagnetic power source aimed at damaging the electrical components of adversary's vehicles in order to immobilize them without destroying them.

Firing certain weapons in closed environments such as buildings or small alleyways can become very dangerous for the person using the weapon. According to Gen. Bouquin: "the detonation of certain weapons such as rockets can result in deadly high pressures in the room where the shooter is located." To this end, MBDA has developed the MMP (*Missile Moyenne Portée*/Medium Range Missile) thermal-guided surface-to-surface weapon which is currently in production for the French Army and will commence delivery in early 2017. A spokesperson for MBDA told *Armada* that: "two areas were prioritised for the development of the MMP: firing from confined spaces and developing a bi-mode military load, that is, anti-infrastructure and anti-tank capabilities, which can be selected by pressing a simple button before firing." The MMP can be operated either by a dismounted soldier using a firing post or from armoured vehicles such as a Panhard/Renault PVP four-wheel drive vehicle. MBDA states that it will deliver 2850 MMP missiles and firing posts to the French Army.

Elsewhere in Europe, in 2014, Saab revealed its new M4 Carl Gustav recoilless rifle which the firm has developed as a variant of the Carl Gustav family optimised for use in urban terrain. According to Saab's official figures, the M4 has a lighter weight than its predecessors, with a 3.5kg (7.5lb) weight reduction due to using lighter carbon fibre components, and with a shorter length of 905mm (37in). In 2014, media reports announced that the US Department of Defence (DOD) would spend two years evaluating the M3A1 (as the M4 is designated by the US DOD) with testing and weapons qualification expected to be completed by the first



The UZI PRO's compact size, advanced accuracy and reduced weight make it ideal for use in complex urban environments where flexibility is key.

quarter of 2017, with the weapon expected to be declared available for procurement by the US armed forces by late 2017. The US Army operates the legacy M3 Carl Gustav, having declared the weapon as standard equipment for army light infantry units in 2014, its operation had previously been the preserve of the US special forces community, according to open source reports.

I EYES AND EARS

MOUT are particularly stressful, compared to operations in open spaces, because threats can come from many different directions. The echoes resulting from the confined spaces can misguide perception, making it particularly difficult to understand from where shots have been fired. Israeli company Camero has developed two products that facilitate the detection of people and movement through walls. The Xaver-100 is a handheld, through-

wall life detector that uses a radar sensor and mathematical algorithms to detect the presence of life behind a wall. It can penetrate materials such as cement, plaster, brick, concrete, reinforced concrete, adobe, stucco and dry-wall at ranges of between four metres (13.1 feet) and 20 metres (65.6 feet) with a field-of-view of 120 degrees in azimuth and elevation. Using the same technology as the Xaver-100, the Xaver-400 goes one step further by providing not only information regarding the presence of life behind a wall, but also the number of people, their location in the room, their movement patterns and the room's general layout, including dimensions and major infrastructure elements.

Meanwhile, IAI offers the EL/O-5220 Othello, a passive optical fire locator that detects and precisely locates the source of hostile fire on the battlefield. It can be mounted on a vehicle as four independent detection units that cover 360 degrees in azimuth, or used as a portable device, which consists of a single unit covering 96 degrees azimuth. Using thermal imaging technology it can detect the heat signature of incoming surface-to-surface missiles, rocket propelled grenades and small arms fire. Furthermore, IAI states that the EL/O-5220 can be integrated in a wide variety of systems such as vehicle-mounted remote weapons stations.

Similarly, to respond to the challenge of threats coming from all directions, Meprolight has developed the Mepro-M5 red dot weapons sight. Compatible with second and third generation night vision goggles, the Mepro-M5 has a large display window that allows the user to aim with both eyes open, thus avoiding a reduction of their field-of-view. Benny Kokia, Meprolight's vice president of marketing and sales said "With its large display window and clearly-defined red dot, the MEPRO-M5 ensures critical rapid target acquisition with both eyes open, in an area where targets appear for a very short time."



The X-95 Tavor can be easily converted between an assault rifle, a carbine and submachine gun.



Camera

Camera's Xaver-100 is a handheld, through-wall life detector that uses a radar sensor and mathematical algorithms to detect the presence of life behind a wall.

ISR

Another French military source strongly emphasised to *Armada* that: "while it is key to prepare any kind of military operation, MOUT requires even more preparation and planning because it takes place in such complex environments that one can never have enough information regarding potential threats." ISR (Intelligence, Surveillance and Reconnaissance) technologies, while not necessarily initially developed for the purpose of MOUT, have found a special place of importance in the context of these operations. For example, Safran's JIM-Compact lightweight and long-range multifunction binoculars weigh under two kilograms (4.4lb) and have three observation channels (cooled thermal, colour day and low light) that give soldiers a maximum detection range of twelve kilometres (7.5 miles) for vehicles. Another key feature is the JIM-Compact's connectivity as it can store and stream images and videos across Ethernet, WiFi or Bluetooth links, to name just three. The JIM-Compact has already been sold to two NATO (North Atlantic Treaty Organisation) countries, including France to replace the French Army's current Sagem/Safran JIM-LR optronics systems, with Safran disclosing that some JIM-Compacts were delivered to the French Army in late 2016; with mass production commencing at the end of that year. Similarly, Senop of Finland provide soldier optronics, in addition to its weapons sights products, optimised for use in urban areas such as the firm's LISA

observation system. According to Senop, the product is designed for day and night use and provides the user with an uncooled thermal imager, which unlike a cooled thermal imager does not take time to chill once activated, a day channel, plus an eye-safe laser rangefinder. With the ability to hand off its imagery to

other users, via wired and wireless connectivity, the LISA includes a GPS and the ability to capture still and video imagery.

In Israel, IAI offers a wide range of man-portable and vehicle-mounted surveillance equipment. The EL/I-3370 light portable surveillance system includes a ground move-

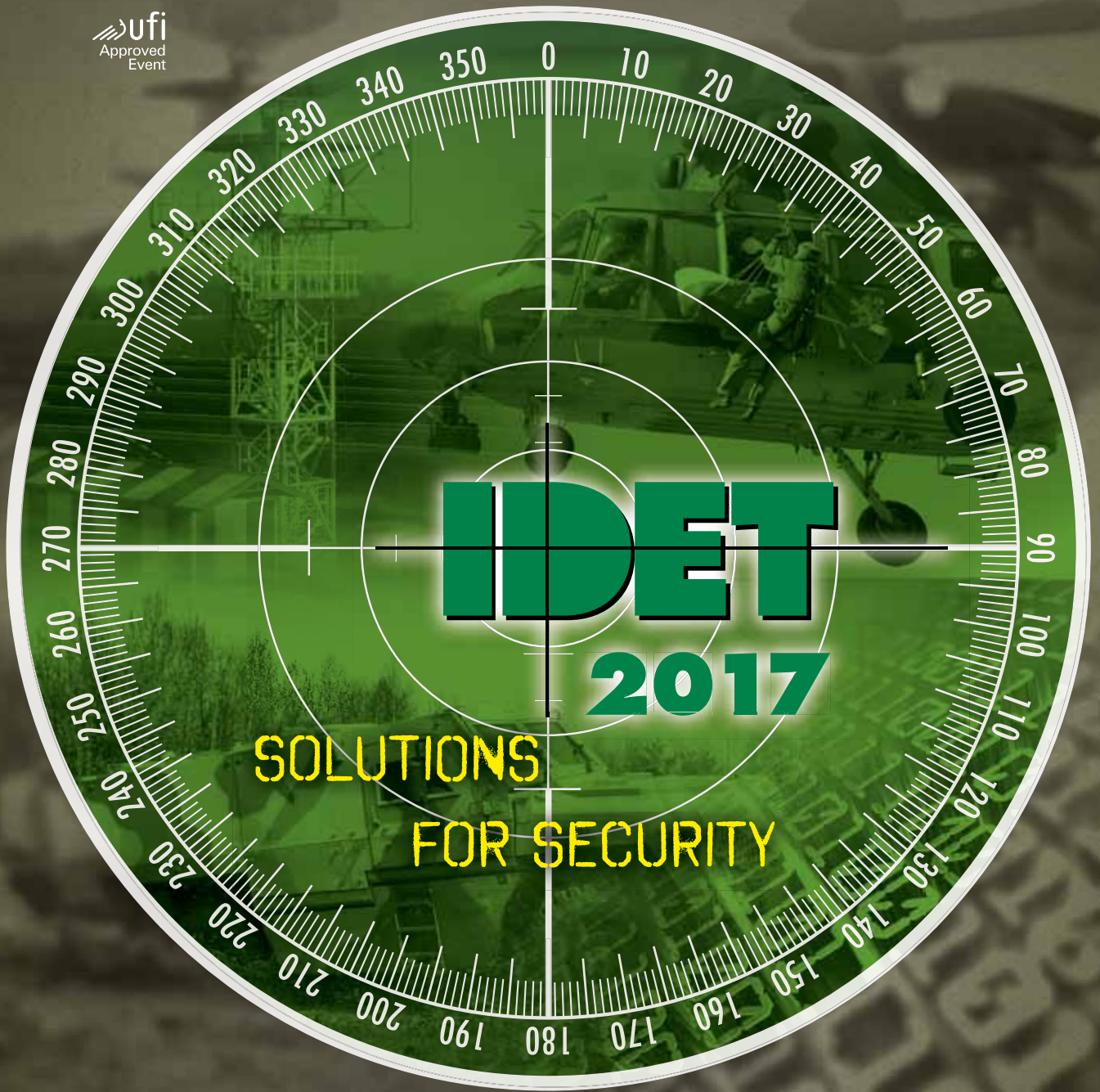


Saab

Saab's M4 Carl Gustav recoilless rifle has been optimised for use in urban areas. The weapon is now in use throughout infantry units in the US Army.

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Thales

Thales' Spy Ranger is a mini-UAV that can be transported in a backpack and quickly deployed without which offers three hours' autonomy with an optronics package.

ment detection radar integrated with day and night optronics. According to the firm, it has a detection range of eight kilometres (five miles) for a person and 15km (nine miles) for a vehicle with a 90 degree field-of-view and a total weight of 45kg (99lb).

UNMANNED VEHICLES

According to *Armada's* French military source: "robotics and, more generally, unmanned vehicles will certainly evolve and develop exponentially in the coming years; not only do they save lives by doing reconnaissance ahead of a units' movement, but they also allow military forces to perform reconnaissance without putting a human life in danger."

In relation to UAVs, the same military source remains cautious, however: "they need to be pretty small, such as micro- or mini-UAVs (see below), otherwise if they are too big they may be able to carry more but they also simultaneously become more vulnerable to threats." As such, Safran's Patroller UAV has a payload of up to 550lb (250kg) but might remain too conspicuous for the urban environment. Mr. Curlier indicated that Safran is currently working on the development of a mini-UAV, which should be ready for testing in 2018. Generally speaking, mini-UAVs weigh less than circa 44lb (20kg) with micro-UAVs having a wing span as small as 150mm (six inches/in). Thales has developed two UAVs in the form of the Spy Ranger and the Spy Arrow: The Spy Ranger is a mini-UAV that can be transported in a backpack, deployed without tools in less than twelve minutes, offers three hours' autonomy and is equipped with an optronics package. The Spy Arrow is an easy to use, lightweight, portable UAV, with a wingspan of 670mm (26.3in), a weight of 1.3lb (0.6kg) and an autonomy of 30 minutes. On 5th February 2017 Thales announced that it had been selected by the DGA to deliver 70 Spy Ranger systems, with three UAVs per system, to the French Army. Deliveries are slated to commence by the end of 2018.

The progress made in robotics is also opening up new avenues for the development of unmanned ground vehicles that can

be used for a wide variety of missions. As Mr. Curlier indicated: "robots can be used for reconnaissance, transport, or simply following the unit as a backup." To this end, Safran has been developing the E-Rider, a hybrid four-wheel drive vehicle that can be used in three different configurations: It can seat four people and can be driven as a simple transport vehicle with a capacity of over 100kg (220lb). It can also be remotely operated and used as a reconnaissance vehicle or deployed as an autonomous device to identify potential threats such as IEDs. Currently the E-Rider is at the first stages of development and in November 2016 it began a six month trial with the French Army's Technical Department.



Safran

Safran is developing the E-Rider, a hybrid four-wheel drive vehicle that can be used as a simple transport vehicle seating four, remotely operated or deployed in as an autonomous device.

CONNECTIVITY

Gen. Bouquin stresses that: "cities, with their many streets, their ring roads and obstacles such as destroyed buildings and debris, quickly become disorienting, making it crucial for armies to have adequate technology to help them proceed in this environment efficiently and safely." In an environment with dismounted soldiers and combined arms manoeuvre, it is equally as important to have a Battle Management System (BMS) that links everyone and everything as much as possible.

Thales offers the Commander Battle-group, a system that delivers accurate situational awareness fed by geospatial data, Blue Force Tracking (BFT) as well as critical sensor data. The systems facilitates the sharing of comprehensive and near real time situational awareness between all members of a unit, thus increasing operational capabilities such as navigation, observation and protection to facilitate the synchronisation of manoeuvre and close fire.

Away from Europe, IAI has developed the Combat Team Battle Management System (CT-BMS), a command and control software that connects commanders, soldiers, sensors, weapons, platforms, headquarters and supporting forces to create a comprehensive, accurate, real-time common situational awareness picture across the whole combat team. The CT-BMS is carried across conventional tactical radio links as well as satellite communications and cellular networks. It provides



IAI

IAI provides its Tac4G broadband tactical smartphone and modem that supports secure third and fourth generation cellular communications.

not only BFT and situational awareness, but provides an intuitive map, and communications in the form of instant messaging and push-to-talk radio communications as well as voice-over-internet-protocol calls. According to Mr. Curlier: "mobile phones will play an increasing role in command and control capabilities, as not only are they are lighter and smaller to carry but they are also an easy interface to use which today's young soldiers grew up with." With this in mind, IAI offers its Tac4G broadband tactical smartphone and modem that supports secure third and fourth generation cellular communications.

VEHICLES

Urban areas are also complex for military vehicles which can be limited in where they can travel due to their high curb weights, which may have a detrimental effect on roads and bridges. As a point of comparison, official company figures note that a General Dynamics M-1126 Stryker eight-wheel drive armoured personnel carrier can have a weight of 16 tonnes. Manoeuvrability is also complex in urban environments due to narrow streets or low bridges. Military vehicle manufacturers therefore need to take all these aspects into consideration, without compromising on armour protection, especially as vehicles can be particularly vulnerable to IEDs.

Oshkosh has been working to develop vehicles that attempt to respond to as many of these challenges as possible. The firm's M-ATV four-wheel drive vehicle: "offers troops the optimal balance of agility, interior capacity, mobility and protection for military operations in urban environments," said Jennifer Christiansen, vice president for global strategy and marketing at Oshkosh: "So whether it's engaging or disengaging, on-road or off-road, the M-ATV can be tailored at the vehicle design level to meet a military's unique mission or customisation requirements." According to Ms Christiansen, more than 10000 such vehicles have been ordered and are in service worldwide with the US Army and Marine Corps, as well as with US allies in the Middle East and Europe.



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FIGHTING IN THE STREETS


With rapid urbanisation, and fighting increasingly taking place in urban environments, the focus on MOUT (Military Operations in Urban Terrain) in the defence industry will continue to grow.

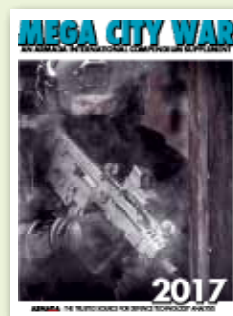
Gadi Shamni, a retired Israeli Army Major General who is now head of MOUT activities at Israel Aerospace Industries argued that: “as the emergence of non-traditional threats changes the battlefield ... it will become of strategic importance to develop technologies that facilitate the designation of a target and its neutralisation with as little collateral damage as possible.”

With this in mind, it is worth noting that BFT (Blue Force Tracking) devices have come a long way in providing support to ground troops, however a French military source warned that: “(defence companies) need to be very careful in developing tablets and other BFTs and BMSs (Battle Management Systems) that are easy to use for a soldier that is caught in a very stressful and complex environment: every second spent looking at a tablet is a second not spent securing the surroundings, so these technologies need to be as simple as possible.” They also need to be as connected as possible to all decision-making tools, including intelligence gathering, so as to facilitate quick decision-making, the source adds. According to Sean Page, a senior associate at the Avascent consultancy in Washington DC: “at the moment you need to

go to three or four different sources to get the information you need, which is time consuming, so it would help to have everything in one BMS.” This, however, is complicated by the fact that information may come from many different proprietary systems Unmanned Aerial Vehicles (UAVs), tactical radios, soldier optronic systems, weapons locating radar, for example that it is hard to integrate this into one single architecture: “The industry will have to work to overcome this,” concluded Mr. Page.

UAVs will remain high on the list of defence technology priorities for MOUT. Colonel Pierre Santoni, the French Army’s former commanding officer for its *Centre d’Entraînement en Zone Urbaine* (Urban Zone Training Centre) located in northeast France, argued that such aircraft are not only crucial for intelligence gathering: “UAVs and other unmanned vehicles are also important for transporting equipment and ... maybe in the future they will also transport the wounded.”

Finally, Mr Page adds: “we will also see military vehicle manufacturers developing interesting programmes with optimised weight-to-firepower ratios.” This will greatly add to the manoeuvrability of these key support vehicles in the urban environment. 



ON THE COVER: Meprolight’s Mepro-M5 red dot weapons sight has a large display window that allows the user to aim with both eyes open, thus avoiding a reduction of their field-of-view. © Meprolight

Mega City War Compendium
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
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