AWQ

AGILE WARRIOR QUARTERLY 2019 EDITION 2

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PREFACE

Agile Warrior (AW) is the Army's intellectual examination of current and emerging threat and opportunities for land capability. It generates an evidence base to inform the continual transformation of land forces and force structures across all lines of development.

It aims to be both reflective and progressive, challenging current assumptions where necessary. While many of us routinely focus on the near-term future, it is critical that we extend our gaze beyond the short-term horizon to inform our experimentation and modernisation agenda, so that our land forces can continuously adapt to successfully meet future challenges. AW has a horizon of approximately 20 years. As such it is aware of current policy, budget and equipment – however, AW is not constrained by these factors and should encourage conceptual exploration and exploitation of trends and emerging technologies.

The research and experimentation conducted is traditionally published in an annual AW Report. However, publishing articles this way hampers debate and discussion throughout the year and only allows a selection of articles to be published. The intention of the Agile Warrior Quarterly (AWQ) newsletters is just that; by periodically distributing a newsletter to a wide audience debate will be encouraged and facilitated. The digital and unclassified nature of the AWQ supports this objective. You can easily subscribe to AWQ by sending an email to the address in the contact details.

AWQ welcomes submissions of scholarly, independent research from members of the Ministry of Defence, security policymakers and shapers, defence analysts, academic specialists, and civilians from the United Kingdom and abroad. Submit articles for consideration to ***ArmyCap-FFD-Concepts-AW@mod.gov.uk***

AWQ will reflect ongoing work within the AW team and themes addressed during the AW events throughout the year. Additionally, AWQ input from the wider community will give you the opportunity to shape future events and further research. An annual AW report which will hold a selection of articles will still be published. With your commitment and contribution this report will remain an influential document for Future Force Development in the United Kingdom and beyond.

Finally, we are confident that the articles in this edition of AWQ will provide food for thought. We hope you enjoy reading it and are looking forward to your contribution to future editions.

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- International Institute for Strategic Studies (IISS)
- Chatham House

FUTURE LAND ACTION SEMINAR

MARCH 2019

“ The unifying challenge is how to create and sustain a credible asymmetric advantage ”

General Sir Mark Carleton-Smith KCB, CBE, ADC Gen, Chief of the General Staff, British Army.

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FUTURE LAND ACTION SEMINAR 2019

In March 2019 the British Army hosted the third Future Land Action Seminar (FLAS) at Robertson House, the Royal Military Academy Sandhurst. This event brought together the Chiefs of Army from the United Kingdom, France, Germany, the Netherlands and the Director Futures and Concepts, United States Army Futures Command. The fifteen senior officers discussed the future of warfare and its impact upon their military forces, and as such supported a strong interoperability narrative from the onset of these fundamental themes of future warfare. This booklet captures the key tenets of the discussions and identifies a possible way ahead for all nations as they wrestle with the challenges of employing land power in the future.

As General Sir Mark Carleton-Smith highlighted in his opening remarks:

"Forums such as these are important to cohere our thoughts and generate a shared vision of the way ahead for our Land Forces".

The two-day seminar considered four themes that are relevant to the contemporary environment in which various adversaries are changing their approach to warfare; the doctrinal premise of a new way of warfare, Robotic and Autonomous Systems, soldier enhancement and physical and electromagnetic deception. In today's global strategic military environment, peer adversaries to western democracies seek advantage in the grey zone, where competition is constant through hybrid means. As such, western allies are now challenged to consider how Land forces demonstrate greater utility in non-war fighting activity as well as keeping their edge in war fighting at scale; this activity stretches across the spectrum of military effect and explained as "secure, engage and contest".

The character of warfare continues to change, and we are about to enter a significant technological transition that could lead to a revolution in military affairs akin to the transformation from the horse to the tank. For example, unlocking the potential of true artificial intelligence, data analytics and machine learning will have significant implications for how we conduct command and control or deploy truly autonomous robotic systems.

Furthermore, our information systems will become all pervasive, generating a degree of understanding that seems unbelievable today. In addition, we may soon augment our armoury with radio frequency weapons and directed energy systems. In the near term, if we can deliver the capabilities promised by novel materials, they could combine to deliver robotic and automated (not autonomous) systems this year that will reposition our soldiers on the battlefield, allowing the dangerous and dirty to be initiated by machines rather than our people; saving our soldiers and officers for the decisive acts.

However, even with such technological change, we must address how we fight. Our doctrine and tactics will need to change while retaining doctrinal principals that bind us as western armies and solidify our positions within coalitions. Mission Command, the Manoeuvrist Approach and Information Advantage remain untouched, for now. We must develop innovative operational and tactical approaches to allow us to break into enemy area denial systems as well as countering massed kinetic and non-kinetic fires. In many ways, we should seek to make the deep battle increasingly decisive and the close battle anticlimactic.

Armies must not lose sight of their unique selling point, as practitioners of dismounted close combat; where soldiers are selected purely on talent and not by any other characteristic. Led by outstanding junior officers and non-commissioned officers, with their distinctive tenacity and fighting spirit, our people are, and will continue to be, our most valuable asset. Hence, the themes discussed at FLAS were predicated on protecting the fighting force for the decisive act.

The seminar included academic challenge from renowned experts in military strategic thinking. Professor Colin Williams (Warwick University), spoke on the Mind Machine: Our Cyborg Future. Doctor Jonathan Boff (Birmingham University), on being First Movers or Fast Follower? Professor Mike Neiberg (US Army War College), on how we might consider Fighting the Future. At the informal sessions, the Chiefs and their staffs were joined by defence commentators; Shashank Joshi (The Economist), Robert Fox (The Evening Standard), and Con Coughlin (The Daily Telegraph).

THE DOCTRINAL PREMISE OF FUTURE LAND ACTION – THE FUTURE OF WARFARE

After General Sir Mark Carleton-Smith's welcome, all five nations outlined their national developments since last year's FLAS. Common themes were modernisation and transformation via increased experimentation in the areas of robotics, automation, and Artificial Intelligence. There was overwhelming general agreement that the shifting ways of warfare required a new lens with which to consider the utility of Land forces across the spectrum of conflict. The challenge would be remaining relevant and credible in warfare, peace support operations, COIN and sub-threshold operations against an ever more aggressive adversary; best described as contest, engage, support and fight.

Discussions provided opportunities to draw the five nations towards a shared vision of European conflict and how we might act sub-threshold prior to escalation; as well as to direct our focus on balancing and prioritising force design areas such as firepower, lethality, C2 and sustainment. Issues such as the relevance of mass verses notice to effect and generating tempo in relation to decisive action were highlighted. It was suggested that 'mass' was best understood in terms of an effect rather than simple numbers; especially as no nation in Europe can deliver and sustain a 'massive' Army. Hence 'combat mass' might be better achieved through increased speed/tempo and increased flexibility.

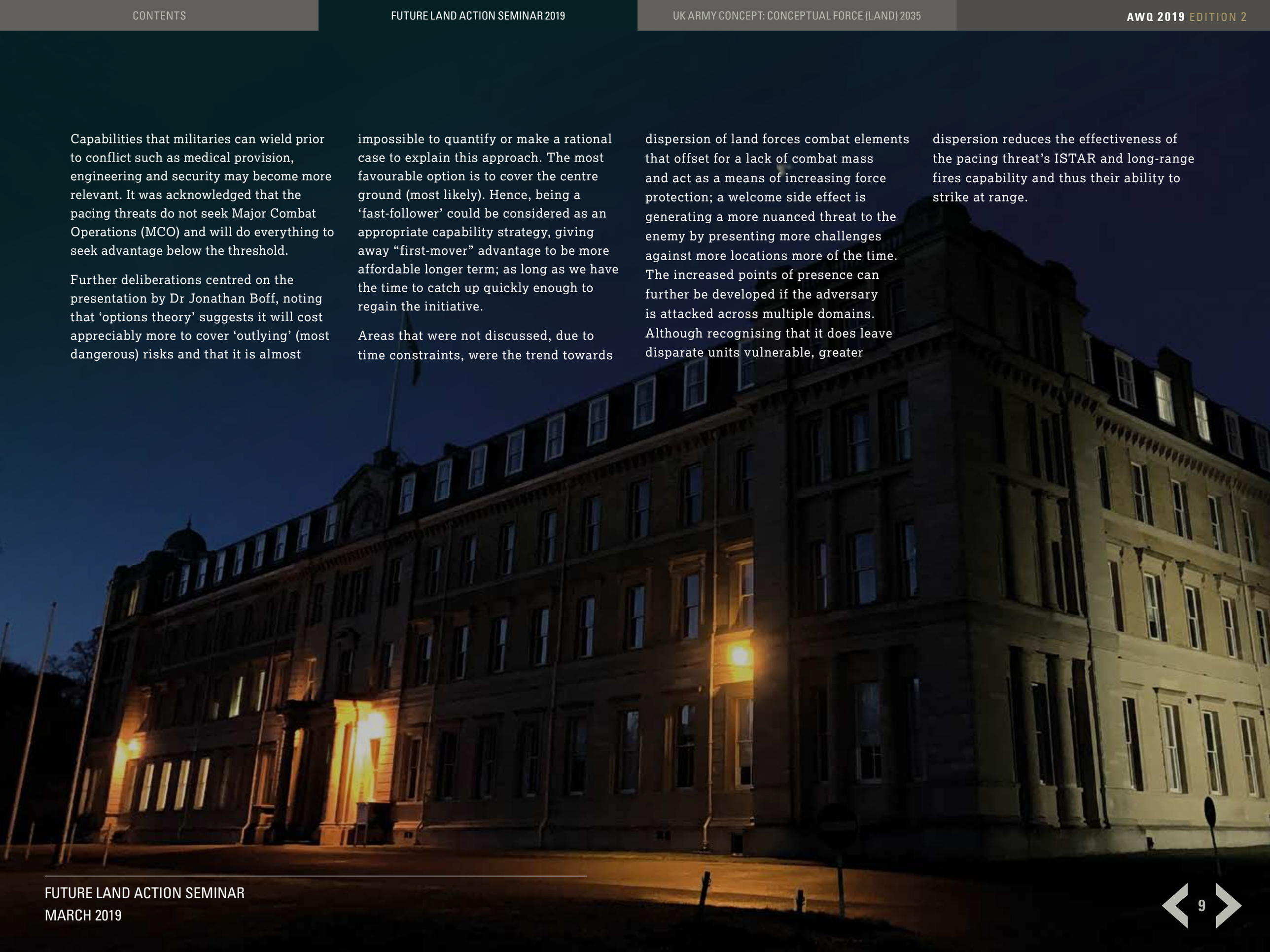
It was noted that doctrine and tactics will need to change while retaining some doctrinal principals that bind western armies and solidify their positions within coalitions. Mission command, the Manoeuvrist Approach and Information Advantage will no doubt remain untouched. However, there is a requirement to develop operational and tactical approaches to allow us to break into enemy area denial systems as well as countering massed kinetic and non-kinetic fires. In doing so, we may wish to pursue options that seek to make the deep battle far more decisive and the close battle as anticlimactic as possible.

Future warfare will challenge the modernisation plan of all nations as they seek to balance the capabilities required for traditional armoured warfare with emerging capability requirements for contesting below the warfare threshold.

Capabilities that militaries can wield prior to conflict such as medical provision, engineering and security may become more relevant. It was acknowledged that the pacing threats do not seek Major Combat Operations (MCO) and will do everything to seek advantage below the threshold.

Further deliberations centred on the presentation by Dr Jonathan Boff, noting that 'options theory' suggests it will cost appreciably more to cover 'outlying' (most dangerous) risks and that it is almost impossible to quantify or make a rational case to explain this approach. The most favourable option is to cover the centre ground (most likely). Hence, being a 'fast-follower' could be considered as an appropriate capability strategy, giving away "first-mover" advantage to be more affordable longer term; as long as we have the time to catch up quickly enough to regain the initiative.

Areas that were not discussed, due to time constraints, were the trend towards dispersion of land forces combat elements that offset for a lack of combat mass and act as a means of increasing force protection; a welcome side effect is generating a more nuanced threat to the enemy by presenting more challenges against more locations more of the time. The increased points of presence can further be developed if the adversary is attacked across multiple domains. Although recognising that it does leave disparate units vulnerable, greater dispersion reduces the effectiveness of the pacing threat's ISTAR and long-range fires capability and thus their ability to strike at range.



ROBOTIC AND AUTONOMOUS SYSTEMS

The future of warfare will likely see smaller forces be routinely more dispersed, fighting a harder to identify adversary, amongst the people, in complex urban terrain. Warfare may morph from specifically kinetic to constant competition in more places more often but without the overtly kinetic actions synonymous with armies. RAS could be central to a new way of warfare, offering more opportunities more of the time while reducing the threat to our soldiers in the dangerous and dirty tasks that consume so much manpower.

Discussion confirmed that the pursuit of deployable RAS technologies is becoming less a question of desire and increasingly an issue of necessity as adversaries chase after these game-changing benefits. Robotic and eventually Autonomous Systems will arrive on the battlefield in the next five years, typified by the Russian Uran-9. The inclusion of RAS in combat is thus non-discretionary, despite some political decision makers and pressure groups striving to outlaw the lethal variants. With most of the nations represented involved in ISTAR and sustainment as part of their R&S experiments, what was once an acronym will soon be deployed on operations in Europe.

The FLAS debate agreed that the use of the word 'autonomous' was misleading and that 'automated' is more appropriate, but all present acknowledged the opportunity to change the lexicon had probably been missed. However, this nuance was deemed important as in itself it can denude some of the scepticism and fear of truly autonomous systems, which are considered to still be at least 10 years away from operational deployment.

Excellent briefs from QinetiQ outlined that employing truly autonomous RAS requires the manipulation of large volumes of data by machine learning (ML) algorithms and the predictive reasoning and decision-making tasks performed by artificial intelligence (AI). Talking about RAS (other than in the sense of a robotic, 'tethered' system under close human control) without the supporting AI and ML debate is naive. As technology delivers the algorithms, power cells and smart materials to enable RAS, their utility and prevalence will expand quickly. When blended with a desire to seek advantage in hybrid warfare through dispersion, deception, a focus on the deep battle and higher tempo, their capacity and relative cost will be decisive. It was briefed that even the most exquisite RAS remains affordable and could be employed in significant numbers.

Maintaining a close dialogue with industry to keep these systems affordable and not exquisite would be key. We have the opportunity as the leading companies develop RAS to insist on low unit costs that enable large quantities. Thereby, redundancy is avoided by maintaining a high turnover of the fleet.

The ethics of RAS are confused and subjective. As briefed, the landscape is changing rapidly and what was once fanciful must now be considered as an ethical consideration. However, the utility of driverless cars and the developing proximity to the population will probably reduce political scepticism for RAS, allowing them to be deployed amongst our soldiers and populations without ethical boundaries.

For every suggestion that lethal RAS is morally wrong, it is countered by the theory that to face lethal RAS, and not have our own, results in sacrificing our soldiers against machines; it is a circular argument. We should not forget that RAS exist in our militaries already, such as point defence of maritime shipping using Goalkeeper systems or the Trophy system for IFVs and these systems are well understood and accepted. The soft way into RAS will be via teaming machines with humans as the systems evolve from robotic to autonomous in the next decade and beyond.

It was briefed and discussed that fielding RAS will start with augmenting tactical ISR and small unit sustainment, such as ammunition resupply for the fighting echelon. The nascent ability of RAS to follow a leader is delivering basic Manned Unmanned-Teaming (MUM-T) now. After logistic RAS, it is likely that CASEVAC, repair and CSUPS will follow in quick order. Secondly, persistent ground ISTAR platforms will arrive within five years and form the basis of potentially more lethal platforms. The RAS hardware is ready, the ML and AI are close to fruition. Establishing the optimum level of MUM-T is the force design principle allowing best integration of future RAS capabilities into force structures.

DECEPTION

"Deception doesn't sit at the heart of our doctrine but does with our adversary; we must react and resource it".

General Sir Mark Carleton-Smith KCB, CBE,
ADC Gen, Chief of the General Staff, British Army.

Deception comprises camouflage, concealment, denial, mimicry, misdirection, misinformation, feints and ruses. It is a central element of the Manoeuvrist Approach and an essential part of our current doctrinal framework. Deception not only adds to surprise and gaining the operational advantage, but it also directly contributes to protection of the force. Deception can be exploited in the physical and virtual dimensions to achieve a cognitive change or effect.

Seminar participants agreed that deception remains credible in the information age. The paradox of multiple sensors and infinite data can be construed to deny credible deception, but this mantra can be reversed if the deceiver seeks to hide within the vast amounts of information. Hence, a new approach is required. From an approach of minimising our EMS emissions to one of maximising them so that military entities can hide within the EMS noise, seeking to 'hide in plain sight'.

Debate considered the utility of deception at the grand strategic and with non-state actors. What is not in doubt is that our probable pacing threat in Europe conducts deception and our best way of countering their efforts is by instigating our own.

This paradigm can also shift in our favour if we challenge adversary's decision-making processes with plans for or deployment of deception capabilities. Even the effect of having a debate about deception has a destructive effect on our pacing threat as they are now forced to consider their apportionment of ISTAR assets differently.

The seminar stressed that reinvigorating deception would require a deliberate and systematic approach. Technological advancements can support Army units to mimic and spoof adversary ISR and ground elements and support.

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If we can simultaneously procure RAS that deliberately transmits simulated HQ broadcasts, we can aid HQ survivability. We should reconsider the quality and usability of our current camouflage and concealment capabilities and invest in paint systems that denude adversary detection. Also, the ability to use dummy AFVs to lure the adversary into false COAs would allow the West to initiate the counter battery fight first to our significant advantage. A mix of physical and virtual effects could truly fix the adversaries' decision action cycle, leaving our armies to exploit their hesitation.

In order to deliver a credible deception capability across the entire EMS a training system should be created that rewards deception and seeks to promote it. That rather than allowing it to be a secondary task, promotes it to be a primary output. This cultural change was considered as the most important development if deception was to be woven back into our military DNA.

"We have bred a generation of officers who do not think deception and anti-deception from the beginning of the planning process".

General Sir Mark Carleton-Smith KCB, CBE, ADC Gen, Chief of the General Staff, British Army.

It now seems prudent to initiate a workstream to investigate the benefits of tactical deception for operational effect that can be briefed to the 4th seminar in 2020. Hence the UK will initiate such a study, under the joint Chairmanship of Brig Kev Copsey (Future Force Development) and Brig Ben Kite (C4ISTAR), both of the British Army HQ to which the FLAS nations will be invited once established.

PHARMACOLOGY

"The primary issue of pharmacology is one of ownership. Is it a clinicians, operations team, legal or personnel staff issue?".

General Sir Mark Carleton-Smith KCB, CBE,
ADC Gen, Chief of the General Staff, British Army.

Multiple pharmacological interventions are progressing towards a level of maturity that will allow performance enhancement of human cognitive and physical capability to be a reality. Improvements can be made to physical endurance, strength, exercise capacity, cognitive capacity and cognitive endurance. However, there are precautionary reasons for not employing these interventions just yet.

Arguably, in a complex battlefield, being able to make a better decision quicker than the adversary and being able to prosecute the mission for longer, physically or cognitively, will deliver advantage. It is assessed that our adversaries are developing bespoke pharmacology to enhance their battlefield performance. If we are to face such an adversary, the ethical imperative to compete/survive implies we should also adopt, or at least understand, similar approaches or else be defeated.

Discussion led to broad agreement that the ethical concerns, especially from the clinicians, would prevent immediate investment. But the opportunities do warrant further investigation as the pharmacology market migrates below the ethical line and perhaps becomes more accessible in the near future. Now is the time to have the ethical debate so that the advantage can be taken when needed.

Western Armies have experimented using stimulants and sleep aids to overcome fatigue; anabolic hormones and nutritional supplements to help repair muscle and increase confidence; and drugs that maximise the oxygen-carrying capacity of blood. Some Air Forces currently use amphetamines for long-range support to the aircrew. Hence, enhancement is not new, but remains blurred in the morality of medical officers having to prescre pharmaceuticals that are not for the treatment of disease but for enhancement. This places our medical professionals in awkward moral dilemmas.

The professional sports community has significant knowledge of physical enhancement on both sides of the ethical boundary, and some of this for COTS procurement. The concerns rest with the longer-term effects of expediting pharmacology beyond current medical trials. This means the ability to direct that medications are taken on military operations is fraught with legal implication and medical morality issues.

In the brief benefits discussion, it was almost unanimously agreed that first steps into pharmacology would be in cognitive effect and that increasing awareness and maintaining cognition for longer would be the most appropriate starting point, especially as most of the pharmacology is already well established and trialled by medical bodies.

However, the advantages look clear and the ethical boundaries could be surpassed if the knowledge and understanding of the pharmacology mechanisms and their longer-term effects were better understood.

It now seems prudent to initiate a workstream to investigate the benefits of pharmacology for cognitive and physical enhancement that can be briefed to the 4th seminar in 2020. Hence the UK intend to initiate such a study, under the joint Chairmanship of Brig Kev Copsey (Future Force Development) and Brig Tim Hodgetts (Senior Health Advisor) both of the British Army HQ, to which the FLAS nations will be invited once established.

NEXT STEPS

Future warfare will surprise us in its location, ferocity, pervasive nature and changing character. It will occur where least expected and will not give us enough time to react to the change, as history shows. The winners will be the best adaptor and hence the militaries with the most agile structures and minds. Future warfare will be more than fighting; but it will necessitate military contributions to engagement, security and constant competition where we may not be the leading agency or partner.

This will require fundamental changes to our current doctrinal frameworks and underlying tactical approach as we seek to contest, secure and engage prior to warfighting. Foremost, the possession of ground will remain key as will the dismounted close combat inherent in military operations, delivered by our soldiers and officers in parts of the world and in conditions others will not tolerate.

Maintaining an "eye and a feel for the ground" together will ingenuity and genius in decision-making based on military experience and tactical instinct will remain crucial. New technologies such as Artificial Intelligence (AI), Machine Learning (ML), Electromagnetic Weapons, Directed Energy systems, automation, big data and neural networks are potential game changers that will continue to push our armies on an evolving path towards the next decades.

The Future Land Action Seminar showcased that our Armies are forging ahead together in conceptual development, experimentation and innovation. Speed in movement and thought, decisive effects at reach, dispersion vice concentration, cross-domain integration, deception, empowering all levels of command, enhancing soldiers both mentally and physically and smart sustainment will be some of the tenants of future warfare. As we seek to maintain a rules-based approach that is constantly challenged below the threshold of conventional warfare our adaption at pace will be key. This will lead, no doubt, to militaries being employed in more ways to prevent warfare as we seek to secure populations and areas from enemy interference. Bringing our efforts together as five nations, within existing coalitions and specifically NATO will be key. Our ideas through programmes such as Agile Warrior (GBR) and Unified Quest (USA) will ensure collectively that the future will look less uncertain.

Our thanks go to the Royal Netherlands Army for offering to host the next Future Land Action Seminar on the 7th of May 2020 in The Hague prior to the Invictus Games.


FUTURE LAND
ACTION SEMINAR
MARCH 2019


CONCEPTUAL FORCE
(LAND) 2035
CF(L)35 CAPSTONE
SUPPORTING ANALYTICAL SUB-CONCEPT: COMMAND & CONTROL
SUPPORTING ANALYTICAL SUB-CONCEPT: LAND JOINT FIRES
THE FUTURE COMBAT TEAM
THE FUTURE COMBAT TEAM (HEAVY)

CONCEPTUAL FORCE (LAND) 2035

CF(L)35 **CAPSTONE**

SUPPORTING ANALYTICAL SUB-CONCEPT: **COMMAND & CONTROL**

SUPPORTING ANALYTICAL SUB-CONCEPT: **LAND JOINT FIRES**

SUPPORTING ANALYTICAL SUB-CONCEPT: **SUSTAINMENT**

THE FUTURE COMBAT TEAM

THE FUTURE COMBAT TEAM (HEAVY)

INTRODUCTION

In Dec 17 ECAB directed that a Conceptual Force (Land) 2035 (CF(L)35), be developed to offer a means to leapfrog to a new way of fighting and operating from 2030. CF(L)35, the output of seven years of Agile Warrior (AW)[1] experimentation, is an analytical concept which understands the key drivers influencing the case for change as: increasingly complex threats; technological advancement; continued resource constraints; and an increasingly challenging urban environment.[2] In light of recent ECAB direction, to develop a New Operating Concept fit for the next decade and beyond, publishing the CF(L)35 concept provides an essential reference point.

The CF(L)35 is designed to face the pacing threat in non-discretionary warfighting at scale, within a coalition. It is unashamedly a high intensity force, which also has utility in the secondary concurrency set.

The CF(L)35 was not endorsed by ECAB but has been used for successive wargames for wider force development understanding as a future force. As such, it is just one version of the future, but one that remains compelling for 2030 and beyond.

[1] Agile Warrior is the British Army's intellectual programme to test an alternative force structures based upon the future operating environment derived from DCDC.
Full evidential reports held by Concepts Branch:
http://cui1-uk.diif.r.mil.uk/r/852/Concepts/AgileWarrior/Forms/AllItems.aspx

[2] RUSI (2018). 'The Utility of a Future Land Component in Megacities'DSTL/AGR/000616/01 (O), pp 12-13.

THE CASE FOR CHANGE

INCREASINGLY COMPLEX THREATS

CF(L)35 used DCDC publications to set the context, threats and opportunities. The updated Global Strategic Trends 6[3], the Future Operating Environment 2035[4], and the Future Force Concept[5] have been synthesised to describe the five-domain and three-dimension environment that a CF(L)35 would operate within. The pacing threat currently operate: fourth generation aircraft[6]; capable AH; long-range Anti-Tank Guided Weapons (ATGW); long-range and massed rockets/artillery; and SF capable of either leading or facilitating intelligence gathering, subversion and sabotage.[7] Future capabilities under development include: GLATGM providing overmatch at increased ranges; Cyber, Space and Electro-Magnetic Activity capabilities which will degrade the EMS and deceive/spoof our sensors and communications; advanced computing; biological enhancements of humans; and Robotic and Autonomous Systems (RAS). The ethical and legal standards of adversaries may lead to the use of mass propaganda, deniable operations, cyber capabilities, CBRN weapons, and sub threshold competition in a manner counter to international norms. Hence, the British approach of concentrating combat mass to achieve decisive effect, may present greater risk than before by playing directly into the pacing threats hands.

TECHNOLOGICAL OPPORTUNITIES

Actors who exploit technology to develop novel capabilities will derive significant advantage. Soldiers and commanders will need to be both digital natives, feeling intuitively comfortable operating disaggregated when connected, and able to operate without a network if it is disrupted. Developing a workforce that has the intellectual and psychological aptitude to work within an increasingly automated environment will present new challenges,[8] however failure to understand AI capabilities may create vulnerabilities and cede advantage to competitors. This concept makes assumptions that there is enough time to develop machine learning and robotic and automated systems (RAS) to be credible and deliver the mass required for future warfighting. This will require adopting a more flexible system of procurement to achieve a shift from “exquisite and therefore few” to “inexpensive and therefore many”.

CONTINUED RESOURCE CONSTRAINTS

Current financial constraints compound the challenge. Human mass is increasingly difficult to resource; personnel costs consume 55% of the Army’s budget and their rise is the single most significant contributor to Defence inflation. This seems unlikely to change in the near future. The search for more mass assumes that numbers and size are the only solutions to threats. Using Newtonian physics as a metaphor, combat Force may equate to the Mass of the force (size) multiplied by its velocity squared (speed) in much the same way Newton declared f =mv2. If this is a valid assumption, then Force may also be generated by speed as well as size and perhaps the future British Army should focus on notice to effect (NTE), speed of decision-making and speed across the ground, i.e. tempo, to offset pure mass.

DEDUCTIONS

AGILE WARRIOR evidence points towards developing a new operating concept to outmanoeuvre the enemy conceptually and simultaneously exploit emergent technology. The force could be reconfigured to establish more appropriate groupings and learn to fight in new ways that challenge the assumptions of our adversaries. The force should be confident dispersed, generate increased tempo while actively deceiving the enemy. The Land force should then focus on achieving more decisive effects at range, using precision strike, aviation and area-effect, enabled by multi-spectral sensors while masking the force by decentralisation, dispersal and deception. As technology enables automation the close battle should initially be conducted, as far as possible, by automated platforms and sensors that preserve human war-fighters, therefore improving resilience and political utility. It should be noted that increased automation raises the premium on the human, a risk yet to be quantified through experimentation.

[3] https://www.gov.uk/government/publications/global-strategic-trends-out-to-2045

[4] https://www.gov.uk/government/publications/future-operating-environment-2035

[5] https://www.gov.uk/government/publications/future-force-concept-jcn-117

[6] International Institute of Strategic Studies, “Military Balance”, accessed 20 Oct 16; Flight International, “World Air forces 2015.”

[7] Foreign Military Studies Office, ‘Getting Gerasimov Right’, dated 28 Feb 17, accessed 2 Aug 17.

[8] Ministry of Defence, Global Strategic Trends, Version 6, 15.

THE CF(L)35 DOCTRINAL PREMISE

NEW WAYS

The concept proposes a new way of operating, force design, and capabilities to deliver a more effective force. A UK sovereign war-fighting division will remain as the baseline offer to our allies. It does not consider offsetting capability to other nations and looks to support a UK military industrial base capable of supporting a divisional warfighting effort, possibly scalable to the corps level. We will deliver multiple, cross-dimension, dilemmas to the enemy so that we impose decision paralysis. Although consistent with the Integrated Action, Manoeuvrist Approach, and Mission Command, the fundamental premise focuses on the following principles:

a. **Dispersal.** We will manoeuvre dispersed as the norm, which will increase protection, improve deception and allow us to fight disaggregated when applicable. We will consequently challenge the enemy at more locations simultaneously, aiming to achieve decision paralysis. This will place higher demand on our C2 and sustainment but AW evidence suggests this is now less of a risk than concentrating combat power. To support both dispersal and generating tempo we will refine our TASKORG to lower the level of combined-arms grouping.

b. **Tempo.** We should seek to generate tempo at the expense of other factors. History and recent AW experimentation has shown that whoever drives the decision-action cycle is more likely to win. On the basis that tempo is key, units must not wait for supporting assets from higher. CF(L)35 task organises critical assets at lower levels so that tempo is easier to attain.

c. **Deception.** The force design includes elements whose focus is to deceive the enemy in both the physical and across the EMS. AW experimentation continues to point at the adversaries' approach to deception and the UK lack of resource in this capability.

d. **Protection.** We will seek protection by speed of manoeuvre and decision rather than just physical armour, so that our forces remain strategically deployable. Evidence points towards 'big, heavy and slow' migrating to 'small, light and fast'. (Broster, M, Lowe, M (2016). 'Future Land Challenges 2 (FLC2) Report'. Dstl, Fareham: 71.)

e. **Dislocation.** Current doctrine focuses on the destruction of enemy combat power, specifically MBTs, artillery and infantry. The CF(L)35 focuses effort on dislocation of the enemy by striking HQs, logistic bases and the narrative, to bring about cognitive dislocation and defeat.

FORCE DESIGN

AGILE WARRIOR experimentation provides evidence for generating greater tempo, fewer casualties and requiring less sustainment thus:

a. **Command and Control.** Fighting disaggregated with the inclusion of RAS and AI for decision making generated more speed, aggression and surprise. Exploiting developing AI technology will increase tempo, reduce the number of staff deployed in forward HQs and challenge the current concept of no more than five points of command.

b. **Information and Intelligence.** By leveraging RAS for recce, ground and airborne, a considerably higher level of situational awareness was achieved. The enemy was denied information by C-UAS capabilities and organic deception. Machine learning algorithms will enable smaller HQs by managing the incoming data, preventing cognitive overload and providing a fused ISTAR picture for commanders. Focus should switch from gathering to the exploitation of data. The Information Manoeuvre (IM) element within the FCTs will find information in the cyber domain while placing disruptive information of its own.

c. **Manoeuvre.** Deeper, more risky and aggressive manoeuvre with RAS unhinged the enemy and broke cohesion. Employing RAS for reconnaissance to the point of destruction gained tempo at no human cost. Lack of mass can be off-set by exploiting tempo, both physically and cognitively. Multiple sensors will enable greater mobility in complex terrain. The force design maintains the premise of the "rule of four" in its orbat with a specific covering force, assault force, echelon force and reserve force.

d. **Firepower.** With more dedicated organic Fires, the FCT increased tempo, making the dismounted close combat more achievable. Future forces should have integral short-range indirect fire support, augmented by brigade medium artillery for counter-battery fire and divisional long-range rockets for shaping the deep. ATGW capability may off-set today's MBT capability with a suite of smaller vehicles which, when taken in combination, offer what today's MBT achieves, but with less cost, greater sustainability and better strategic and operational mobility.

e. **Sustainment.** . Compared with the average of the Armored and Strike JF 25 BGs the FCT required less food, water, fuel and ammunition. Contemporary technology, such as power and water generation, will be used to reduce logistic demand. Additive manufacturing technology will produce or repair some items. Sensors on equipment throughout the force, combined with AI, will provide a common logistics picture and enable autonomous resupply when required, including health monitoring and the CASEVAC of personnel. Medical support will embrace health monitoring and rely upon automated systems to remove casualties from the contact battle. However, this does not change the overall need for MBTs.

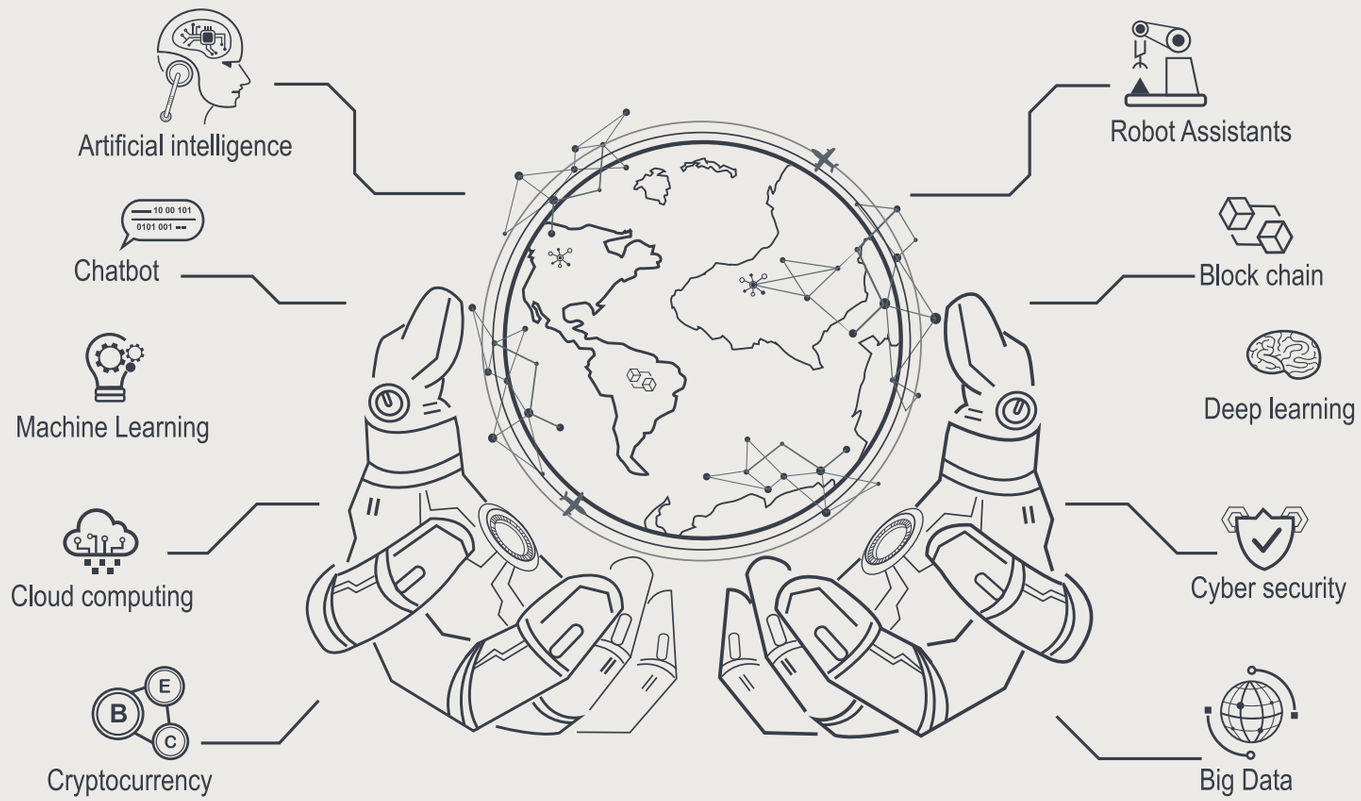
FORCE STRUCTURE

With an increasingly complex environment, new technology and a new way of operating, the land force would require a new structure to make the most of the new capabilities:

a. **Future Combat Team (FCT).** The new unit of force will be the FCT, consisting of approximately 500 personnel that will deliver the mission sets attributed to today's Armoured Infantry (AI) Battle Group of circa 1,250. It will be a combined arms force, with fewer personnel but increased manoeuvrability, firepower and sensors, delivering more combat mass.[10] The FCT will have a flatter hierarchy, and have a better ratio of combat to combat support and combat service support than today's BG so that it is sustainable and can fight with all its assets simultaneously.[11] Mass will be augmented by Manned Unmanned Teaming (MUM-T) with the addition of RAS in the FCT, that with a degree of artificial intelligence, novel materials and next-generation power generation, provide direct and indirect fire support, ISTAR, sustainment, communications, and deception, but without requiring as many personnel. The platforms displace the soldier from the firefight, until a time when DCC is decisive. The RAS, with a person in the loop, allows for quicker manoeuvre, less sustainment and more firepower.

b. **Brigade Combat Team (BCT).** BCT organisation will be flexible, delivering full spectrum effects in the deep to shape with long range massed precision fires, CEMA, and IM enabled by persistent ISTAR and resilient, high-bandwidth networks. Each BCT has sufficient CS and CSS to enable it to conduct operations independently of the Division or to provide mutual support to other BCTs as part of a divisional-level operation.

c. **Division.** A CF(L)35 Division could contain circa 16,500 personnel rather than the 27,500 of the Joint Force Division of 2025. The Brigade Combat Teams (BCT), each of 3,500 individuals, are supported by Joint Fires, ISTAR, Manoeuvre Support, Aviation and sustainment assets. Hence, the UK Land Force of 2019 could be used to deliver three war-fighting divisions' worth of combat power and adequate divisional troops using the FCT and BCT structure.[12] The structural change is a balance of manpower, offset by RAS and the grouping of former Div assets at the Corps level.



[10] The US Army in Multi-Domain Operations, TRADOC Pamphlet 525-3-1, 6 Dec 2018

[11] This specific FD is the amalgamation of many dstl wargames and force variation testing events over the last 7 years.

[12] The FCT structure within CF(L)35 delivers 16 sovereign FCTs within the division and three comparable divisions; giving a total UK manoeuvre force of 48 FCTs. This contrasts with the JF 25 modernised division which delivers 15 battle groups and assumes subordination of a US BCT and DK BG.

IMPLICATIONS FOR CAPABILITY DELIVERY

RISKS

Exploiting the opportunities of AI development is in line with current Gov policy.[13] However, the ethical considerations have only been analysed at the strategic level.[14] [15] Reliance on a Single Information Environment (SIE) produces vulnerabilities when the EMS is easily interdicted. As technology is central to the proposition the ability to procure new systems will require behavioural and process changes[16]. The proposition does not include detail on CBRN and it is acknowledged that transforming to a new structure is a significant challenge. Furthermore the existing inability to visualise how the Army will achieve modernisation objectives means that we do not understand where our choice points are.

[13] Industrial Strategy White Paper, HM Government, 27 November 2017, accessed 10 October, 2018

[14] AI in the UK: ready, willing and able? House of Lords Select Committee on Artificial Intelligence, HL Paper 100, published 16 April 2018, accessed 10 October, 2018.

[15] AI is not better, or somehow more objective, than any other approach by virtue of its "autonomy" in decision-making. It's still math, guided by the choices of the humans who fine-tune it and the data it learns from—both of which are extremely vulnerable to bias.

[16] Marshall N (2017). 'Conceptual Force (Land) 2035: The design of a Future Combat Team'. NorScot Consulting Ltd, Stoford Salisbury.

CONCLUSION AND NEXT STEPS

CONCLUSION

CF(L)35 generates greater tempo, requires less sustainment, poses more challenges to the enemy and presents fewer targets, as it seeks to displace the human from the initial fire-fight. This is enabled by a new doctrinal way of fighting with more flexibility, trust and disaggregation and with a more flexible unit of force, in the Future Combat Team. The CF(L)35 proposition offers three comparable UK Sovereign Divisions with Corps enablers while providing more deployment options across the spectrum of conflict and savings in supply. It provides HMG more opportunities, reduced risk and remains fundamental to collective defence with NATO and broader coalitions. However, while the CF(L)35 is focused 17 years away, it may be available much sooner.

NEXT STEPS

CF(L)35 is an analytical concept providing an essential waypoint for transformation. Developing a 'New Operating Concept fit for the next decade' will require a more applied concept, which considers constraints and restraints to a greater degree. This focus will require x-DLOD engagement internal and external to the Army. Further research will try and quantify technology feasibility, especially the utility of AI and RAS, while also engaging further with industry on the practicalities of pharmacological enhancements. Corralling the interest and energy of soldiers and officers alike from across the Army will be facilitated by the Force Development Nexus (FD Nexus) and regular workshops.

SUPPORTING ANALYTICAL SUB-CONCEPT: **COMMAND & CONTROL**

INTRODUCTION

This analytical sub-concept lays out how the Command and Control (C2) of the Conceptual Force Land 2035 (CF(L) 35) is foreseen, taking evidence obtained from the British Army's AGILE WARRIOR experimentation programme for the development of the CF(L) 35 into consideration.

The AGILE WARRIOR derived CF(L) 35 is a force proposition which articulates a new way of fighting in 2035. This new way of fighting has as its core principles: dispersal, tempo, deception and protection by speed of manoeuvre and decision in response to new and emerging threats, specifically to force concentrations and freedom of movement.

By 2035 Land forces will face increasingly complex threats. These threats will be broad and extensive, especially from increased range of adversarial weapons systems and enhanced adversarial capability to exploit the growing reliability of land forces on the use of the electromagnetic spectrum. Without appropriate and enduring measures to adapt and overmatch these threats land forces will find it challenging to maintain their competitive edge not only in response to expected, but also to unexpected challenges and threats.

Land forces ability to gain and maintain freedom of movement will not be only dependent on the violent application of physical force but also of activities in the virtual and impacts in the cognitive domain. Due to the complexity of the future Land Environment (LE) operations conducted by land forces will become increasingly heterogeneous, involving Informational, cyber and electronic activities, which will all have to be orchestrated with manoeuvre. Dealing with complex problems means operating with uncertainty that cannot be addressed through analysis alone. Instead, commanders must adopt a 'probe-sense-respond'[1] approach to decision-making and action, generally at the lower levels of command. Given the adversarial nature of the land environment, this must be conducted rapidly and iteratively to generate and maintain tempo. This will have significant effect on the spectrum of land force's tactical activities when conducting operations, including C2.

The following concept looks at the elements of the CF(L) 35 doctrinal premise and draws conclusions for C2 capability development, with regards to leadership, situational awareness, planning, decision-making and control as the essential elements of command[2]. Whereas leadership represents the essential human nature of C2, decision-making and execution represent process and technology. Both sides make up the C2 System[3].

Evidence generated from the British Army's AGILE WARRIOR experimentation programme[4] suggest that C2 of land forces in 2035 will be significantly different, from how C2 is conducted today. Developments in technologies such as automation, big data analytics, machine learning, and data storage will have an immense impact on C2 processes and structures.

Leveraging for example Robotic Automated Systems (RAS) for ground and airborne reconnaissance and Artificial Intelligence (AI) in support of **decision-making** have the potential to:

- increase shared situational awareness,
- allow faster conduct of decision-making cycles,
- increase tempo of manoeuvre elements,
- reduce the number of staff personnel deployed in forward HQs through optimisation of planning and battle space management processes and procedures,
- enable smaller HQs by managing the incoming data, preventing cognition overload and providing a fused and coherent ISTAR picture for commanders,
- challenge the current concept of no more than five elements in the span of command, and
- test current organisational partialities towards hierarchical command chains through new C2 approaches possibly rendering current rank structures inconsequential.

Concluding this introduction, it is useful for the understanding of this concept to recognise C2 as a key **capability**[5].
As an independent capability area C2 requires **personnel, organisation, processes, procedures and technology**.
Finally, this C2 concept relates closely to another key capability area: intelligence, surveillance and reconnaissance (ISR).
C2 and ISR are inseparable to operations. ISR informs every activity within C2, and C2 in turn directs ISR. To identify a seem between both functions would be artificial and a useless endeavour therefore the concept focuses on C2 and refers to ISR aspects as underlying supporting functions of the C2 system.

[1] 'Probe-sense-respond' is an approach for engaging with a complex operating environment. Planned actions should include 'probing actions' designed to generate learning opportunities. Resultant behaviours and actions are sensed which provide, through learning, the basis for a response [7].
[2] Reference Army Field Manual Command.
[3] The C2 system comprises of the C2 components (leadership, decision-making and control) the functions of C2 (situational awareness, planning, decision-making and execution); Forms and organisation of C2 (mission command, C2 approach) C2 enablers (command support functions: staff, provision of HQ, Communication and Information Systems (CIS) and processes and procedures) and C2 resilience.
[4] Since 2014.
[5] Currently C2 is seen solely as a doctrinal tactical function. For example, in HQ Army Directorate Capability there is no Head of Capability Command and Control.

COMMAND AND CONTROL OF THE CF(L)35

In comparison with current force structures the CF(L) 35 way of fighting will test traditional, linear C2 hierarchal approaches. Even though new and emerging information and communication technologies will enhance C2 capabilities, the need for example of maneuvering dispersed and at tempo to avoid enemy long-range fires will require the empowering of lower tactical formations with additional capability, and by decreasing their dependency from higher echelons could demand a rethink of existing forms of C2 approaches and adoption of more agile C2 processes and procedures[6].

Land Forces in 2035 will extend their repertoire of C2 approaches to include more decentralized (less centralized) and more collaborative approaches, empowering lower levels of command to an even greater degree. Land forces will be able to change within and between different C2 approaches, as required to gain and maintain the initiative, and ultimately, to survive.

The CF(L) 35 C2 relationships are designed to identify and exploit opportunities across the force to generate cognitive advantage by dominating the enemy's decision-making cycle, and to deliver overmatch on the battlefield and within the battlespace.

Current C2 doctrine, structures and processes are shaped by analogue, signal emitting forms of communications, rigid hierarchies and clustering of C2 functions based on the principle "the more the better". The CF(L) 35 uses opportunities provided by the "information age"[7]. These are best accounted for through digitisation and resulting significant improvements in the way information can be used by an enterprise, as well as improvements in non-emitting methods of exchanging large volumes of data in a timely way.

Key challenges and consistent themes for CF(L) 35 C2 capability development are:

- the complexity of warfare and the criticality of C2 to cut through complexity,
- the need to adapt C2 to ensure success in the face of complex and diverse threats that exploit pervasive information,
- the increasing reliance of C2 enablers on new and emerging information and communication technologies and resulting inherent vulnerabilities[8],
- the continued dependence on a complex Command Post infrastructure in a future highly transparent battlespace, and
- the understanding that failures and shortcomings in C2 may cause tactical shock, paralyse operations and ultimately endanger military and political objectives.

Centre of Gravity for C2 of CF(L) in 2035 will be the 'fight for information'. Even with new and emerging information and communication technologies promising to lift the fog of war to allow unprecedented understanding, permit near-perfect decisions, and facilitate absolute precision, C2 will remain foremost a human undertaking. At the forefront of the fight for information are the intentions, relationships, and actions of groups that are difficult to understand and mostly invisible to technology. Over-reliance on technology threatens to become a vulnerability that adversaries will seek to exploit, often in covert or indirect ways.

[6] DCDC's Joint Conceptual Note (JCN) 1/17 "Future Force Concept" suggests enhancing joint action through exploiting information and being more integrated and adaptable, will be underpinned by agile C2 as one of six foundational elements (Further foundational elements are: partnerships, people, technology, training and experimentation, and future force resilience). NATO understands agility as the ability to change between courses of action in a dynamic and changing environment.

[7] See JCN 2/17 Future of Command and Control", foreword.

[8] Vulnerabilities to digital C2 systems result from these systems being rendered ineffective by peer adversary's capabilities and increasingly non-peer adversarial "hackers" to conduct offensive persistent cyber and electromagnetic activities (CEMA) that will contest and degrade the electromagnetic spectrum (EMS) and deceive and spoof data as well as sensors and communication networks.

THE CF(L) 35 COMMAND AND CONTROL SYSTEM

The CF(L) 35 vision of **agile C2** includes a kinetic and a behavioural understanding:

- the kinetic focused vision of C2 is understood as: "an information superiority enabled capability that generates increased combat power by networking sensors, decision-makers, and shooters to achieve shared situational awareness. This delivers increased speed of decision-making cycles, higher tempo of operations, greater lethality, enhanced survivability, and a degree of self-synchronisation[9]".
- the behavioral focused vision of C2 includes cultural understanding, building relationships, human networking and institutional patience.

The CF(L) 35 C2 System takes a novel approach elevating the levels at which control is exercised, enhancing understanding and command decision-making enabled by new and emerging functional, technical and procedural capabilities thereby requiring fewer staff . Underlying principle is that forces that are quicker in thought and deed are better at offsetting enemy mass and unhinging the enemy's decision action cycle[11].

The command authority of the CF(L) 35 is vested at Future Combat Team (FCT)[12], Brigade Combat Team (BCT) and CF(L) 35 levels[13] of C2. C2 nodes will be deployed to facilitate command as intermediaries when FCTs deploy over long distances or within complex terrain. AI-algorithms will monitor the status of personnel, equipment and materiel via a Single Information Environment (SIE). This will increase tempo and reduce the number of staffs deployed in forward Command Posts (CP). FCT's and BCT's CPs will be configured to command up to five elements at any one time with the ability to take on further forces via a robust control structure.

C2 of the CF(L) 35 requires a range of C2 approaches to overcome increasingly complex, and uncertain crisis and conflict situations in which the CF(L) 35 will be required to fulfil missions and tasks. In addition, the CF(L) 35 will also be in competition with adversaries who will be using a wide variety of C2 approaches to gain advantage. Following a single inflexible C2 approach will therefore be unlikely to deliver mission success.

The CF(L) 35 C2 approach is based on the following three core elements which set the conditions of its operation to ensure efficiency and survivability of the C2 system:

- Mobile dispersed command,
- Sense-making based on new and emerging information and communication technologies, and
- Distributed control.

The elements describe the settings in which agile C2 of the CF(L) 35 is operationalized. To achieve the required flexibility and agility the C2 approach is dependent on many possible interdependent variables that can be tailored specifically for the environment in which the CF(L) 35 is operating to achieve required kinetic and behavioural effects.

Common characteristics of all C2 approaches are: robustly networked collection of C2 nodes and dedicated Command Posts[14] having broad and easy access to information, sharing information extensively, and interacting in a rich and continuous fashion, based on sense-making supported by new and emerging information and communication technologies.

[9] Understood in the context of the JCN 2/17 "Future of Command and Control" as self-adaptive, self-organising systems enabling decisive and consistent operational advantage.
[10] For example, networked C2 and CIS systems based on open architectures utilising machine learning, artificial intelligence and data analysis (Big Data) to establish near to real time situational awareness allowing collaborative planning and execution within a well-trained and self-disciplined staff.

[11] Understood as: Observe, Orient, Decision, Action (OODA) loop
[12] FCTs are empowered combined arms company groupings
[13] The CF(L) 35 level relates to contemporary divisional level C2.
[14] Configuration will be based on the principle's efficiency, survivability and collaboration, exploiting the concepts of distributed and dispersed C2 to the fullest leading to optimised deployed C2 footprint orientated towards agility and operational and tactical tempo.

Grounded on these C2 enablers the following C2 approaches are envisaged[15]:

Fully autonomous decision-making	is characterized by self-synchronisation and having the broadest possible distribution of decision rights. Conditions for autonomous decision-making are: Unfettered access to intelligence products to the shape the conflict area and tactical battle space. Intelligence-led, effects-linked actions to maximise outcomes. For example, by the unconstrained employment of RAS, and to allow lower level force elements to cooperate and coordinate in a federated way (i.e. flatter chains of command) to achieve effects across domains (multi-domain operations).
Semi-autonomous decision-making	is characterized by condition-based distribution of decision rights. For example, by the need to exercise some form of constraint on RAS through human analysis and assurance as well as maintain a flexible and adaptable task organisation and the ability to rapidly assign units depending on the required capabilities, whilst being dispersed and operating at reach.
Collaborative decision-making	involves a considerable amount of delegation of decision rights for the purposes of developing a single shared plan. It aims to develop synergies by negotiating and establishing collective intent as well as a shared plan; establishing or reconfiguring roles, coupling actions, rich sharing of organic resources, some pooling of non-organic resources, and increased shared awareness. For example, by dispersed command and distributed control and planning functions.
Co-ordinated decision-making	involves the development of a degree of common intent and an agreement to link actions in the various plans being developed by the individual C2 staff. It is characterised by: seeking mutual support for each other's intent; developing relationships and links between and among a C2 network; plans and actions to reinforce or enhance effects; some initial pooling of non-organic resources; and increased sharing of information. For example, when operating in a multi-national task force
De-conflicted decision-making	is characterised by the C2 staff partitioning the problem space to avoid adverse cross-organisational impacts. This requires limited interactions between C2 staffs. For example, by highly dispersed operations within a multi-national task force.
Centralised decision-making	is characterised by individual contributors exercising C2 only over their own forces. Hence, there is no shared collective objective, or any C2-related information distribution or other kinds of interaction between C2 staffs. For example, by deployment of single units before transfer of authority to a task force commander.

Table 1 – CF(L) C2 approaches.

[15] The C2 approaches follow in principle the five recognized C2 approaches described in the JCN 2/17 "Future of Command and Control", para 3.2, however tailored to include the CF(L) 35 range of capabilities.

The C2 approaches are not mutually exclusive. For example, a CF(L) 35 unit exercising unconstrained employment of RAS can easily conduct concurrent collaborative planning. In general, complex missions with the prevalent use of RAS should tend towards fully autonomous decision-making but other C2 approaches should not be considered negatively as all approaches may be appropriate for any given mission and task. Therefore, no one approach is necessarily better than any other, it will depend on circumstance, leadership style and prediction of the best outcome for mission accomplishment.

Table 1 is useful in referencing the required range of C2 approaches by the CF(L) 35, such that each C2 approach can be applied and further tailored specifically for the mission context in which it is required. For example, to exercise a C2 approach based on fully autonomous decision-making for a complex mission, the critical elements of C2 would be:

- maximising decentralized decision-making and collaboration by adapting an appropriate mission command culture and related leadership behaviours,
- maximising the use of RAS through adopting appropriate structures and doctrine, and
- broadening information availability through extending and integrating information and communication networks permitting self-synchronisation and timely decision-making.

The unifying effect of these approaches is to set the conditions to get inside the enemy's decision-action cycle and cognitively overload and/or disrupt their command systems leading to decision paralysis and thereby maintaining the initiative.

The CF(L) 35 C2 system will need to be continuously evaluated to ensure they are set correctly. This can best be achieved with appropriate means to measure and assess the CF(L) 35 C2 approaches, deciding how and when to adapt and identifying who makes the decision at the outset.

An important aspect of agile C2 that needs to be addressed in the context of this analytical concept is the span of command. Analysis conducted prior to the development of this concept suggest that the span of command that a commander and his or her staff will be able to manage can significantly increase. This increase is due to the utilisation of autonomous decision making. The more a human decision-maker encroaches in the decision-making loop the more the cognitive burden to the person making the decision will increase. This is reflected in the different C2 approaches. A C2 approach with greater human control will be bound by moral and ethical considerations, but also by limitations to the amount of information individuals are able to process. A C2 approach with less human control utilises opportunities based on autonomous systems being more consistent in their understanding and execution of tasks, hence needing less monitoring and correction and therefore increasing the span of command.

FCT C2 MODEL

The following C2 model highlights the linkage between C2 approaches and the C2 of an FCT. The model represents the key elements of the C2 System essential for decision-makers at the FCT level to generate required effects in the execution of operations and mission accomplishment.

Tempo is highlighted, as the key contributor to gaining and maintaining the initiative. Moving beyond the definition in ADP Land Ops, gaining and maintaining tempo is not just about deciding and acting faster than the adversary.
There are different ways that tempo can be achieved and maintained for example:

a. Deciding and acting faster than the adversary (speeding up). This could be achieved through:

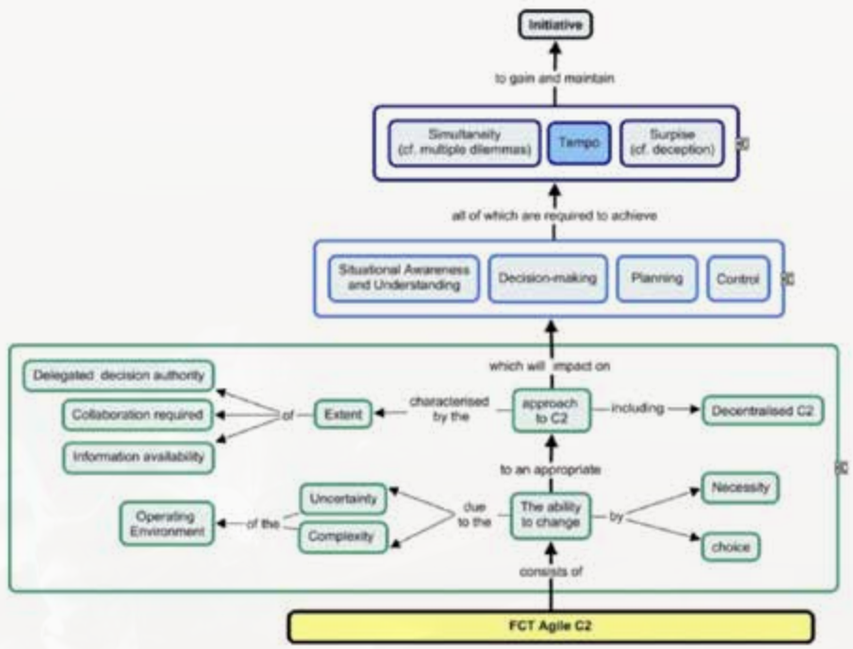
- i. Observing, orientating, deciding and acting quicker than the adversary – relying more on anticipation, learning and adapting rather than lengthy processes and analysis.
- ii. Deciding and acting quicker than the adversary, limiting observation and orientation in favour of speed – requiring risk taking.
- iii. Making quality decisions relative to the adversary (assuming that this would reduce the number of iterations of observing, orientating, deciding and acting required to achieve the desired effect.)

b. Reducing the adversary's ability to decide and act (slowing them down) whilst maintaining one's own speed. This could be achieved through:

- i. Delivering multiple dilemmas, confusing and / or deceiving the adversary – anything that reduces or eradicates their ability to observe, orientate, decide and act in a timely manner, and / or reduces their ability to make a quality decision.

As shown on the model key to achieving tempo is the need to adopt an appropriate C2 approach. Fundamentally the CF(L) 35 C2 approach is set by outcome of the commander's intent based on the need for timely decision-making. The required C2 approach is therefore dependent on the timeliness and thus speed of human decision-making, which can range from decentralised and fully autonomous to highly centralised. Thus, C2 is not every decision commander's make, but the choices that shape information flows and ultimately behaviors. Therefore, C2 is about establishing the conditions under which sense-making and execution take place

Timeliness of decision-making is a trade-off between the level of exploitation and the resulting consequences. Exploitation aimed at achieving effect to overcome an adversary will be focused on optimising opportunities to engage fleeting targets, creating multiple dilemmas and taking advantage of windows of opportunity. The consequences range from high risk, "high payoff" to no risk, nothing gained.



IMPLICATIONS FOR FUTURE LAND C2

Implications for C2 capability development will be dependent on the outcome of the assessment of CF(L) 35 C2 approaches. As experience is gained of adapting C2 approaches for different missions and circumstances this will enable organisational learning and innovation. CF(L) 35 headquarters and the wider CF(L) 35 C2 enterprise will need the ability to analyse performance and effectiveness, even while running operations.

CF(L) 35 C2 capability development will need to know when to change or adjust C2 approaches, what to change to, and what an effective and safe transition mechanism will be. Adjustments come at a cost and C2 capability developers must therefore know that the benefits of adjusting outweighs the costs of not doing so.

It follows that a culture of learning must be at the heart of CF(L) 35 C2 capability with a governance and a support function that drives changes in C2 through organisational and experimental learning.

Experimentation through exercises, war-gaming and using synthetic environments will allow C2 capability developers to explore, assess and tailor C2, the distribution of force elements and specific partnering arrangements.

While assessing C2 of the CF(L) 35 capability developers need to measure the parameters and variables of the wider C2 enterprise. This will also require assessing Headquarters. The headquarters maturity model as detailed in the JCN 2/17 “Future of Command and Control” should be used as a common framework, to develop required headquarter footprints.

Delivering C2 capability must also consider that C2 as a socio-technical system crosses organisational, domain and capability boundaries as well as a number of academic disciplines. This results in a large C2 stakeholder community with a wide range of interests, which are often misaligned or divergent. Therefore, defining clear roles and responsibilities for C2 capability is essential. If C2 capability is to be addressed effectively this will require governance and a programmatic approach that manages effectively all appropriate lines of development, including interoperability.

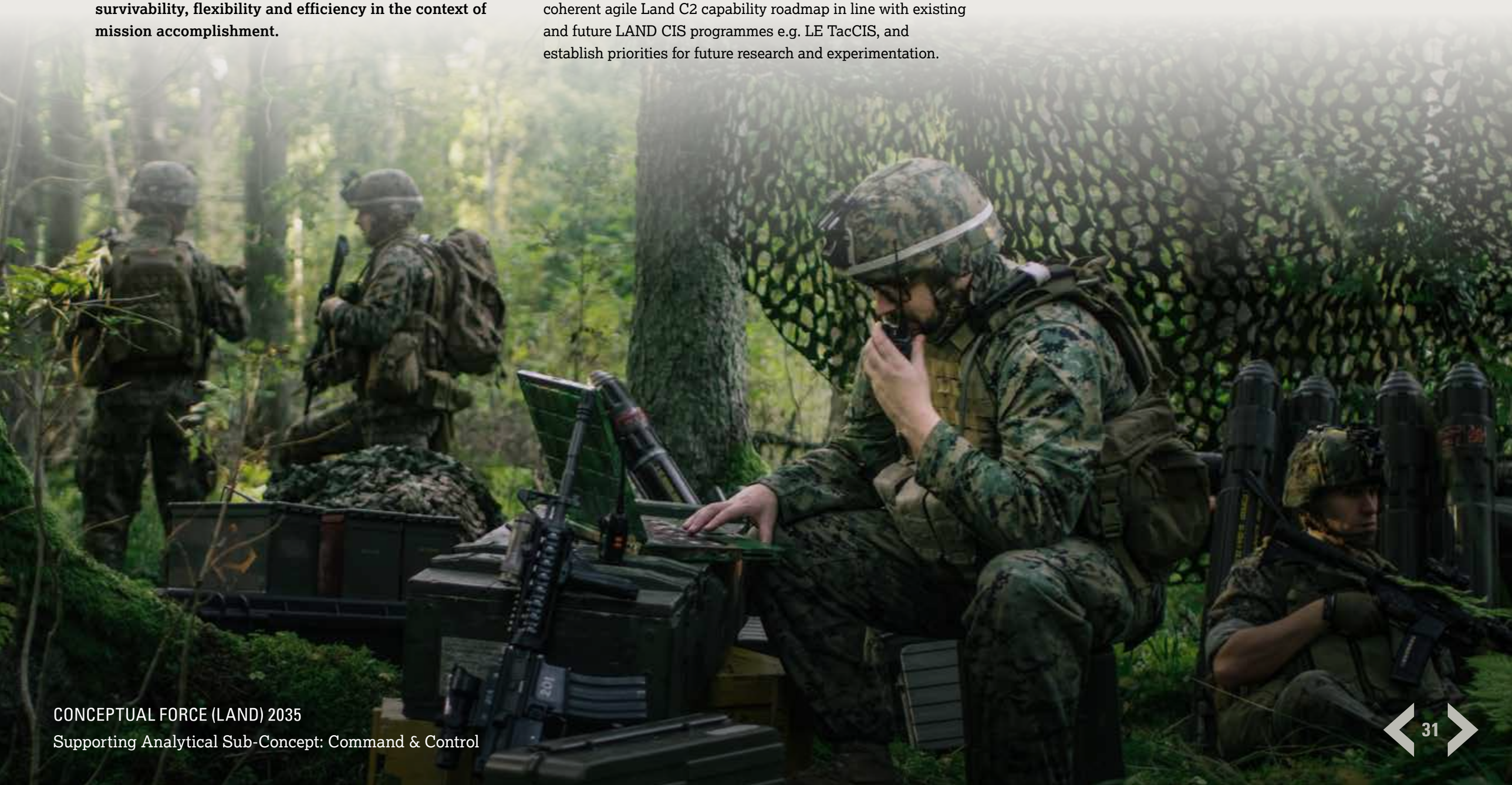
The most significant changes in C2 approaches will most likely come from the rapid development of new and emerging information and communication technologies, sensors, automation and autonomy. The combined effect of vast growth in processing power and connectivity will fundamentally shape how the world lives and works. Advances in data-to-decision technology, exploitation of efficient and effective human-machine interfaces, and cloud solutions all offer the potential to enable the evolution of C2 from its current form to an information-centric foundation and migrate from a single to multi-domain C2 construct.

With persistent ISTAR enabled by machine learning and AI available to all levels of the CF(L) 35, efforts focus more on exploitation and better able to generate actionable intelligence. Machine learning, and AI algorithms will enable FCTs and BCTs to make more of the information they collect. The Information Manoeuvre (Info Mvre) element within the FCTs and BCTs will be able to find information in the cyber domain while placing disruptive information of its own. Info Mvre will supplement more traditional means of manoeuvre as it places the forces of the CF(L) 35 in a non-physical position of advantage. ISTAR will be increasingly provided by unmanned platforms. The critical enablers will be the algorithms that reduce the cognitive burden and alert staff to ‘targets / windows of opportunity

CONCLUSIONS AND RECOMMENDATIONS

Adopting this concept will provide the analytical framework to change from current C2 hierarchical decision-making procedures and processes to adopting a range of C2 approaches from fully autonomous decision-making at speed to directive C2 that can better ensure C2 survivability, flexibility and efficiency in the context of mission accomplishment.

It is recommended to establish an agile Land C2 Community of Interest based on the above priorities for agile Land C2 capability development, review the existing Capability Management Sub-Strategy (CMS) with regards to aligning agile Land C2 developments with this concept, develop a coherent agile Land C2 capability roadmap in line with existing and future LAND CIS programmes e.g. LE TacCIS, and establish priorities for future research and experimentation.



SUPPORTING ANALYTICAL SUB-CONCEPT: **LAND JOINT FIRES**

INTRODUCTION

This analytical sub-concept details the requirement for Land Joint Fires[1] in the British Army Conceptual Force (Land) 2035.

Analysis[2] confirms that British Army surface-to-surface/land joint fires are outranged and outgunned by peer adversaries. Key weaknesses and consistent themes are range (of both target acquisition and weapon), target effect mass, weapon lethality, platform and sensor survivability and the speed of the sensor to shooter link; while ensuring the fires system is interoperable with allies[3]. The Army needs to be able to attack enemy high value targets which are protected by air defence systems, electronic guidance jamming and manipulation systems, directed energy systems and non-lethal and traditional protective countermeasures. Fires sensors (both surface to air and surface to surface) require the ability to fulfil persistent, all-weather, ubiquitous air surveillance, ground surveillance and counter-fire roles to provide flexibility to the commander.

[1] The 'Fires' tactical function is 'the use of weapons to create a specific lethal or non-lethal effect on a target'. ADP Land Operations 2017.

[2] Analysis conducted since 2014 under the AGILE WARRIOR programme by Dstl and also drawing on other Dstl and SFD-compliant sources as well as allied sources (eg from the US Army TRADOC UNIFIED QUEST series and from the US Army Fires Center of Excellence).

[3] See Cap GM 'Future Fires Capability' (OS) dated 1 Sep 17, para 11.

CONTEXT

Traditional missions such as fixing enemy manoeuvre forces and eliminating high payoff targets and threats will be as important as ever, but integrating information, cyber, and electronic warfare capabilities will offer more options to accomplish them. However, fires cannot guarantee a complete overmatch in such a way as to grant complete freedom of manoeuvre for friendly forces. Our focus must be on creating pockets within enemy ISR and fires threat envelopes to facilitate freedom of manoeuvre at decisive places and times. To achieve this at speed, fires elements must be guaranteed; they must be integral from unit/ Future Combat Team (FCT) level though Brigade Combat Team (BCT) and division.

In parallel, changes in fires and ISTAR capabilities, such as increasing precision, reach, penetration, persistence, ubiquity and range, are highlighting a convergence of conventional and irregular tactics[4]. Non-state actors are increasingly as well-armed and effective in some critical/niche areas as their more conventional military counterparts[5].

Over and above the possibilities offered by AI, manned-unmanned teaming (MUM-T) and a pervasive network providing a Single Information Environment (SIE), technological advances offer the following potential enhancements both now and in the future at a low-risk TRL[6]:

a. Weapon locating radars with ranges out to 150-200km.
b. Novel missile technologies with ranges out to 150km from systems able to acquire andengage up to 6 targets simultaneously.
c. Surface to surface rockets with 150-499km ranges. MLRS (currently 84km) will be extended out to 150-200km under GMLRS-ER; the US Deep Fire Rocket System ranges out to 499km.[7] Typical CEPs will be in the order of 15m or less.
d. Swarming/layered UAV target acquisition systems capable of instantaneous cross-cueing.
e. Semi-autonomous medium-calibre, long-range tube artillery optimised for a high burst-rate of fire[8] with reduced crew sizes (as few as 3), computing firing data on-board or 'cloud-based' (thereby increasing responsiveness and improving survivability by dispersing within bigger artillery manoeuvre areas while remaining in target range; or deploying forward in order to range/reach further in depth).
f. Multi-round simultaneous impact (sequential rounds being fired at the same target at varied elevations matched to a modular/variable charge system).
g. Near-precise cannon artillery shells using course-corrected fuses, increasing accuracy at maximum ranges (to a CEP of 30m) and reducing logistic load[9].
h. 'Heavy' (typically 120mm) mortar systems (which might be rifled, semi-autonomous and with a rate of fire of up to 8 rds/min) firing sophisticated munitions[10] out to a range of 15km.[11]
i. In the 'deep future', speedy and precise electro-magnetic rail-guns firing hypersonic projectiles above Mach 6, gun launched ramjet-powered quasi missiles and deep magazine DEW technologies.

[4] Referenced in many sources, but for a simple yet comprehensive assessment see Marine Corps Gazette April 2017: '21st Century Fires: The King is Dead, Long Live the King'.

[5] Nowhere is this convergence more obvious than in urban environments, as evidenced by recent events in Syria (Aleppo), Iraq (Mosul) and Ukraine (Donetsk).

[6] Ibid, para 15. Also drawn from readily-available open source material.

[7] Limited by the US-Russia Intermediate-Range Nuclear Forces Treaty to 499km, which has since been abrogated.

[8] Selected capabilities are referenced at Cap GM 'Joint Effects (GM) Future Programmes' (OS) dated 18 Jan 18, para 5. The US proposes to move to a 155mm/58 cal cannon and autoloader combination, providing a rate of fire of 6-8 rounds per minute. The proposed UK Mobile Fires Platform also meets or exceeds these capabilities.

[9] For example, Land Precision Strike is a precision fires capability intended to be able to hit moving armoured targets at a range of 60km; the Leonardo Vulcano 155mm GPS Guided Long-Range projectile has a demonstrated range of up to 90km and is in the process of being adapted for use by the 5"/127mm naval gun.

[10] A US next-generation proximity sensor will allow programmable height of burst, tactical telemetry and include anti-tamper features while Saab have developed the Strix 120mm mortar munition with a range out to 7,500m, optimized for top-attack against armoured vehicles.

[11] Such as a combination of the BAE Systems Mjolner CV^{90} twin ^{120}mm mortar and the RoK ^{120}mm SP rifled ^{120}mm mortar; the US are developing an extended-range bomb which will range to ^{30}km with rocket-assist and glide technology, albeit with a reduced payload.

DETAILED LAND JOINT FIRES CONCEPT

This Joint Fires Concept posits that Land Fires organisations must include:

a. Fire support teams capable of directing and coordinating information, cyber, and electronic warfare as well as land, sea and air-delivered joint fires.

b. Fires delivery elements expeditionary-ready at every level from FCT upwards, scaled and equipped to provide guaranteed fires and organised on the premise of 'distributed delivery, converged effects'. Semi-independent sections of as few as two systems with rapid emplacement/displacement capabilities will become routine. In most cases, semi-autonomous fires delivery systems will deploy and operate in close conjunction with manned systems. The pace, reach and distributed nature of 21st century warfare will also necessitate a greater reliance on guided missile/rocket artillery vice conventional shell artillery[12]. Although the need for the latter, and for unguided rockets offering a mass effect, will not disappear, the balance between them is not yet quantifiable.

c. No unobserved fires. Every platform is a sensor. UAS provide a key ability to observe fires, and their effects. There are also on-board fires available given the right UAS system[13]. Regardless, persistent wide area surveillance and shared situational awareness is crucial for fires. Loiter time distinguishes UAS from other aviation assets and enables them to provide a 'persistent stare' and support all types of fires and effects. Smaller UAS, organic to FCTs, should have the capacity to spot indirect fires at a minimum. UAS will feed directly into the SIE and thus vastly increase the responsiveness of fire support.

d. The conventional 'kill chain' from visual target identification and location through transmission of a call for fire to approval and delivery of fires, is not responsive enough to compete with an advanced adversary in the contested battlespace of the 21st century. To the greatest extent technology will allow, processes such as target location and handoff to firing agencies will be automated[14] using new systems such as those proposed under the British Army's Integrated Weapons Operations (IWO) initiative. IWO's aim is to implement a]'kill web' (US term) that will 'use any sensor with any weapon anywhere in the battlefield…to create dynamic integrated engagement chains' to enable a rapid and proportionate response to dynamic threats across the land environment. Such a system would include deep AI-enabled planning tools and decision aids that would provide threat evaluation, target tracking, weapon availability and coverage assessments, target prioritization and deconfliction, ammunition status and usage, trajectory optimization, battlespace management and warning, dynamic weapon allocation (including weapon-target matching), collateral assessments and BDA/outcome assessments. This system would contribute to the SIE and would need to be able to operate in network-denied environments. It will integrate advanced sensors (manned and unmanned) with firing platforms and C^2 systems to allow rapid cueing and prosecution of targets across a dispersed, contested battlespace. This must be done in conjunction with fires delivery elements that provide the necessary balance of range, mobility, precision, responsiveness and concentration to regain an overmatch of fires capability against a peer adversary.[15]

e. Integration of advanced sensors and surveillance capabilities to provide automated sensor to shooter links. Fires elements will directly feed (and take from) the SIE. Intelligence gained by fire support sensors will not be used solely to inform fire support. Reconnaissance units especially will gain a great deal of information through fires planning and prosecution.

f. Responsive and guaranteed fires at the FCT level. This will drive the need for lightweight, mobile, sustainable systems capable of delivering precision fires in support of the FCT in operating environments where deployment and/or sustainment of large batteries is precluded by the threat of enemy fires and observation. A modern heavy mortar is an ideal candidate for this requirement. At the same time, the ability to achieve local fires overmatch will require that forces can also reach back to long-range sources of fires, including from ships, aviation platforms, and expeditionary advanced bases/FOBs, with access to sufficient mass of fires to defeat enemy fire support systems and gain and maintain a local fires advantage for the duration of their mission.[16]

[12] Where rocket artillery systems are in use on today's battlefield, sources claim they cause roughly 85 percent of opposing force casualties. See Marine Corps Gazette April 2017, Op Cit.

[13] The near-term revolution may be precision strike effects via as low weight devices as Class 1 UAS.

[14] Balanced with ethics and policy – there is a trade-off. Technology might allow firing on targets generated by AI – policy might not.

[15] We need here to also understand where the human-in-the-loop interventions may occur. Issues of judgement and proportionality have long been the subject of discrimination.

[16] This is not to suggest a change to the guiding principle of artillery being commanded at the highest level and controlled at the lowest; rather, it describes a significant 'thickening' of fires at every level.

Surface-to-surface fires also have a symbiotic relationship with other force elements capable of providing lethal and non-lethal effects into multiple domains, including:

a. Air/Aviation. Air and army aviation, among its other functions, will continue to be a key component of fires and the combined arms approach. However, the air supremacy and relatively permissive air environment that has characterised the last 15 years of conflict cannot (will not) be guaranteed. Manned aircraft may be constrained in both time-on-station and in where they can safely be employed due to the effectiveness of an adversary's Anti-Access and Area Denial capability and the proliferation of land-based air defence systems. Aviation, which will likely be held at divisional level but whose effects may be delegated to the very lowest tactical level, will continue to be one of the most flexible and responsive assets available to the ground commander. Planning will be needed to allow aviation to operate in windows of opportunity; but within the air domain in general, 'drones will find targets for the artillery, artillery will destroy enemy anti-aircraft systems, and manned aircraft will strike deep through the resulting weak points'[17]. There is a potential fires/ISTAR disconnect however, if we are unable to FIND in depth while shifting to a doctrine of 'no unobserved fires'. There is a need to articulate the future role and utility of army aviation in support of ground forces in a Joint context in 2035 – balancing Deep Strike, flying artillery, flank protection, COMAO, observation and/or liaison.

b. Maritime, principally naval gunfire support. Within the Joint Operational Area there are unlikely to be adequate numbers of naval fire support vessels available for both amphibious operations and fire support for land forces in the littoral. However, in the 2035 timeframe a Conceptual Force (Maritime) might deploy small, survivable, swift, and stealthy naval platforms that can deliver both area and precision fires in support of both amphibious operations and a variety of other missions in the land domain.

[17] The need for Force Protection, GBAD, SEAD and airpower including rotary wing are unchanged. See https://breakingdefense.com/2018/03/army-will-field-100-km-cannon-500-km-missiles: A discussion paper from the US Army Fires Center of Excellence LRPF Cross-Functional Team accessed 26/03/2018

OPERATIONAL EMPLOYMENT

This Land Joint Fires Concept will consist of a small number of manned command vehicles coordinating highly-mobile manned, semi-autonomous and autonomous platforms that deliver lethal effect, from short to long range, matching or exceeding the range and lethality of enemy fires. Fires will be successfully prosecuted throughout the adversary's close area, deep manoeuvre area and operational deep fires area.[18]

Fires delivery platforms will continuously manoeuvre away from point of firing: pause: deploy and fire: and manoeuvre again[19]. This dynamic and dispersed means of operating will be enabled through significant levels of autonomy at the platform level and through platforms with: high terrain accessibility; on-board or 'cloud' computing; and assured PNT. It will increase deception, complicate adversary counter-battery and overwhelm enemy C2 by employing multiple firing points to engage single or multiple targets – massing fires and effects rather than delivery platforms.

Rate and effectiveness of fires will be increased through a range of munitions and delivery mechanisms. Once the fires platform receives the authority to fire from the Command platform the firing sequence will be optimised and highly-automated and decrease error. Human input will be primarily within specialised command platforms, although some levels of manning will be required to serve the delivery platforms. Command platforms will provide a man-in-the-loop to respond to priority decisions or alerts prompted from autonomous/remote platforms, such as a change to the target.

Targeting data will be provided through ISR assets and fed through the command nodes. The delivery platform will link through the SIE to ground and air reconnaissance (manned and augmented), FSTs and other 'observers', direct fire systems (manned and autonomous), logistics, and command platforms. This will facilitate constant targeting 'pull and push': detect, recognise, identify, fire and assess but systemic and ongoing and not a single event or action. Automated damage assessment and mission effectiveness feedback will be provided through the SIE.

Fires elements will be integral to each level of CF(L) 35, organised, equipped and operating in a manner that achieves the effect required. Most close battle control of fires will be undertaken by the Fire Support Team (or equivalent) in the FCT. The range required must at the very least reflect the FCT area of influence (out to 15km); for which a 120mm mortar system (combining optimum payload, range and logistics considerations) might be most appropriate. Medium and long-range fires will be controlled by a fires coordination element within the BCT and division HQ; ranging out to 90km (BCT) and 499km[20] (division). At this level a combination of cannon and rockets/missiles (guided and FFR) will be most suitable. A dedicated aviation attack element will be an integral part of an echelon above BCT (either division or corps).

Fires autonomous delivery platforms will be intelligent and mobile: they will be able to dynamically route-plan using 'military Waze'[21], avoid obstacles and adopt tactical positions to avoid being targeted and to optimise firing positions. They will be 'tethered' to a manned platform (at the MUM-T ratio of 1 manned: 1 unmanned, but capable of rapidly resubordinating to another manned platform at a higher MUM-T ratio to provide redundancy). Capable of negotiating simple terrain, they will be able to assist with self-recovery. Ammunition resupply will be simplified by using an exchangeable/reloadable cartridge; while on-board sensors will link to the SIE to provide maintenance and ammunition expenditure data to feed the algorithms which will enable monitoring, predicting and effecting repair and resupply.

[18] Terms taken from Multi-Domain Operations Operational Framework.

[19] As described in 1 Arty Bde 'Reimagining Close Support Artillery' Draft STRAWMAN paper.

[20] Treaty-limited range (subsequently abrogated).

[21] 'Waze' is a dynamic route-finding smart-phone application.

OPERATIONAL IMPACT

Under this concept, Fires will be more effective and will enable the force to disperse while also delivering a broader and more appropriate, including more lethal, range of options; both earlier, to enable better shaping, and throughout the battlespace. Manpower will be reduced, principally through greater automation on delivery platforms; and there will be a reduced risk to manpower through lower signature of platforms and their improved mobility.

The FCT is the CF(L) 35 tactical unit of action, organised and operating in such a way as to deliver the equivalent (or greater) combat power of a FF25 battlegroup. Its integral joint fires capability includes:

a. A fires coordination/Joint Effects element within/linked to the FCT HQ.Joint Fires Control teams (mounted in special-to-role vehicles).

b. A 'close supporting fires' Troop (equipped with 4 manned and 4 unmanned systems, which may be twin-120mm mortars mounted on vehicles which are comparable to the FCT ground combat vehicle).

c. A 'close air defence' Troop equipped with 6 manned VSHORAD systems (which may be equipped with multi-effector platforms such as Hanwha's BIHO II system) controlling a further 6 counter-UAS UGVs and 6 counter-IDF UGVs[22].

d. This latter capability includes a weapon-locating and air defence radar system which might be the same integrated sensor.

BCTs will be able to achieve decisive effects at long range by coordinating massed and precision fires, CEMA, and IM enabled by persistent ISTAR and resilient, high-bandwidth networks. Each BCT has sufficient fires to enable it to conduct operations independently of the division or to provide support to other BCTs as part of a divisional-level operation. They can influence the FCT deep battle, allowing FCTs to safely operate dispersed with the protection afforded from brigade-level assets.

The brigade fires battalion includes:

a. A fires coordination/Joint Effects element within/linked to the BCT HQ.

b. Additional Joint Fires Controllers to support deep and flank operations.

c. Ground-based fires provided by cannon batteries each of 8 medium guns (4 manned/4 unmanned), scaled to provide a battery in 'Direct Support' of each FCT.[23] Firing all natures of ammunition and ranging out to 80km, they will provide both precision and massed fires.

d. Cannon fires are supplemented by further kinetic and non-kinetic fires which may be assigned from an echelon above BCT (eg MLRS precision/area fires).

e. The fires battalion GBAD Battery has a warning Land Environment Air Picture Provision/Recognised Air Picture (LEAP/RAP) element, manned SHORAD systems (each paired with a RAS UGV SHORAD system) and Laser/RF DEW weapon systems for VSHORAD (but see Footnote 18 below).

CF(L) 35 echelons above BCT command manoeuvre formations and additional enablers. They span the tactical and operational level to deliver Integrated Action. Echelons above BCT contain substantial integral Joint Fires and ISTAR capabilities, akin to a US Army Division Fires Command. This includes:

a. A fires coordination/Joint Effects element.

b. 2 or more Depth Fire Rocket System (DFRS) battalions providing support to assigned BCTs and further reinforcing or discrete depth fires.

c. A 155mm cannon battalion.

d. A SHORAD battalion to provide cover for fires elements, 'force troops' and lines of communication.

e. A 'Find/ISR' battalion, equipped with Medium UAS, WLR and other sensing capabilities.

[22] The Class 1 UAS threat is proliferating to such a degree that this will be one of the most pressing force protection risks. The need to counter UAS (and rockets, artillery and mortars) necessitates a pan-FCT response which might see most platforms equipped with a very low level C-UAS/C-RAM kinetic/non-kinetic system.

[23] The manned part of this requirement could be met by the British Army Mobile Fires Platform with a projected ISD of 2026. Initial requirements are for a range of 80km, 5-round multiple simultaneous impact capability at 25km, sustained suppressive fire capability of 20 rounds/minute and STANAG 4569 Level 4 protection. Janes Defence Weekly 10 Apr 19, p5.

IMPLICATIONS FOR CAPABILITY DELIVERY

Delivery of this capability will be challenging but offers significant advantages over persisting with incremental development of the joint fires elements contained in FF25; further detail on capability delivery is contained at Annex A.

CONCLUSION AND RECOMMENDATIONS

Adopting this sub-concept will provide:

a. Fires that are more lethal, more precise, at a greater volume, at longer ranges and at all levels from FCT and above, providing a guaranteed effect at short, medium and long ranges from common/modular systems and minimal equipment types.

b. Targeting, battlefield damage assessment and logistic information flows from all elements involved in the targeting process at each level of command, operating with flexible C2 in a dispersed environment.

c. Manned and autonomous Fires platforms that are mobile, deployable and self-protecting and which disperse and synchronise to engage targets from multiple locations.

In the short-term it is recommended that:

a. The integrated weapons operations (IWO) programme should be a high-priority for funding, development and fielding (MORPHEUS design and architecture must take account of this).

b. AJAX, MIV/BOXER and MRV-P vehicle architecture ought to embrace DefStan 23-09 to allow them to access/host the SIE and control combat UGV and UAS RAS.

c. The practicality of procuring a manned (wheeled and/or tracked) 120mm mortar as described in this paper should be examined.

d. The practicality of pairing such a system with an autonomous version should be investigated.

e. The practicality of pairing the 155mm Mobile Fires Platform with an autonomous version should be investigated.

f. MLRS should be replaced by a wheeled rocket system capable of area and precision effects out to a range that exceeds the 'pacing threat' capability.

In the longer term, the development of a military-grade secure end-to-end SIE should be an Army priority. It will need to be supported by a self-healing Mobile ad-hoc Network and enabled by deep AI.

DETAILED CAPABILITY DELIVERY IMPLICATIONS

ANNEX A TO CF(L) 35 LAND JOINT FIRES SUB-CONCEPT

Ser	Key User Requirement	Enabling Technologies/Concepts	Consequences
1	Fires to be more lethal, more precise, greater volume, at longer ranges	• Precision munitions • Novel munitions • Enhanced range munitions	• 'Better' fires • Reduced personnel required • Less risk to humans
2	Guaranteed effects at short, medium and long ranges	• Precision munitions • Novel munitions • Enhanced range munitions	• 'Better' fires • Reduced personnel required • Less risk to humans
3	C2 in a dispersed environment	• Precision munitions • Novel munitions • Enhanced range munitions	• 'Better' fires • Reduced personnel required • Less risk to humans
4	Targeting, battlefield damage assessment and logistic information flows from all elements involved in the targeting process at each level of command	• Precision munitions • Novel munitions • Enhanced range munitions	• 'Better' fires • Reduced personnel required • Less risk to humans
5	Fires platforms to disperse and synchronise to engage targets from multiple locations	• Precision munitions • Novel munitions • Enhanced range munitions	• 'Better' fires • Reduced personnel required • Less risk to humans
6	A common/modular system with minimal equipment types	• Precision munitions • Novel munitions • Enhanced range munitions	• Facilitates regrouping • Increases operational efficiency • Optimises use, re-use and adaptation of hardware, software and interfaces • Reduced training, logistic and ES burden • Different (converged?) skill sets required
7	Both manned and autonomous platforms to be mobile, deployable and self-protecting		• Reduced size and profile • Reduced sustainment • Roll-on/roll-off • Preservation of the force – fires platforms will be High Value Targets

SUPPORTING ANALYTICAL SUB-CONCEPT: **SUSTAINMENT**

INTRODUCTION

If trends continue the future battlefield will be more lethal than today's and force elements will be more dispersed. Improved detection and increased lethality on the future battlefield increase the likelihood of the loss or denial of those large and static areas. Loss or denial of such traditional large sustainment hubs will have catastrophic consequences for the operation.

To leverage opportunities and to counter these threats, the Conceptual Force (Land) 2035 (CF(L)35) envisages that the Future Combat Team, a combined-arms grouping of ~500, will achieve the same effects as today's battlegroups with less than half the people[1]. To be realised, this concept of operations requires a radical reassessment of how the British Army will provide sustainment to major combat operations. Thus, this Analytical Sub-Concept[2] describes the required capabilities of CF(L)35 sustainment.

This dispersed concept of operations cannot be adequately supported by today's methods and procedures of sustainment. Even though Demand is likely to be reduced in most classes, Distance, Duration, Destination and Dependency will be more challenging than today. Successfully supporting CF(L)35 forces and operations requires a much more flexible and adaptive system with sufficient capacity to meet future logistic demands. The current AFM Sustainment offers a broad foundation on which this new system can be designed. Additionally, the same technologies that facilitate dispersed operations are used to realise this sub-concept for sustainment.

AFM Sustainment describes the evolving way operations are sustained. Non-linear and non-contiguous operations have been taking place since the beginning of the 21st century. This has led to moving away from traditional sustainment chains, towards creating a Land Environment Support Network (LESN).[3] Even though this network is capable of supporting dispersed operations and also provides redundancy in Land Lines of Communications, it is still based on creating relatively large, static and echeloned support areas with a high level of vulnerability towards future threats. This is one of the reasons why the future LESN cannot allow itself to use large sustainment hubs and echeloned support areas.

[1] CF(L) 35 was developed during AGILE WARRIOR in 2017 and 2018 at D Strat's behest, in response to Executive Committee of the Army Board direction; see in particular Dstl Reports for AW 17.4, 17.6 and 18.3.

[2] This Analytical Sub-Concept is one of several that support the main hypothesis of the Conceptual Force (Land) 2035. It was initially developed as a combined British Army/Dstl product during AW 17.2 in early 2017. It has been further refined since then as part of the development of the CF(L) 35 combined arms manoeuvre elements, the Future Combat Team (FCT) and the Brigade Combat Team BCT).

[3] AFM Sustainment, 1-6.

CONTEXT

Analysis[4] confirms that future sustainment must be dispersed and offer a level of redundancy by nature to support operations across a dispersed and contested operations area. This will create extended and highly vulnerable supply lines from the homeland all the way to the Forward Edge of the Battle Area (FEBA). Thus, to sustain operations in a future operating area, sustainment needs to shift from its current design towards a highly flexible and fluid network of sustainment-nodes and Future Combat Units (FCT) with strong organic support and ability to remain logistically independent for longer periods of time. The future LESN (F-LESN) will be built around the premise of 'many and cheap' and define itself by a very high level of autonomy, blockchain technology, robotic unmanned aerial vehicles (UAV) and unmanned ground vehicles (UGV), energy generation, additive manufacturing [5] (3D-printing), soldier enhancement and advanced medical care[6].

[4] Analysis conducted since 2014 under the AGILE WARRIOR programme by Dstl and also drawing on other Dstl and SFD-compliant sources as well as allied sources (eg from the US Army TRADOC UNIFIED QUEST series and from the US Army Fires Center of Excellence).

[5] https://www.contracts.mod.uk/blog/3d-printing-and-defence-an-industry-revolution-in-the-making/

[6] DSTL, Achieving the strategic edge through people: 2040 programme

DETAILED SUSTAINMENT CONCEPT

To enable its dispersed style of operating, FCTs will be logistically independent for longer periods of time because of better ways to organically support themselves.[7] Nevertheless, FCTs will still require sustainment support from higher echelons to cope with contingencies, losses, to exploit opportunities or to regenerate FCT capacity. FCTs will be enabled through techniques such as higher efficiency of platforms, water and energy generation and storage, additive manufacturing and predictive maintenance, but not to the extent that FCTs will be self-sustainable.

The resupply and services within the FCT will be enabled by Artificial Intelligence (AI) and advanced Health and Usage Monitoring System (HUMS). This will allow the FCT to monitor equipment and personnel status and predict consumption in order to prevent breakdown of equipment. The use of preventive medicine will improve soldier performance and reduction of non-battle injuries.

It is assumed that the carbon-footprint of an FCT will be significantly less than the current force. This reduction is achieved through the use of fuel cells based on hydrogen[8]. This application also allows the FCT the ability to self-generate via the use of hydrogen generators and provide for a large part of its energy-needs.[9] 3D-printing will not only be used for printing certain types of ammunition but also to print food based on hydrocolloids. This will allow for higher flexibility, less space and longer independency-levels.[10,11,12]

The basis for F-LESN is the concept of the sustainment network described in AFM Sustainment. F-LESN shares the same technology as is used in the FCTs to reduce manpower and cognitive burden, while increasing tempo and effect. The network will mostly function automatically; AI will monitor and adjust flows just as the human body adjusts heart rate and blood flow to optimise its performance. The network is based on dispersed nodes of physical stocks, production facilities and capabilities such as repair, other services and medical facilities. The production nodes will be capable of producing water[13] and generating energy and will use additive manufacturing to produce items such as spare parts and consumables.

To guarantee efficiency and effectivity the network will function dispersed. Nodes will not be dedicated to support a specific FCT or formation and therefore the F-LESN moves beyond traditional echeloned structures. This nodal network provides flexibility and adaptability, resulting in the ability to draw stocks across echelons and allowing for a lower reserve capacity. Nodes can operate as dedicated support providers or as alternate support providers, depending on their location in time and space.

[7] See Analytical Sub Concept …

[8] https://www.army.mil/article/200366/us_army_tardec_demos_zh2_fuel_cell_vehicle_at_schofield_with_25th_infantry

[9] https://www.mwrf.com/materials/army-s-aluminum-powder-produces-hydrogen-needed

[10] https://sputniknews.com/military/201609301045887540-3d-printing-munitions/

[11] https://www.digitaltrends.com/cool-tech/3d-food-printers-how-they-could-change-what-you-eat/

[12] https://ac.els-cdn.com/S2351978915010574/1-s2.0-S2351978915010574-main.pdf?_tid=7fb02f1e-f06d-4822-8871-c646e90f17f8&acdnat=1540553433_b9080193f075f861acda8aecf6838d51

[13] Water can be generated from air (see www.water-gen.com), pumping or purification of natural sources.

By having multiple nodes creating a flow, overall distance between demand and stock is reduced and consequently response times can be faster (ref. figure 1). A sustainment flow basically consists of an algorithm-based move of stock between nodes, predominantly delivered via unmanned vehicles.

The physical layout of the nodes, the number of nodes and the configuration of the network is calculated by AI. Human input, such as intent, planned actions, main effort et cetera can be added to generate the desired effect. Large redirection will require human decision. However, the network does allow for 'reflexive' fixes, which are 'system decisions made by an algorithm', in order to maintain flows or even to enhance survivability.

The nodes are platforms and can be transported over ground or through the air, either via UGV or autonomous air-drop[14]. As soon as the flow requires stock to move on, the nodes will adjust within the network and new nodes will either extend the supply line, replace depleted or destroyed nodes or add extra capacity when demand requires it.

As there will be many dispersed elements in every geographical area, such as C2, AD and Fire Support, sustainment nodes will use camouflage and concealment able to hide in the physical and information environments. Due to their small size, credible dummy nodes could be created at low expense and effort. The network structure is resilient. When a node is destroyed or a LoC denied, the network will auto-reconfigure an alternative route.

[14] DST-Group-TN-1573: Automated and autonomous systems for combat service support, Oct 2016

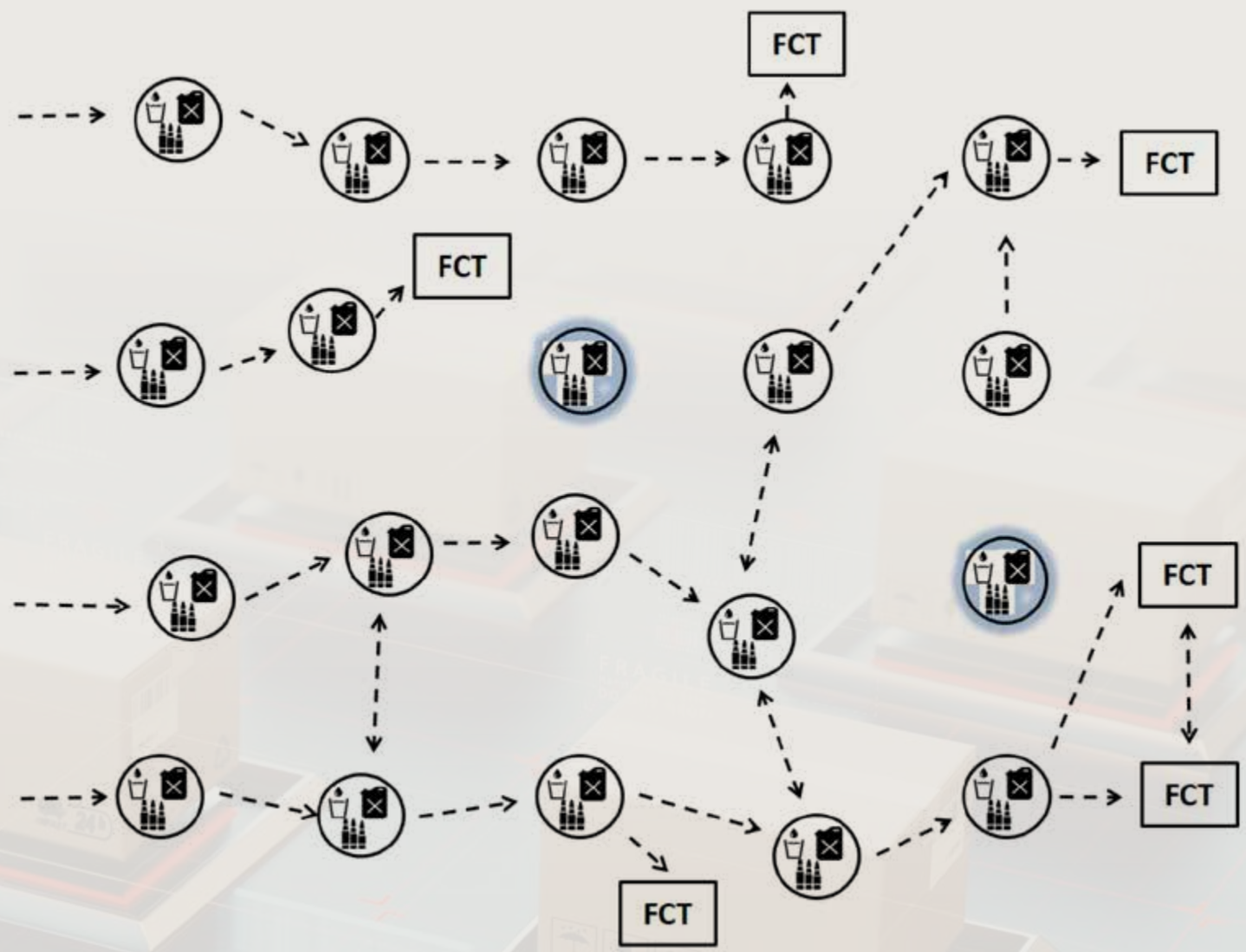


Figure 1. The Future Land Environment Sustainment Network.

Additional unpredicted demands and routine regeneration of stock levels need to be pushed forward by the F-LENS, without requiring FCT capacity and capabilities. For this purpose, the stocks in the nodes are already cross loaded at the Brigade Combat Team (BCT) level. Stocks will be delivered via DROPS-size autonomous UGVs or smaller hybrid UAV/UGV for air-resupply means. These hybrid vehicles will also allow for time sensitive emergency resupply. The nodes and UGVs are predominantly passively protected by advanced camouflage and concealment. Small detachments of personnel will cover a number of nodes to trouble shoot, cross load, maintain assets and provide additional resilience for unforeseen circumstances that cannot be dealt with by RAS. Planning, monitoring and delivering will require small numbers of personnel as most will be performed by AI and RAS. This will allow for a very robust and trustworthy sustainment network that allows for a high level of flexibility and assured delivery between the homeland and FEBA.

The sustainment concept assumes that a FCT has the sustainment capabilities to support itself for 7 days (6 days of low intensity warfighting/routine operations and 1 day of high intensity warfighting). This is achieved by a combination of turret stocks and additional stocks on sustainment vehicles organic to the FCT and Brigade Combat Team (BCT). These vehicles will predominantly be autonomous vehicles capable of carrying 8 pallets or 12 m^3 of liquids/hydrocolloids.[15]

For last mile resupply, smaller autonomous ground vehicles will be available, capable of carrying two pallets[16]. For extremely time sensitive last mile resupply UAVs will be used.[17] The number of support vehicles is different per type of FCT, as heavier FCTs require more sustainment capacity than lighter FCTs.

The FCT support vehicles will have the capability offloading and loading of smaller vehicles (for last-mile resupply). Within the FCT cross-loading of stock across different vehicles will be the golden standard, reducing vulnerability when a vehicle is lost. Stock level monitoring will be realised without human input using AI and HUMS. BCT elements carry their own supplies for 7 days. The BCT will not hold additional days of supply for the FCTs, as all elements rely on F-LESN flow for additional replenishment. BCT does however provide additional control of the flow of supplies from the F-LESN to the FCTs and other BCT elements.

Although the initial calculation and generation of the movement of stocks is done autonomously, priorities in sustainment efforts do give the BCT commander the ability to redirect supplies to where he assesses they will have the most effect on his plan, enabling him to reinforce or change the main effort. In addition, as the BCT does not hold additional stocks to support its subunits and the BCT level units hold their own organic sustainment, a BCT can actually manoeuvre on the future battlefield.

MEDICAL SUPPORT

Medical support (MS) in 2035 is provided by automated and remote systems[18 19] and human enhancement. Not only will automated and remote systems be used for transporting and delivery of blood but they will also facilitate rapid evacuation of wounded personnel from high intensity, high threat, remote and austere areas directly to specialist care.

Even though it is believed that the effects of weapons and weapon systems will be more effective, advancements in neuroscience, biotechnology, nanotechnology, genetics, and drugs will enhance the human body in such a way that, together with advanced trauma care, a wounded soldier on the CF(L)35 battlefield will have a very high chance of survivability[20]. Human enhancements and trauma care will remove the 'cold chain' and allow more flexibility towards extracting wounded personnel from the battlefield to role-hospitals in order to receive the necessary surgical care. The use of bionic or printed transplants and synthetic blood will ensure a very high ready-to-return rate of wounded personnel returning to duty at a later stage[21].

[15] Even though the capacity will be similar to that of DROPS, the fact that it is unmanned and thus does not require a cab or armour reduces the size and weight of the vehicle. The vehicle will therefore look more like todays trailer.

[17] DST-Group-TN-1573: Automated and autonomous systems for combat service support, Oct 2016

[18] https://onlinelibrary.wiley.com/doi/full/10.1111/ijcp.12989

[19] https://www.questia.com/library/journal/1G1-398829524/ethics-and-the-enhanced-soldier-of-the-near-future

[20] Glimpses of future battlefield medicine - the proliferation of robotic surgeons and unmanned vehicles and technologies, Journal of Military and Veterans Health, Vol 22-3

[21] http://assistivetechnologyblog.com/2017/10/bionic-body.html

[22] For smaller, low-end RAS a considerable spare capacity is available and they will be used in a more disposable manner in order to allow risk-taking and the generation of tempo.

EQUIPMENT SUPPORT

It is assumed that the maintaining battle worthiness of manned and large high-end RAS within the FCT will receive equipment support (ES) priority in dispersed operations.22 This will require additional knowledge and skills for the vehicle crews and organic FCT first-line support elements. Augmented reality and conditions-based maintenance will help this first-line personnel to make diagnoses and repairs traditionally done by the second-line.[22] The FCT and BCT first-line elements carry a basic load of spare parts for direct use, while the F-LENS pushes predicted and routine spare parts and consumables forward.

Predictive maintenance and HUMS systems will improve mean-time-between-failure times and distances, enabling dispersed operations over extended lines of communication. AI and HUMS will enable a higher level of availability of the correct spare parts when needed (at the right place, at the right time). Based on planning and issuing of tasks to the BCT and FCT, the AI support calculates and delivers the spare parts that are likely to be required when executing the assigned operation, thus supporting the seven days of independent operations.

When equipment is irreparable at the FCT level or when repairs will take too long to realise, the following options are available:

- based on the 'many and cheap' principle, broken equipment will be destroyed and replaced with a vehicle from the RAS holding & delivery unit (a FCT unit that holds replacement RAS but can also be used as a reserve element);
- broken equipment can be transported and repaired at a repair node that can afford to be static over a prolonged period;
- equipment can be carried with the BCT to allow repair later;
- equipment can be left behind, to be collected and repaired later (protected by camouflage and concealment).

Recovery of vehicles remains to be a very complex task. Therefore, in 2035, manned recovery platforms will still be required and they will require the same level of protection as the other FCT elements. Additionally, unmanned recovery platforms will be introduced to perform routine recovery tasks and high-risk high-payoff recovery tasks.

When a heavy vehicle is recovered but needs to be transported back into the F-LENS to be repaired, the BCT holds 40 (optionally manned) HET vehicles. For lighter vehicles the DROPSsized UGVs of the F-LENS can be used as well. The HETs can also be used for intra theatre transportation of the heavy tracked vehicles of the H-FCT and the BCT Manoeuvre Support element which both have direct fire platforms.[23]

For large high-end unmanned systems, the equipment support is as above. However, for less exquisite systems and systems that are designed to be used sacrificially the FCT and BCT hold additional systems to immediately replace damaged, lost or stuck systems. This allows the FCT to regenerate its combat power during the operation. As unmanned systems will be deployed to preserve the manned systems and because they will constitute the larger percentage of combat mass, the unmanned systems will take the majority of the losses.

The combination of preserving manned systems and immediate replacement of unmanned systems will allow CF(L)35 forces to operate longer, faster, further, at a higher tempo and with less casualties.

As not all RAS are used in a similar way and not all RAS are tasked at the same level of risk, there is a differentiation in the ratio of RAS held as immediate replacements. For reconnaissance RAS a reserve is held within the BCT for every vehicle that is present in the BCT (100%). For direct fire, indirect fire, anti-tank, bridging, C-UAS and Counter Battery 50% replacements are available. For load carriers and last mile resupply this number is 25%. Small UAS will be held in multiple numbers at the organic operator level.

The replacement RAS will be on unmanned trucks carrying 8 medium or 1 heavy RAS. Four of these trucks will be pushed forward to the FCTs as immediate replacement carriers. Configuration of these loads will depend on the type of operation and FCT task.

Recovery and repair of unmanned systems will be done when circumstances, such as threat and priority, allow. If a system is still capable of moving, but has lost other combat essential capabilities, it can move autonomously to an element that can recover or repair it. For repair and maintenance of unmanned systems, the teamed manned platform is responsible and additional capacity is available at the FCT and BCT levels.

[22] DST-Group-TN-1573: Automated and autonomous systems for combat service support, Oct 2016

[23] When a BCT is task organised with more than one H-FCT additional HETs are required as well.

CAPABILITY DELIVERY

Delivery of CSS capabilities will be challenging but will also offer significant advantages in comparison to the current CSS processes and capabilities. Further detail of capability delivery is contained at Annex A-1.

Adopting this sub-concept will provide:

- an overall reduction in CSS personnel-levels in comparison to current equivalent-sized units;
- deployment of a robotic component that comprises of UAV and UGV and will, to a large be expendable;
- a CSS robotic replacement capability that can also function as a reserve force component (RAS Holding & delivery unit);
- a rapid deployable and self-sustaining CSS nodal network/supply chain to provide stocks, maintenance and medical supplies;
- use of alternative energy sources, using fuel cells, self-generating and regenerating capability, resulting in a more efficient energy-footprint;
- rapid CASEVAC and MEDEVAC solutions through use of robotic components;
- AI Tracking and monitoring of equipment and equipment 'health';
- 3-D printing for spare parts, munitions and food.

CAPABILITY DELIVERY

Sustainment of military operations in 2035 will be very different from what it is today. It will still be 'getting the right stuff, at the right time and in the right place' but the what, when and how will be completely different. Troops will be self-sustainable for a longer time and for certain types like food, energy and ammunition technology will allow the time until re-supply will to be extended even further. Human enhancement will allow injured front-line troops to remain on the battlefield much longer and rapid extraction means will transport them in time to a medical facility that will provide them with advanced life-saving trauma care. All of this will reduce and disperse the logistic footprint significantly and lessen the burden on the tempo of military operations, allowing commanders more freedom to manoeuvre.

Ser	Key User Requirement	Enabling Technologies/Concepts	Consequences
1	Advanced camouflage and concealment	EMS-emitters, multi-spectral camouflage nets	Protection against ENY identification (visual, radar, thermal etc.)
2	Accounting and planning	AI and blockchain	Trust and assurance
3	Scalable energy	Alternative energy sources (non-fossil fuels), fuel cells	Self-sustaining energy solutions
4	Autonomous vehicles	AI, advanced sensing, robotics	Smaller human footprint, higher speeds and higher precision
5	Advanced packaging	Renewable energy	No garbage waste, small environmental footprint
6	Additive manufacturing	3D printing	Production of food, munitions, medication etc.
7	Protected and assured plug & play data network	C2 concept	Data-monitoring of sustainment nodal-network
8	Improved soldier performance (med)	Preventive medicine	Reduction of non-battle injuries
9	Improved stabilising techniques (med)	Trauma care	Reduced casualty numbers and flexible medevac (no more golden hour)
10	Advance stock level monitoring	AI	Just-in-time resupply
11	Bionic transplants, printed organs	Bionic transplants, trauma care	Casualty chain-time reduction

THE FUTURE COMBAT TEAM

INTRODUCTION

The Future Combat Team (FCT) is the unit of tactical action within CF(L)35, and may be Heavy/Tracked, Medium/Wheeled or Light/Wheeled. The FCT will consist of between 490 and 610 soldiers with the combat power to deliver the mission sets attributed to today's armoured infantry, STRIKE or light infantry battle-groups of circa 1,250 soldiers. The FCT will be a combined arms force; the lesser number of personnel in the FCT will manned-unmanned team (MUM-T) with UGV and UAS to increase their effective mass and provide increased firepower and superior situational awareness. The FCT will be able to sense and engage out to 15 km, and sense and understand out to 30 km. It will be more manoeuvrable, have a flatter hierarchy, and have better combat to combat support and combat service support ratios than its current battle-group equivalent. This will render the FCT more sustainable and allow it to apply all its assets to the fight simultaneously. There will be four FCTs within a Brigade Combat Team (BCT).

At its heart, the Heavy FCT has a recce force, a squadron of armour, a reinforced infantry company (of four rifle platoons) and a platoon of assault pioneers – all enabled by integral RAS direct fire support. It features a strong integral combat support force based on a 120mm mortar battery, manoeuvre support elements and air defence. Medium FCTs have a similar structure, although none of their force elements are tracked. The Light FCT is larger than both other variants in terms of personnel, with a structure adjusted to suit their anticipated role[1]. The various FCT are described in Part 3.

The FCT will be able to fight with, stabilise, or accompany and mentor indigenous capability. For warfighting it will be brigaded for concentrated effect but is designed to operate on its own and in a dispersed manner. The FCT will be highly capable in complex terrain, particularly the urban environment. Capable of contesting and holding ground in non-contiguous battle-space and defeating a range of opponents, including a peer adversary in major combat operations in denied and/or degraded environments, the FCT will excel in situations where it can manoeuvre freely.

The FCT is supported by technologies and analytical concepts which means the whole adds up to more than the sum of the parts. It operates according to the principles at Part 2 below.

[1] Air assault; operations in urban/complex terrain; and roles which require a greater ability to 'people-face'

PRINCIPLES OF TACTICAL EMPLOYMENT

FCTs employ a 'next-level Manoeuvrist Approach'. They aim to shatter the will of the adversary and create the perception of defeat in his mind, and achieve this by posing multiple dilemmas at a tempo that overmatches the enemy's decision-action cycle.

a. **Command.** Command will be achieved through using separate command HQs and controlling entities. There will be no specific HQ at what is now considered battle-group level; rather command will be vested only at FCT and Brigade levels. This reduces friction and increases tempo. Controlling HQs will be deployed to facilitate command as intermediaries when FCTs deploy across long distances or within complex terrain. Algorithms, feeding off data gathered by ISTAR and sensors monitoring the status of our personnel, equipment and material via a Single Information Environment and ubiquitous SA, will automate many of the staff functions. This will increase tempo and reduce the number of staff deployed forward. FCT HQs will be configured to command up to five elements at any one time with the ability to take on additional groupings (such as indigenous forces) via their inherently flexible and robust control structure[2].

b. **Information and Intelligence.** With persistent ISTAR available to all[3], efforts should focus on exploitation not gathering. Machine learning algorithms will enable the FCT HQs to make more of the available information and turn it into actionable intelligence. The algorithms will not be binary in nature and will be able to flex to accommodate a changing tactical situation. The Information Manoeuvre (IM) element within the FCTs will be able to find information in the cyber domain while placing disruptive information of its own. Deception will still be possible in a mass media environment where the amount of information may hide that which is true or false and the speed at which it is used will prevent rigorous consideration of information as accurate or not. IM may supplement more traditional means of manoeuvre as it places our forces in a non-physical position of advantage.

c. **Firepower.** The FCT will have integral indirect fire support from self-loading heavy mortars, augmented by brigade wheeled medium artillery for counter-battery fire and divisional long-range rockets for shaping the deep battle beyond 100 km. The FCT will have organic direct fire support RAS, replacing conventional fire support company assets. The FCT will have an ATGW capability for its protection and may off-set today's MBT capability with a suite of smaller vehicles which, when taken in combination, offer what today's MBT achieves, but with less cost, greater sustainability and better strategic and operational mobility. The CF (L) 35 Fires will shape the battlefield before the commitment of dismounted close combat forces, with fires that can reach into the air and cyber domains as well as land.

d. **Manoeuvre.** FCTs will be able to self-deploy up to 1,600 km and attack the enemy across all domains simultaneously and across geographic depth. The FCT will manoeuvre in both the virtual and physical dimensions. Lack of mass will be off-set by exploiting tempo, both physically and cognitively. The force will be able to move more easily in complex terrain due to its multiple sensors. The FCT will manoeuvre to shape the battlefield before the commitment of close combat force elements, with long range, cross-domain fires targeted by persistent ISTAR from UAS and UGVs operating in advance of manned vehicles and dismounted troops.

e. **Protection.** The FCT will deploy with an integral GBAD capability and typically sit within improved brigade coverage when available. While focused on anti-air and aviation platforms it will be equally effective against UAS. The FCT will deploy with a range of RAS sensors that will warn of incoming threats. Combat Support elements will continue to protect with physical barriers and enable manoeuvre. Novel weapons such as RF and DEW will also offer a new level of protection. Information Manoeuvre (IM) will aid protection by deceiving the enemy about the FCT's intentions and location. Anti-Tank Guided Weapons (ATGW) and Very Short-Range Air Defence (VSHORAD) may share a common missile system that is equally capable of defeating ground and air systems, instantly doubling the capabilities of both within the FCT.

f. **Sustainment.** The FCT will be more sustainable as it will carry more of its own CSUPs and not have to rely upon ad hoc resupply. It will use contemporary technology, such as power and water generation, to reduce its logistic demand. It will produce or repair some items leveraging additive manufacturing technology. Sensors on equipment throughout the force, combined with AI, will provide a common logistics picture and enable autonomous resupply when required; this includes health monitoring and the CASEVAC of personnel. A cloud-based predictive logistic artificial intelligence will automate logistic support planning. An increasing number of platforms within the FCT will have been procured by "many and cheap" rather than "few and exquisite" principles, facilitated by open standards design architectures. Medical support will embrace health monitoring and rely upon automated ambulance systems with human medics to remove casualties from the contact battle. The FCTs are designed to deploy for seven days during which they will be self-sustaining. They will not maintain 100% CSUPS at all times but be resilient and able to operate with less[4]. The FCT is designed to require less and will rely heavily upon automated sustainment from RAS platforms that move CSUPs to it from distributed logistic nodes. Travelling independently, these RAS platforms will not routinely require protection or the support of combat power.

[2] AGILE WARRIOR programme research suggests that an individual/HQ can handle more than five points of command; the capacity to command more does exist, especially if enabled by artificial intelligence and greatly improved battle management applications.

[3] ISTAR will be provided by loitering UAS and UGV recce platforms and systems, with comparable/additional assets at brigade and divisional levels. The critical enablers will be the algorithms that combine the available information, reduce the cognitive burden and alert staff to incidents of interest.

[4] In Agile Warrior Dstl-supported experimentation, the Heavy FCT requires approximately 45% less sustainment by volume than a comparable AI BG.

ORGANISATION AND OPERATION

The FCT will utilise cross-domain manoeuvre to dislocate or destroy enemy forces, neutralise enemy attacks, engage in close combat, seize terrain and control land areas including populations and resources. Operating dispersed to prevent effective targeting by likely adversary massed UAS/drone and indirect fire capabilities, FCTs will consolidate only at decisive locations and times to gain positions of relative advantage against the enemy.

The FCT is optimised to conduct:

a. Coordinated combined-arms offensive tactical actions, at tempo, employing a range of effects across domains[5] to achieve tactical goals[6].

b. Wide area security employing force protection enablers and leveraging emerging information manoeuvre techniques.

c. Mobile defensive operations designed to hold ground, facilitate transitional phases and canalise the enemy into killing areas of our choosing.

d. Military activity in conjunction with an orchestrated whole force approach.

e. Deployment direct from an APOD, SPOD or self-deploying into an austere operational area with minimal reception, staging, integration and onward movement requirements.

[5] 'Domains' is used in the same context as US Multi-Domain Operations.

[6] Principally to dislocate, defeat or destroy enemy forces and/or seize and secure terrain.

[7] Unmanned ground vehicles (UGV) (other than the 'Robotic Combat Vehicle–Direct Fire' in the Armd Sqn and some other specialist vehicles) will have evolved significantly beyond the current platform in mobility (principally speed across country), reliability and capacity. By 2035, deep artificial intelligence and machine learning are predicted to permit manned-unmanned teaming (MUM-T) ratios at greater than 1:1.

FCTs share the following common characteristics:

a. Fight and win across multiple domains.

b. Contest and hold ground in a non-contiguous battle-space against a peer enemy.

c. Are enabled by a self-healing Mobile ad-hoc Network (MANET) and through a secure, end-to-end SIE.

d. Make extensive use of RAS to supplement and replace manned systems where practicable[7].

e. Are equipped with the organic systems to sense and engage out to 30km.

f. Can coordinate effects out to 120km when allocated Joint Fires.

g. Are self-sustaining for 7 days (one day at high, 3 at medium and 3 at low intensity).

h. Normally part of a brigade combat team (BCT), FCTs can operate independently.

The FCT Heavy/tracked is organised as per the table below and has the following specific characteristics:

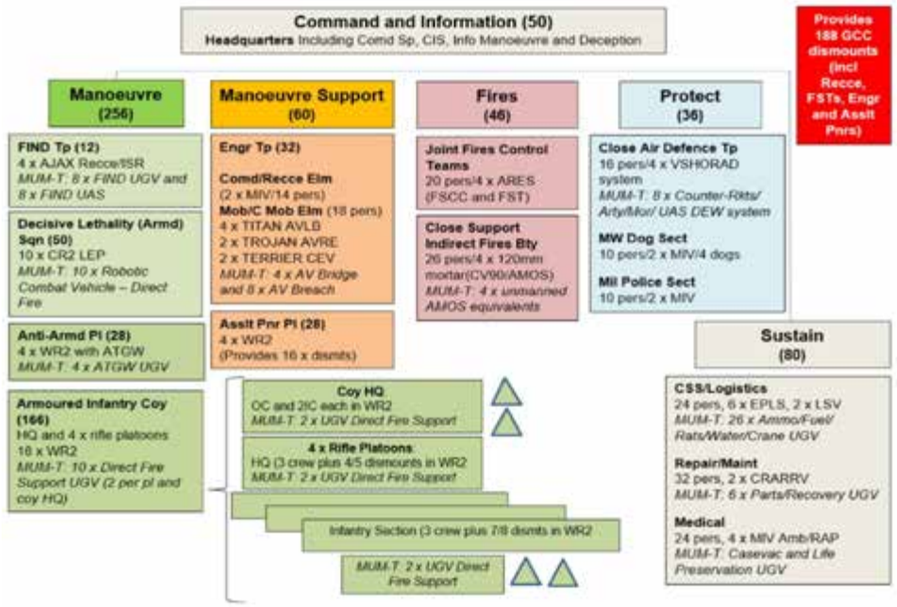
a. Is predominantly based on tracked, heavy, armoured platforms.

b. Generates greater combat power than a 'legacy' AI battlegroup updated to 2035.

c. Has 520 personnel and can deliver approximately 200 personnel into the Dismounted Close Combat (DCC) role.

d. Moves at a planning speed of 30km/hr out of contact and up to 5km/hr in contact.

e. Is capable of marching/self-deploying 200km unsupported.



The FCT Medium/wheeled is organised as per the table below and has the following specific characteristics:

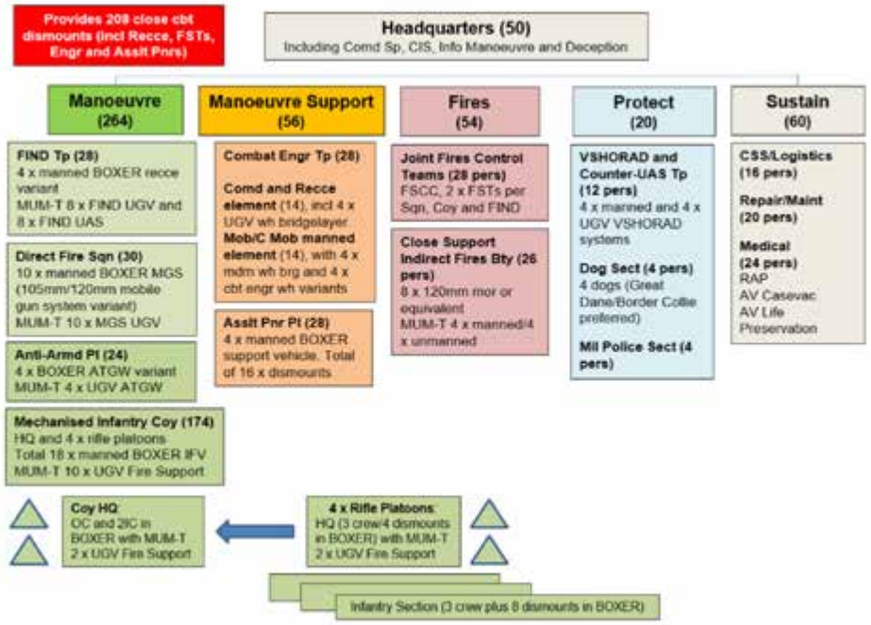
a. Is predominantly based on wheeled, medium, armoured platforms.

b. Generates greater combat power than a 'legacy' Mechanised Infantry battlegroup updated to 2035.

c. Has 504 personnel and can deliver approximately 210 personnel into the DCC role.

d. Moves at a planning speed of 60km/hr out of contact and up to 5km/hr in contact.

e. Is capable of marching/self-deploying 1,600km unsupported.



The FCT Light/wheeled is organised as per the table below, the FCT Light has the following specific characteristics:

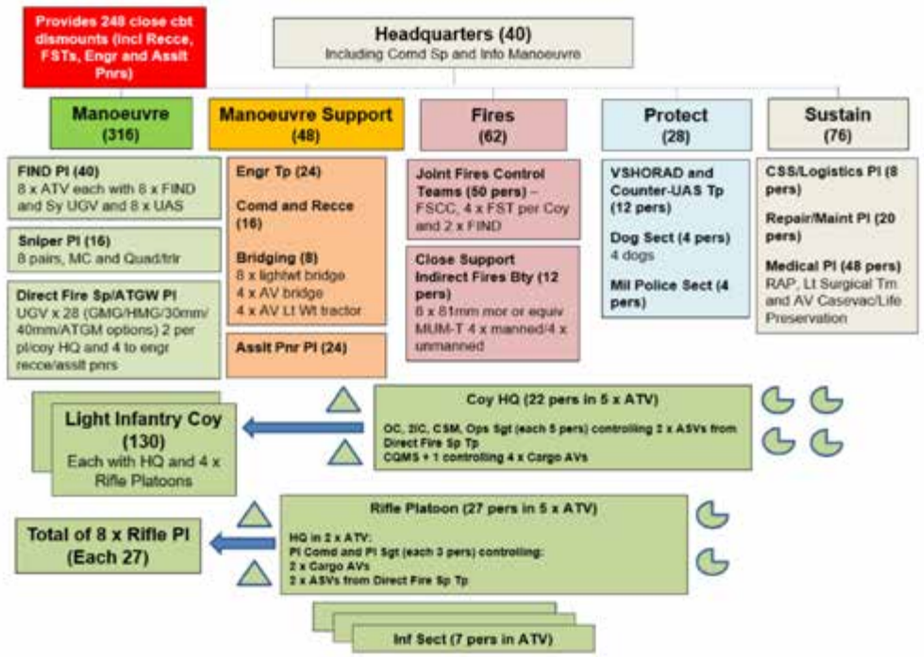
a. Is predominantly based on wheeled, light platforms.

b. Generates greater combat power than a 'legacy' Light Infantry battlegroup updated to 2035.

c. Has 562 personnel and can deliver approximately 250 personnel into the DCC role.

d. Moves at a planning speed of 60km/hr out of contact and up to 1km/hr in contact.

e. Is capable of marching/self-deploying 1,600km unsupported.



SUMMARY

Consistent with Integrated Action, the Manouevrist Approach and Mission Command, FCTs (whether Heavy, Medium or Light) are combined-arms units of tactical action which will deliver multiple, cross-dimension dilemmas to the enemy and thus impose decision paralysis through a focus on the following principles:

a. Dispersal, to protect the force, cover more ground and impose dilemmas on the enemy at more locations simultaneously: with a force that is combined-arms at the lowest level and facilitated by increased use of robotic and autonomous systems (RAS).

b. Higher relative tempo, achieved through a pervasive Single Information Environment (SIE) allowing quicker decision-making, with a flatter organisation with enabling capabilities (such as fires and mobility support) permanently grouped to the FCT.

c. Deception, in both the physical and virtual domains.

d. Protection, through speed of manoeuvre and execution as well as (where possible) smaller platform size, armour and more effective passive and active defences.

e. Dislocating rather than destroying the adversary; by prosecuting and winning a deep battle through an all-informed sensor-shooter network which maximises the effective use of fires in depth, coupled with superior Information manoeuvre.

THE FUTURE COMBAT TEAM (HEAVY)

INTRODUCTION

The Future Combat Team (Heavy) was initially developed as part of the Conceptual Force (Land) 2035 analytical concept. This paper refines into an applied concept so that it can be used for further evaluation and costing. The Future Combat Team (Heavy) (FCT(H)), the tracked/heavy tactical unit of action of the Conceptual Force (Land) 2035 (CF(L)35) analytical concept, was set in the 2035 timeframe. Analytical concepts are not constrained by resource and policy and thus represent distant aiming marks set on the 'sunlit uplands'.

Developing an applied concept grounded in the reality of the 2029 timeframe however, requires a focus on the relevant policy and resource areas. Such an applied concept will of necessity comprise much 'legacy' equipment (such as CR2 LEP, WR2, MIV and AJAX). Because the FCT(H)29 applied concept represents a 'waypoint' between today's funded AI battlegroup and any planned/future force it can also be costed with some degree of accuracy. The FCT(H) demonstrates utility in the CONTEST as well as the FIGHT space, due to its being able to be deployed more quickly and having a smaller 'footprint' and comparable combat power to an AI BG. Thus it might also be used to inform the 2019 Army Iterative Strategy (principally Work-Strand [1], a New Operating Concept for the Army).

As a Future Force Development/Concepts requirement, the FCT(H)[29] applied concept is not intended to be a full Concept of Employment/CONEMP and only the Equipment, Concepts/Doctrine and Organisation Lines of Development will be considered in any detail.

[1] A summary of the relevant research findings and insights taken from 18 reports during this period may be found at: Analysis Support Construct Task 221: Dstl Concepts Review QINETIQ/19/00824 FINAL dated 22/03/2019.

THE FCT(H) ANALYTICAL CONCEPT

The CF(L)35 analytical concept was developed by FFD/ Concepts and Dstl/Land Environment Future Concepts during 2017/18. During these two years evidence was gathered under the AGILE WARRIOR programme through literature research, historical analysis, seminars, workshops and wargames set in Strategic Force Development (SFD)-compliant scenarios[1]. CF(L)35 was exposed to AFDC and ECAB and agreed to by both. The final analytical concept 'thesis' was published in April 2019.

THE FUNDAMENTAL PREMISE OF CF(L)35

While remaining consistent with Integrated Action, the Manouevrist Approach and Mission Command, CF(L)^{35} would deliver multiple, cross-dimension dilemmas to the enemy and thus impose decision paralysis through a focus on the following principles:

a. Dispersal, to protect the force, cover more ground and impose dilemmas on the enemy at more locations simultaneously: with a force that is combined-arms at the lowest level and facilitated by increased use of robotic and autonomous systems (RAS).

b. Higher relative tempo, achieved through a pervasive Single Information Environment (SIE) allowing quicker decision-making, with a flatter organisation with enabling capabilities (such as fires and mobility support) permanently grouped to the FCT.

c. Deception, in both the physical and virtual domains.

d. Protection, through speed of manoeuvre and execution as well as (where possible) smaller platform size, armour and more effective passive and active defences.

e. Dislocating rather than destroying the adversary; in particular by prosecuting and winning a deep battle through an all-informed sensor-shooter network which maximises the effective use of fires in depth, coupled with superior Information manoeuvre.

CAPABILITIES OF THE FCT(H)

Adhering to the tenets outlined above, force design of the tactical units of action of CF(L)^{35} allows the creation of an FCT with the following characteristics[2]:

a. Fights and wins across multiple domains.

b. Contests and holds ground in a non-contiguous battle-space against a peer enemy.

c. Is predominantly based on tracked, heavy, armoured platforms.

d. Generates greater combat power than a 'legacy' AI battlegroup updated to 2035.

e. Has 650 personnel and can deliver approximately 200 personnel into the Dismounted Close Combat (DCC) role.

f. Is enabled by a self-healing Mobile ad-hoc Network (MANET) and through a secure, end-to-end SIE.

g. Makes extensive use of RAS to supplement and replace manned systems where this is practicable[3].

h. Is equipped with the organic systems to sense and engage out to 30km.

i. Can coordinate effects out to 120km when allocated Joint Fires.

j. Moves at a planning speed of 30km/hr out of contact and up to 5km/hr in contact.

k. Is capable of marching/self-deploying 200km unsupported.

l. Is self-sustaining for 7 days (one day at high, 3 at medium and 3 at low intensity).

m. Is normally part of a brigade combat team (BCT) but can operate independently.

[1] A summary of the relevant research findings and insights taken from 18 reports during this period may be found at: Analysis Support Construct Task 221: Dstl Concepts Review QINETIQ/19/00824 FINAL dated 22/03/2019.

[2] The difference between an FCT in ^{2035} and ^{2029} is that this Applied Concept seeks to make best use of what we are still likely to have in service, together with the expected additional enablers (such as MORPHEUS) and some military-off-the-shelf purchases (such as the Robotic Combat Vehicle – Direct Fire and the manned ^{120}mm rifled gun mortar system under armour).

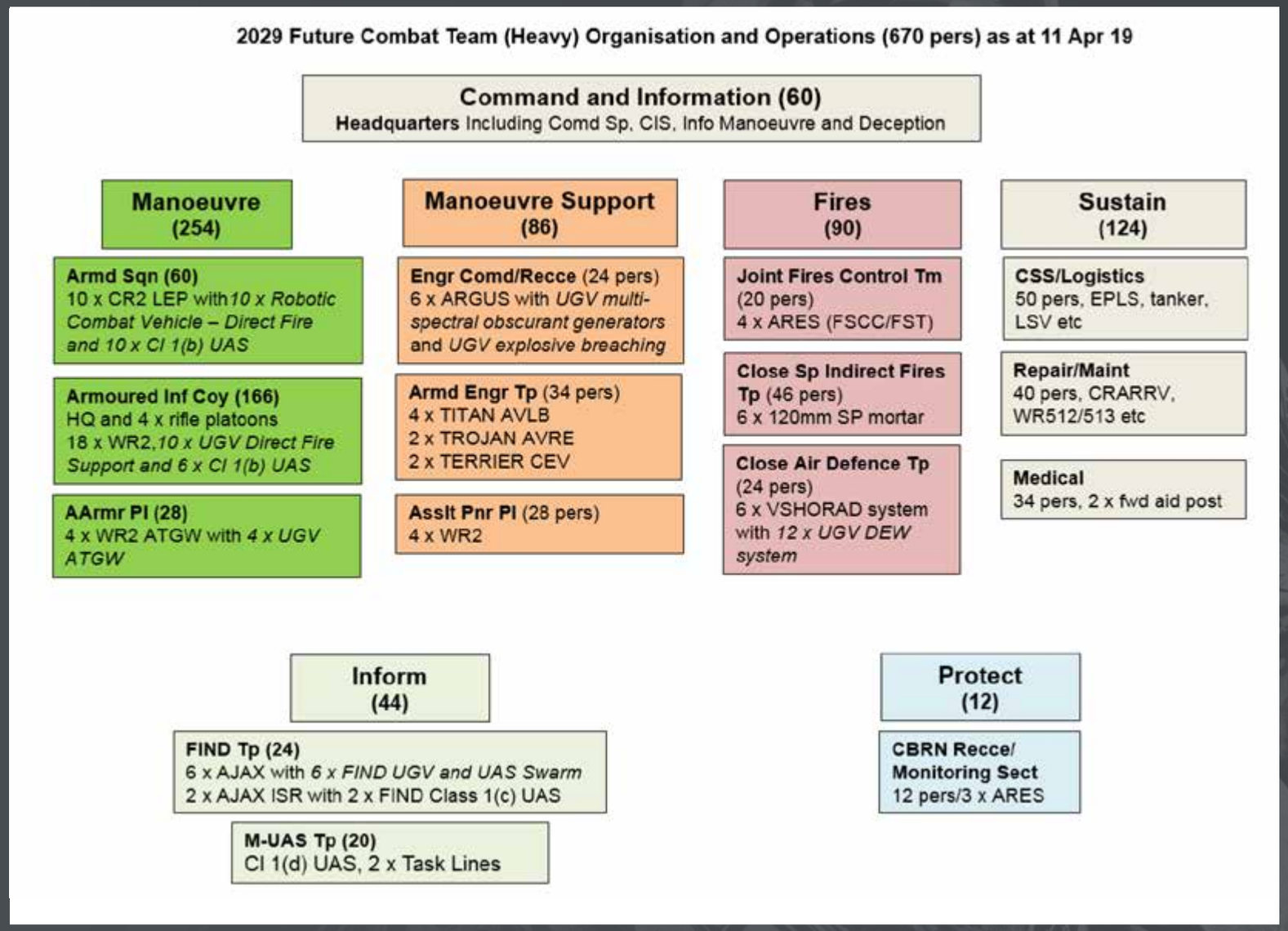
[3] Unmanned ground vehicles (UGV) (other than the 'Robotic Combat Vehicle–Direct Fire' in the Armd Sqn and some other specialist vehicles) will have evolved significantly beyond the current MILREM THeMIS platform in terms of mobility (principally speed across country), reliability and capacity. And by ^{2029}, deep artificial intelligence and machine learning (AI/ML) are predicted to permit manned-unmanned teaming (MUM-T) ratios, but probably at no greater than ^{1}:^{1}.

DEVELOPMENT PATHWAY AND ASSUMPTIONS

Any FCT fielded in 2029 would be part of the 'funded force' and would thus contain current in-service 'legacy' equipment. To develop the FCT(H) into an applied concept (brought forward into the 2029 timeframe and thus containing CR2 LEP, WR2, MIV and AJAX etc), FFD/Cap Strat and HoC GM advice was sought to appropriately adjust capabilities and organisations. Where such adjustments were done they took account of the most appropriate current policy, namely the Lead Armoured Task Force as articulated in the Army Readiness Order[4], out of service dates (OSD) and projected in-service dates (ISD). The likely RAS scaling was referenced to the Army RAS Roadmap[5]. It was assumed that the *'Robotic Combat Vehicle – Direct Fire'* would be in US service and could be a MOTS purchase as could *a manned 120mm rifled gun mortar system under armour*. Where organisational detail was insufficient the Staff Officers' Handbook 2018 was used to supplement. Further details may be found at the Vehicle and Equipment Table at the end of this Applied Concept.

[4] ADOC 04 02 dated 12 Dec 17, Appx 2 to Annex I.
[5] D Cap 4 2 32 dated 26 Feb 19.

FORCE ELEMENT STRUCTURAL CHART



COMPONENTS OF THE FCT(H)

a. **Command and Information.** 2 x FCT mobile tactical command nodes contain network and staff enablers, intelligence, Information Manoeuvre, CEMA/cyber-attack and Deception. Manned vehicles are predominantly WR2 Comd and ATHENA.

b. **Inform**

- **(1) FIND Tp.** The FIND Tp provides the FCT with ground manned mounted reconnaissance and comprises 6 x AJAX Recce, each controlling a UGV FIND and UAS Swarm. A further 2 x AJAX ISR variants each control a Class 1(c) UAS (similar capability to DESERT HAWK). The FIND Tp can also operate as 2 independent elements over a wide frontage and significant depth. UGV FIND are waterproof, can swim/ford wet gaps and can typically operate 2km distant from manned AJAX recce.
- **(2) M-UAS Tp.** The M-UAS Tp is equipped with a Class 1(d) UAS system (range 40-60km and similar capability to Project AQUILA) and can operate 2 x Task Lines.

c. **Manoeuvre –** Armoured Squadron. The Armd Sqn provides the primary 'shock action', tank-killing and mobile protected firepower element of the FCT:

- (1) The manned system in the Armd Sqn is 10 x CR2 LEP. The unmanned system is based on the US Army 'Robotic Combat Vehicle – Direct Fire'[6]. There are 10 x RCV, with each CR2 controlling a 'wingman' RCV[7].
- (2) Absent the emphasis on keeping the crew safe, the RCV is lighter (27-35 ton depending on armour fit), smaller, as lethal per platform and less expensive than CR2 LEP. It can be transported more easily, can cross a greater range of bridge classes, can manoeuvre easily in more types of terrain and requires less fuel than CR2 LEP while being able to move rather faster on equivalent going. Survivability is likely to be greater due to lack of crew vulnerability, reduced vehicle dimensions, advances in active protection systems and the ability to create specialised (lighter and more effective) armour for some components. RCV is capable of firing at +50o from the horizontal, allowing for greater utility in the urban environment and for firing beyond line of sight out to 8-12km. The RCV main armament has similar range and penetration capabilities to the CR2 LEP high-pressure gun. The RCV carries 34 ready rounds.
- (3) There are 4 x Tk Tps in the Armd Sqn. Each Tp comprises 2 x manned CR2 LEP and 2 x RCV. The Sqn HQ of 2 x CR2 LEP and 2 x RCV can also deploy a UAS Swarm and can split if the Sqn is task-organised.

d. Manoeuvre – Armoured Infantry Company. The AI Coy of 4 x Platoons is mounted in WR2, and provides the FCT's principal dismounted close combat capability:

- (1) The manned system is 18 x WR2 organised as 4 x Pls each of 4 x WR2 and a Coy HQ of 2 x WR2 (which may also deploy a UAS Swarm). These may also mount a self-protection ATGW or NLAW.
- (2) The unmanned Direct Fire Support (DFSp) system is a significantly uprated MILREM THeMIS UGV or equivalent mounting several direct fire system options (eg .50cal HMG, 40mm GMG, 30mm/40mm cannon or NLAW).
- (3) Each Pl and the Coy HQ includes a section of 2 x UGV DFSp – effectively providing a powerful fire support group that allows additional manoeuvre options. The 4th Pl combined with the UGV DFSp provides enough combat power integral to the AI Coy to allow it to be further task-organised.

[6] RCV-DF is anticipated to be available for MOTS purchase to meet an ISD of 2029.

[7] This concept assumes adequate automation within the CR2 LEP turret to allow a crewman to positively control the RCV-DF 'loyal wingman'.

e. **Manoeuvre – Anti-Armour (AArmr) Platoon.** The AArmr Pl is mounted in 4 x WR2. Each sect is equipped with two 4th generation MRATGW/LRATGW and NLAW systems, and controls a UGV ATGW mounting a 4th generation MRATGW/LRATGW and/or quad NLAW system. This capability forms the basis of the FCT AArmr matrix.

f. **Manoeuvre Support Group (Engineer Command and Reconnaissance (Engr Comd and Recce), Armoured Engineer Troop (Armd Engr Tp) and Assault Pioneer Platoon (APnr Pl)).** This grouping provides mobility and counter-mobility support to the FCT(H) as well as other specialist engr and pnr capabilities:

- (1) Engr Comd and Recce is mounted in ARGUS Engr Recce vehicles and controls the UGV multi-spectral obscurant generators and the UGV explosive breaching capability. It will also task and coordinate the APnr Pl[8].
- (2) The Armd Engr Tp provides 4 x assault bridges (TITAN AVLB), 2 x TROJAN AVRE vehicles and 2 x TERRIER Combat Engineer Tractors (CET).
- (3) The Asslt Pnr Pl is mounted in 4 x WR2 allowing it to accompany the AI Coy and/or operate in complex terrain. It provides the FCT with support in infantry Mob/C Mob tasks – eg for route improvement/denial, construction of improvised obstacles and emplacing future, smart (Ottawa-compliant) mines.

g. **Fires.** The Fires grouping provides integral Joint Fires to the FCT:

- (1) Fire Control Teams. 4 x Joint Fires Control Teams are mounted in ARES OPVs. They provide Fire Support Coordination and Fire Support Direction/Application of Fire for the FCT, utilising both integral and Joint fires.
- (2) Close Support Indirect Fires Platoon. Integral fire support comprises 6 x manned 120mm rifled gun mortar systems under armour (similar to CV90/AMOS). The weapon uses a modular charge system and on-board computation to fire all 120mm ammunition natures out to 15km, including precise and loitering munitions. It is also capable of direct fire. It will normally deploy into 3 separate gun-lines of 2 mortars each to provide maximum coverage and enhance protection.
- (3) Close AD Troop. The 6 x AD Sects (each in ARES variants) are equipped with a manned VSHORAD system which provides an 'AD bubble' for the FCT. Alerting and tracking is provided through the SIE and a vehicle-mounted radar. Supplementing these manned systems are a further 12 x UGV Laser DEW systems optimised for Counter-Rocket, Artillery, Mortar and UAS.

h. **Protect.** The Protect function for the FCT is provided by a CBRN Recce Sect in ARES variants.

i. **Sustain.**

- (1) The CSS/Logistics operating assumption is that the FCT is self-sufficient for energy and water and hold rations for 7 days.
- (2) Integral FCT logistics lift is thus primarily for ammunition (particularly special missile natures) and fuel.
- (3) The Repair and Maintenance element can repair and reconfigure UGVs and recover all close combat vehicles in the FCT. Elements will deploy forward in support of sub-FCT groupings.
- (4) The Med element is organised to provide CASEVAC, forward med support to sub-FCT groupings and a triage facility for the FCT, from two locations.

[8] If unmanned cbt engr systems, including Autonomous Assault Bridges and Autonomous Breaching Vehicles (as well as generic UGV transporting stores and engineer specialist equipment) are in service by 2029 then they will also be controlled by the Comd and Recce Element.

HOW THE FCT(H)29 OPERATES AND FIGHTS

FORCE DESIGN.
The FCT(H)29 is a cross-domain capable manoeuvre organisation purposely designed to move away from current systemic ideas such as mass, multi-mission units and a fixed span of control. Heavily enabled and supplemented by RAS, facilitated by a trusted and pervasive all-informed network providing shared SIE, with its own integral cross-domain fires, the ability to reconnoitre and conduct ISR in depth and breadth and permanently grouped with a combined-arms capability the FCT(H) is specifically designed to defeat threat ground manoeuvre formations in high-intensity combat environments. Mobility, firepower and reduced sustainment requirements allow the FCT(H) to deploy configured for combat and rapidly transition to offensive operations with precision cross-domain effects and tempo that threat formations and units cannot match. The FCT(H) also moves away from traditional personnel manning constructs. With approximately 650 personnel and a smaller organisational footprint, the FCT(H)29 can achieve the same offensive lethality and combat capability as an AI BG of circa 1200.

ROLE.
The FCT(H)'s role is to employ cross-domain manoeuvre to dislocate or destroy enemy forces, neutralise enemy attacks, engage in close combat, seize terrain and control land areas including populations and resources. The FCT(H) operates dispersed to prevent effective targeting by likely adversary massed UAS/drone and indirect fire capabilities, consolidating only at decisive locations and times to gain positions of relative advantage against the enemy.

FCT(H) GROUND MANOEUVRE.
The FCT is a permanent combined-arms grouping and its relatively large and capable manoeuvre sub-units offer the FCT Commander multiple options for task-organising. It is also quite possible that command status and battlespace management will differ radically from today. The FCT(H) is optimised to conduct:

a. Coordinated combined-arms offensive tactical actions, at tempo, employing the full range of effects across domains[9] to achieve tactical goals[10].

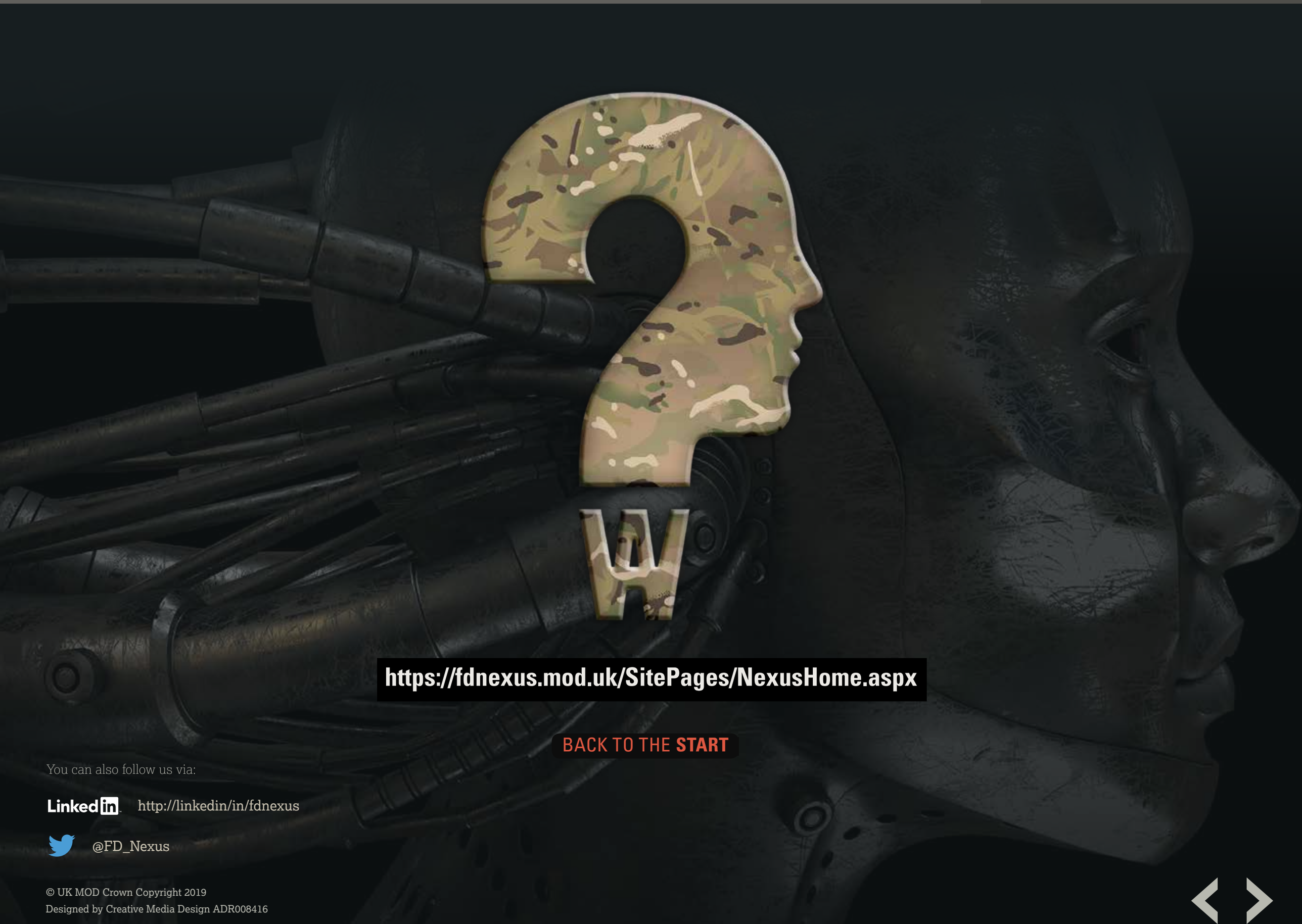
b. Wide area security employing force protection enablers and leveraging emerging information manoeuvre techniques.

c. Mobile defensive operations designed to hold ground, facilitate transitional phases and canalise the enemy into killing areas of our choosing.

d. Military activity in conjunction with an orchestrated whole force approach.

e. Deployment direct from an APOD, SPOD or self-deploying into an austere operational area with minimal reception, staging, integration and onward movement requirements.

[9] 'Domains' is used in the same context as US Multi-Domain Operations.
[10] Principally to dislocate, defeat or destroy enemy forces and/or seize and secure terrain.



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