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Artillery and Warfare 1945-2025

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ABSTRACT

For millennia battles were essentially affairs of linear encounter. From the 14th Century to the 20th Century, artillery generally fired directly in the two dimensional plane, limiting potential effects. The development of indirect fire changed this two-dimensional model. Warfare became not so much a matter of linear encounter as one of engagements across and throughout an area; and artillery dominated land operations in both the First and Second World Wars as a result.

Firepower was subsequently often applied in even greater weights, but its effects were frequently excessive, and high-value targets proved elusive. During the Cold War in Europe, the importance of field artillery waned relative to other arms. Artillery could only regain its utility by acquiring the highest-value targets and engaging them effectively with the appropriate degree of force in time and space – true precision, as opposed to mere accuracy at a point. Improvements in target acquisition and accuracy will enable land systems once more to engage targets effectively throughout the battlespace, with implications for warfare analogous to those precipitated by the introduction of indirect fire a century ago.

Land operations will become increasingly three-dimensional and Joint. The effects of fire will increasingly be applied in, not merely via, the third dimension, since targets themselves will increasingly be located, not just on the area of a battlefield, but in the volume of three-dimensional battlespace, with values often determined by considerations of the fourth dimension, time. Fire, lethal and non-lethal, will also be targeted in other less tangible dimensions such as cyber-space; and new types of ‘virtual counterfire’ will also emerge in the forms of legal and moral restraint. All will be viewed through the lens of perceptions.

The burgeoning of firepower from all sources now becomes the spur for changes in the relationship between the land and air components, mindful of those novel factors that will increasingly inhibit the application of that firepower.

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GLOSSARY

Adjust An observer adjusts fire onto a target by ordering corrections of aim to the guns.

Air Interdiction Air operations designed to destroy, isolate, neutralize or delay the enemy's military potential, before it can be brought to bear effectively against friendly forces, conducted at such a distance from friendly forces that detailed integration of each air mission with their fire and movement is not required. (Contrast *Close Air Support*).

Ammunition A device charged with explosives, propellants, pyrotechnics, initiating compounds or nuclear/biological/chemical material, for use in connection with offence or defence, including demolitions.

Assault Gun A form of tracked self-propelled gun, with a gun of larger calibre than normally found on a tank. The traverse of the gun is limited to a narrow forward arc, and the vehicle carries heavier frontal armour than found in a SP field gun designed primarily for indirect fire. The assault gun's role is usually to accompany tanks and infantry in the assault and to suppress the enemy's defences, usually with direct fire.

Assembly Area An area in which a command is assembled, preparatory to further action.

Battlefield Air Interdiction (BAI) Air action against hostile surface targets, which are in a position directly to affect forces, and which requires joint planning and co-ordination. While BAI missions require co-ordination in joint planning, they may not require continuous co-ordination during the execution stage.

Calibre The diameter of the inside of a barrel.

Cannon A term used formerly to describe a field or siege gun. Now commonly used to refer to any barrelled weapon other than a mortar or small arm.

Close Air Support (CAS) Air action against hostile targets which are in close proximity to friendly forces, and which requires detailed integration of each air mission with the fire and movement of those forces.

Close Support The action of the supporting force, against targets or objectives, which are sufficiently near the supported force to require detailed integration or co-ordination of the supporting action, with the fire, movement, or other actions, of the supported force.

Command Authority granted a commander to assign missions or tasks to subordinates, to deploy units, to re-assign forces, and to retain or delegate operational and/or tactical control.

Concentration Area An area where troops are brought together, briefed, rehearsed, administered, and prepared for battle.

Control The detailed, and usually local, direction of the control of movement, manoeuvres or fire necessary to accomplish missions or tasks assigned.

Counter Attack Attack by part, or all of a defending force, on an enemy attacking force for specific purposes, such as gaining lost ground or cutting off and destroying enemy advancing units, and with the general objective of denying to the enemy the attainment of his purpose in attacking.

Counter Battery Fire Fire delivered for the purpose of destroying or neutralizing indirect fire weapons systems.

Counter Mobility Denying the enemy mobility by obstacles or fire.

Counter Penetration Action to counter enemy penetration of a defended area.

Counter Stroke A counter-attack at formation level, with the specific aim of destroying enemy forces which are on the move or have temporarily halted.

Dead Ground An area within the maximum range of a weapon, radar or observer, which cannot be covered by fire or observation from a particular position because of intervening obstacles, the nature of the ground, the characteristics of the trajectory, or the limitations of the pointing capability of the weapon.

Deception Measures designed to mislead the enemy to induce him to react in a manner prejudicial to his interests.

Defence

Active Defence Similar to *Mobile Defence*.

Main Defensive Area Area containing firmly held positions, obstacles and reserves designed to destroy the enemy's main attacking force.

Positional Defence Strong, mainly static, defence where terrain can be held by well-prepared and mutually supported positions, protected by obstacles and supported by reserves.

Mobile Defence A means of defeating an attacking enemy as he forces his way into and through a framework of well sited and prepared positions with mobile reserves operating between them. First coined by the German Army in 1917, referring to enemy deep penetrations destroyed by counter-attack. More recently, emphasis has been placed on the defeat of enemy penetrations in prepared areas by mobile forces.

Defence in Depth Siting of mutually supporting defensive positions designed so absorb and progressively weaken an attack, to prevent initial observation of the whole position by the enemy, and to allow the commander to manoeuvre his reserve.

Defensive Fire (DF) Fire delivered by supporting units to assist and protect a unit in a defensive action.

Defilade To shield from enemy fire or observation by use of natural or artificial obstacles, usually with the purpose of engaging an enemy in the flank (with enfilade fire).

Depth Fire The engagement of targets beyond the contact zone, for example headquarters, artillery, logistics and reserves.

Desant A force placed in the enemy's rear.

Direct Fire Fire directed at a target which is visible to the aimer.

Direct Support (DS) British artillery placed in direct support of a formation or unit provides an artillery commander, observers and communications to that formation or unit.

Economy of Force The optimum use of type and quantity of arms to achieve an objective with the minimum casualties and wasted effort.

Electronic Silence The deliberate prohibition of electronic radiation, normally applied for a stated period, to specific equipments or frequency bands.

Electronic Warfare (EW) Military action involving the use of electromagnetic energy to determine, exploit, reduce or prevent hostile use of the electromagnetic spectrum; and action to retain its effective use by friendly forces.

Encirclement Envelopment from both flanks simultaneously.

Enfilade Fire Fire striking the flank of the target, usually from a defiladed position.

Exploitation The taking of full advantage of success and following up of initial gains.

Fire Support Coordination Line (FSCL) A line established by the ground force commander to ensure coordination of fire which is not under his control, but which may affect operations which are.

Forward Edge of the Battle Area (FEBA) The foremost limits of a series of areas in which ground combat units are deployed, excluding the areas in which the covering or screening forces are operating, designed to co-ordinate fire support, the positioning of forces or the manoeuvre units.

Fire Mobility The flexible switching of fire from one target to another across a front and in depth.

Forward Line of Own Troops (FLOT) A line which indicates the most forward position of friendly forces in any kind of military operation at a specific time.

Final Protective Fire (FPF) An immediately available pre-arranged barrier of fire designed to impede enemy movement across defended lines.

Forming-Up Place (FUP) The last position occupied by the assaulting echelon before crossing the Start Line or Line of Departure.

Forward Slope Any slope which descends towards the enemy.

General Support Artillery British artillery controlled at divisional or corps levels.

Gun Since the end of the 19th Century, a weapon in which projectile and charge are loaded in one piece, and which fires at high muzzle-velocity in flat trajectories. The term is now commonly used to refer to any barrelled artillery equipment.

Gun-Howitzer An artillery weapon in which projectile and charge can be loaded separately, as with a howitzer, but which can also fire at high muzzle-velocities and with low trajectories.

Harassing Fire Fire designed to disturb enemy troops, to curtail movement by threat of losses, to lower morale.

H Hour The specific time on D-Day at which hostilities commence, or, in a planned operation, at which operations commence. In World War Two this was known as Zero Hour.

Howitzer An artillery weapon in which the projectile and charge are loaded separately, allowing the size of the charge to be varied according to the range and type of the target, and which can be fired in the high angle.

Indirect Fire Fire delivered at a target which cannot be seen by the aimer.

Limber Originally a wheeled carriage which can be attached to the trail of a gun and is usually used for carrying ammunition or the gun detachment. In modern times the limber is usually a separate vehicle.

Line of Departure The line at which an operation begins.

Mil One mil is $1/6400^{th}$ part of a circle used for aiming and survey. One mil subtends one metre at one kilometre.

Minimum Force The least force of any type required to achieve an objective.

Mortar Generally a smooth-bored weapon firing finned bombs in the high angle.

Munitions Explosive ordnance, such as ammunition and bombs.

Mutual Support A condition which exists when positions are able to support each other by direct fire, thus preventing the enemy from mounting an attack against any one position without being subject to direct fire from one or more adjacent positions.

Muzzle Brake A device fitted to the muzzle of a barrel, which deflects the propellant gases following the projectile to develop a forward thrust, countering the recoil.

Neutralize To render the enemy's weapons temporarily ineffectual.

On-Call Target A planned target other than a scheduled target, on which fire is delivered when requested.

Operational Level Operations are conducted at theatre or campaign level, and are tactical actions with strategic implications.

Ordnance Originally a generic term for all military equipment and supplies, now usually restricted to artillery equipments.

Piece Any barrelled weapon. The term is being increasingly applied to any artillery firing or launching system.

Predicted Fire Indirect artillery fire without observation or adjustment. The firing data result from computations allowing for map co-ordinates of target and guns, meteorological conditions, the ballistic variables of the guns and other factors.

Projectile Anything fired from a gun, howitzer or launcher.

RAP See rocket-assisted projectile.

Recoilless Producing gases on firing which escape to the rear of the gun so as to produce minimal recoil force.

Rocket-Assisted Projectile (RAP) A projectile which increases its range by a rocket motor cutting in as it loses forward speed at the high point of its trajectory.

Registration The determination of correct firing data by adjusting the fall of shot onto a target.

Reverse Slope Any slope that descends away from the enemy.

Round A projectile, or a projectile and propelling charge.

Scheduled Target A target engaged at a predetermined time.

Shell A projectile with a hollow interior into which HE or some other cargo can be packed, and fired by a gun or howitzer.

Shot A solid artillery projectile used primarily against armour.

Start Line A line designated to co-ordinate the departure of an attack.

Survey The calculation of the precise co-ordinates of a firing unit so that an accurate relationship may be established between the positioned guns, observer and target.

Tank Destroyer A tracked SP anti-tank gun specifically designed to destroy tanks.

Time on Target (TOT) In order to achieve the maximum shock effect, artillery fire from various sources is often synchronized to fall on a particular target at a particular time. To achieve this, firing units are given a TOT. Because of their different distances from the target, the time at which firing units open fire may vary in order to achieve a common TOT.

Trail That part of a towed gun which extends from the axle to the ground to provide support and to counter the recoil.

LIST OF ABBREVIATIONS

AD	Air Defence
ADP	Automatic Data Processing
AFATDS	Army Field Artillery Tactical Data System
AFOR	Army Force
AGRA	Army Group Royal Artillery
AH	Attack Helicopter
ANGLICO	Air/Naval Gunfire Liaison Company
AO	Area of Operation
AP	1. Armour-piercing 2. Ammunition Point
APFSDS	Armour-Piercing Fin-Stabilized Discarding Sabot
ARRC	ACE (Allied Commander Europe) Rapid Reaction Force
ASP	Advanced Sound-Ranging Programme
ATGW	Anti-Tank Guided Weapon
BAI	Battlefield Air Interdiction
BC	Battery Commander
BDA	Battle Damage Assessment
BEF	British Expeditionary Force
C2	Command and Control
C3	Command, Control and Communications
C4	Command, Control, Communications and Computation
C4I	Command, Control, Communications, Computation and Intelligence
CAGRA	Commander Army Group Royal Artillery
CAS	Close Air Support
CB	Counter-Battery (Fire)
CCRA	Commander Corps Royal Artillery
CF	Counterfire
C/LU	Container/Launcher Units
CNAD	Conference of NATO Armaments Directors
CO	Commanding Officer
COIN	Counter-Insurgency
COMAFOR	Commander AFOR
COMKFOR	Commander KFOR
COMSFOR	Commander SFOR
CP	Command Post
CRA	Commander Royal Artillery
DAER	Daily Ammunition Expenditure Rate
DASC	Direct Air Support Center

DEW	Directed Energy Weapon
DF	1. Defensive Fire 2. Direct Fire
DPICM	Dual Purpose Improved Conventional Munition
DS	Direct Support
DSWS	Divisional Support Weapon System
DU	Depleted Uranium
DZ	Drop Zone
ECC	Effects Control Center
ET	Emerging Technology
EW	Electronic Warfare
FAC	Forward Air Controller
FASCAM	Family of Scatterable Mines
FB	Firebase
FCS	Future Combat System
FDC	Fire Direction Center
FEBA	Forward Edge of the Battle Area
FIBUA	Fighting in Built-Up Areas
FLOT	Forward Line of Own Troops
FOFA	Follow-on Forces Attack
FOO	Forward Observation Officer
FPF	Final Protective Fire
FSB	Fire Support Base
FSCC	Fire Support Co-ordination Center
FSCL	Fire Support Co-ordination Line
FSCM	Fire Support Co-ordination Measure
FSCOORD	Fire Support Coordination
FSE	Fire Support Element
FSR	Field Service Regulations
FSSB	Fire Support Surveillance Base
FUP	Forming-Up Place
GBAD	Ground-Based Air Defence
GPS	Global Positioning System
HE	High Explosive
HQ	Headquarters
ICM	Improved Conventional Munitions
IDF	Israeli Defence Forces
IFOR	Implementation Force
IPDS	Improved Positioning Determining System
IS	Internal Security
ISTAR	Intelligence Surveillance Target Acquisition and Reconnaissance

JASSM	Joint Air-to-Surface Stand-off Missile
JDAM	Joint Direct Attack Munition
JSTARS	Joint Surveillance and Target Attack Radar System
JTACMS	Joint Tactical Missile System
KFOR	Kosovo Force
KLA	Kosovo Liberation Army
LS	Landing Site
LOCASS	Low-Cost Autonomous Attack System
LZ	Landing Zone
MAD	Mutual Assured Destruction
MOUT	Military Operations on Urban Terrain
MBRL	Multiple-Barrel Rocket Launcher
MLRS	Multiple-Launch Rocket System
MRBM	Medium-Range Ballistic Missile
MTA	Military Technical Agreement
NMD	National Missile Defense
NATO	North Atlantic Treaty Organization
NFS	Naval Fire Support
NGS	Naval Gunfire support
NORTHAG	Northern Army Group (NATO)
NSFS	Naval Surface Fire Support
OAV	Organic Air Vehicle
OBUA	Operations in Built-Up Area
OMG	Operational Manoeuvre Group
OP	Observation Post
OPCOM	Operational Command
PGM	Precision-Guided Munition
RAC	Royal Armoured Corps
RAP	Rocket-Assisted Propulsion
RDF	Radio Direction Finding
RFA	Royal Field Artillery
RGA	Royal Garrison Artillery
RHA	Royal Horse Artillery
RISTA	Reconnaissance Intelligence Surveillance and Target Acquisition
ROE	Rules of Engagement
RPG	Rounds Per Gun
RPV	Remotely-Piloted Vehicle
SACEUR	Supreme Allied Commander Europe
SADARM	Search and Destroy Armor

SEAD	Suppression of Enemy Air Defence
SFOR	Stabilization Force
SL	Start Line
SP	Self-Propelled
SRARM	Short-Range Anti-Radiation Missile
STA	Surveillance and Target Acquisition
TBM	Theatre Ballistic Missile
TMD	Theatre Missile Defence
TNW	Tactical Nuclear Weapon
TOC	Tactical Operations Center
TOT	Time on Target
TRADOC	Training and Doctrine Command
UAV	1. Unmanned Aerial Vehicle 2. Uninhabited Aerial Vehicle
UCAV	Unmanned Combat Aerial Vehicle
UNPROFOR	United Nations Protection Force
UV	1. Unmanned Vehicle 2. Uninhabited Vehicle
WMD	Weapons of Mass Destruction
WP	Warsaw Pact
WTC	World Trade Center

ARTILLERY AND WARFARE 1945 - 2025

The thesis will not consider events after 31st December 2002.

CHAPTER 1: INTRODUCTION

“The object of artillery construction is the projection of a missile over long range, at a given target, to strike with powerful impact...”

“...When men concern themselves with the artillery...they will remain tranquil in their consciousness of security, while potential aggressors, observing their study of the subject will not attack. But every act of aggression, even the most feeble, will overwhelm the neglectful since preparations in their cities will not exist.”

Heron of Alexandria, *Belopoeica*.¹

1.1 THE CONTENTION

Pyrotechnic artillery was first deployed on the battlefield in the mid-14th Century, but its greatest impact over the next 300 years was in siege warfare. Its influence in the latter caused the drastic redesign of fortifications, and until the 18th Century, siege operations remained generally the most important factor in European warfare. The European gun fort, and the artillery that underwrote its firepower, also made possible the establishment of European global empires.²

By the early 18th Century, technological advances matched with tactical innovation and increasing professionalism had made artillery an important factor in field operations. By the end of the 18th Century, artillery had become an arm of equal standing to that of cavalry and the infantry. Artillery pieces could achieve greater range than infantry weapons, but like them their fire was direct, and in essence fired in a two-dimensional plane. If artillery had exploited its ability to fire further, by using a higher trajectory into the third dimension, its effects would have been drastically reduced. The combat range of artillery was thus severely restricted by the need to fire parallel to the ground. Short range limited the ability to concentrate fire. This could generally only be achieved by concentrating equipment itself, which was extremely difficult in mobile operations and rapidly changing circumstances. Ball was the most lethal projectile, although canister was highly effective at shorter ranges. Munitions such as shrapnel were of technical and conceptual merit, but of relatively little effect.

By the end of the 19th Century, further technological innovation had greatly enhanced artillery firepower. The introduction of sophisticated shells permitted effects to be achieved at greater ranges than could be achieved with solid shot; but while fire remained

direct, the advantage of artillery in mobile battles of linear encounter was in doubt. This was largely because there were also major improvements to the firepower of the infantry, which by the 1870s could often overmatch the range and effectiveness of field guns on a battlefield, and render the latter highly vulnerable.

Indirect firing techniques offered the tactical means to shelter artillery pieces from infantry fire; but came to have much greater significance. The development of indirect fire at the end of the 19th Century, and its practice in the early 20th Century, also promised to change the 'two-dimensional' model of warfare, characterized by linear encounter, which had prevailed for millennia. Not only could the effects of fire be applied and concentrated at long range, by firing in higher trajectories through the third dimension, but targets in range could be engaged simultaneously throughout the enemy's battlespace. Deep battle and its synchronization with the close battle became a crucial part of all military planning. This revolutionary change in warfare was only fully revealed in the First World War. Artillery became the dominant arm in warfare, and contrary to popular impression, probably played the dominant role in combat in the Second World War as well as the First, increasingly in concert with airpower.

Following the Second World War, firepower was applied in even greater weights in the Korean War and in the Vietnam War. It became apparent, however, that such firepower could have tactical, Operational and strategic penalties, especially if perceived to be disproportionate and too costly in collateral damage. The need for the more sophisticated application of fire became apparent.

In the Cold War confrontation between NATO and the Warsaw Pact, both sides planned for a battle between massive land and air forces in Northern Europe. These forces incorporated large quantities of artillery. The Soviets still believed that their vast artillery arm would play a critical role should war come, but it was clear on NATO's side at least that field artillery would not be the critical factor in success. This was largely because it lacked the ability to acquire moving armoured targets at long range and to engage them effectively even if it could. As a result, artillery became a relatively smaller part of NATO's land force, while the relative importance of tanks and fixed- and rotary-wing aircraft grew. Meanwhile in smaller wars, the effects of artillery firepower were seen to lack utility, often because the collateral damage proved unacceptable, and because high-value targets proved elusive.

In the past, deficiencies such as those suffered by NATO artillery had sometimes been overcome by increasing the weight of fire, rather as the Soviets still intended; but this was logistically dubious, and in NATO armies out of the question. The ability to prosecute deep attacks was therefore in doubt, and artillery could only regain its utility if it could acquire the highest-value targets and engage them effectively, which would mean with the appropriate degree of force in time and space - precision. This would depend upon improvements in target acquisition throughout battlespace, and munition accuracy, either with target designation or 'fire and forget' technology. Accuracy will cease, necessarily, to be a function of range when such technical advances have been achieved. The ability of

land systems to engage targets effectively throughout the battlespace will then be restored, with consequences for warfare analogous to those precipitated by the introduction of indirect fire one hundred years ago.

The need for precise, Joint fire to execute long-range precision attacks has been recognized, and investments in the systems to achieve this are maturing fast. Just as airpower joined with artillery in the 20th Century to provide fire at long range, so it will itself increasingly employ indirect systems, using unmanned platforms and stand-off munitions. As Joint effects merge or complement each other, so the arms and Services will themselves need to be restructured to accommodate these new requirements. Artillery is increasingly seen as but a component of Joint fire and a contributor to Joint effects; and its success in this relationship will be the test of its continuing utility after 650 years.

These developments will not be significant merely because they restore the effectiveness of fire in current models of warfare and its utility in an increasingly sensitive international environment. The effects of fire will increasingly be applied in, as well as through, the third dimension, as land operations themselves become more three-dimensional, no longer grounded in the two-dimensional plane. Fire, lethal and non-lethal, will also be targeted in other less tangible dimensions such as cyber-space. It will be judged not merely by its primary physical effects and the secondary cumulative and synergistic military effects that these may have. It will be applied increasingly for its 'third order' effects on the minds and will of commanders and political leaders, sometimes through leverage exerted on political opinion. The ability to apply such effects precisely in time and space will be expressions of the highest Operational art. Just as indirect fire began as a tactical means of protecting a gun itself, yet changed warfare at the Operational level, so the technical advances in target acquisition and accuracy in the 21st Century will have other and more important Operational and strategic consequences.

1.2 THE ORGANIZATION AND METHODOLOGY OF THIS THESIS

This thesis will start by laying out the elements of the 'artillery conundrum', most of which have been recurring, conscious or unconscious themes throughout the development of artillery over 650 years. It is the permutations of these themes which have given shape to the development of artillery theory and practice; and they remain the key to understanding their future. The thesis will then outline the development of artillery, from its use of direct fire in the two-dimensional plane in the 'age of the smoothbore', to its dominance of warfare in the first half of the 20th Century with indirect fire, applied throughout the battlespace via the third dimension. These arguments have been elaborated more fully elsewhere³, but will serve here to lay the foundations for the major part of this work.

The main body of the thesis begins with a study of artillery in the Cold War, when its power waned in relative terms, but without which the developments of artillery in the early 21st Century would probably not have been funded. The Cold War is divided into periods, analysing the Warsaw Pact (WP) and NATO in turn. This enables a better understanding

of how each was engaged in action and reaction to the other, and developments in artillery were a part of that process. This symbiotic relationship is also displayed in matrix form to aid clarity. The technical, tactical, organizational and doctrinal dynamics of the Cold War were the foundation of the artillery practice which followed, even though the strategic scenario was very different.

The thesis will then examine the operations since 1945 which ran concurrently with the Cold War. These highlighted the problems of applying firepower on a massive scale in the traditional manner. These operations encouraged the evolution of new approaches to new problems in a changing strategic, legal and ethical environment, and demonstrated the need to make the application of fire more sensitive to the complexity of international relations, and showed the opportunities that exist to apply artillery in more sophisticated ways in intangible dimensions. The thesis will then assess the future of the fire system in its Joint context and the emerging strategic environment.

1.3 SOURCES

It is hard to find works which present the principles of field artillery operations, tracing the continuities in theory and practice across the centuries, while relating these to emerging technology and future doctrine. On the other hand, the sum of this material is available, scattered in fragments across the literature, in books, journals and in cyberspace.

There are histories tracing the development of a particular nation's artillery over time; and there are books that examine the role of artillery in particular periods or wars. Unfortunately the few general studies tend to skimp on detail and analysis. For example, J. Norris's *Artillery*⁴ devotes only thirty or so pages to artillery since 1900. Very few have examined the role of artillery in the context of its relations to other arms - the artillery's 'ying' to their 'yang', in the totality of action in battlespace. Equally, there is little about the evolution of that battlespace and war in general seen from the perspective of the development of artillery, even though the latter could be judged to constitute the major innovation in land warfare since the 14th Century. R.E. Simpkin's works⁵ see the battlefield in terms of space and motion, with warfare as a kind of military 'physics'. This thesis is sympathetic to that view, but there are few who have shared it.

There are many books appealing to those interested in the development of artillery equipment and munitions, but these are generally technical reference books. Pre-eminent among these works are those of I.V. Hogg⁶. There is, however, very little that relates the technology to the practice of field artillery, describing the tactics that drove this technology or which resulted from its availability, in what has always been a symbiotic relationship.

There are surprisingly few works on the origins of guns and gunpowder, and those which mention them seem almost relieved to repeat the orthodox view of the day, if only one suspects because fresh investigation of the original material would require a daunting familiarity with numerous ancient languages. Thus for nearly ninety years H.W.L. Hime's

*The Origin of Artillery*⁷ seemed to be the definitive word on the chemistry and physics of early gunnery. His conclusions have now been challenged by the likes of B.S. Hall's *Weapons and Warfare in Renaissance Europe*⁸; and J.R. Partington's studies of primary sources in *A History of Greek Fire and Gunpowder*⁹ have caused a fundamental revision of the subject and, at least for now, seem to offer the definitive assessment. Technology aside, there is little on early tactics, of which we still know relatively little. J. Norris's recent *Early Gunpowder Artillery*¹⁰ focuses more on technology and historiography than the essentials of tactics; and even K. Chase's *Firearms. A Global History to 1700*¹¹ offers no thorough analysis of how artillery was handled in battle.

The author's lack of languages has hindered wider exploration of foreign artillery. To compensate for this, extensive use has been made of the work of those such as C.H. Donnelly, C.J. Dick and C.D. Bellamy with their Russian expertise, D.T. Zabecki with his German and G. Parker with his Spanish. The many articles in American and British journals prior to 1945 that were routinely translated from European journals have also been useful. There is, however, relatively little available on Asian artillery, despite its undoubted size and importance in various periods of history. The development of artillery technology and practice in Asia has been briefly described by Parker¹², but in the context of Europe's imperial expansion, and there remains little comprehensive material that describes the development of Oriental artillery technology, but above all practice.

Histories of warfare tend to be written from the point of view of the manoeuvre arms, with artillery seen predominantly as a supporting adjunct. This is puzzling given that artillery grew to become the dominant system in both world wars of the 20th Century. Memoirs have tended to be written by those who, despite being the primary victims of artillery, did not see it to be the major player in their drama. That said, many memoirs and biographies contain valuable insights into the practice of artillery at particular points in time, for example: R.P. Davis's biography of William Phillips in *Where a Man Can Go*¹³, describing his role as the British artillery commander in the American War of Independence; the thoughts of A.S. Frazer in, *Letters of Colonel Sir Augustus Frazer*¹⁴ relating to British artillery of the Napoleonic period; N. Fraser-Tytler's account of life in a field battery in France in the First World War in *Field Guns in France*¹⁵; H. Pabst's diary of his time as an artillery observer on Germany's Eastern Front in the Second World War, *The Outermost Frontier*¹⁶; and A Gillespie's *Desert Fire*¹⁷ covering the Gulf war of 1991.

Most nations produce general histories of their artillery arms, usually written by those arms themselves. Some provide a general narrative history for heritage purposes, but many are short on analysis, lacking exploration of the big themes and projections about the future. Britain's Royal Artillery Institution produced a number of volumes of history in the late 19th and early 20th Century, and more recently it has produced the first six volumes of its history of the First and Second World Wars¹⁸. These are generally exceptions to the above criticism, as is D.L. Dastrup's *King of Battle: A Branch History of the US Army's Field Artillery*¹⁹.

C. Duffy has produced numerous works, especially on the Russian, Prussian and Austro-Hungarian armies, which deal with field artillery in passing²⁰. However, there are very few works which seek primarily to explain how artillery tactics have evolved in the context of other developments in warfare. A number offer historical 'snap-shots' of artillery tactics over a limited period. B.P. Hughes's *Open Fire*²¹ and *Firepower*²² have considered how artillery was handled in battle in the 18th and 19th Centuries. The two rather dated, standard works on the role played by artillery in the US Civil War are VanLoan Naisawald's *Grape and Canister*²³ and J.C. Wise's *The Long Arm of Lee*²⁴, which take Federal and Confederate viewpoints respectively. Books such as C. Johnson and R.C. Anderson's *Artillery Hell*²⁵ describe specific battles, in this case Antietam. There are also many booklets available, normally from the US Park Service shops, on more esoteric aspects of these battles, for example R.L. Murray's monographs on artillery at Gettysburg²⁶.

Bruce Gudmundsson's *On Artillery*²⁷ provides a brief history of European and American artillery since the late 1860s and is unusual for following this history with a look at artillery's future development. The most admirable analysis of British artillery tactics during the First World War must be the series of articles written by A.F. Brooke between 1924 and 1927, not only for the concision of their expression but also for their original analysis – not surprisingly Alan Brooke went on to greater things²⁸. D.T. Zabecki's *Steel Wind*²⁹ offers unique insight into the development of German artillery during the First World War, based on his unrivalled knowledge of the German archives at Freiburg. M. Grotelueschen's *Doctrine under Fire: American Artillery Employment in World War One*³⁰, fills a much neglected void on the American side. Shelford Bidwell and Dominick Graham's *Fire-Power and Theories of War*³¹ is an excellent treatise on British artillery before and during the Second World War; but the most rigorous analysis of the latter is offered by A.L. Pemberton in *The Development of Artillery Tactics and Equipment*³².

The best survey of the employment of American artillery in the Vietnam War lies in D.E. Ott's series of articles in the *Field Artillery Journal*³³. Christopher Bellamy has written many articles on Soviet artillery during the Cold War; but it is his *Red God of War: Soviet Artillery and Rocket Forces*³⁴ that stands out and is unusual in its approach. He has provided a unique examination of Russian/Soviet artillery across time, an analysis matching technology, tactics and culture. In 1990 Robert Scales produced the excellent *Firepower in Limited Wars*³⁵. He is one of the few authors to link the tactics and technology of the past to the future. In the 1970s he wrote a thesis on British artillery 1860-1914³⁶ and his book of 1990 continued this story. He has complemented these works with numerous articles in journals relating artillery practice to the broader debates in defence today. He also wrote the acclaimed *Certain Victory*³⁷ which gives due credit to the role of field artillery in a broader analysis of the Gulf War of 1991.

Very few books have offered original contributions to the debate. That is probably because the physical size of those contributions have not warranted books, and because books can lack the immediacy of the journal and the short 'action-reaction cycle' of the doctrinal debate. Hence publications such as the UK's *Journal of the Royal Artillery* and

the *Journal of the Royal United Service Institute*, and the US Army's *Field Artillery Journal* and *Military Review*, have been the 'forum for debate' on military history, innovation, and lessons learned. Essay competitions have often provided the medium for innovative thinking, allowing officers of all ranks to join the debate.

The trade and defence journals such as *Jane's International Defense Review*, *Jane's Defence Weekly*, *Defense News* and *Armed Forces Journal International* have led the way in describing technical innovation and offering a rapid digest of lessons learned in contemporary conflicts. R.B. Pengelley and C.F. Foss have been unrivalled in the value of their work reporting and recording current technology and tactics. Of late, the internet has become a valuable source of detail on current events and topical comment on, for example, conflict in the Middle East. The *Jerusalem Post*, *The Washington Post* and *The New York Times*, all on-line, have been important sources. Equally, the *Albawaba* site has been of interest, but along with the many, perhaps most, sites dealing with Middle Eastern or Balkan politics it is not always easy to assess the reliability of the information offered.

The cutting edge of ideas in the practice of artillery has seldom been found in official documents. These documents generally reflect decisions taken after the debate has been settled elsewhere, either in the field during operations, or in the professional or trade journals. Refreshingly, over the last hundred years the debate has often been led by relatively junior officers, perhaps because they have the inclination to embrace change, or because they have the first-hand practical experience of recent operations that many of their superiors have lacked. For this reason, those publications are of necessity the primary sources for this thesis, and long may this argument prove valid. It is the absence of general and key texts covering the subject that in part prompted this thesis.

1.4 THE CRITICAL ISSUES

The height of achievement in the application of firepower throughout history has been to create a chosen effect, on a selected target, at the decisive time and place, at optimal cost – factors which collectively constitute 'precision' in its broadest sense. This effect should be directly related to the overall intention of the commander, and is most likely to require the close integration of the effects of fire with manoeuvre. The technical means of achieving this have improved greatly over the centuries, but the intellectual and practical challenges in delivering such an outcome remains essentially unaltered. Thirty years of experience have caused the author to conclude that there are certain key themes evident over the 650-year evolution of artillery. These are the enduring building-blocks of artillery theory and practice and their changing values and permutations have shaped the development of artillery. They constitute the agenda of the ongoing debate on the future of fires and their effects in military operations.

Reconciling Centralized Command with Decentralized Control

If fire is to support the commander's intent, men, equipment and ammunition must be positioned, cognizant of his assessment of the enemy and his own scheme of manoeuvre.

The chain of authority to fire, and to what purpose, must also be made clear. This can usually best be achieved if the command of artillery assets is held at high level. Circumstances in war change rapidly and decisions made at high level are unlikely to remain appropriate at lower levels for very long. The problem of how to reconcile the decentralization of tactical decision making and the control of fire at low level, with centralized command at high level, has remained an enduring challenge.³⁸

Delivering Communications to Match Command and Control (C2)

The demands on communications to mesh the imperatives for C2 at all levels are daunting. They have been especially acute for those wishing to practise indirect fire. The introduction of the radio had a profound effect on the solutions to this problem, but the provision of adequate, reliable and secure communications remains a critical concern. Protecting terrestrial and space-based communications from counterfire (CF) is a major challenge for the future. Designing communications architectures which balance autonomous operation with the imperative for human judgement in complex situations will be the key to speeding up decision making in the application of fire and its effects.

Concentrating Equipment to Concentrate Effects

Early artillery fire may have surprised those who had not encountered it before, but its physical effects were relatively minor. These could be increased by massing fire on particular targets, but limited range meant that this could only be done by massing the guns themselves in close proximity to the target. Massing equipment in order to concentrate effects can simultaneously create points of potential vulnerability. Devising the means to obviate this logic has been a constant theme over the centuries and remains topical.

Breaking the Connection Between the Massing of Guns, Their Proximity to a Target and Their Effects Upon It

When guns could only engage what could be seen from their own location, range and the ability to mass effects were limited by human sight on battlefields where visibility in any case tended to be poor. The development of indirect firing techniques at the end of the 19th Century permitted the engagement of unseen targets at whatever range was technically feasible; and it overturned the necessity to mass equipment geographically close to a target to achieve concentrations of effect upon it. Guns could be dispersed anywhere within range of their target.

Achieving the Mobility to be at the Right Place at the Right Time

Massing equipment carries high risks, not merely by making it a lucrative target; but because the mal-location of that mass might deprive manoeuvre arms of their symbiotic partner. Some tried to disperse equipment more widely to cover multiple eventualities, but they often paid a high price for dissipating their combat power. Others tried to

establish mobile reserves to 'hedge the bet' made in the original deployment. Sometimes this reserve was vital, but sometimes merely a waste of resources. The issue of how to provide coverage by fire throughout a battlefield, and whether this should be achieved by a discrete reserve, improved mobility about the battlefield or technical improvements in delivering fire itself, has remained a constant challenge. Fire mobility, the ability to switch fire rapidly around the battlefield, has often been able to compensate for equipment immobility, but the tactical mobility of artillery about the battlefield remains vital in achieving 'reach'.³⁹ Such debates will determine whether armies decide to buy traditional heavy, self-propelled (SP) equipment, lighter systems or develop entirely new solutions.

The Balance between Weight, Effects, Logistic Burdens and Timeliness

Timely effects could only be achieved if artillery could be moved about the battlefield in tactical concert with other arms, and share the latter's Operational and strategic mobility. Greater mobility usually requires less weight, and in the case of artillery, smaller guns with less range and ammunition and consequently less powerful effects at the end of a munition's journey. Greater physical effects have usually required larger or more sophisticated munitions, or greater range which offers the potential to concentrate more fire. This has usually reduced mobility and imposed a logistic penalty, unless accuracy has been improved at the same time, for greater accuracy often reduces the need for heavier munitions. The technical struggle to achieve greater range and timely terminal effects without adding to the logistic burden has therefore also been a constant theme in the development of artillery.

Matching Logistic Capability to the Combat Requirement

Artillery logistics includes the industrial capacity to produce the materiel of the system, and the ability to deliver this to the theatre, and to the field and the point of firing, for use in sufficient quantity, and in time, to achieve the desired effects. A poor logistic system may either not have the capacity to deliver this, or have excess stocks mal-deployed, at great economic cost, creating 'logistic drag' and other military penalties. Improvements in a supply system can reduce capital costs and deliver precisely what is required when it is required. Ideally, the marginal cost of each unit of supply actually consumed would be cheaper as a result; but even if this were not so, the total cost should be, or rather the total cost of achieving a given effect. The question remains, however: How much of what resources is required to achieve what effect? This answer can only ever be known with hindsight, and even then imperfectly. It has remained a lethal variable in the artillery equation and in normative military judgement. Should the quantity of resources required be a consequence of a doctrinal premise, or is a prevailing doctrine the consequence of a pragmatic logistic reality? Can an optimal operational synthesis ever be achieved when military assessments encounter political and economic pressures?

Increasing the Rate of Fire, Effects and Survivability

Increasing the rate of fire of artillery pieces has been a constant theme in the development of artillery technology, from Gustavus Adolphus' 'fixed ammunition' to the automatic loading of today. Effects on a target, or the same effects on more targets, can be increased by attacking with more weapon platforms; but effects can also be increased by a higher rate of fire from fewer equipments. An increased rate of fire using the same quantity of ammunition permits more rounds to be fired in a shorter time. This greater concentration in time may in itself increase the effects on a target and enhance the survivability of the firer.

Mass Can Compensate for Inaccuracy

A large object travelling at high speed which hits its target accurately is more likely to be effective than a small, slower, less accurate one. If the accuracy of the system is poor, or there are many targets to engage and they are closer, many smaller, slower objects fired in the general direction of the target may prove more effective. A single, well-aimed, accurate shot may 'overkill' what it hits, leaving others unscathed by this inefficient concentration of resources. If the location of a target is uncertain, or accuracy is inherently poor, one way of increasing the chances of a hit is to fire many rounds at the area in which the target is thought to be; but this massing of fire will probably require larger quantities of equipment and manpower. Even so, it may still be a relatively economic undertaking in terms of effects achieved. Fielding large quantities of equipment to generate sufficient fire to compensate for uncertain target location, or inherent system inaccuracy, has been an enduring theme in the history of artillery, as has the development of C2 to command and control its operation. Obviating this logic is an enduring aspiration.

Accuracy Can Compensate for Lack of Mass

It follows that a reduction in the quantity of equipment, and hence its logistic costs, and the more efficient use of what remains, can be achieved by improvements in target location and the accuracy of the overall system. Reducing the quantity of equipment, however, diminishes the redundancy that can absorb casualties. More accurate fire requires more precise and timely target data, uncorrupted communications and a delivery system that sends a munition close enough to the target to achieve its intended effect. In response, the enemy can try to disperse, or generate more targets than the fewer weapons firing fewer munitions can hit.

Accuracy as a Function of Range

The longer the range of a ballistic weapon, the greater its inherent inaccuracy. The consequences of this can be overcome by using a more powerful munition to increase its effects, but this greater weight results in other penalties. If a munition can be made more precise through terminal or other guidance, not only can the quantity of equipment and numbers of munitions be reduced to achieve a comparable effect, but so also can the weight of the munition itself. The precision munitions of the Information Age have

broken the necessary ballistic connection between accuracy and range, but perfecting and exploiting these remain a challenge.

Target Acquisition

Where is the target? Can it be located and tracked for timely engagement? Once attacked, should it be attacked again? How can the value of targets and their priority for the expenditure of resources be assessed comparatively? Staff branches and whole fields of technology have been developed to assist in making these judgements and are integral to the system of fires.

Identifying and Assessing the Effects of Artillery Fire

Artillery has always achieved both psychological and physical effects. The controversy about the relative efficacy of different munitions and the manner in which they should best be applied has been at the heart of artillery doctrine and technology throughout its development. Even where the effects are themselves evident, the military value of these in any given situation may be unclear. It is difficult to assign comparative values to destructive, suppressive and neutralizing effects, and to quantify which elements of the last two are physical and which psychological. Attempts to identify those effects which are militarily significant, to design munitions that achieve them and to assess whether after a given action they have indeed been achieved, have been the preoccupations of artillerymen for centuries. The judgement as to whether these effects are best achieved by artillery fire or by some other force lies at the heart of any Joint plan. Today, the effects created on perceptions are of unprecedented importance, but are even harder to assess.

Survival on the Battlefield: Force Protection

Artillery has always been vulnerable to the combat power of other arms and its enemy counterpart. As artillery became more important, so did its operations against the latter. Protecting artillery has called for active measures such as the cooperation of other arms and ensuring that artillery has sufficient range and effects to overmatch the threats against it. It has also required passive measures such as deception, armour, camouflage and advantageous siting, the latter being greatly facilitated by the development of indirect firing techniques.

Manning the System

Artillery developed from being a minor participant in hostilities to being the arm around which all others operated. At times, the manpower requirement was massive, in keeping with the masses of assets deployed. At others it diminished, either as the importance of artillery was deemed to have waned, or as fewer artillerymen became more productive through improved technology or techniques.

Employability in all Conditions

The power of artillery has such utility that there are few environments in which commanders would not wish to use it. It has therefore had to develop the techniques applicable to operations in hot deserts, extreme cold, the jungle, mountainous country, on the littoral, in amphibious operations and in the ever-expanding urban areas of the world. The inherent problems have been salved but seldom solved.

Relevance in all Forms of Conflict

Artillery has always had to adapt itself to changes in the character of warfare and lesser forms of conflict. It achieved the transition from siege system to an arm capable of mobile operations in the field. It shifted from its primary focus on the close battle to an emphasis on the deep battle. It moved from a purely direct fire role to one based on indirect fire, yet with the advent of the tank, found itself once more the prime anti-tank direct fire system. It played its dominant role in high intensity world wars, and yet was also vital in smaller conflicts. More recently, it has proved its worth in operations short of war, whose intellectual complexity now defies terminological consensus.

The Maturing of Fire as a Function in Warfare

As artillery became more powerful, it came to be recognized as an arm of equal standing with those which manoeuvred, rather than merely existing as some tactical appendage to them.⁴⁰ The necessity for close cooperation between all arms to optimize fire and manoeuvre in accomplishing the commander's intent became axiomatic. Sometimes manoeuvre would play the major part in this, and sometimes fire. Until the end of the 19th Century, and except in siege warfare, manoeuvre was generally the more important. Throughout the 20th Century, the effects of fire were the dominant feature of the battlefield. It also came to be recognized that the effects of fire could be decisive in their own right. Today, the debate has too often been premised on the false assumption that the application of fire is an inherently attritional activity, while manoeuvre is somehow not. Historically, manoeuvre has often been highly attritional, while fire has exerted 'leverage', and usually inflicted desirable attrition on the enemy and protected friendly forces. It is also unfortunate that the debate has often been cast in terms of the two functions being at odds with each other. Where this has been so in the past, the military failures have often been spectacular. The challenge today is to optimize the synergy between them.

Delineations of Joint Fire

Airpower has contributed to Joint fire for nearly a century, but the 'division of labour' between the air and land components over which should produce what effects where and when, has often been contentious. The air component may wish to reinvent traditional activities such as Close Air Support (CAS) by manned aircraft, by flying at higher altitudes; but equally, novel types of aircraft such as UAVs may usurp such activities at all altitudes; and some surface-to-surface systems may prove more effective in roles

previously the preserve of aircraft. It will become increasingly hard to distinguish between air component platforms and munitions, and those of the land component. Equally, it will be harder to distinguish between what is a munition and what is a firing platform.

Blurring of Roles in Expanding Battlespace

The introduction of indirect fire vastly expanded the battlespace in which field artillery could achieve effects, at about the same time that its direct role against tanks became enhanced. Shortly after that, with the rise of air warfare, the need for direct firing artillery in an AD role created a new arm operating in the previously undisputed third dimension of battlespace. It seems likely that the distinction between remote platforms firing directly, and other platforms firing indirectly, will become blurred; and all will seek effects in the three physical dimensions of battlespace. This phenomenon will become as important in the land component's considerations of fire and manoeuvre as it was formerly in two dimensions. Targets will lie in three dimensions and many will themselves be lethal munitions. CB/CF will increasingly be against the munition in flight. The distinction between AD and CB/CF will become blurred, and both will be seen as critical forms of active force protection.

New Effects and Forms of Counterfire

At the same time, new forms of lethal and non-lethal fire will be used to create effects in other dimensions of battlespace, in the electro-magnetic spectrum, in cyberspace, and in the human mind – the realm of perceptions. It is not just perceptions in the mind of those on the battlefield and in command that are important. The most important perceptions may be those of an increasingly globalized international opinion, in an environment where legal, political and moral factors are not constants. In turn, these effects will be matched by CF of the same ilk. The evolution of novel forms of fire in these uncharted dimensions will echo the transformations of earlier times.

Will Artillery Survive as a Distinguishable Arm?

Such developments may question the notion of surface-to-surface artillery as a distinct arm. Why should it require a specially trained arm to fire indirect weapons, when others may also use stand-off weapons, and target acquisition may be achieved and fire ordered by a centralized command? If Gunners are merely weapon platform servers, what distinguishes them from other arms serving sophisticated weapons? A remotely fired 'box' of precise indirect munitions may require the same skills to operate as a 'box' of directly fired munitions. All arms may be equipped with short-range direct fire as well as longer-range indirect fire munitions. The debate over how and at what level these might be commanded, and their fire coordinated, will very likely mirror the debates over the C2 of artillery fire over the last three hundred years.

Will Fire from the Air Replace Surface-to-Surface Fire?

If, in future, the effects of fire can be better delivered from the air, is the role of artillery's surface-to-surface fire a declining one? Is there a fundamental change taking place in the way that wars will be fought, or are such thoughts the product of limited experiences that do not adequately reflect the broader trends that will endure?

A Doctrine for Fires

As the complexity of the artillery system within the Joint system of fires has grown, so understanding its precepts and mastering its practice has been vital to success. The need to develop these conceptually, to write a doctrine, to establish a method for the systematic introduction of new equipment, to create a training regime for personnel and to educate leaders has caused the artillery of many armies to take the lead in the fields of professionalism and the education of officers.

ENDNOTES

- ¹ E.W. Marsden, *Greek and Roman Artillery. Technical Treatises*, Clarendon Press (Oxford, 1971), p.19. Heron probably wrote on artillery in the late 2nd Century AD.
- ² Parker (1996) and Cipolla (1996). By the end of the 18th Century, nine European nations maintained forty-three forts on the West African coast.
- ³ Bailey (1996).
- ⁴ Norris (2000).
- ⁵ For example, Simpkin (1985).
- ⁶ For example, Hogg (1987).
- ⁷ Hime (1915).
- ⁸ Hall (1997).
- ⁹ Partington (1999).
- ¹⁰ Norris (2003).
- ¹¹ Chase (2003).
- ¹² Parker (1996).
- ¹³ Davis (1999).
- ¹⁴ Frazer (2001).
- ¹⁵ Fraser-Tytler (1995).
- ¹⁶ Pabst (1986).
- ¹⁷ Gillespie (2001).
- ¹⁸ *History of the Royal Artillery*, Royal Artillery Institution, (Woolwich 1978-2003).
- ¹⁹ Dastrup (1992).
- ²⁰ For example Duffy (1981) and Duffy (1996).
- ²¹ Hughes (1983).
- ²² Hughes (1997).
- ²³ VanLoan Naisawald (1999).
- ²⁴ Wise (1991).
- ²⁵ Johnson and Anderson (1995).
- ²⁶ For example Murray (2000).
- ²⁷ Gudmundsson (1993).
- ²⁸ For example, Brooke (1924).
- ²⁹ Zabecki (1994).
- ³⁰ Grotelueschen (2001).
- ³¹ Bidwell and Graham (1982).
- ³² Pemberton (1950).
- ³³ For example Ott (1975).

³⁴ Bellamy (1986).

³⁵ Scales (1990).

³⁶ Scales (1976).

³⁷ Scales (1993).

³⁸ Decentralized control at low level may be exercised by an observer or some other sensor ordering fire. The sensor itself may be commanded at high level in terms of its mission and authority to initiate fire, but it may achieve low-level control through its direct sensing of the target and its direct communication with the firing platform.

³⁹ 'Reach' is the sum of munition range and equipment mobility at any given time and place.

⁴⁰ Manoeuvre is sometimes understood in modern doctrine as tactical movement supported by fire. In much military writing, however, it is often taken to mean tactical movement. In the British Army's doctrine, the 'Manoeuvrist Approach' incorporates a bundle of notions reflecting 'The Indirect Approach', so-called 'Manoeuvre Warfare' and 'Auftragstaktik'.

CHAPTER 2: HISTORICAL PERSPECTIVE

2.1 THE AGE OF THE SMOOTHBORE

Introduction

The Age of the Smoothbore, from the mid-14th to the late 19th Century was the age of two-dimensional linearity in warfare. It saw artillery develop from being a military novelty of limited effect, to becoming the key system in siege warfare, the most important operation of the day. It soon became an effective battlefield system and eventually emerged as an arm of equal status to the infantry and cavalry.

The Principles of Gunnery and Command and Control

Artillery was most likely to be effective in the early stages of battle, because once battle was joined and the situation had changed, it was generally too heavy to be repositioned. An overall commander, or the artillery commander, could select initial positions and state the priority of targets, but after that he would usually be unable to control events except by messenger. Subsequent movement and fire control in the heat of battle would, by default, generally fall to the commanders of individual guns or groups of them.

Lack of foresight in the initial deployment of guns could mean that they might play little part in events, while luck, or the prescience of a great commander in placing them within his scheme of battle, might make them decisive. When a commander was able to intervene to reposition his field artillery at a crucial moment in a battle, the consequences could be profound. Commanders such as the Dukes of Marlborough and Wellington, and Napoleon Bonaparte had an uncanny ability to anticipate the flow of a battle and position their artillery advantageously from the outset; but this was a rare skill noted by contemporaries as a key element in generalship. Skill in positioning guns was not merely a question of space, timing was also critical; and some of the blame for Napoleon's defeat at Waterloo (18th June 1815) lay in his delays in positioning his artillery.¹

Well-placed artillery could inflict terrible damage. At the Battle of Gross-Jaegersdorf (30th July 1757), the well-sited and resolute battery of the Russian Major Tyutchev turned the battle. At the Battle of Minden (1st August 1759), Ferdinand of Brunswick commanding the Anglo-Hanoverian Army ordered Macbean's battery of heavy 12pdrs forward to concealed positions on his right flank, enfilading the French cavalry which it engaged for twenty minutes at pistol range, causing carnage and the French Army to withdraw in confusion. It has been estimated that the battery fired 40,000 bullets in case-shot at the French.² On St Lucia in 1778, well-positioned British artillery was able to hit French columns in the flank as they formed for the attack, advanced and then retreated. At Malvern Hill (1st July 1862), the most significant determinant of the Union's victory was the accomplished siting of its artillery and the poor positioning of the Confederacy's.

To obviate the risk of mal-deployment before battle had even begun, there was a strong case for decentralizing the deployment of artillery, dispersing individual or pairs of guns amongst the infantry, to ensure that the latter would always have some artillery support, albeit forfeiting the possibility of concentrating fire in the process.

Artillery occupied a comparatively large space on the battlefield, usually a line of about one hundred metres for six guns, with space behind that for their logistic support of horses and ammunition.³ Guns were best positioned on commanding ground, permitting them to maximize their range, but range was not the most important consideration in positioning.⁴

Optimal fire was usually of flat trajectory. Frederick the Great frequently cautioned against placing artillery on hills. If guns were positioned too high above the target, falling rounds would plough into the ground, particularly in wet conditions, hitting merely that particular point with excessive 'overkill'. It was also difficult for guns on hills to engage infantry advancing towards them across both convex and concave terrain. The ideal was a position on a hill with a height of between five and six percent of the engagement range, or a gradient of two to three degrees. If a steeper position had to be defended, it was best done by infantry, unless guns could be so positioned as to rake the ranks of infantry from a flank as they ascended the slope. If guns were sited too far below the target, their range would be reduced, and it was likely that many rounds would pass harmlessly over the enemy's head. Wellington was noted for the trouble he took in defence to position his infantry, wherever possible, on a reverse slope above enemy artillery, ensuring that as many balls as possible flew over them.

The greatest advantage of a flat trajectory was that rounds could be made to bounce off the ground in a series of ricochets. Such fire was especially effective against an infantry phalanx, although it did not become common practice in field operations until the late 18th Century.⁵ Once the enemy had closed to about 100 paces they would switch to canister fire.⁶ Another advantage of ricochet fire was that infantry were more unsettled by it than by direct fire. At the end of the 18th Century, the Prussian reformer Scharnhorst tested the effectiveness of ricochet versus direct fire and found that, in the cases of 6pdrs and 12pdrs, at least three times as many hits were scored by ricochet at 1,000m, and at greater ranges its advantages were even more pronounced.⁷

Because shots fired at anything but zero elevation, were less likely to ricochet, but rather to plough into the ground instead, artillery seldom fired over the heads of friendly troops, who would also have been in danger from erratic fire. Howitzers could overcome uneven terrain by firing in the high angle, and thus threaten troops in reserve, but their shells, exploding above a point, were relatively ineffective compared to flat-trajectory roundshot or a modern detonating shell. They were consequently seldom deployed in large numbers.

It was not merely the 'geometry' of the trajectory of each piece that was important, but the way that the fire of groups of guns was coordinated and directed, relative to the shape and position of the enemy. Commanders such as Frederick the Great tried to place their guns to fire obliquely, covering enemy approaches by crossing fire, rather than merely

massing them at a single location in the path of the enemy. In the linear warfare of the day, this was the means by which direct fire could be concentrated, whilst maintaining a wide distribution of guns across a front.⁸

Most smoothbore ammunition was roundshot and not explosive, and the area of its greatest lethality was therefore not at the point of termination, but along the narrow flight path to it. Canister represented an attempt to widen that lethal flight path at the expense of range; and shrapnel and shells were an attempt to increase the effect at the final point of the trajectory, accepting the loss of effect along the path to it. Nevertheless, roundshot remained the most commonly fired munition of the smoothbore era because it was the most damaging, especially when delivered along a heavily populated virtual 'tunnel' of probable destruction. The 'tunnel' was the space through which a ball might be expected to fly, given its inherent inaccuracy.

A number of guns firing in the same direction would create another wider 'tunnel' of fire. The more balls flying down the same 'tunnel', the greater the concentration of fire, but this would only be effective if the target also lay along the line of that 'tunnel'. A ball could scythe down many men in its path through this 'tunnel'; and when artillery was massed to achieve such destructive geometry, the effects could be gruesome. If the enemy infantry line were at right angles to the 'tunnel', then fire would be inefficiently applied, achieving overkill on a section of the target, rather like repeatedly hitting but one point on an area target with indirect fire.

The skill in concentrating flat-trajectory fire lay in deploying artillery so that the 'tunnel' ran parallel to, and inside, an enemy phalanx. Hence crossfire, raking lines of infantry from their flanks, was the height of achievement; but that achievement depended upon the commander's tactical skill in the initial deployment of his guns, and the ability of the artillery to integrate its operations with the scheme of manoeuvre of the infantry on whom it relied for mutual support.⁹

Ideally, guns would not be deployed in the path of the manoeuvre of other arms in their own force. Neither would they be placed directly behind bodies of friendly troops on level ground, since these would be at hazard from their flat trajectory direct fire and mask the guns themselves. On the other hand, artillery was sometimes deliberately masked by a body of cavalry, which would move out of the way just before firing in order to surprise the enemy. If placed out of sight, behind the front line, guns might be safe except from howitzers or guns firing at extreme range; but this would very likely also place them out of range of their own targets. The forward deployment of guns was the norm although space for this was usually limited, and opportunities to mass a large battery infrequent. Guns were consequently often squeezed into spaces between the infantry, or deployed out in front of them.

Once the infantry advanced, the guns would have either to cease firing or to redeploy; and such difficulties were an argument for dispersing the deployment of artillery from the outset. Consequently, by the middle of the 18th Century, most armies had light guns

assigned to each infantry battalion to ensure that they did not become detached from at least some fire support. Against this, there was the case for concentrating the guns in large batteries for maximum and decisive effect, rather than dissipating them amongst troops who might be employed sequentially, and from an artillery point of view inefficiently, or perhaps never come into action at all. These arguments were hard to reconcile and the debate over the merits of 'infantry guns', the centralization or decentralization of artillery, and the command and control arrangements to meet these options remained the core controversies of artillery tactics into the 20th Century.

The pros and cons in the debate over artillery command have altered over the years as each of the factors, the components of the overall artillery 'system', have evolved: The mobility of artillery relative to the pace of other actors in battle; the ability of commanders to control the movement and fire of guns, given the communications of the day; and the improvements in target acquisition, range, accuracy, rate of fire, survivability, types of munitions and their terminal effect. Each one of these elements of the system has constituted but a single shifting tile in the disrupted kaleidoscope of evolving military philosophy and doctrine; and any 'turn', or change in the value of a single 'tile' has resulted in a new calculus and pattern.

2.2 WARFARE OF THE EARLY 'INDUSTRIAL AGE' 1866-1914

By 1866, the effectiveness of field artillery relative to other arms on the two-dimensional, linear battlefield was in decline. It was not able to achieve greater effects at greater ranges than the arms it supported. Glimpses of new methods of concentrating effects using the third dimension were soon in evidence and these became the foundation of artillery's dominance in two world wars.

The half century before the First World War witnessed two impressive achievements in the development of artillery, one technical and the other essentially conceptual. Together they changed the way of war. The first was the marked increase in the rate of fire and in the range of artillery. This was made possible by the maturing of the technologies of rifling, breeches and recoil mechanisms, integrated in reliable field artillery systems. The second was the notion that the effects of that fire could be delivered in an entirely different way, indirectly, enhancing the survivability of the guns and concentrating the effects of fire on targets which previously could not have been engaged.

These two developments ran parallel but, surprisingly, remained doctrinally unconnected for most of the period. The increased rate of fire was used, according to the doctrine of the day, to improve the close support of infantry in the assault, engaging the enemy at close quarters with direct fire, albeit at huge risk. The price of such tactics was revealed early in the Russo-Japanese War; and as a result, by its end the practice of indirect fire had become routine for both sides. The importance of this fundamental shift in military practice was well documented at the time, but the lessons proved unacceptable to Europe's armies; and as the First World War approached, direct fire at close range was the prevailing practice, whatever the manuals might recommend.

The Evolution of Indirect Fire

Indirect fire had been used in siege warfare for centuries; but its use on the battlefield was the most important innovation in artillery practice for over 500 years. Experiments with indirect fire on the battlefield were made by the Russians using howitzers as early as the 1750s, but major technical development was not undertaken until the last decades of the 19th Century. Although the principles of the system were by then already well understood, it was not until the First World War that its potential was realized and the products of the Industrial Revolution unleashed on the battlefield. Without indirect fire, the great artillery concentrations of the First World War, and of the Eastern Front in the Second World War, would not have been possible. The ability of the artillery to provide close support would have diminished in the face of growing infantry and armoured firepower, and the importance of artillery would have continued the decline which began with the introduction of powerful infantry rifles in the 1840s.

Prior to 1914, direct fire was generally concentrated by using Napoleonic masses of guns. Had the range of guns been greater, this massing would not have been so necessary; but the value of any increase in range was limited because, even with a telescopic sight, guns could not engage accurately beyond the range of an observer's eye. This optical range was also that which applied to the firing of the conoidal bullet and machine gun, which were introduced at a time when the new smokeless powder was exposing gunners to the enemy's view. If guns could be positioned in cover, smokeless powder would assist their concealment rather than compromise their position. A means was required to enable artillery to move back into cover, while producing accurate concentrations of fire.

The Russian siege of Plevna in 1878 proved extremely costly, and there seemed little way to attack troops in entrenched positions if supported only by direct-firing artillery. This stimulated the debate about the use of howitzers, shells and the indirect firing techniques they would require. These were fully described as early as 1882 by a Russian officer, G. Guk, in his *The Covered Fire of Field Artillery*. This discussed the role of the compass, aiming points, crest clearance and the passage of observers' corrections to guns.¹⁰

General von Hindersin, whose views on the lessons of the Franco-Prussian War were regarded as authoritative, held strong views against the technical developments that made indirect fire possible. He cautioned against the approach of the 'scientific caste' who wanted artillery to adopt hidden positions. Nevertheless, the Germans developed the concept of indirect fire; and in 1892 they were the first to produce an indirect laying instrument, the 'Richtflaeche', which was issued to all light guns along with a new regulation for its use. This noted that bold 'Napoleonic' tactics had been made obsolete by infantry firepower, and by 1894 indirect fire had become the preferred method rather than the exception in the German Army. It was subsequently adopted by the Russians.¹¹ In 1889, Prince Kraft zu Hohenlohe-Ingelfingen advocated the crest of a hill as the most suitable position for field artillery, but he went on to describe the benefits of cover if it could be found.¹²

The practice of indirect fire was widely discussed at the turn of the Century. In 1897 General Major Moritz Elder von Reichold noted the need to remain concealed to avoid CB fire and the consequent requirement to fire indirectly.¹³ General von Sauer was a pioneer of indirect fire. He identified howitzers and heavy guns as the means by which artillery could overcome the defensive power of the rifle, "To shake the enemy's infantry upon the point where the commander-in-chief has decided to breakthrough."¹⁴ The case for indirect fire found increasing support, and in 1900 the German artillery was issued with the 'goniometric' sight.

The British were aware of these devices and debated the methods and merits of indirect fire, but generally viewed it as an unsatisfactory German technique. The majority regarded a clear sight of the target as essential.¹⁵ Nevertheless, on 16th August 1891, Lord Wolseley observed an exercise of the British Army and noted the need for artillery to be concealed from its enemy, and the advantages of laying guns indirectly. Experiments were carried out on low-level exercises, but turning these into accepted general practice was more difficult in the face of fierce cultural opposition.¹⁶ Some British officers were therefore surprised to find that in the German Army, by whose experience in 1870 they believed their opposition to be vindicated, close, direct fire was rapidly losing favour.

Nevertheless, despite the evidence of the Russo-Japanese War, and a brief enthusiasm for indirect fire in its immediate aftermath, by 1914 it was far from general practice. The Italian observer, San Marzano, noted in 1907 that the Austro-Hungarian artillery habitually adopted mass-deployments in suicidally exposed positions. By 1908, with the introduction of the new QF 80mm gun, all its firing was from 'modern' defiladed positions; but this did not amount to the adoption of indirect fire as the primary method. Scepticism about new-fangled gunnery techniques was widespread, even within the artillery itself, which often remained ignorantly conservative.

The British realized during the Second Boer War that the ability to fire indirectly was often essential but probably unachievable. Rudimentary indirect fire systems were devised, whereby gunsights would be aligned with markers on crests in line with the target, and observers on the crest would then send instructions to adjust the fire.¹⁷ The home-made 'Gunners's Arc' of 1904 was later replaced by the German Goerz goniometric sight, which was issued in 1913 as the 'Number 7' dial sight.

In the British Army, the Royal Field Artillery (RFA) was renowned for its unscientific approach to gunnery, admiring intuition and subjective judgement, not calculation, when opening fire. The RFA did not practise temperature corrections, map shooting was virtually unknown, and communications were by visual signal, sometimes by short telephone line, but more usually by megaphone. By comparison, the Royal Garrison Artillery's (RGA) approach was relatively scientific. By 1914 it was firing from cover and laying guns on line with instruments on calculated data. It shot from maps and corrected for weather before firing. In May 1914, in a lecture at the Royal Artillery Institution (RAI), Captain Hill of the RGA was met with hoots of laughter by a largely RFA audience

when he said that the RFA would be making meteorological corrections within two months of the start of a war.¹⁸

In 1913, Major General Knox attacked the Secretary of State for War over the predicament of Britain's artillery: "...outranged by hostile gun and rifle, untrained to recognize friend from foe, innocent of the tactical requirement of a combined fire fight, does not the result spell murder?"¹⁹ The rhetorical question would be answered in less than a year. In the event, all European armies were broadly guilty in 1914 of neglecting the potential of indirect fire. It would largely be ignored until armies were shocked into using it by the harsh realities of 'Industrial' warfare.

The First World War witnessed a 'Military Revolution' in which the dominance of indirect artillery fire and deep battle were established.²⁰ This became the conscious orthodoxy of all major armies by 1917. That Revolution should have been the immediate consequence of the experience of the Russo-Japanese War; but although the basic components of that revolution were evident by 1905, and their implications noted by observers, there seemed to be little institutional awareness of them, of the scale or significance of their sum, let alone appropriate reforms. For military doctrine, 1905 was the false dawn of the 'Military Revolution' of 1917, as much as it was for the political and social revolutions in Russia that year.

2.3 THE FIRST WORLD WAR 1914-1918

By 1914, indirect fire, the means of engaging the enemy from the relative safety of covered ground, was understood but scarcely practised despite experience in Manchuria. What was not appreciated was that this method of tactical self-protection would also transform the effects that artillery could create and give it dominance over the battlefield. Neither was it envisaged that such artillery practice would be intimately linked with that of airpower in a three-dimensional network.

The pressures of combat during the First World War brought about the radical revision of artillery tactics and counter-measures, resulting in a fundamental and revolutionary change in the manner in which warfare was conducted. Preoccupation with rifle fire and the manoeuvre of infantry, gave way to a fixation on the firepower of artillery, machine guns, tanks and aircraft; but it was developments in indirect fire in particular that gave artillery its ascendancy over the infantryman and his rifle. The art of C2 was soon seen to lie in the way a commander marshalled and applied the effects of firepower, rather than in the way he deployed foot soldiers.

Warfare in 1914 was a linear affair, with prevailing doctrines emphasizing flanks, envelopments and annihilations. Its essence was the contact battle between masses of infantry and cavalry, supported by artillery firing directly, generally at short range, with guns deployed in the open. While the few aircraft could carry out reconnaissance, there were no means of locating targets in depth; and only the relatively few howitzers in service were capable of engaging targets in covered ground. Counter Battery (CB) fire was

advocated but was generally impractical; harassing fire, let alone continuous fire, was seldom used; and artillery played little part in battlefield deception. Adjustment of fire was primitive and generally estimated on the gun position itself. Communication with observers was by means of limited numbers of telephones, semaphore or megaphone. In the case of the British field army, all artillery ammunition was shrapnel. There was no means of supplying large quantities of artillery ammunition to manoeuvre forces in the field, and partly in recognition of this fact there was very little ammunition. Artillery planning did not exist at the Operational level, except in siege warfare.

By 1917-8 the new paradigm exploited an expanded battlespace and had a psychological aspect. The object was not so much mere flanking envelopment and annihilation as achieving a breakthrough, paralysing the defence by applying synchronized effects throughout the battlefield, leading to the enemy's collapse. Indirect firepower was the key to it. This 'modern style of warfare' is familiar one hundred years later, but it was radically different to the style of warfare practised in 1914 and for previous millennia.

This transformation was common in varying degrees to all the belligerents and experienced four phases: the realization in 1914 that existing artillery practice was inadequate, the consequent testing of new methods of indirect fire and the build-up of materiel in 1915, the tactics of 'mass destruction' by artillery fire from 1916-17, and finally the adoption of 'neutralization' from 1917-18, based on predicted indirect fireplanning. The lessons learned from these experiences shaped the foundations of modern artillery operations.

By 1918, predicted indirect fire was the norm. This enabled artillery once more to create Napoleonic concentrations of fire; but now through 'fire mobility' rather than the massing of equipment close to the target; and fire could be applied simultaneously in close and deep operations. The application of firepower was measured to achieve a variety of specific effects, and not merely attrition to the enemy's forward units. Fireplanning was designed to create shock and maximum dislocation, presenting the enemy with so many problems at once that his C3 system was unable to react effectively. It was synchronized with air operations and the scheme of manoeuvre to achieve synergies of effect.

Intelligence and targeting were the key to the success of this new style of operations, and data about enemy dispositions were gathered by aerial, electronic, acoustic and optical means. Using this data, the predicted fireplan attacked enemy headquarters, communications systems, artillery, logistics, bridges and depots simultaneously. It blinded enemy observers and destroyed strong points and field defences. It attacked enemy positions in depth, especially the enemy reserve before it could join the contact battle, sealing off the battlefield. At the same time it provided close support to the manoeuvre force as it advanced on its objectives. All of this was accompanied by ruses and deceptions, including a complete dummy fireplan if necessary. The planning for operations was conducted at high level under new centralized command, but measures were taken to make the plan responsive to the unexpected that inevitably occurred.²¹

The deep battle was the creation of the First World War, made possible by the practice of

indirect fire, target acquisition and the greater range of guns. Eventually the greater part of the artillery was dedicated to the deep battle, in particular to CB fire. The need for ever-greater accuracy, range and less collateral damage became characteristic of the technical advances which have continued to the present day. Although artillery fought the deep battle without infantry assistance, it was fought with the intention of directly influencing the close battle, in particular of reducing friendly casualties; and artillery achieved still greater importance as an offensive arm in its own right. By March 1918, artillery deep operations even included surface-to-surface strategic attack, a conceptual precedent set by the German 'Paris Gun', or 'Kaiser Wilhelm Geschuetz'.²²

Von Clausewitz asked, "How much artillery can one have without inconvenience? An excess of artillery is bound to cause operations to partake more and more of a defensive and passive character. A shortage of artillery will on the contrary enable us to let the offensive, mobility and manoeuvring predominate".²³ His view was a precursor of the disastrous sentiments of 1914 and the 'Cult of the Offensive'. The experience of artillery in the First World War challenged von Clausewitz's assertion. Artillery was not responsible for the onset of static trench warfare in 1914. That was a consequence of the prevailing delusion that infantry could successfully manoeuvre in the face of unsuppressed infantry firepower. The trench warfare that resulted brought about a burgeoning of artillery in an attempt to break out of the suppurating infantry stalemate, using massive 'destructive' and later 'neutralizing' firepower.

This firepower was generated in many ways, most directly by increasing the size of artillery in relation to other arms. In the British and German Armies the number of guns per 1,000 riflemen doubled, and in the French Army it trebled. Not only were there more guns, but they became heavier and more destructive.²⁴ The First World War demolished the prejudice against 'Siege' and 'Foot' artillery, which were seen to have similar tactical mobility and considerably more effect than the traditional 'Field' Branch. Indeed the distinction between branches became blurred as medium and heavy guns were handled as field pieces.

By 1918, all British pieces were calibrated for variations in muzzle velocity, meteorological corrections were applied and ammunition was issued by uniform weight and batch of manufacture, principles which have lasted for over eighty years. In 1918 an 18pdr was expected to achieve an accuracy of 80m at a range of 4km through prediction, a similar performance, in terms of accuracy if not range, to modern guns firing ordinary ammunition. The days when a battery commander was judged to have used underhand methods by measuring distances off a map were long gone.

Throughout the War, C2 had become increasingly centralized; but with poor communications it was difficult to effect modifications to fireplans as the battle progressed. Despite technical experiments and the use of FOOs accompanying advancing troops, control remained poor unless pieces themselves moved forward into vulnerable forward areas, where they were likely to suffer the same fate as artillery deployed in open positions in 1914. Experiments with wireless proved disappointing, and telephones

remained the primary means of communication, although liaison officers were regarded as the most reliable medium.²⁵

Firepower was reliant on the provision of ammunition, which made unprecedented demands on logistic services. Industrial societies were galvanized to deliver not merely vast amounts of manpower but to transform themselves into armament economies. It was initially the demands of logistics rather than combat per se that eventually made armies reliant on the internal combustion engine.

The type of ammunition required also changed. British field guns had started with shrapnel, which proved highly successful; but trench warfare and a shortage of heavier pieces hurried the development of HE rounds, which arrived in 1915. Artillery also became the means by which the horrors of chemical warfare were delivered. The development of the instantaneous fuse enabled artillery to create similar effects to those of shrapnel, but without the skill required to fire it effectively. It made it possible to cut wire in depth by indirect fire, sparing the close deployment of field guns in the direct fire role. The instantaneous fuse marked a qualitative improvement not matched until the introduction of the radar, Variable Time (VT), fuse in the Second World War.

Artillery developed other new roles. Ironically, no sooner had indirect fire and deep battle become the new orthodoxy, than the importance of direct anti-tank fire became evident, leading to the possibility of new self-propelled (SP) assault, and anti-tank branches of artillery. A German order at the end of the War declared that, "The first duty of the field artillery is to keep off the enemy tanks. All other duties must give way to this".²⁶ The tank was seen by many as a means of providing protected artillery firepower in close support of infantry, as well as a means of breaching obstacles; and yet the tank itself required fire support. The debate over the role of the tank and its relationship with artillery in armoured warfare had begun. Should artillery accompany tanks to protect their flanks; should it hold back and destroy anti-tank weapons with indirect fire, or was it no longer required in the close armoured battle at all, because of an over-riding concern for the deep battle? The value of indirect fire against tanks was questionable, while the advantages of direct fire systems were clear; but these would need to be deployed forward, and whether they should be manned by the infantry or artillery was again open to debate.

Similarly the advent of air warfare brought not only air-to-air combat, strategic bombing and aerial reconnaissance, but also the creation of a new Air Defence (AD) branch of artillery, firing directly into the third dimension. Before 1914 aircraft played little part in artillery operations. By 1918, they were the primary source of the battlefield intelligence needed for fire-planning, and they were an important means of controlling artillery fire. More than that, aircraft had themselves become combat platforms delivering integrated effects as part of a sophisticated Operational and tactical Joint fireplan.

The War had caused rapid developments in all areas of technology, tactics and Operational thinking, but after five years it had spawned at least as many fresh issues as it had resolved, and these received intense study in the years which followed.

Primitive it may have been, but in essence the artillery C3 system established during the First World War was conceptually robust, and it retains its validity as a network of sensors, deciders and shooters to this day. In that sense, the First World War was the defining period in modern artillery practice and one of astonishing innovation in the most demanding circumstances. By 1918 warfare was no longer linear, despite the deceptive appearance of fronts defined by lines of trenches. It entailed engagements throughout the two-dimensional area of the battlefield, and the third dimension was the medium through which this was effected.

2.4 1918-1939

The artillery networks which enabled the new model of warfare had been developed in relatively static conditions. The challenge in the years that followed was how to adapt this to concepts of manoeuvre.

After the Armistice of 1918, the possibility of another Continental war seemed remote; moreover, political and economic constraints militated against major re-equipment and reorganization. Yet it was also a time of intellectual vigour in many armies. The recent war had brought changes, stimulated ideas that would not be quickly forgotten, and posed questions it had not answered. The factors of success in 1917-18 were analysed by the participants: the relationship between firepower and mobility; the relationship between speed, surprise, momentum and the mass of a defence in terms of its depth and the reaction time of reserves; and the agility of forces in executing the decisions promulgated through new C3I systems.

German military planners realized that in changing circumstances these relationships should be resolved with urgency, and General von Seeckt set up fifty-seven committees to analyse every aspect of the phenomenon of the last War. There could be no repeat of the KAISERSCHLACHT of Spring 1918 which, while brilliant in many ways, was also a catastrophic Operational defeat in the Materialschlacht to which Germany became irrevocably committed. Even the British mechanized model of 1918 was too expensive in men and materiel, particularly artillery ammunition, to constitute an acceptable one for future war, but technical elements in it had the potential to accelerate tactical change, encouraging further technical developments in a virtuous technical/tactical spiral

The Germans concluded that they needed a new model, with tactics based on offensive mobility, speed and precise, flexible firepower, with manoeuvre compensating for the weakness of the latter in absolute terms. This was essentially the same concept of the breakthrough and exploitation to which planners of 1917-18 aspired, but with technological upgrades facilitated by radio, improved armoured vehicles and aircraft. Many wrote of such visions and experimented in a limited way, but the Germans built a force which proved capable of fighting

on these terms.²⁷

Artillery had emerged as the dominant arm on the First World War battlefields, ending the pre-war pre-eminence of manoeuvre over firepower; but the future role of artillery and its relationship to other arms was unclear. Was it still the role of artillery to breach obstacles through which infantry and armour might pass? Was artillery still to neutralize enemy infantry in covered defensive positions? Should artillery 'neutralize' or 'destroy' enemy firepower? Was artillery to provide close support for tanks in the mobile operations that were anticipated, and was artillery responsible for anti-tank defence? If artillery was to carry out any of these tasks, what types of equipment should be provided, and should these constitute discrete branches? Artillery had proved its worth in the deep battle, but where lay the division of responsibility with air forces for harassing and CB operations; and how far could artillery rely on airpower for target acquisition? Great improvements had been made in gunnery techniques, but these had been developed in relatively static operations. Could artillery deliver accurate observed, let alone predicted, fire in mobile operations? If artillery moved forward to keep in touch with the battle, was it too vulnerable; and if so, was it possible instead to use wireless as an electronic means of bridging the greater distances between gun and observer? Would manoeuvre re-assert itself over firepower?

The First World War demonstrated the importance of firepower and fire mobility, but revealed the difficulty of providing these in close support during mobile operations. After the war, political and economic constraints thwarted the realization of the ideas of armoured warfare that were widely discussed. By the late 1920's, experimental armoured formations existed with integral, and in some cases SP and anti-tank, artillery. These formations and their tactics were the logical consequence of the experience of the First World War, and were artillery's attempt to maintain close fire support by equipment mobility rather than fire mobility.

By the early 1930s imagination had outstripped experience. Both armour and infantry sought independence from artillery firepower, either by enhancing their own, or by substituting it with aircraft. The SP gun was abandoned, and wheeled artillery left vulnerable in the forward combat zone, assuming it could keep up with the battle. Having lost equipment mobility, artillerymen tried to compensate by improving fire mobility.

In mobile operations fire mobility could be achieved only through improvements in radio communications, survey and accuracy; but these were hard to perfect. The shortcomings of armour and airpower operating alone would be revealed in the Second World War; and the mobility of artillery equipment was soon restored to improve support for armoured forces. The return of equipment mobility coincided with the development of improved techniques of gunnery, and was to revive artillery's influence on the battlefield in a way that few would have predicted ten years earlier.

2.5 THE SECOND WORLD WAR 1939-1945

By 1939, most armies had created networks incorporating airpower and artillery in mobile operations, with varying degrees of success. Nevertheless, the perception that artillery would be at a disadvantage in such operations persisted, and this ensured that it was once again relegated to a subordinate role. This perception proved short-lived.

In 1939 artillery was a much neglected arm, whose proven value in the First World War had been questioned in peace, often because its firepower had seemed to characterize the unacceptable horrors of that War. The theories of armour and mobility that flourished in the 1930s were seen to offer attractive alternatives to the tyranny of firepower, and with the exception of the USSR, the armies of the major powers were organized and equipped to fight accordingly. The hard-won lessons of the First World War were thus discarded for more appealing options, most notably in Germany, where intensive study of that War produced 'militarily glamorous' yet ultimately flawed conclusions, with catastrophic consequences in a war in which firepower was to prove as dominant as it had been in 1914-18. The delusion was similar to that after 1905, when the unattractive lessons of the Russo-Japanese War had been rejected, with dire consequences in 1914.

In the Second World War artillery planners had to re-learn those lessons and make the necessary changes in tactics, organization and equipment. Soviet artillery had the least adjustment to make, because of its adherence to much of the doctrines of the First World War, while the American and British artillery had to undergo complete transformations once war had broken out. The Germans also realized their error, but their transformation was the more painful, in view of the early success of Blitzkrieg tactics; and they never mustered the resources to reform as they might have wished. The Japanese found themselves in an even worse predicament, having adopted the principles of Blitzkrieg from the Germans, and adapted them to the Far East theatre. By the time firepower had re-asserted its dominance on the battlefield in the hands of the Allies, it was too late for the Japanese to respond effectively.

The lessons re-learned in all theatres were similar, but the experience which taught them, and the practice which resulted, varied considerably. The issues at stake were: the ability of artillery to give fire support in mobile operations; the ability of artillery to counter mobility with anti-tank fire; the ability to apply the effects of fire through the generation of masses of artillery; their enhancement by fire mobility and co-ordination through optimized command and control; and above all the ability to apply the effects of fire throughout the battlespace.

The War in the West

The War in the West began in 1940 with the triumph of superior German offensive technique in the operation of combined arms, and the apparent avoidance of a crippling war of attrition through mobility of armour. It ended with the victory of superior Allied firepower, which was achieved by applying artillery effects according to traditional principles, and enhancing these by advances in technology and organization.²⁸ It resulted in fundamental changes in the relationship between different arms and their responsibility

for providing fire support.

In 1940 the Wehrmacht paralysed its opponents by the shock of armoured mobility and CAS in an innovative and highly effective Joint network. German mobility created concentrations of force, which the Allies were unable to meet with adequate concentrations of firepower. Victory was as much psychological, political and moral as military – and chance was a significant factor in it. Artillery played a useful but minor part in the drama.

In North Africa the dominance of armoured mobility proved short-lived as artillery guns asserted their superiority, so much so that from 1940-42 anti-tank fire became the primary role of anti-tank and field artillery alike.²⁹ The Germans were the first to appreciate the tactical revolution which was taking place, and used their armoured mobility to exploit superior anti-tank artillery firepower. The re-equipment of the British Army after its losses in 1940 enabled it to master attacking German armour with anti-tank guns, releasing the growing strength of field artillery to take up its indirect fire role once more.

The British reverted to the precedent of the First World War organizations and tactics to achieve this, after a period of disastrous experiment with mobility and decentralization. It was recognized that infantry could not assault without thorough-going artillery support, and that armour could not act successfully on its own.

The fireplanning techniques adopted in the desert were even more apposite to the Italian theatre, where terrain handicapped armoured manoeuvre and favoured static defence. The Germans abandoned manoeuvre and adopted fortified lines which became ever more formidable. The firepower originally developed to counter the mobility of Blitzkrieg was redirected to blasting a way through these positions, re-creating opportunities for Allied mobility. The massed indirect fire which became indispensable could be generated by concentrating artillery and multiplying its effect through centralized C2, made responsive to low-level requirements through comprehensive communications. Its effect was further improved by developments in target acquisition and technical accuracy.

The Germans appreciated the advantages the Allies enjoyed through reviving and expanding the role of artillery; but by 1944 as Allied strength swelled, the Germans' material inadequacy left them unable to compete effectively, or to take full advantage of the benefits of the centralized C2 which had been demonstrated by others since 1942.³⁰ They were instead forced to adopt lesser tactical expedients, rather as the British had had to do in North Africa in 1940-42, and to seek an equivalent to mass by enhancing survivability on all fronts with huge fortifications. Ironically, once they in turn were thrown onto the strategic defensive, the exponents of Blitzkrieg ended up as the constructors of the largest fixed fortifications that the world has ever seen, dwarfing the Maginot Line and its relatively puny firepower.

The Eastern Front

Germany was intent on war with the USSR, and despite many misgivings, applied a military formula in 1941 that had been fatally endorsed by the victories of 1940, although these had probably been as much the product of 'Risiko und Wagnis' and extreme good fortune as of any new insight into military technique. The underlying fundamental, the ascendancy of firepower relative to the area of the battlespace, became evident soon after, over-ruling wishful thinking and hopes of further so-called Blitzkrieg. The Germans were fated to refight their military anathema on the Eastern Front, while woefully ill-equipped and configured to succeed. The Second World War was to be even more costly for Germany than the First and its campaigns more attritional; but because they involved, at least initially, dramatic and 'glamorous' ground manoeuvre, the human catastrophe that this entailed at the hands of well-orchestrated Soviet and Allied firepower is seldom laid at the feet of their fatal and flawed offensive armoured doctrine - another 'Cult of the Offensive'.

Operation BARBAROSSA sought a quick victory through political and military shock before the USSR could mobilize its potentially much greater materiel resources. The Wehrmacht could not contemplate a slow, deliberate advance across the steppe, recognizing Germany's inability to win a war fought on terms of comparative mass. Enhanced mobility seemed to offer the only means of circumventing this unacceptable conclusion. The Germans therefore relied on armoured mobility to achieve early victories, paralysing the opposition; and sought through mobility to concentrate what relatively scant firepower was available against selected points in a vast terrain.

This concept of operations would have found some support in much German historical thought, which tended to disparage the value of artillery. Von Clausewitz warned that with "An excess of artillery... One will seek salvation in strong positions, in formidable features of the terrain, and even in mountain positions, in order to shift the burden of defence and of protecting the numerous artillery on to the obstacles presented by the ground, so that hostile forces need only advance to be annihilated. War will be waged at a stately, formal pace, a la minuet. A shortage of artillery will, on the contrary, enable us to let the offensive, mobility and manoeuvring predominate. Marches, hardships, exertions, will become peculiar weapons for us; war will become more diversified, more lively, more ruffled: great battles will be gained quid pro quo".³¹ Operation BARBAROSSA reflected that spirit. By contrast, the USSR sought salvation, in the 'strong positions', 'formidable features of terrain', and 'numerous artillery' which Clausewitz described and decried.

It was in the Soviets' interest to create a Materialschlacht, given their superior resources. Unlike the Germans, the Soviets championed the decisive power of the gun. In 1945 Lieutenant General I.S. Prochko, describing these developments, wrote, "Military doctrine fought against theories which tried to belittle the importance of the role of artillery in modern warfare. Neither tanks nor aviation, no matter how great their importance may be, can replace artillery. Artillery was and still is the most powerful weapon of the Red Army."³²

The Germans, unlike the British, actually provided armour with the air support that the

theorists of the 1930s had advocated. The Soviets, though eager to exploit air-power whenever possible, regarded tanks and aircraft primarily as a means of enhancing the role of artillery. The Soviets believed that, given the strength of field defences combined with artillery, the balance of advantage still lay with defence. Yet they accepted that a war could only be won through offensive action. The belief that the gun was supreme in defence led to the conclusion that the gun and fire superiority over enemy guns would also be supreme in the attack. The essential problem was to provide mobile offensive forces with that firepower, and to give them protection in the absence of field defences. The belief that tanks and infantry should not attack until the enemy in their path had been destroyed by artillery created a greater need for field artillery support, as well as for anti-tank artillery in defence.

The term 'Blitzkrieg' was invented after the fall of France, but it was now 'put about' by the Nazi propaganda machine as some 'magic formula', and many found it attractive.³³ The force that invaded the USSR seemed to be modelled on the assumption that this formula would indeed prevail. It comprised three million men, 600,000 vehicles, 3,580 panzers, 7,184 guns and 1,830 aircraft. However impressive these figures may sound, they were comparable to those engaged in earlier campaigns in much smaller theatres. Hitler intended his war, let alone the campaign in Russia, to be complete by December 1941 – he did not plan for, or anticipate, prolonged attrition.

In reality, Operation BARBAROSSA was not founded on sober military analysis yet, persuaded by the propaganda images of the day, it retains its allure as a military 'success', and a high point in the practice of Operational armoured manoeuvre. In reality it was a model of chaotic, flawed military planning, justifiable only in terms of political dogma bordering on the metaphysical.³⁴ The operation was led by a small panzer elite, while seventy-eight percent of the force was predominantly infantry, relying on caravans of hundreds of thousands of horses and carts plodding east.³⁵ The war against Poland had convinced the Wehrmacht that air-power could bring a quick victory, avoiding a protracted war. However, the Luftwaffe which was to support the armour comprised a rapidly ageing fleet of models, unable to conduct decisive operations at the strategic or Operational levels.

While German operations in France in 1940 had obvious parallels with the KAISERSCHLACHT in terms of conceptual planning, a more horrendous parallel soon emerged between the Western Front of 1918 and the Eastern Front 1941-45, for BARBAROSSA was to follow a similar pattern to the KAISERSCHLACHT. It was also intended to be a quick operation completed before the enemy's superior logistic strength could be brought to bear. It employed innovative techniques, refined from those demonstrated months earlier on another front, and it was led by an elite manoeuvre force. Shock and consequent psychological collapse were to be weapons as much as firepower itself. After dazzling early tactical success, inflicting huge losses on an apparently demoralized and complacent defender, the 'velocity' of the blow was absorbed in depth, blunted by superior defensive firepower, logistics and the reaction time of reserves.

Defences could not be breached consistently at the Operational level, and the enemy's strategic collapse never occurred.

As one soldier on the Eastern Front observed, "We were spoiled by the preceding Blitzkriege".³⁶ In Russia, the scale of the battlespace negated most of the advantages the Germans had contrived for themselves in France. 'Mass', not the achievable 'velocity', would tell. No consideration was given to the series of campaigns that would be required in the East, and "Everything was staked on the Schlieffenian belief in a quick campaign".³⁷ BARBAROSSA was intended to succeed within three months, outshining the success of SICHELSCNITT, a term invented by Winston Churchill and subsequently adopted by the Nazis, which had justified the operation. When it did not, the fundamentals which the 'Blitz' had sought to 'short-circuit' reasserted themselves.

Planning had been based not on military calculation, rather upon Hitler's ideological conviction that, if he could strike a devastating early blow, the Soviet regime would collapse; and German manoeuvre doctrine had been an accomplice to this error. Like Rome after the Battle of Cannae (2nd August 216 BC), the Soviet regime did not collapse - the most important lesson of Cannae. The reaction of General Halder to the problems on the Eastern Front was merely to observe that, "The tough and spirited German soldier shames the staff which meticulously tots up numbers"³⁸ It was rather the devotion to the unbalanced doctrine of lightning armoured warfare that was ultimately the undoing of the Wehrmacht.

The failure after 1941 was ironic since superficially the Wehrmacht appeared to be a highly mobile 'modern' force, with an integrated land/air concept. The Germans had hoped that airpower would provide the firepower required; but in the USSR it could not, and relative to the Red Army, the Wehrmacht had neglected its artillery arm, both materially and in its doctrine. The Germans underestimated the effects of firepower that were required throughout the battlespace. From late 1940 the Wehrmacht was stripped of much of its firepower in the belief that rapid armoured manoeuvre would win the war by the end of 1941, an article of political faith rather than dispassionate Operational analysis. Once the campaign was underway, it was too late to rectify the problem.

From May-September 1940 in the Battles of France and Britain, the Luftwaffe lost 3,064 aircraft, sixty-five percent of its force. In September 1940, the month that Germany lost more planes than it produced, Hitler ordered that planned aircraft production be cut; and that year British aircraft production outstripped Germany's. Between July and December 1941, the USSR produced 5,173 fighters and the Germans 1,619. Such setbacks and chaotic Luftwaffe procurement programmes ensured that Germany fought the last four years of the War with inferior CAS, and without a fully-fledged strategic airforce.³⁹ What resources there were, continued to be directed towards projects which did not deliver successful military outcomes. For example, the resources devoted to 'revenge weapons' amounted to the equivalent of 24,000 fighter aircraft.⁴⁰

Changes in artillery production and deployment illustrate the same point. In Summer

1941, the Soviets and the Germans had roughly the same number of field guns at 6,000 and 7,000 respectively. The Germans broke up their corps artillery and devolved it to divisions, believing quite reasonably that given the huge space of the USSR and the speed of operations, corps artillery would not be able to keep up. The Operational design accepted that the speed of manoeuvre would outstrip fire support above the divisional level. This proved to be the case, but without self-propulsion, even divisional artillery was often left behind. Airpower proved an inadequate substitute, and rapid territorial gains could not be sustained without appropriate firepower. The French are often criticized for dispersing their armour in 1940, but criticism is seldom heard of the Germans for failing to concentrate their artillery and airpower decisively in 1941 and thereafter.

Industrial priority was given to tank production over artillery, because the tank was deemed to be the campaign winner, as it had been in France, and artillery merely a subsidiary factor. In July 1941, as Operation BARBAROSSA was launched, a seventy percent cut in planned artillery production was ordered, and between April and December 1941, funding for artillery ammunition was reduced from 69.1m Reichsmarks, to 15.7m Reichsmarks.⁴¹ By December 1941 artillery ammunition production was falling fast, and that month Germany produced 9,000 light howitzer shells but consumed 1,260,000.⁴² By 1942 it was clear that Germany's imperative for a quick victory would not be achieved. She scoured the arsenals of occupied Europe in search of equipment to match Soviet firepower. By Winter 1940-41, eighty-eight German divisions, forty percent of the total were equipped with captured French material.⁴³

War on the Eastern Front was characterized by the Wehrmacht's demonstration of how tactical mobility could sometimes concentrate firepower at the decisive time and place; by the realization on both sides that the tank could be mastered by the gun and by the eventual understanding that massed artillery, handled in the manner developed in the First World War, was still decisive in defence and offence. It also showed that unless Blitzkrieg achieved an immediate knock-out blow, as the term implied, an army which necessarily relied upon mobility rather than firepower could not prevail at the Operational level in a war of attrition, against one with an opposite priority and the means to support it.

The Far East

The factor that most shaped the war in the Far East was terrain. The Pacific campaign witnessed a series of battles for islands, in which ground forces were wholly dependent on naval and air forces for movement and re-supply. The South East Asian land campaign offered opportunities for tactical mobility, though under arduous conditions of terrain and climate. The difficulty in achieving equipment mobility in the mainland campaign inhibited the concentration of firepower, and on occasions naval and airpower became the most important sources of fire. Strategic mobility made it possible to concentrate field artillery; but terrain often restricted the size of the battlefield, concentrating violent action in a small and isolated area.

The defender of an island could seldom expect relief, had little to gain from tactical

manoeuvre, and in the face of a set-piece attack with tri-service fire support had everything to gain by sacrificing mobility in favour of camouflage and massive physical protection. Offensive operations were therefore usually characterized by efforts to defeat such positions.

In the Pacific, where concentrations of forces were widely separated, amphibious operations were the equivalent to the encirclement operations of the Eastern Front; and island defence resembled the German 'hedgehogs' of the steppe. These themselves became attractive targets and concentrations of vulnerability, running the risk of isolation at the hands of superior attacking forces that commanded the sea and air. The seizure and defence of small areas of vital ground was more important than the breaching of defences to win mobility for other arms. Artillery was therefore seldom required to neutralize the enemy, whose refusal to surrender ensured that his destruction was usually the object of operations in itself; but the need for firepower coincided with exceptional difficulties in providing it.

By contrast with the Soviet theatre, it was often impossible to find sufficient space in which to deploy field artillery.⁴⁴ Apart from the problem of space, the difficulty of moving masses of guns and ammunition by land was appalling. In New Guinea, British ammunition had to be carried by porters through miles of jungle where it took a porter one day to carry a single round four miles. A road-bound army could not mass without roads; and these had often to be built, or abandoned for amphibious or air transport.

The physical difficulties in massing artillery were matched by those of achieving fire mobility through good target acquisition and accuracy. The jungle hampered observation and made flash-spotting and sound-ranging almost impossible. All artillery support tended to be close support, and fired at very short range.⁴⁵ Air OPs often proved effective, but these required landing strips or aircraft carriers. Survey was as difficult as target acquisition, and accuracy was further hampered by climatic effects on munitions. The one outstanding advantage that artillery did enjoy was the opportunity to conceal and protect itself with abundant materials for camouflage and the construction of field defences.

The Japanese neglected to build up artillery materiel and an organization that could generate concentrated firepower. They were content to use artillery as mere 'infantry guns'. Rather than overcome disadvantageous conditions, they sought to maximize what advantages were available to enhance their scant resources. They placed high priority on survivability through camouflage, physical protection, and local defence. They also believed that careful siting of individual guns produced better results than the fire mobility gained by the co-ordination of a number of guns.

The Allies strove to overcome the problems of the theatre and to create conditions where the principles of artillery tactics learned elsewhere could be achieved; but field artillery's prime role in attack was the destruction of fortified enemy positions, often by direct fire, and neutralization seemed an inadequate tactic. In defence, there was greater scope for the Allies to concentrate indirect fire, since the Japanese had little armour and they

presented massed and vulnerable targets if artillery could co-ordinate and deliver timely and accurate fire.

It was appropriate that in a theatre where artillery was so relatively weak, an aircraft should deliver the most powerful destructive blow, whose secondary effect was so great that it ended resistance on far removed battlefields. This ultimate source of concentrated firepower was soon to be harnessed by artillery, changing the face of battlefields and tactics around the world.

Conclusion

In the Second World War, artillery still played a decisive role and it was founded on an ever-more sophisticated network linking sensors, decision-makers and shooters. The most important targets were armoured, and these were eventually mastered by new direct-firing artillery guns. Indirect artillery, however, lost its relative potency against armour, but had a crucial role against all other targets, especially anti-tank guns. This continuing importance can be seen in the resources allocated to it. In the British Army, artillery, including AD, accounted for forty percent of manpower. In the Soviet Army, the number of guns increased fivefold between 1941 and 1945, and thirty-three percent of its men were field artillerymen. Artillery was rightly seen as the Soviet Army's primary means of destruction.

The Second World War confirmed the importance of artillery support, but it was uncertain whether firepower was best obtained by mass on the Soviet model, or by the more efficient use of resources and complex networks favoured in the West. The seeds of doubt were being sown, and more problems were posed than resolved. As in 1918, the areas of uncertainty lay around new and undeveloped weapon systems that would transform the role of artillery and its relationship with other arms.

The rocket had been both a means by which the infantry could lessen its dependence on scarce artillery resources, and for the artillery a method of combining greater shock with a heavy weight of fire. It had the potential to reduce the role of artillery in the close anti-tank battle, which had been the former's primary role in the Second World War; and at the same time it offered artillery the possibility of achieving a new and deeper role on the battlefield at all levels of warfare. Dr. W. Dornberger of the V2 programme rightly suggested that in decades to come it would be the vehicle for the delivery of high-technology munitions.

The decisive role of firepower on the battlefield which had been neglected in the 1930s was re-asserted in the Second World War, changing the relationship between arms in the process, and in some cases the perception of which arm was responsible for its provision. Theorists in the 1930s had assigned responsibility for the deep battle to aircraft, even though little provision was made for it outside Germany. The shortage of medium and heavy artillery and the growing availability of aircraft and naval gunfire brought such ideas to fruition for the Allies by 1943. Field artillery was thus able to devote its energy almost

entirely to the close battle, or at least to targets which, on a battlefield of greater depth than in the First World War, were of closer relative proximity. Targets, which on the scale of a the First World War battlefield would have been for engagement by artillery, were now allocated to aircraft, whose lack of accuracy made them suitable to carry out tasks analogous to the predicted, unobserved area saturation missions of many artillery bombardments in the First World War. Artillery's role in deep attack after 1945 would depend upon improving its own performance relative to aircraft capabilities, and the ordering of ground attack in air force priorities.

What aircraft could not produce was a heavy weight and variety of accurate fire, at short notice, at any time, in any weather, at any range up to about 15km. This was artillery's unchallenged preserve. Artillery's role through history has been to provide fire effects of a weight, severity or range beyond that of other arms; and it was this which had clearly re-emerged again by 1945 after the confusion and mistakes of the 1930s.

The means by which artillery rediscovered its role was not so much improved ordnance, as C3 networks which optimized its effects throughout the area of the two-dimensional battlefield. The introduction of the radio was in its own way as important as that of the petrol engine. It permitted a centralized system of C2, which synthesised the authority and priorities of high command with the fresh intelligence and immediate requirements of the smallest sub-unit. Together these could create the swift concentrations of fire which artillery has always striven to produce.

Above all, the nuclear warhead created grave uncertainty at a time when it had seemed that tactical orthodoxy had been restored to the delivery of fire. Nuclear weapons could generate such mass destruction that it was thought by some that conventional war, let alone conventional artillery support, had become obsolete. If a conventional war were indeed out of the question, perhaps artillery would regress, and be used only in limited wars in inhospitable regions of the world, where few lessons of the Second World War would be considered relevant.

¹ On 18th June 1815, he accepted the advice of his senior artillery commander, Druot, that the water-logged ground would dry out sufficiently for his cannon to be positioned by noon. They were not, and this gave Wellington and Bluecher a precious extra three hours. Chandler (1992), p.24.

² Hughes (1983), p.46.

³ This frontage was similar to that of a conventional six-gun battery deployment in the latter half of the 20th Century.

⁴ The maximum effective range of a light gun or howitzer firing roundshot was about 1,000m, and for heavier pieces about 1,500m. Canister was perhaps effective out to about 600m, but it was best fired at less than 300m.

⁵ Ricochet fire was originally used only in siege operations. The first reference to ricochet fire was by the Venetian engineer Thomas Meretti in 1672. The French engineer Vauban experimented with ricochet fire at the siege of Ath in 1697. The intention in such cases was to bounce rounds over the walls of fortifications to strike defending artillery behind the parapet. Nosworthy (1997), pp.387-8.

⁶ A shot from a typical 8pdr or 9pdr cannon fired at zero elevation, would probably strike the ground at 400m, ricochet and bounce again at 600m and again at 700m. It would then roll another 50m. This lethal journey would all be below head height. A 4pdr or 6pdr would first strike the ground at about 300m, and a 12pdr at 600m. Increased range could be achieved, but at a price. Were an 8pdr or 9pdr

elevated by just one degree, the first bounce would be at 700m, having previously travelled most of its journey above head height. It would bounce again at 1,000m, but probably not again. At two degrees of elevation, the first strike would be 900m, and the round was unlikely to ricochet. For these reasons, guns were seldom elevated. These distances were affected by the state of the ground. Wise (1979), pp.27-9.

⁷ In *Instructions of Field Marshal Bluecher for the Chief of Brigades*, issued at the start of the campaign of 1815, ricochet fire was held to be more accurate than other modes of fire at long range. Nosworthy (1997), pp.389-90.

⁸ Concentrating fire does not necessarily imply a heavy weight of fire overall. Greater accuracy may permit effects to be concentrated economically with fewer munitions. Today, when indirect fire is the norm, concentration of fire is seen in terms of converging fire at a point or area from above, rather than along the whole length of converging lines of trajectory. In future, the concentration of fire will be assessed increasingly in terms of the terminal effect of a precision munition at a critical point, rather than the volume of pieces and fire necessary to create that effect; and the implications of this will be as radical as those consequent from the dominance of indirect fire after 1914. Precision of effect will thus assume the importance previously assigned to the mere concentration of fire.

⁹ It has been estimated that 1,000 of the 3,000 French casualties at the Battle of Albuera (16th May 1811), were caused by British field guns, yet this destruction was probably caused by just four well-sited pieces. Hughes (1997), pp.121-2. Similar siting of Lawson's guns at the Battle of Talavera on 28th June 1809 had dire consequences for French columns. Ibid. p.136.

¹⁰ Bellamy (1982a), p.215.

¹¹ Some British officers recommended the adoption of the 'Richtflacche'; but others who studied German experience in 1870, used the latter as evidence not to adopt the more modern German techniques. "I only trust that the English field artillery will never consider their role is to sit behind a hill a mile and a half in the rear while the assault is taking place." Headlam (1897), p.395. Headlam's views were subsequently to carry a heavy price.

¹² Kraft zu Hohenlohe-Ingelfingen (1899), p.890. In later years he became increasingly critical of indirect fire, believing it to be impractical in mobile field operations.

¹³ Dastrup (1992), p.129. His ideas were thoroughly vindicated early in the Russo-Japanese War and almost certainly influenced Japanese practice.

¹⁴ Scales (1976), p.146

¹⁵ There were frequent lectures and articles written at the turn of the Century about the ballistics of indirect fire. In a lecture in 1897, Major J.L. Keir stated the case for indirect fire most clearly. Keir (1897a). He warned that through the practice of direct fire, "...we may run the risk of suffering great losses at the outset of a campaign...". He made a further attempt to gain support in Keir (1897b), noting ominously that "time alone can decide who is right."

Captain C.D. Guinness shared some of these fears and described his vision of a future war, where British guns deployed in the open, firing directly against concealed German guns firing indirectly. He concluded, "I make bold to assert that the odds are we shall get the worst of it in the first ten minutes of the artillery duel." His article outlined the debate between advocates of forward and concealed deployments, and the ballistics and terminal effects of shells fired on indirect trajectories. Guinness (1897). Strangely he concluded that direct fire was usually the preferred option, and that artillery should merely avoid skylines. It transpired that his objection to indirect fire was that it ran contrary to the sporting nature of the Royal Regiment. Lord Wolseley - no great friend of artillery - who was present when Guinness presented his ideas, disagreed, urging that guns be fired from behind cover. Ibid, p.84.

¹⁶ The opposition to the development of indirect firing techniques in the British Army was led most vociferously by Brigadier General C.H. Spragge, Colonel G.H. Marshall, Major J. Headlam and Colonel E.S. May. May in particular believed in the moral aspect of close engagement, and that firing behind cover "...will destroy the whole spirit of the arm." Ironically, one of the leading advocates of indirect fire was an infantry officer, T.D Pilcher. His unfortunate treatment at the hands of the Royal Artillery is described in Scales (1976), pp.174-7. Headlam argued that the general employment of indirect fire in the field was "...absolutely out of the question." On 26th August 1914, Brigadier General Headlam, commanding the artillery of 5th Division, deployed five brigades of guns in exposed positions at Le Cateau, between 50m and 200m from the infantry front line. Two battery commanders who believed their

positions were untenable, moved their guns to covered positions, but Headlam ordered them to return to their forward position. Headlam was unable to engage his opponent's pieces which were in concealed positions, 3,500-5,000m away. After eight hours of bombardment, the battle was lost and twenty-seven of his forty-two guns were captured. This engagement has typically been seen as a gallant action, focusing on attempts to retrieve the guns. It should more aptly be seen as a striking example of the lethal consequences of technical and doctrinal conservatism. The authorized history of the Royal Artillery covering the pre-War period failed to analyse the debates about the introduction of indirect fire. Its author was Maj Gen J. Headlam who had done so much to oppose it.

¹⁷ The shortcomings of British artillery in the Boer War were examined by the Brackenberry Study which recommended a major re-equipment of the Royal Artillery with the Ehrhardt 15pdr. This piece had a full recoil and could equal the rate of fire of the French '75'. It was replaced in the Regular Army before the First World War.

¹⁸ Kirke (1974).

¹⁹ Knox (1913), p.41.

²⁰ J.B.A. Bailey in Knox and Murray (2001), pp.132-153.

²¹ This was the blueprint for battle as tested by the British Army at Cambrai in November 1917, but seen in more complete form in the German offensives of Spring 1918, the KAISERSCHLACHT, and the Allied offensives later that year. Eighty-five years later this style of warfare remains familiar, but in 1914, a mere three years earlier, it would have seemed entirely bizarre. This model of 1917-18, a new orthodoxy in fireplanning, was evident in the doctrine of NATO and Warsaw Pact armies of the Cold War. It was also evident in the Egyptian crossing of the Suez Canal in 1973, and Coalition planning for the Gulf War of 1990-91.

²² It had a range of 125km and remained the longest-ranged gun until the introduction of rocket-assisted projectiles. Aside from aircraft, it was the only means of strategic attack, in its case against Paris. It had major shortcomings, notably a light projectile, a slow rate of fire and a short tube life. The life of a barrel was judged to be sixty rounds, and these were issued in graduated sizes, to account for the expanded calibre of the barrel. The first was of 210mm and the last of 222mm. The gun fired 303 shells in forty-four days killing 256 people. It was intended to strike a paralysing blow at French national morale but lacked the desired accuracy. It was an astonishing achievement in technical terms, but the means and tactic of the day proved inadequate for the revolutionary strategic objective.

²³ Quoted in Balck (1914), p.241.

²⁴ By 1917 the ratio of gunners to infantrymen in many battles had risen to 8:10. The Royal Artillery became larger than the Royal Navy. In 1914 the British Army possessed only six heavy batteries compared to seventy-two field batteries. By November 1918 it had 440 heavy batteries and 568 field batteries. In 1914 the Russian Army had 797 heavy guns, but by 1917 it had 2,550. Simpkin (1987), p.109. Whereas in April 1917 the US Army had nine field regiments, by the Armistice it had 234. Dastrup (1992), p.163.

²⁵ In 1918 the French had 50,000 telegraph engineers. There were up to 200 signallers in every artillery regiment, and many French houses had been stripped of wiring to provide communications.

²⁶ Quoted in Hay (1920), p.112.

²⁷ Recent interpretations have discounted the idea that the German offensive in France in 1940 was planned and carried out as a Blitzkrieg per se. While the components of success had indeed been put in place, the idea that it all along followed a conceptual masterplan was a notion put about by Nazi propaganda, and popularized by some German generals after the War. See Frieser (1995). Frieser quotes Halder, who was not such a propagandist, speaking after the campaign, "Das ganz Ausland ist auf der Suche nach den neuen Methoden der Deutschen - diese waren es gar nicht - Krieg ist immer ein System von Aushilfen". Ibid, p.1. This echoes some of the notion in Crown Prince Rupprecht's remark on German doctrine after the First World War: "There is no panacea. A formula is harmful. Everything must be applied according to the situation." Quoted in Lupfer (1981), p.58. Prior to 1939, the Germans did not so much design a force with a premeditated 'magic formula', as come to believe after 1940 that that is what they had done. Operation BARBAROSSA was the catastrophic consequence of that delusion.

²⁸ Pemberton (1950).

²⁹ The story of the tank versus anti-tank gun is discussed in Appendix 8 to *History of the Second World War: The Mediterranean and Middle East*, Vol.III (HMSO, 1960).

³⁰ Wilks (1978).

³¹ Von Clausewitz (1976), pp.287-8. Also quoted in Balck (1914), p.241.

³² Prochko (1945), p.20.

³³ See Bellamy (1990), p.91 and Frieser (1995).

³⁴ Early planning had assumed that the campaign would last five months. Its planned duration was eventually based on the availability of enough gasoline for just three months, at rates of consumption experienced in France in 1940, even though seventy-five percent of motors used diesel, and there was only of enough of that for one month. In the event, much movement in the USSR would be off-road, fuel consumption would be three times higher than in France, and most captured Soviet fuel would be unusable because of its low octane rating. Divisions were expected to carry their own stocks and there was a reserve supply for just twenty divisions. Planning was based on the assumption that one train would support each army, but in the event the Germans could manage only one train behind each army group. The Germans' most optimistic forecast acknowledged that the Soviets could not be defeated within the first 300km of their frontier. Beyond that, once divisional stocks had been used up, army and army group transport would have to make long round trips to resupply the front. If the elite mechanized divisions were to be given their full requirement, there would be no transport available at all to supply the remaining 111 divisions. Almost nothing was done to plan for cold weather, and eighty percent of German railway engines had burst their main waterpipes by November. Ellis (1990), pp.39-79, relying heavily on the work of Martin van Creveld.

³⁵ The notion of Schwerpunkt in German doctrine acknowledges that relative weakness must be accepted in some areas to achieve a decisive strength elsewhere. A similar imbalance is often noticeable in German force structures, creating a well-furnished elite to lever a decisive advantage, albeit at the material expense of the majority of the force. The same German preference for an elite with its consequent imbalances can be seen both in the stormtroop forces of the First World War, and in the creation of a relatively small panzer force to lead the larger, horse-drawn army into the USSR in 1941. The consequences once that elite had been shattered were similar. This phenomenon was also evident in the disastrous decision to build the Panzerschiffe elite at the cost of the potentially war-winning U-boat programme. See Herwig in Murray (1996), pp.231-241.

³⁶ Quoted in Bartov (1992), p.21.

³⁷ Wallach (1986), p.271.

³⁸ Ellis (1990), p.78.

³⁹ Irving (1973).

⁴⁰ Murray and Millett (2000), p.333.

⁴¹ Ellis (1990), p.48.

⁴² See Engelmann (1995), p.112.

⁴³ Van Creveld (1977), p.145.

⁴⁴ Nothing Atoll, for example, saw possibly the most unorthodox deployment of a 155mm howitzer battalion of the war. It went into action on a beach-head only 300-400m deep, with two batteries trail to trail. Another battalion on the Atoll occupied an area just 200m square, whereas the norm in the Italian Campaign was 800m by 800m. US forces often overcame this shortage of space by landing artillery on an island close to the one defended by the Japanese, from which they could bombard the enemy with impunity. This was successful at Tarawa in November 1943, and at Kwajalein in January 1944.

⁴⁵ Because an OP's view was limited, the British in Burma often found it necessary to have up to eight OPs for a battery, but were often handicapped by poor radio communications, caused by the rugged terrain and jungle.

CHAPTER 3: THE COLD WAR 1945-1990

3.1 INTRODUCTION

By 1945, artillery and airpower had been joined in a potent network. This evolved throughout the Cold War, but in very different ways on either side of the Iron Curtain in a symbiotic relationship of action and counter-action. This is illustrated in Table 1, whose chronological format replicates the structure for this chapter.

Table 1. The Development of Artillery during the Cold War.

WARSAW PACT	NATO
1945-1962: Minimal tactical reaction to the introduction of atomic weapons. Maintained concept of mass, but involving little manoeuvre. Predominantly towed equipment. Eventually acquired atomic weapons.	1945-1965: Atomic weapons seen as justifying reduction in conventional forces. Deterrence through Mutually Assured Destruction (MAD). Dispersal seen to be necessary on atomic battlefield. Armoured SP artillery required for manoeuvre.
1962-1982: Cuban Crisis and growing intensity of the Cold War led to large build-up of forces. Lessons of Yom Kippur War led to programme of mechanization and modernization. Threat from NATO ATGW led to thinking about surprise and development of Operational Manoeuvre Groups (OMG).	1965-1982: MAD increasingly seen to lack credibility. Flexible Response replaced MAD. Attritional model replaced by Active Defence. ATGW introduced to counter WP armoured threat. Artillery made more efficient by improved C2 and computers. Rocket artillery introduced to increase long-range firepower, along with artillery mines. Massive WP superiority in firepower still seemed overwhelming, and nuclear weapons underwrote NATO doctrine.
1982-1990: WP doctrine sought to avoid nuclear warfare and to win rapidly by conventional means. Huge build-up of artillery, and development of OMG concept. WP weapons, especially armour and ATGW, remained at forefront of technology. Growing awareness of future Western	1982-1990: Forward Defence offered little space for manoeuvre. New ideas created space for lateral manoeuvre and in the WP's depth. AirLand Battle and Follow on Forces Attack (FOFA) indicated new NATO confidence and a willingness to take offensive action. Achievable only through greater air-land cooperation.

technological superiority, and WP inability to keep up in the long-term.	Introduction of key high-tech systems: JSTARS, ATACMS. Precision munitions seen to be best means of countering WP mass.
1990+: WP reliance on mass and manoeuvre seen to be vulnerable to new NATO doctrine, and doomed in the longer-term to succumb to Western technological superiority. Legacy of WP advanced weaponry remained around the world after the Cold War.	1990+: Development continued of advanced military technology in C4ISTAR and precision. Doctrine of AirLand Battle, deep battle and advanced technologies gave NATO nations advantages in warfare after the Cold War.

3.2 THE SOVIET BLOC 1945-1962

After 1945 the power of conventional field artillery was overshadowed by that of the atomic warhead, but the USSR's accommodation with this new factor differed from that of the West. The Soviets' aim was to secure the territories they had gained in the Second World War against a background of American atomic superiority; but their military strategy remained largely unchanged. Soviet forces deployed and trained in the style of the Second World War. They were echeloned and practised fire and manoeuvre with the emphasis on fire. This was predominantly pre-planned, massed artillery fire; and the C3 of all arms was highly centralized, with the division being the lowest level of decision-making.

During the 1950s, rifle and mechanized formations were converted to motor rifle and tank formations, making combined-arms operations more practicable; but there were few innovations in conventional Soviet field artillery. On the other hand, the Soviets conducted their first atomic test in August 1949, and this was followed four years later by their production of a hydrogen bomb. Tactical systems were soon developed to deliver these weapons.¹

Although the Soviets accelerated research during this period, Stalin himself remained curiously unmoved by the power of nuclear weapons; and the Soviet Army continued to train and organize for conventional war. Soviet conventional numbers remained constant, in contrast to those of Western armies, and little account was taken of the need for greater battlefield dispersion. By the mid 1950s, the consequences of the atomic threat on the battlefield were more clearly perceived, and a fourth arm was created, armed with the strategic nuclear missile. Between 1957 and 1962 the emphasis on nuclear forces grew, in response to NATO's strategy of 'Massive Retaliation'. Theatre nuclear weapons (TNW) came to be regarded as a form of heavy field artillery and an integral part of any offensive; but Soviet field manuals persisted in teaching operations by other arms in the style of the Second World War.

NATO's approach to artillery differed to that of the Warsaw Pact (WP). In NATO,

artillery strength was greatly reduced in lieu of increasing nuclear firepower. In the WP, on the other hand, it was maintained, albeit with a re-ordered priority of resources.² The number of field guns did not grow, but there was a steady modernization and improvement in the range of field artillery as older pieces were replaced.

Self-propulsion had been increasingly favoured by Soviet artillery in the Second World War to accompany deep armoured thrusts; but in the following decades this trend was reversed because the Soviets saw little prospect of executing such manoeuvres on the atomic battlefield.³ High mobility was envisaged only in airborne operations, and in 1956 two SP anti-tank guns were produced for airborne forces; but there was no place for these equipments in other formations.

The introduction of atomic warheads did not cause the strength of Soviet artillery to be reduced, rather it changed the course of its development. This involved not just the decline of the SP gun, but also a lack of innovation in the handling of conventional artillery. On the other hand, development of the MBRL quickened, partly because of 'spin-off' from the high priority accorded to strategic rocket and missile programmes. It was also partly because the MBRL concept had a place on a battlefield in which close support of armour was not a major task, but where heavy 'shock' firepower was required against targets which did not merit, or were technically unsuited to, atomic attack.⁴

3.3 THE WEST 1945-1965

Strategy

After 1945, nuclear warheads combined with more accurate ICBMs, derived from the V2, provided the technology to match the strategic concept of the Paris Gun of 1918. Like the V2 programme itself, this was essentially a technical enhancement to an older concept - deep, strategic, indirect fire; and Karl Becker and Werner von Braun were the human links in the chain.⁵ This new combination proved so effective that the equivalent of shock and paralysis in war was achieved in the Cold War in the form of deterrence. The proliferation of missiles and chemical weapons, introduced but unused during the Cold War, constitutes a serious threat in the coming decades.

As early as 1947 Major General Homer of the US Guided Missile Center foresaw that missiles would soon be able to strike anywhere on earth, and that the USA would lose its strategic insularity.⁶ Atomic weapons made this threat uniquely lethal. NATO armies were designed to fight 'the last war', and the realization that they would have to operate on an atomic battlefield, not just of their own making, upset fundamental assumptions. At the same time there was continuing domestic pressure to reduce the size of the West's standing armies.

In its early years, NATO planned to defend from west of the Rhine. The NATO Military Committee Report 14/1 of 1952 called for light active forces of twenty to thirty divisions to screen an attack, prior to atomic interdiction by the US Strategic Air Command. There

would then be a ground offensive to recover NATO territory and liberate Eastern Europe, using a further seventy divisions from the US and European reserves. That year General J. Lawton Collins predicted that the employment of atomic weapons would reduce the requirement for conventional forces; but General Omar Bradley observed that, "When they get a bomb to neutralize ours, we better have an army to neutralize their army."⁷ Despite this caution, by the mid-1950s NATO had reduced its estimate of the number of divisions it required to twenty-six, with nuclear weapons compensating for any conventional deficiency.

In 1953, the US Army published *Atomic Weapons in Land Combat*.⁸ This and similar papers maintained that the firepower of atomic weapons enhanced the power of the offence over the defence. Frontal assault was now preferable to flanking and enveloping manoeuvres, since nuclear weapons could blow a hole through even the strongest defence. Defence would therefore have to be fluid, avoiding continuous lines, and be deployed in depth to avoid annihilation. Forces would have to be more self-contained.

By 1957, NATO's planning had become more ambitious, seeking to exploit its lead in the emerging technology of tactical nuclear weapons. The MC 14/2 'Sword and Shield' concept entailed a defence with conventional weapons as a shield, behind which tactical nuclear weapons could be prepared and deployed. These would then attack targets as far east as the Urals. There was no plan for a ground counter attack into the East since little of worth would remain. This was often termed the 'Trip-Wire'. If the Soviets launched a nuclear attack, NATO would respond in kind, a policy of 'Massive Retaliation'. By the early 1960s, the ability of each side to destroy the other, or Mutually Assured Destruction (MAD), had been accepted as the reality of the strategic stalemate.

Artillery and the Atomic Battlefield

In 1948, the US field artillery considered a role for artillery firing guided conventional munitions; and in 1950 it was agreed that missiles should be regarded as an extension of tube artillery. The Soviet detonation of a nuclear device in 1950 spurred the USA to develop tactical atomic warheads for the rocket system that would become Honest John; and between 1953-55 the US Army fielded the Corporal missile with a nuclear warhead and a range of over 140km.⁹ In July 1950, following the invasion of South Korea, the US Army developed a 240mm nuclear cannon.¹⁰

NATO also had to consider how its armies would survive and fight on the atomic battlefield. Firepower had been the decisive factor in the two World Wars; but with atomic munitions exceeding all previous norms, the need for masses of guns supported by huge logistic organizations seemed to some to have evaporated.¹¹ Many forecast that the missile, not the gun, would prove decisive¹², and some doubted that conventional weapons were required at all.

Such radical ideas did not prevail, and there was caution about 'science fiction' warfare. This ensured that US forces retained their conventional capability, and new equipment

programmes continued. One advantage of atomic weapons, however, was that they allowed the steady reduction of conventional forces from their levels of 1945, without apparently endangering the defence of Western Europe against undiminished Soviet forces.

The most notable consequence of atomic munitions was the ending of the physical concentrations of men and equipment which had characterized the Second World War. These were seen to be attractive targets for atomic fire, and in any case the resources to sustain them in peacetime were lacking. It was concluded that reduced conventional forces should disperse and be made more self-sufficient. It was estimated that with the advent of atomic warheads the depth required in defence had doubled.¹³ The generation of firepower and speed of movement had increased in an apparently constant relationship, and greater dispersion was their product. It was believed that, given the known effects of atomic yields and mobility on both sides, desirable patterns of deployment could be mathematically determined.

NATO's conventional defence in its early years was therefore based on a series of widely dispersed strong points in forward areas, with more battle positions in depth, and a mobile striking force held in reserve. Artillery was often their only means of support; but providing this for widely separated battalion positions was problematic. Dispersion encouraged the renewal of artillery affiliations, particularly at battalion level, although an infantry battalion could often expect the support of but one battery. The guns themselves were in the 'front line', which was in effect no longer linear but a series of dispersed strong points. These became extremely vulnerable, since they could no longer rely upon other arms to provide adequate local defence.

The US Army's *Atomic Weapons in Land Combat* of 1953 was a consequence of these ideas and encouraged the decentralization of artillery so that firepower could be better distributed throughout this dispersed force, which would probably be out of range of any centrally commanded, higher-level force of artillery.¹⁴ Conventional artillery was no longer expected to produce heavy bombardments to break a defence or halt a major offensive. Its tasks were humbler and tactical, if only because equipment could no longer be massed to undertake any others.

The increasing centralization of C2 had been the process over centuries by means of which greater concentrations of fire had been made possible. In this case, the decentralization of C2 after 1945 stemmed from the need to increase coverage by fire with fewer resources, and above all to mass limited quantities of fire quickly and accurately. The quality of fire support, rather than its volume, was the prime consideration. This new thinking was permissible after 1945 because massive firepower could be summoned instantly, in the form of atomic weapons; and conventional field artillery could rid itself of the burdens associated with concentrating sheer weight of fire.

With fewer assets, the arguments for centralizing their command, if not their control, retained their force, yet effective centralization was dependent upon good

communications, the problems of which were exacerbated by the dispersion of resources. The US Army acknowledged that its artillery communications were poor, because land-line was unreliable over long distances, and the threat of WP radio interference was becoming evident. In a large dispersed divisional area, fire could only be massed by relying upon the physical allocation of guns from the corps, as opposed to the fire mobility of reinforcing fire. This was normal practice in 1945, and the lessons of the Second World War were formally recorded by the US Army in training circulars, which established the principles, responsibilities and procedures for the C2 of fire support; but even in 1952 there were no detailed operational procedures or standardized organizations at corps level, "Yet corps is the most important level".¹⁵

Attempts continued in the US Army to create a yet more centralized command, with control exercised in command posts relatively distant from the guns, but based on broader intelligence. The so-called 'Pentomic Organization' of the mid-1950s in effect did away with the artillery battalion headquarters in the fire support organization; and divisional Fire Support Elements (FSE) were tasked to co-ordinate requests for fire and apportion resources to answer them; but this failed, as the FSE could not cope with the size of the task.¹⁶ By 1956 the US Army believed that its communications were greatly improved¹⁷ and by 1960, the FSCC chain had been fully integrated from corps to battalion levels.

Reforms of the early 1960s in the US Army ended the role of the artillery commander as the automatic co-ordinator of all forms of fire support. The Tactical Operations Center (TOC) was formed at corps and army, and later at divisional level. The artillery FSE became an integral part of the TOC at all levels; but in effect the authority of the fire support co-ordinator was limited to surface-to-surface systems, with no authority over aircraft or atomic demolitions, which were regarded as specializations.

The difficulty in providing adequate close and mutual support encouraged attempts to enhance the firepower of the fewer guns available by improving their mobility. Mobility could have disadvantages, and NATO armies recognized the vulnerability of mobile forces to WP air attack and enemy penetrations, let alone the logistic problems posed when units made frequent moves. Nevertheless, the US Army also saw greater mobility as an aid to survivability, and believed that it gave conventional field artillery a role on the atomic battlefield, indeed one on which atomic tactics would come to rely. Its policy was to 'shoot, move and communicate'¹⁸, displacing more often, faster, and with security. If guns were to move in forward areas of the battlefield without the close protection of other arms, they needed greater protection; and so in NATO armies at least the SP gun remained in service, eventually becoming standard for close support artillery.

By the end of the 1950s most artillerymen believed that close support artillery required a piece of about 150mm, on an SP mount, with a range of 25kms¹⁹; and similar equipments, but with lesser ranges, came into service in the 1960s, most notably the ubiquitous US M109. The British nevertheless also produced the 105mm Abbot SP gun.²⁰ Although improvements were made in NATO armies to equipment mobility and firepower, the Soviets retained a substantial numerical advantage; and ultimately this could only be

matched by a nuclear response.

The role of field artillery on the atomic battlefield became more distinct. Despite reliance on atomic munitions, there were still reservations about their use. They were acknowledged to be clumsy battlefield weapons, creating excessive destruction, termed 'overkill'; and their response time could be slow, given the need for their political release. The uncertainty surrounding the latter ensured that conventional artillery would still be required, if only until nuclear release was given.

NATO saw conventional artillery as a means of holding an attack, forcing the enemy to concentrate his forces to break in, and in so doing to present a suitable atomic target.²¹ Atomic weapons provided the massive firepower which in the World Wars had broken defences, allowing supported arms to manoeuvre. Firepower of all types, more than ever, became the means of defeating the enemy so that others could manoeuvre to seize and hold ground at less risk. "The ultimate objective is to destroy, or so to neutralize the enemy that the manoeuvre force can take and hold its objective without casualties."²²

Conventional artillery tended to concentrate more on close support than depth fire, since high-value deep targets such as C3I installations were ideal for atomic attack. Atomic warheads were also considered the best means of conducting CB operations, which required heavy concentrations of fire on positions that could not be identified with great precision. A single atomic round over enemy divisional artillery was judged to be more effective than the fire of hundreds of guns. It was, however, unlikely that the enemy would always present ideal high-value atomic targets. It would not be technically possible to hit some, and others would not merit atomic attack, being more economically and efficiently hit with HE.

There were two generally accepted scenarios for the use of conventional artillery in the attack. It could be used to defeat forward enemy positions, maximizing surprise with a high density of fire for short periods. There would be no conventional battle of attrition, but rather the enemy's forces would be encircled at speed and then annihilated by atomic coups de grace. Alternatively, atomic weapons could be used in a form of 'Blitzkrieg', whereby the defence was shattered by their destructive firepower, after which supported arms could advance. Atomic firepower would thus become the equivalent of 'carpet bombing' in the Second World War, or artillery 'area saturation' in the First.

It was noted that where similar conventional techniques had been applied in the Second World War, operations had often foundered on enemy positions in unexpected depth. In an atomic 'Blitzkrieg' operation, intelligence of deeper enemy positions was likely to be poor, and given the slower response-time of atomic fire, manoeuvre forces would need the support of quicker conventional field artillery. Once the attackers had entered enemy territory, these forces would require the support of conventional artillery to protect their flanks. In the advance after a breakthrough, small enemy rearguards were bound to be encountered. These would not merit atomic attack, but would be suitable targets for conventional missions. In this scenario conventional artillery's role therefore became one

of 'accompanying artillery', with atomic forces responsible for providing a destructive preliminary bombardment.

3.4 THE WARSAW PACT 1962-1982

The effects of the Cuban missile crisis of 1962 on the development of Soviet nuclear and conventional forces were profound. Strategic aims remained unchanged, but the Soviets deemed it necessary to build up both their nuclear and conventional forces to match or surpass American strength. The new thinking required greater mechanization and modernization of conventional forces, and a change to more mobile and flexible operations, capable of conducting a lightning war of 'bold thrusts'.

The Soviets judged that NATO would delay using nuclear weapons for as long as possible, and that while the delay lasted there would be the chance that swift and numerically superior WP forces could defeat their opponents. The Soviets themselves drew no marked distinction between their own NBC weapons and conventional forces, and never ruled out the possible use of NBC weapons to open an offensive. The Soviet concept of operations continued to require concentration in great strength to smash through NATO's defences, in echelon, on a broad front. Surprise, speed and firepower would achieve deep penetration of NATO territory, paralysing the political decision-taking and C3I structure, and knocking out nuclear delivery systems.

The two major tasks for Soviet artillery in the Second World War had been anti-tank fire and massive area attack. Sokolovskiy maintained in *Military Strategy*, first published in 1962, that these tasks were now better performed by missiles than guns. "As far as conventional means of fire support are concerned, the ground forces require weapons which can at the same time provide massive fire, both to counter enemy missiles and nuclear weapons, and to overcome small pockets of resistance, and also destroy enemy tanks. Only rockets and anti-tank missiles can truly satisfy this requirement, and it is therefore imperative that these developments be pursued."²³ The Soviet commitment to guns did not waver, but Sokolovskiy's work set the scene for the build-up of missile artillery over the next five years, when overall Soviet strength increased from 136 to 170 divisions.

Soviet strategic aims changed after 1970, with the achievement of nuclear parity. The Soviets adopted an independent nuclear policy to match the USA's independent MRBM capability in Europe. They also developed an independent conventional posture in Europe, and balanced this with the creation of world-wide intervention forces with naval and air support.

The Soviets were attracted by Fuller's idea that mobility could bring victory, not by destroying the enemy, but by disrupting him and creating total confusion. The theory of 'bold thrusts' was implemented, and their short war scenario developed eventually to incorporate the Operational Manoeuvre Group (OMG).²⁴ These developments demanded that Soviet artillerymen give closer consideration to the changing threat; develop new

equipment and tactics; and make a re-appraisal of the relationship between artillery and air-power.

The Threat and its Consequences

The Soviets believed that NATO's field artillery would not be effective against their tanks, but would be a danger to their infantry when it dismounted to assault a position. By the late 1960s, infantry anti-armour weapons were becoming more lethal, and posing a serious threat not only to APCs but also to tanks.²⁵

It became clear to the Soviets that ATGW defences would have to be suppressed, as anti-tank guns had been in the Second World War. The answer then had been to destroy them with massive artillery fire, and this remained the preferred solution; but the Soviet Marshal of Artillery G. Peredel'skiy observed that, "In a modern war it is particularly topical and pertinent to question the effectiveness of artillery fire against enemy anti-tank defences, which present a formidable obstacle to our attacking tanks and APCs".²⁶ The difficulty was that Soviet strategy required a quick victory, and it was unlikely that towed artillery, favoured after 1945, could provide adequate support on such a scale for highly mobile armoured formations. Marshal Grechko remarked that, "The continuing process of perfecting anti-tank weapons has placed before science and technology a serious task in the business of tangibly raising the viability of tank troops, and developing more effective means of reliably suppressing anti-tank defences".²⁷

In the Second World War, SP assault and field guns were used to accompany mechanized formations, and to provide close support against contingency targets as the battle developed. The Soviets noted the ineffective use of masses of towed artillery by the Arabs in the 'Six Day War' of June 1967, when it had been deployed wheel-to-wheel, firing inflexible fireplans in support of mobile armour. Even though the Israelis were outnumbered and outranged, their armour was given far better, albeit inadequate, support by their SP equipment; and the latter proved much less vulnerable to CB fire.²⁸

Soviet operational concepts were based on surprise, speed, mobility and maintaining the initiative. The evidence of the Yom Kippur War of October 1973 convinced the Soviets that they needed SP artillery to accompany their armoured formations to provide close fire support.²⁹ The rise of the ATGM was not seen by the Soviets to reduce the importance of artillery, which had formerly provided direct anti-tank fire; rather it made artillery indirect fire even more important, for the suppressing power of artillery was now to preserve the mobility of the tank.

The success of a combined-arms assault was seen to depend upon the suppression of anti-armour defences by artillery; but with improved means of target acquisition, NATO artillery posed a threat to Soviet artillery carrying out that task. Suppression of enemy artillery thus became as important as it had been in the Second World War. In October 1976 Lieutenant General Anashkin, the Chief of Soviet Artillery, went so far as to say that CB operations were the foremost task for artillery to master.³⁰ The Soviets met the threat

from NATO artillery by deploying mobile long-range pieces; and since NATO artillery was generally armoured and SP, Soviet guns had to be capable of firing short intense bursts to catch them before they moved after a mission. Their guns therefore needed a high rate of fire, and to be supported by improved means of target acquisition, all linked by a new CIS system.

Re-equipment

The Soviets did not discount the use of nuclear weapons to provide massive firepower; but by the late 1960s realized that they might need more conventional artillery as a short-term conventional substitute. They traditionally improved fire support by increasing both quality and quantity; and this method held true in the 1970s, as the number of pieces at all levels of command rose sharply. It reflected not just the Soviets' liking for mass, but also their commitment to the integration of artillery in all formations for combined-arms operations.

The Soviets believed that an artillery superiority of 8:1 on critical sectors was required in the attack³¹; and during the 1970s the quantity of equipment rose in keeping with this.³² This approach contrasted with that of Western armies, which tended to solve problems by changing procedures or improving technology. The Soviets typically tried to avoid changes in procedure, and instead to increase the numbers and quality of equipment.

In the 1970s the Soviets embarked on a major re-equipment of their artillery, producing new MBRL, SP and long-range guns³³; but the new equipment had much in common with the old, in keeping with the Soviet policy of commonality and interoperability.³⁴

The first major new piece was a 152mm SP howitzer, the M1973 (2S3), which replaced the towed D-1 M1943 at divisional level, and some of the 152mm D-20s above divisional level.³⁵ A 122mm SP howitzer, the M-1974 (2S1), followed soon after, replacing the towed 122mm D-30 at regimental level.³⁶ The 240mm M-1975 SP mortar and the 203mm M-1975 (2S7) SP gun were introduced in 1979 to replace the 203mm M1931 howitzer and the 240mm M1953 mortar; and the turretless 152mm SP (2S5) replaced the 130mm M-46.³⁷ The purpose of the 2S5 was to achieve greater range for CB tasks and to operate from greater depth. To protect an already heavy piece with armour would have made it too cumbersome, and so its survivability was enhanced instead by greater mobility through self-propulsion, like the US M107.

Consistent progress in MBRL design resulted in the BM-21 in 1964, which had a range of 20km³⁸; and by 1978 the BM-21 had been supplemented by the 220mm BM-27 in the brigades of front-level divisional artillery.³⁹ Wheeled MBRL systems were deemed unsuited to operations in forward areas, but were designed to provide massive shock by fire on pre-planned targets.

The need for high rates of fire and heavy concentrations at short notice encouraged the Soviets to streamline fire-planning procedures and the calculation of data by computer.

Such improvements in the West were usually made to increase the output of limited assets; but in the WP they were part of an overall expansion of capabilities. Improvements were certainly required, for Soviet artillery communications in particular were primitive by Western standards. Throughout the 1960s, organic artillery communications were very limited; and observers usually relied upon the supported arm to send requests for fire. These observers were tied to particular batteries and it was hard to send commands from one battery's observers to another's. The Soviets also introduced a range of new C2, reconnaissance, OP and radar vehicles, such as the BMP-1975 and the MT-LB.

The production of improved artillery equipment in the 1970s enabled the Soviets to increase artillery support at all levels; but control was often decentralized to increase flexibility at divisional levels.⁴⁰ New heavy artillery brigades were created which could be committed to a front, artillery regiments at army level were expanded to brigade strength, and at divisional level the BM-21 battalion was integrated into the divisional artillery regiment; but the most significant changes occurred at regimental level. In the early 1970s the motor rifle regiment had an organic battery of 122mm howitzers, and the tank regiment had none, but in the mid-1970s the motor rifle regimental artillery was increased to a battalion of eighteen 122mm 2S1 howitzers, and soon after that the tank regiment received an organic battalion of D-30 and then 2S1 howitzers. This distribution of SPs reflected the Soviets' wish to provide greater firepower among manoeuvre units at the lowest level to suppress enemy anti-armour defences.

The Operational Dimension

In 1977 Marshal N.V. Ogarkov, Chief of the Soviet General Staff, asked for a report on progress made in achieving the goals set by *Military Strategy*, which had caused the massive re-equipment of the Soviet Army. He concluded from this report that the re-equipment programme was satisfactory, but that its tactical application had received insufficient attention. A re-appraisal of Soviet tactics followed, which confirmed long-established principles, and introduced innovative techniques.

Soviet military thinking began with a strategic aim, an analysis of the opposition, and finally the development of tactical counter-measures, what was called the 'negation of negation'. The Soviets traditionally favoured mass and combined-arms operations to accomplish their aims; and their intention in the 1970s was to harness these in an overwhelming force which could, if required, deal a knock-out blow at the outset of hostilities, from which an enemy could not recover.⁴¹

The first 'negative' was NATO's anti-armour defence. Soviet tactics required its negation by artillery close support, followed by the negation of the NATO artillery which threatened this operation. The Soviets relied upon the speed of their armour for victory, but recognized the essential role of artillery in it, as they had done in the Second World War. In Soviet eyes, firepower and manoeuvre were inextricably linked. A force manoeuvred to apply firepower, and firepower enabled manoeuvre. Artillery remained the supreme source of firepower, even though the capability of other arms continued to

increase. Marshal of Artillery G.E. Peredelskiy declared that, "Artillery has become the basis of firepower of the ground forces. It has the decisive role of creating the preponderance of power over the enemy, which frequently determines the outcome of battle".⁴²

The problem was how to apply this firepower in the rapid mobile operations envisaged. The requirement was stated in *Voyenny Vestnik* in November 1981, which called upon artillery in a fast-moving battle to provide "accurate, shattering fire, day and night, and in any terrain and in any weather. Thus the growing importance of artillery fire in combat operations has become one of the most critical trends in the development of military art".⁴³ As in the Second World War, artillery was seen not merely as a supporting arm but as "one of the principal means of destroying the enemy decisively". The relative importance of artillery had increased. In October 1976 Lieutenant General Anashkin, the Chief of Soviet Artillery, claimed that while artillery accounted for less than thirty percent of Soviet ground forces, it had become responsible for eighty percent of missions to destroy an enemy by fire, compared to seventy percent in 1945.⁴⁴

Soviet artillery doctrine in the 1970s was preoccupied, as it had been thirty years earlier, with the questions: How could a continuous effective weight of fire be provided throughout the area of operations? How much would achieve the desired effects; and how could this best be applied in mobile operations?

The Soviets could deploy 1,300 barrels per 4km on a breakthrough sector, in keeping with norms in the Second World War; but the firepower these could generate was greater since calibres, munitions and rates of fire had increased and improved. Concentrations of equipment were achieved by means of their highly flexible organization, in which artillery held at high levels was apportioned to lower, so that at each level a formation was supported by its own organic artillery and assets from higher formations.⁴⁵ The distribution was worked out mathematically, according to the importance of the sector for attack, the effect required, and thus the number of barrels necessary for its realization.

On the other hand, in highly mobile operations guns would frequently have to displace and hence be out of action, reducing the volume of fire; and that fire would certainly be less effective if there were no time for thorough survey. Thus in mobile warfare the Soviets deemed it desirable to increase the ratio of artillery support to other arms.

The Soviets described the effects of artillery fire under three headings, which were not identical to similar terminology often used in the West: neutralization, suppression, and destruction. Neutralization created minimal damage but temporarily paralysed the defence; suppression of a position was achieved by killing twenty to twenty-five percent of the enemy holding it; and destruction meant destroying sixty percent of the men and equipment. Soviet gunners worked from tables which laid down the quantity of fire per hectare needed to achieve these effects against different types of target; and these assumed that no registration or adjustment would be fired. The type of fire required was apportioned to phases of battle, but there was debate in the 1970s over whether the

traditional preliminary bombardment, barrage leading the assault, and exploitation phases were still valid under modern conditions. In the thirty years after 1945, operations had speeded up and targets had become more mobile. Firing the traditional bombardment and barrage would have expended large quantities of ammunition ineffectually and slowed down operations.⁴⁶

In the early stages of a campaign it would have been relatively easy to fire pre-planned concentrations and barrages, but in the encounter battles which would have been expected subsequently, this would not have been the case. The Soviets had seen the dangers of armour operating without proper artillery support during the Yom Kippur War, and the task of supporting armour by engaging unexpected enemy positions was given to the SP field gun, as it had been in the Second World War. It was intended that SP guns would bombard the enemy from concealed positions 1,000m-3,000m from the FEBA, in support of a 'hasty attack'. Such fire would last for ten to twenty minutes and be followed up quickly by an assault. SP guns would not be expected to join the assault, but rather to position themselves to fire directly at strong points. In the exploitation phase, SP guns would act as 'accompanying artillery', 500m-1,000m behind leading vehicles, to consolidate captured positions and to give direct fire if necessary to break up counter-attacks.⁴⁷

It was recognized that the support of an assault against modern anti-tank weapons posed complex problems.⁴⁸ It was calculated, however, that if speed were sufficient and fire support available, attackers stood a good chance of rushing and overwhelming the defence. This also explained the introduction of the flechette round which could be fired in the final stages of an assault without endangering friendly vehicles. The new tactic encouraged reliance on smoke screens from artillery and generators, which the Soviets considered might reduce their own casualties by sixty to eighty percent by blinding enemy defences.⁴⁹

The expansion of Soviet artillery and the adoption of mobile operations supported by shorter but more intense fireplans created new logistic problems and solved others. The very increase in the quantities of equipment at all levels required a re-organization of logistics; and it was clear that so many guns could not hope to be supplied with ammunition according to the norms of the Second World War. There was the danger, familiar to many armies in history, of having numerous guns operated inefficiently for lack of ammunition. In Soviet history, however, inefficiency had more often been caused by the ill-directed firing of masses of ammunition than by the under-employment of guns. The Soviet Army of the 1970s tried to correct this by having more, but better-placed guns, firing less ammunition more productively.

Although ammunition might be used more efficiently, mobile operations created inefficiencies in the ammunition re-supply system. It was harder to predict where ammunition would be required in a series of encounter battles; and if a large amount of ammunition were brought forward and dumped, it was likely to be abandoned and lost, once the advance resumed. On the other hand, the very speed of the advance reduced the

enemy's ability to resist, and hence the weight of fire required to breach his defences. It was estimated that a Soviet tank army of 1944-45, advancing at 16-45km per day, used only one-sixth of the ammunition and one-third of the fuel of an army advancing at 4.5-13km per day.⁵⁰ Similar advantages were expected in the 1970s by maintaining the momentum of an advance. Not only would enemy resistance weaken, but mobile guns would actually have less time to fire. Should the advance be held up by stiffer resistance, this delay would itself allow the massing of more ammunition to achieve a breakthrough and restore mobility.

The Soviet ammunition re-supply system was more responsive to artillery requirements than that of many other armies, since Soviet artillery was responsible for its own re-supply. Higher artillery formations allocated ammunition to lower, according to tasks, just as they decided the distribution of guns. In 1980 this organization was reinforced to reduce the strain on units to which others were attached, and an armoured limber, the MT-LB, was introduced ahead of similar equipment in NATO.⁵¹

Mobile operations created a new balance of logistic advantage and disadvantage, with which the Soviets believed they could cope. On the other hand, the overall logistic advantage was likely to lie with NATO forces in defence, who could dump ammunition for use even for mobile operations. As long as realistic ammunition expenditure rates were approved and provided for, and this was far from certain, NATO guns should always have had more ammunition available to them than those of the WP. This advantage would have been even greater if commonality in shells and logistic assets could have been achieved.

Artillery and Air Power

During the Second World War, airpower was used to provide long-range destructive firepower as well as close support. The degree to which it could be developed and relied upon depended on air superiority, which eventually lay with the Allies. While the British and Americans came to depend almost exclusively on aircraft rather than artillery for deep attack, the Soviets never allowed aircraft to supplant artillery in this role.

In the 1970s, the Soviets faced the problem of how to provide fire support to fast-moving armoured formations, and how to deliver fire deep into enemy territory, either in support of a deep armoured penetration, or in order to knock out the vital C3 and nuclear delivery systems lying beyond artillery range. With the prospect of air superiority, it seemed likely that aircraft could meet this requirement.

The Soviets were impressed by the versatility shown by US helicopters in the Vietnam War, and saw this confirmed in the Yom Kippur War of 1973.⁵² Marshal Ogarkov's review of 1977 called for the re-organization of air support in combination with that of artillery, taking into account both helicopters and fixed-wing aircraft. Airpower was viewed like artillery as an indispensable part of 'Integrated Fire Destruction'.⁵³ As a result 'army aviation', including twenty HIP and forty HIND helicopters, was created at army level; and a squadron of six HIP and six HIND helicopters was allocated to divisions, as

an organic unit, to provide medium lift and a suppressive fire capability.

The particular value of Soviet attack helicopters was seen to be their ability to move, yet remain in close communication with mobile ground formations over long periods of time. They could acquire targets more easily than fixed-wing aircraft, and choose their moment and target for attack with greater flexibility. The Soviet HIP and HIND, and later the Mi-28 HAVOC,⁵⁴ helicopters had a role comparable to that of the Stuka in the 1940s; or, by another analogy, the role of the helicopter in three-dimensional battlespace was regarded as similar to that of the assault gun of the Second World War on a two-dimensional battlefield. In the Second World War, field artillery had suppressed enemy defences to allow the advance of armour. In the Soviet concept for the 1970s and 1980s, field artillery was also to suppress enemy AD weapons in order to assist the mobility and operation of helicopters. Soviet troops identified their own positions with red smoke, and helicopter aerial artillery put in swift attacks on targets beyond the sight or range of field artillery.⁵⁵

Soviet airpower in ground support was regarded as but another means of delivering the effects of firepower, and was therefore subordinated to the ground commander. Helicopters served as a branch of artillery, playing a full part in the preliminary, assault and exploitation phases of the battle.⁵⁶ Western helicopters at that time were, by contrast, generally used like tanks, emphasizing mobility and shock action against enemy armour, rather than close fire support on the artillery model.

The suitability of the helicopter for the close battle allowed Su-25 'Frogfoot' and other fixed-wing aircraft to concentrate on deeper targets.⁵⁷ Until the mid-1970s this had not been wise, since the available MiG-21, Su-7 and Yak-28 aircraft had limited range, and their massive deployment forward to East Germany might have compromised surprise. The introduction of longer-range aircraft such as the Su-17, Su-24 and Su-25 overcame this problem.

Summary

Soviet strategy in the 1970s required that conventional forces be capable of fighting and defeating NATO forces before a nuclear release. The tactics adopted to achieve this emphasized speed and mobility, making it harder to provide the traditional levels of fire support required by the Soviets. Their solution was to re-introduce the SP gun, and to deploy large numbers of helicopters, providing flexible close support for combined-arms formations in encounter battles.

Mobility was not regarded as a substitute for firepower, as it had been at other times in history; and the Soviets introduced qualitative and quantitative improvements in a new range of artillery equipments at all levels to overcome disadvantages inherent in such fluid tactics.

Despite the resources and thought devoted to the reforms of the 1970s, the Soviets themselves were not convinced that their tactics would succeed. NATO's positions

became deeper within agreed forward deployment areas; and its method of operating became more flexible, as proliferating ATGW released armour for mobile tasks. It was far from certain that Soviet artillery would defeat the former, and so enable successive echelons of armour to penetrate swiftly into rear areas, achieving the Operational paralysis which strategic aims required. By the early 1980s the Soviets were considering new ways of increasing the element of surprise and speed of penetration, and the new demands this would make for fire support.

3.5 NATO 1965-1982

In the mid 1960s, assumptions about the conduct of nuclear war came to be questioned in some NATO countries. Deterrence based on 'Massive Retaliation', for even a minor act of aggression by the WP, lacked political credibility. In a sense, the potential destructiveness of this firepower was so excessive that it proved counter-productive. US strategy moved away from 'Massive Retaliation' to one of 'Flexible Response', which became accepted NATO doctrine in 1967 with MC 14/3.⁵⁸

A 'Flexible Response' commensurate with the threat was also underwritten by nuclear deterrence, but it envisaged the likelihood of a conventional phase of war preceding a nuclear exchange. 'Flexible Response' thus required the capability to fight across the whole spectrum of operations. For 'Flexible Response' to succeed, NATO forces had to demonstrate that their conventional forces could avert defeat for at least a matter of days. It was reasoned that an early resort to nuclear weapons would severely limit opportunities for negotiation, and would invite escalation to a strategic nuclear exchange.

The US Army produced its Reorganization Objective Army Divisions (ROAD) in the 1960s to enable it to fight across the spectrum of operations, ending its reliance on nuclear warfare. Those who feared that organizations for nuclear war weakened the US Army's ability to conduct conventional warfare with concentrated artillery fire were reassured. 'Flexible Response' necessitated a re-assessment of relative strengths, the tasks required to match the threat, the equipment and munitions to perform these tasks, and the C3I to operate it effectively.

Relative Strengths

The change in doctrine required NATO to pay closer attention to the conventional balance of forces in Europe. In the late 1960s there was a serious imbalance in favour of the WP in armour, artillery and aircraft, if not in manpower; yet the assumptions of most NATO armies were based on the lessons they had learned in the latter half of the Second World War, when the Allies had enjoyed numerical superiority on land and especially in the air. The character of the battlefield now envisaged would be very different from that of 1945. Throughout the period, the primary threat to NATO was one of fast-moving WP armoured formations advancing in echelon, possibly at short notice, close behind a nuclear or chemical bombardment. Battles would be a series of short engagements in which the WP would have greater artillery support and air superiority, and would practise extensive

electronic warfare.

NATO had already forfeited conventional fire superiority. Cuts imposed on artillery in the West after 1945 were not made good, while in the 1970s Soviet artillery had expanded.⁵⁹ This was particularly unwelcome for the US Army, which had traditionally taken fire superiority for granted.⁶⁰ The prospects of the US Army in Europe beating the enemy conventionally and winning an artillery duel looked remote. In 1977, Brigadier B.W. Davis of the British Army feared that, “within the division of the future we will not have the capacity to carry out any sort of attack above battle group level”.⁶¹

In 1982, artillery comprised twenty-eight percent of the Soviet Third Shock Army, roughly the same percentage as it did in the British Army in 1918 and 1945. By contrast, in 1982 artillery comprised just sixteen percent of the French Army and the Bundeswehr, eleven percent of the US Army, and nine percent of the British Army. The British 1st Corps in NATO’s Northern Army Group (NORTHAG) could muster only about 200 guns across a front on which its WP counterpart could field 100 per km on main axes.⁶²

The British Army had become structured for and accustomed to counter insurgency (COIN) and internal security (IS) operations, tending to neglect considerations of fire support, reducing artillery missions to what often amounted to mere harassing fire.⁶³ Despite the political importance attached to NATO operations, artillery in the British Army remained at levels more appropriate to light operations in limited wars.

Conventional defence was a task for which artillery was poorly equipped and prepared; but this in itself lowered the nuclear threshold, and so perhaps reinforced deterrence, even though the intention of Flexible Response was to raise it. NATO artillery had to devise a means of meeting the threat from Soviet artillery, and the 40,000 AFVs fielded by the WP. With relatively little conventional firepower, and the desire to avoid the costly use of nuclear weapons, NATO was attracted by forms of ‘Mobile Defence’; but these entailed little depth, given the political imperative for forward defence.⁶⁴

US ‘Active Defence’ amounted to a battle of attrition based on the generation of firepower, but with inferior resources in absolute terms. The Germans favoured ‘Position Defence’, intending to hold ground well forward using manoeuvre to create the conditions for the surprise and shock of a counter-attack or counter-stroke. The British, on the other hand, lacked both firepower and mobility, and planned ‘Positional Defence’.⁶⁵ Whatever the nuances of these national approaches, in essence NATO defended forward in a shallow defensive belt, with minimal Operational manoeuvre, supported ultimately by nuclear weapons.

Tasks

The primary task in defence was the close, anti-armour, counter-mobility battle, as it had been in the early years of the Second World War; but this became more important with the steady introduction of APCs for Soviet infantry after 1945. The second was the

suppression of WP firepower both on the ground and in the air. The resurgence of field artillery in the Second World War began with the realization that artillery, whether specifically anti-tank or field, was the arm best-suited to destroy armour; and it developed with the realization that only massed artillery firepower could effectively neutralize or destroy enemy fixed defences.

By the 1960s the tank, armed with an improved gun, had assumed prime responsibility for anti-armour operations; and although field artillery retained a direct fire capability for use in extremis, indirect fire became increasingly ineffective against better-protected WP armoured vehicles.⁶⁶ The US *FM6-20* of 1977 might describe artillery's fire support mission as, "To suppress, neutralize or destroy surface targets with indirect fires"⁶⁷, but the most important of these were armoured and difficult for artillery to tackle. Since the Soviets planned for mobile offensive armoured operations, there was little prospect of artillery proving its worth against WP defensive positions. NATO's artillery therefore struggled throughout the period to regain an effective anti-armour role; but it failed in competition against the improved capabilities of tanks, armed helicopters, and infantry ATGW.

The armed helicopter had demonstrated its value in the Vietnam War⁶⁸, and was seen to have potential against armour as, "An extension of artillery, as close air support for deep armoured raids or to kill tanks".⁶⁹ In 1972 US Army-Bundeswehr trials at Ansbach showed that ATGW could kill eighteen armoured vehicles for the loss of one helicopter platform. Helicopters were armed for such tasks with weapons comparable in sophistication to those used by the infantry.⁷⁰

These weapons were more effective in this role than indirect artillery fire. It was suggested by some that artillery should abandon its indirect role altogether and concentrate on the direct fire anti-armour battle⁷¹, although this would have been at the expense not only of indirect anti-armour fire but also, and more importantly, of CB operations. It was doubtful, however, whether artillery would have proved more cost-effective than ATGW, or as survivable in that role.

The lack of an effective indirect fire, anti-armour capability to hit enemy armour at long range meant that the latter could reach NATO's main, but relatively dispersed and shallow positions undisrupted. It allowed the enemy to advance more quickly, it reduced the time available for preparing defensive positions, and so increased the likelihood that these positions would be swamped.

Matters were made worse by the introduction of Soviet SP close support 'accompanying artillery', which in effect multiplied the number of AFVs in leading WP echelons, and placed an even greater strain on NATO artillery's C3I and logistic systems. It was estimated in 1977 that the WP could achieve a 6:1 superiority over its NATO opponents⁷². Exercises held in the 1970s often showed that defences could be overwhelmed by an attacker's first echelon, and events move so quickly, and with such confusion, that it could take seven minutes to concentrate the fire of a British division, whereas in Korea it had

taken the Commonwealth Division just seventy seconds.⁷³

The British found that they lacked not just an effective indirect artillery anti-tank capability, but for a time in the 1970s even an effective infantry ATGW. They attempted to make good this deficiency by using tanks in what amounted to the static close support of infantry positions, rather as the Germans had done with tanks and SP guns in Italy in the Second World War. This was an expensive means of providing what amounted to an 'infantry gun'; and deprived commanders of their primary means of fire and mobility, and so of counter-attack. By the mid-1970s infantry anti-tank weapons had proved their worth and were available, and the British released their tanks for counter-attacks or counter-strokes. The role of artillery in these major re-organizations was minor, reflecting its relative decline at that time.

The efficacy of infantry ATGW was demonstrated in the Yom Kippur War of 1973.⁷⁴ There were examples of tanks, such as those of the Israeli 190th Armoured Brigade, being stopped or diverted by heavy artillery bombardment⁷⁵; but these were most notable for being unusual, and for the inefficient use of such heavy firepower to achieve an end which ATGW might have achieved more readily. At ranges of up to 4km from the observer, artillery indirect fire was not only expensive and relatively ineffective, it also became a positive disadvantage because its smoke and dust obscured targets for direct fire weapons. Yet few OPs could see beyond 4km in a North-West European landscape. Artillery was faced with the dilemma of concentrating ever more resources on relatively inefficient close support, or reducing that support for affiliated units, and concentrating on deeper, primarily CB tasks.

In peacetime, supported arms had grown used to the 'direct support' of affiliated artillery down to battalion level. In the British Army this was partly the fault of unrealistic small-scale training, and of experience of limited operations. It was hard to convince supported arms that they would receive better support by giving up guaranteed, but limited, local support in order to create larger concentrations of fire, possibly beyond their own observation.⁷⁶

Close support became less attractive, but NATO's ability to wage effective CB operations was doubtful. In the First World War the focus of attention had shifted to depth fire as the war progressed; but during the Second World War this had returned to close support with the expansion of air power. There were many advocates of reviving deep, and in particular CB operations by artillery. Brigadier B.W. Davis saw the deep battle as a separate battle, "unrelated to other arms except in the air".⁷⁷ Targets in the close battle tended to be hard, while those in depth were softer and offered artillery a unique opportunity to find a worthwhile role, provided they could be located.

The success of ATGW in taking over what had formerly been an artillery close task increased the importance of artillery in deep attack, for suppressing those ATGW became the top priority for WP artillery. In turn it became important that NATO forces conduct effective CB to pre-empt this suppression, and so become an indirect means of imposing

counter-mobility.⁷⁸

The US Army went some way towards improving its CB operations, renamed 'Counter-Fire' (CF), by moving target acquisition batteries from corps to division. It had been found that corps could not cope with the scale of the problem on a battlefield of greater frontage and depth. It was hoped that divisions could manage matters better, and that divisional artillery would respond more quickly to intelligence. The problem was that most divisional artillery assets were committed to brigades; and the divisional commands had usually to call on the support of the artillery brigade at corps, so in a sense there was little change.⁷⁹ The Bundeswehr had few resources for depth fire at corps, favouring the divisional level of command, as the Wehrmacht had done in the Second World War; but the British were even worse off at all levels; and relied on C3 as a force multiplier to increase the number of guns available to fire at any one time, and a higher speed of response.

Overall, NATO artillery lacked the means to acquire sufficient WP targets in depth. It also lacked the firepower to defeat WP artillery, which deployed in such strength that it could conduct its close support tasks and still devote more assets to CB than its opponent had guns altogether. NATO guns had the advantage of being largely SP and armoured, but there was little likelihood that NATO might win an artillery duel. The best hope of correcting this imbalance seemed to lie in achieving a 'first-round capability' through sophisticated target acquisition and greater accuracy.

By the mid 1970s, NATO's artillery was in an unhappy situation. In the close battle it was relatively ineffective against armoured targets, and at longer range it was still less effective, even if targets could be acquired. Poor target acquisition, compounded by numerical weakness, made artillery incapable of conducting the effective CB operations which circumstances required. Air support provided the bulk of depth fire in the Second World War in place of artillery; and it was widely and wrongly assumed that somehow large numbers of close support aircraft would continue to be available for such tasks; but the proliferation of WP AD weapons in combined-arms formations made this unlikely, in view of the high risk and expense. Artillery needed to develop its own indirect anti-tank capability, and to improve its CB operations. Both required better target acquisition, and if not more guns, then at least the means of generating more firepower from fewer guns on a dispersed battlefield. That firepower could be increased by improving ordnance and munitions, and multiplied by advances in C3I.

Ordnance

NATO deployed many varieties of field gun, but the US 155mm M109 howitzer was the predominant source of close fire support. It was a highly regarded piece, designed in the 1950s and introduced into service in the mid 1960s. Numerous modifications improved its performance, and it remained in service in many armies into the 21st Century. Even in its original form it was markedly superior to the British 105mm Abbot, whose calibre as a field gun in armoured operations was shown to be obsolete in the Yom Kippur War.⁸⁰

Despite improvements, the M109 of the mid 1980s had serious deficiencies, which prevented major increases in firepower by close support tube artillery.⁸¹ It lacked the mobility of the new generations of tanks such as the M-1 Abrams, and infantry AFVs such as the M-2 Bradley. Its range was relatively short at 18km, and its accuracy did not meet requirements. Its standard shell was less effective than more modern 155mm munitions; its rate of fire was relatively slow and it had no burstfire capability. It had neither an automated ammunition system nor, in most armies, the support of an armoured limber. It lacked NBC protection and its armour was too thin.

It was appreciated in the early 1970s that a replacement would be needed by the early 1980s, if not earlier. The USA opted for a series of major improvements to its fleet of M109s; but a number of European countries set about developing their own close support SP guns.⁸² The UK, West Germany and Italy began a collaborative project named SP70 to overcome many of the M109's deficiencies; but the project was dogged by delays, and was abandoned in January 1987.⁸³ The US Army rejected the SP70 on the grounds of its development problems, low ammunition-carrying capacity, limited rate of fire and lack of on-board fire control and survey equipment. One consequence of the delay in producing SP70 was the spawning of commercial turret designs to replace or modernize the M109. One of these was ultimately incorporated in the AS90 which entered service in the British Army in the early 1990s.⁸⁴

NATO armies were slow to recognize the potential of MBRL, except for the Bundeswehr, which fielded the 110mm LARS in the late 1960s⁸⁵, remembering German experience on the Eastern Front twenty years earlier. By the late 1970s, a collaborative project was underway in Europe to produce a higher calibre launcher⁸⁶; but this failed and the participants joined the USA in its MLRS project.

Munitions

Improvements in ordnance alone could not bridge the capability gap that existed in NATO artillery. If field artillery were to dominate armour as it had forty years earlier, it would need improved munitions as well. There were several potential methods of improving munitions. Range could be increased by 'base-bleed' devices, or RAP⁸⁷. The value of these rounds against armour could be enhanced by increasing terminal accuracy and by making the terminal effect more lethal.

Throughout the period, the tank became a less attractive investment. The power of the ATGW increased at a faster and more cost-effective rate; and as so often in the past, the demise of the tank was prematurely predicted. Although the tank certainly lost relative power, artillery fell even further behind. Infantry and helicopters developed anti-armour capabilities of their own, and were able to deploy that firepower at speeds greater than, or equal to that of the tank; but ATGW lacked the combination of weight, range, flexibility and all-weather, 24-hour availability offered by artillery. The challenge was to create an artillery anti-armour weapon, equalling ATGW in effect, without forfeiting the qualities of

artillery.

The best method of attacking tanks of traditional design is from above or below. Technical possibilities for both were widely discussed in the early 1970s.⁸⁸ The fundamental problem with a traditional HE shell is that it produces 'overkill' at the point of burst, has a wasteful and often ineffectual fragmentation, and an uncontrolled direction of burst. One alternative was seen to be the Improved Conventional Munition (ICM), a carrier of sub-munitions, which spread their effect, preventing 'overkill' at a point, the original rationale behind the HE shell and earlier shrapnel round. These sub-munitions would incorporate terminal guidance and a warhead appropriate to the target, such as a shaped charge. The penalty for this dispersion of the sub-munitions was the loss of concentrated power against a hard target.

A standard 155mm shell stands a better chance than ICM of killing a hard target with a single strike against top armour, but it requires greater accuracy than a spread of sub-munitions, and thus some form of terminal guidance. Without such guidance, 155mm rounds might force tanks to close down, damage ancillary equipment, weaken crew morale and prevent logistic re-supply and maintenance; but they are not likely to be cost-effective tank-killers. A major effort was therefore made to develop terminally-guided munitions, exploiting the emerging electronic technologies of the 1970s.

Such concepts were developed, but none of these advanced munitions had entered service by 1982, except for the US family of scatterable mines (FASCAM), and the German LARS anti-tank mine-carrying rocket, both of which were held at divisional level.⁸⁹ This was one area where artillery expanded its role, in what had formerly been an engineer preserve.⁹⁰

Scatterable mines may be required when engineers' minefields are not ready in time, or when engineers do not wish enemy reconnaissance to see them laying minefields. They allow a quick response to unexpected enemy manoeuvre, can close defiles or gaps in existing minefields, and help to achieve a clean break during a withdrawal. They can be used to separate enemy leading echelons from those behind, and from their logistic support. They are well-suited for harassing tasks on headquarters, forming up places (FUP), bridges and airfields; and they can interfere with enemy obstacle-breaching and DZ/LSs. They can also be laid in terrain unsuited to mechanical laying.

Scatterable mines may often be more cost-effective than ATGW or tanks, since they allow the bottom-attack of tanks while the firer remains unseen. They can be delivered by helicopter, fixed-wing aircraft, or artillery. The artillery rocket has the advantage of stand-off delivery, reliability and flexibility, but aircraft have the advantage in range. They give the commander the ability to control movement on the battlefield within the range of the gun and rocket, creating dynamic reinforcing obstacles which can be used in response to the flow of battle. Anti-tank screens were used in the Second World War to channel the enemy, force him onto unsuitable routes, or halt him. Scatterable mines achieve similar results; and their introduction in the 1970s marked artillery's return to a major anti-armour

role since its eclipse in the 1950s and 1960s. Further than that, they were the first means by which artillery could attack armour effectively in depth, and this was achieved not by weight of fire, but by its equivalent through terminal accuracy and attack against a vulnerable part of a tank - precise effects.

The delivery of FASCAM by 155mm artillery highlighted the problem that arises when close support artillery is employed in deep attack; and the arguments would have sounded familiar seventy years ago. How can artillery provide close support, when it is engaged on deep missions? On the Cold War battlefield, attacks on deep armoured targets were in effect a form of counter-preparation fire, and their planning required good intelligence and an appreciation of the time factor in a commander's mind. The decision when and where to attack, and when mines should destroy themselves, had to be taken at a relatively high level; and this ran counter to the desire to control them lower down. LARS was designated a divisional weapon, and FASCAM were also controlled by US Army divisions; but this complicated matters for guns intended primarily to support brigades with standard varieties of ammunition.

The need to keep mobile guns supplied with a large number of special munitions tended to reduce that mobility, and placed strain on the logistic system. It might have forced guns to stay close to a logistic base, and so reduced tactical flexibility. The alternative was to dedicate guns specifically to FASCAM missions, and to hold them apart from those in close support; but this made the 'opportunity cost' of employing FASCAM high. Another option was to increase the number of guns; but this carried the penalty that those firing FASCAM would probably be under-employed for much of the time. The best compromise was probably to combine FASCAM with other ammunition types, relying on better Command Control and Communications (C3) to optimize their use and logistic support.

Command Control Communications and Intelligence (C3I)

Ammunition, rather than guns, is generally artillery's true reserve, and barring over-riding concerns for concealment or conservation of ammunition, guns should be in action as often as possible. The pressure to keep guns in action is felt most by those with fewest guns, and they traditionally satisfy this demand by improving C3I. For this reason the major advances in C3I during the Cold War were made in the West; but it was only from the mid-1960s that major progress was made, in the knowledge that field artillery had to improve its 'productivity' if it was to compete with more numerous WP forces. For the same reason it was the British Army, with relatively the smallest force of artillery, that led the way in the co-ordination of fire control as an alternative to the high cost of massed manpower and equipment.

The US Army introduced FADAC in 1959, but the first major advance in artillery computation was the British Field Artillery Computing Equipment (FACE) in 1968. It replaced slide rules and firing tables, but did not affect the delivery of fire orders to guns or target engagements.⁹¹ It took into account numerous ballistic factors, and produced

firing data for guns more quickly than older graphical or plotting techniques. It was enhanced in the 1970s by the introduction of the AMETS⁹² meteorological system, of AWDATS, which transmitted data directly from command post to gun, and of the position and azimuth determining system (PADS), which the USA and the UK introduced to improve survey. These systems improved accuracy, response times and consequently the first-time hit capability, which was judged an essential factor in effective firepower. Despite the dispersion of fire units, it once again became practical to concentrate the fire of guns, as had been common in the Second World War; although it would have been unusual to fire the '72-gun battery' of 1943, since it was unlikely that that number of guns would be in range of a given target. This lack of density remained the major problem; but its consequence on the ground was compensated for by the ability to engage series of targets in even more rapid succession by whatever guns were in range.

Other NATO armies introduced comparable systems, such as the US TACFIRE⁹³ and the German FALKE.⁹⁴ These were often upgraded, but during the 1970s they were primarily concerned with the calculation of firing data and target storage. The outstanding problems were the secure communication and processing of the data, which had proliferated. Solving these was the priority for C3 in the 1980s.⁹⁵ The more efficient use of guns, as a result of improved C3, also increased the logistic burden and work-load on each fire unit, assuming that ammunition for higher expenditure rates was available.⁹⁶

Improved C3 made it possible for guns to engage more targets more often, but the value of that fire was only as good as its targeting. Attempts were made to improve artillery intelligence by means of sound-ranging and aerial reconnaissance⁹⁷; but intelligence remained a weak link, and without comprehensive 'real time' systems it was not possible to acquire and attack the larger number of targets which improvements in C3 had been developed to handle.

The need to coordinate tactical fires better became apparent in the US Army in the late 1970s. In 1975 the mechanized infantry company had three separate observer elements, one for the 81mm mortars, another for the 107mm mortars and one for field artillery. The result was that a company commander could not readily coordinate these indirect fires. The US Army's Close Support Study Group I had the task, "To optimize observed fire support for maneuver forces on the modern battlefield". It resulted in the creation of FISTs, combining infantry mortar forward observers with field artillery observers.

Most targets were still located by such ground observers, who were assisted by a variety of new devices such as radars, image intensifiers, and laser range finders. Despite these, an OP was unlikely to acquire targets beyond 4km from the FLOT; and so the majority of artillery remained tied to the close battle, for which its HE munition was ill-suited. The anti-armour battle could not be prosecuted by artillery in depth; and what deep tasks there were, were primarily CB/CF or against headquarters, since these could often be engaged without 'real time' intelligence. Even the Bundeswehr's LARS lacked a target acquisition capability commensurate with its firepower. These faults were recognized, and a number of remotely controlled surveillance projects were initiated, of which several foundered; but

by the early 1980s most NATO armies had firm plans to produce RPVs to support their plans for MLRS.

Conclusion

In the early 1960s, NATO realized that for political and military reasons it must offer a more credible conventional deterrent in order to raise the nuclear threshold. The WP threat had become primarily an armoured one, and artillery had neither the mass, ordnance, munitions, nor C3 to deal with it adequately.

The tank remained the primary anti-armour weapon system until the early 1970s, when advances in ATGW gave the infantry a power and independence it had not held since 1914. It was also found that the helicopter could give ATGW unrivalled mobility. The PGM revolution of the 1970s offered NATO an equivalent to massed firepower through relatively light, but accurate, weapons. Their disadvantage was that their range was generally limited to 2-3km, and their survivability was questionable in the face of enormous Soviet suppressing artillery fire. The challenge was to increase their range by means of artillery delivery systems. Artillery's problem had been that longer range decreased accuracy, but the PGM meant that accuracy was no longer necessarily a strong function of range. Long-range fire became potentially as accurate as close fire. Deficiencies in artillery were recognized and projects initiated to increase firepower and its terminal effect on armour; but these were disappointingly slow to enter service, and throughout the period artillery's importance on the battlefield declined as others were quicker to deploy more effective weapons to tackle enemy armour.

It was a period in which tactics emphasised the need for firepower and attrition in defence, but artillery firepower was lacking and unable to provide it. The potential for armoured manoeuvre by NATO forces was recognised, but it was limited by political considerations to a shallow defensive belt close to the IGB. NATO forces therefore practised little manoeuvre, yet were unable to generate adequate conventional firepower instead.

3.6 THE WARSAW PACT 1982-1990

In July 1982, the Soviet Minister of Defence, Dmitrii Ustinov, declared that, "In the preparation of the armed forces even more attention will be devoted to the task of preventing the development of a military conflict into a nuclear one".⁹⁸ WP policy was guided by the need to avoid NATO's first use of, or retaliation with, TNW; and if possible to decouple US strategic nuclear weapons from NATO's TNW.

In the 1970s, WP doctrine envisaged the use of fast-moving armoured assaults and these became narrower and deeper in planning iterations over the years.⁹⁹ NATO's response was to field masses of infantry anti-tank weapons, deployed in as much depth as the policy of 'Forward Defence' allowed, and to make increasing use of mobile armour in the counter-attack.

These developments alarmed the Soviets, who remembered vividly the costly delaying battles of the Eastern Front in the Second World War; and their concern was confirmed by study of the lessons of the Yom Kippur War conducted at the Frunze Military Academy in 1974-75. In that War the Egyptians had achieved surprise and mobility, yet failed to overwhelm the Israelis quickly enough to prevent their recovery. The Egyptians had also demonstrated the power of infantry anti-tank weapons in defence against Israeli armour lacking adequate fire support.

The Soviets improved the firepower of the tank, to the extent that many tanks were able to undertake the role of the assault gun of the Second World War. Soviet tanks were issued with a large stock of HE ammunition to suppress enemy anti-tank defences, but many also carried the AT-8 anti-tank missile, enabling them to stand off and hit defending tanks beyond the range of direct firing tank guns. In addition, the Soviets tried to devise a tactic that would enable them to retain the initiative in a war, and to break NATO before its conventional forces could organize a defence, and so buy time to fire its nuclear weapons. Drawing lessons from their own history and that of Middle Eastern wars, the Soviets came to favour a doctrine of pre-emptive deep strike, a kind of Blitzkrieg operation that might itself be nuclear, but which was intended to avoid a war of nuclear attrition.

Deep penetration by cavalry had been a feature of Tsarist military tactics in the late 19th Century.¹⁰⁰ Tukhachevsky advocated high mobility in the 1930s, but his ideas were lost in the purges of that time.¹⁰¹ During the Second World War the Soviets employed armour-heavy 'mobile groups' to provide combined-arms mobility and firepower.¹⁰² At the same time, Soviet fire support doctrine called for all targets throughout an Operational area to be hit simultaneously. These precedents of fire and manoeuvre in depth became the conceptual basis for the OMG and its fire support.¹⁰³ The OMG was first considered in the early 1970s, coinciding with the appearance of the 2S1 and 2S3 SP guns and armed helicopters, and it became an established element of doctrine in the early 1980s.

OMGs were intended to destroy NATO's will to resist and to achieve victory before it could fire nuclear weapons. They would operate against NATO's decision-making headquarters, knock out nuclear delivery systems, and make NATO commit its forward troops and reserves as early as possible; but the Soviets believed that a victory on these terms could be gained only if the WP achieved strategic surprise. The OMG was designed to exploit that surprise at the Operational level, and to engage NATO forces before they could establish a coherent defence with engineer support, and deploy an effective reserve. In such a campaign, OMGs would have expected to fight a series of meeting engagements. The Soviets believed that in such close-quarter battles their mass of equipment, firepower, battle drills and momentum would be decisive.¹⁰⁴

The Soviets always put the highest priority on numerical and fire superiority. Major General I. Vorobyov maintained that there was a need for Soviet forces to co-ordinate all sources of firepower to deliver a series of blows, breaching enemy positions, enabling manoeuvre forces to outflank defences.¹⁰⁵ This manoeuvre would spoil enemy

deployments and prevent defences from opening fire and from launching counter-attacks; but these advantages would obtain only if firepower created the opportunity.

By increasing their speed, the Soviets reduced the time available to NATO to prepare defences, and so speed became as important as firepower, and a factor in its effects. The difficulty in providing high levels of fire support was therefore not as serious as it would have been in slower operations; and it reduced still further as the technology of artillery munitions developed.

Soviet OMGs differed from the forces which US corps might have deployed forward to disrupt Soviet second-echelon forces in the AirLand Battle concept. The former were larger, designed to go deeper, and would not necessarily have avoided major engagements. They were consequently 'harder', and expected the support of accompanying artillery as well as that held behind.¹⁰⁶

Soviet artillery was given a preliminary task to support the OMG as it moved forward from its assembly area. It was to attack NATO's long-range fire support systems, which threatened the manoeuvre, a mission called 'support of the manoeuvre element advancing from depths'.¹⁰⁷ The Soviets stressed that conventional fire support should be 'integrated', and allow for the coordination and timing of air support, air defence and long-range missile attacks. Once an OMG was advancing in enemy terrain, a rolling barrage would be impracticable, and it would have to rely on series of concentrations and the swift reactions of support helicopters and SP guns.

Each of the OMG 'divisions' was larger than an ordinary division, and deployed more vehicles and firepower.¹⁰⁸ An OMG was dependent upon its fire support. This in turn was threatened by NATO artillery, and in the case of helicopters by AD weapons. In terms of relative mobility and firepower, the armed helicopter had assumed some of the characteristics of the tank of the Second World War, and WP artillery's task was just as surely to destroy the ground systems which threatened it.

The Soviets were increasingly worried by NATO's improved means of target acquisition, and the enhanced survivability of its guns through mobility. They consequently planned to devote about half of their artillery assets to CB fire, and to devise tactics which would catch fast-moving targets. They favoured firing CB missions in short, intense bursts by battalion or larger units, rather than batteries; and improved CIS enabled them to concentrate weapons more effectively than before.¹⁰⁹

Soviet doctrine of the 1980s was based on the achievement of surprise by mobility, made possible through fire superiority, and it thus differed fundamentally from NATO's, which came to see mobile deep attack as an antidote to the WP's superior numbers and firepower. Unless NATO could manage to achieve at least parity of firepower, in circumstances where the WP held the initiative, it seemed likely that NATO would have to continue to rely on nuclear deterrence. Yet, Soviet confidence showed signs of cracking.

By the mid-1980s, the Soviets were beginning to expose apprehension about the future. In 1982, the Chief of the Soviet General Staff, Marshal N.V. Ogarkov supported the role of nuclear weapons in theatre operations; but three years later he judged that the combat characteristics and effectiveness of conventional weapons were approximating nuclear weapons. He accepted the possibility of fighting a purely conventional war, but saw the balance of technology tilting in favour of NATO. Ogarkov recognized the power of weapons using emerging technology, which "make it possible immediately to extend active combat operations, not just in border regions, but to the whole country's territory, which was not possible in past wars".¹¹⁰

By 1984, Colonel General M.A. Gareyev, Deputy Chief of the General Staff, could claim that the Soviets had worked out a precise system of preparing and executing offensive operations." However, he also admitted to some unresolved problems: How to suppress enemy positions in depth if these contained precision-guided, anti-tank devices and long-range search and destroy weapons? How to envelop and destroy these forces? How to create dispersal in depth and across an advancing force's front?

Soviet fear of NATO's precision-guided weapons was expressed by Gareyev in April 1985. He spoke of the need for action by the USSR before the perceived aggressive threat from NATO's new approach could mature. He believed that this 'high-tech' style of warfare had, "...shifted the centre of gravity to a struggle in the field of military science and military technique."¹¹¹ This concern of the Soviet military was expressed in political action by President Gorbachev who tried to reduce conventional arms levels in Europe.

That same month, Ogarkov published, *History Teaches Vigilance*, which called for changes in Soviet doctrine in view of changes in the technology and the character of combat.¹¹² Gareyev, supported Ogarkov, maintaining that *Military Strategy*, based on nuclear weapons, was obsolete because of mutually assured destruction. On 9th October 1985, Major General I. Vorobiev wrote a column in *Red Star* claiming that NATO's precision-guided weapons now had the effects of tactical nuclear weapons, and could be fired by automated systems like TACFIRE ten to fifteen times faster than by old methods. Battle was thus so speeded up as to make previous Soviet norms obsolete and these "...must no longer orientate you."¹¹³

In August 1988, the Soviet General D. Yazov noted that the accumulation of military might had become an outdated concept. He maintained that the USSR should instead seek to maintain its forces at a level that precluded superiority over the US, yet guaranteed a reliable defence. The Soviet emphasis had moved away from a short nuclear holocaust to the likelihood of a conventional war, in which the advantage seemed to be moving in NATO's favour.¹¹⁴ The stream of Soviet military hardware continued to flow. That year, the Fire Support Board of the US Defense Science Board noted that Soviet artillery systems had increased in number from 23,000 in 1978 to 37,000 in 1988. Over the same period US systems increased from 4,800 to 5,200.

By 1990, NATO's capability to deliver conventional deep fire was expanding and the

Soviets had to consider their response. They could have increased the strength of their first echelon of twenty to twenty-five divisions in the Central Region to thirty, and replaced East European by Soviet divisions.¹¹⁵ The disadvantage of this would have been that these concentrations would have been exposed and in range of NATO guns. They could have deployed their depth echelons in smaller groups to present harder targets, but this would have created C3 problems, which the Soviets were generally less able to solve than their opponents. Logistic problems would also have increased, and they would have had to completely revise their plans. They could also have opted for an even faster assault, leaving NATO's deep attacks with fewer targets, rather as assaulting formations learned to do in the First World War, leaving enemy counter-preparation fire to fall behind them.

The Soviets recognized the rapid pace of technological change and that they would have to be at its forefront, or face stark strategic choices in the future. Any such race would also be at a punishing cost. The Soviets were already estimated to have been spending twice as much as the USA on military research and development in the mid-1980s. It is clear that the Soviets themselves believed that they could not afford a new high-technology arms race and for this and other reasons, the USSR and the WP collapsed. At the time of its demise, however, the USSR possessed an array of excellent equipment, much of it superior to that of NATO; and this remained a formidable legacy around the world after the Cold War.

Conclusion

Soviet operations in the 1970s were characterized by the wish to achieve massive superiority at pre-determined points, and to fight a pre-planned battle with inflexible echeloned formations. In the 1980s, the Soviet aim was to achieve independent combined-arms combat, in particular at divisional, but down to regimental level, exploiting changes in situations and favouring flanking rather than frontal assaults. Deep thrusts were intended to dislocate enemy C3 as a form of indirect approach. The first echelon battle was pre-planned, but those of the OMG and reserves were likely to remain flexible, while the second echelon became less important.

OMGs required more flexible fire support provided by greater numbers of SP artillery and helicopters. The move away from set-piece massive fire-planning, which started in the 1970s, continued; and although the Soviets retained a preference for masses of guns at all levels, they relied on improved fire control to create a better effect, with less ammunition, over a shorter period of time.

In the event, these developments in Operational planning proved irrelevant as the USSR lost the strategic struggle in economic, technological and political terms.

3.7 NATO 1982-1990

Concepts

In the early 1980s major changes occurred in NATO's conventional posture. These reflected the political spirit of the time and the realization that accelerating technological advances offered unprecedented opportunities for change. In both respects, US views predominated and led NATO.

The US doctrine of Active Defence, described in *FM 100-5 Operations* of 1976, was the work of the first commander of the US Training and Doctrine Command (TRADOC), General William E. DePuy. It was perhaps a reaction to the perceived weakening of the USA in relation to the USSR, while attention had been concentrated on the Vietnam War; and an attempt to generate the firepower perceived to be lacking in the light of lessons from the Yom Kippur War. The doctrine was firepower-oriented, with manoeuvre essentially lateral and limited.¹¹⁶

By the late 1970s, Active Defence was already judged unsatisfactory by many, on the grounds that it was too reactive and failed to attack enemy vulnerabilities. It concentrated firepower at the point of the enemy's greatest firepower; and although this had advantages, it would be hard for NATO to shift and concentrate defence laterally, once a WP attack had begun. It was also thought unlikely that NATO's defensive concentrations would be able to beat off a sudden attack, in which its exhausted troops would face successive, fresh WP echelons. Defences would be overwhelmed before they could inflict decisive damage. NATO was planning for a war of attrition in which the attacker held the advantage and initiative. Enemy mobility and firepower needed to be matched by dispersion in depth, or early first use of nuclear weapons; but the former was prohibited for political reasons, and the latter looked increasingly unattractive.¹¹⁷

On a political level, the USA was no longer prepared to accept a strategy in Europe that aimed merely to avert conventional defeat before a nuclear exchange. The USA advocated instead a strategy that could win a conventional war by conventional means, while maintaining nuclear deterrence. The intention was to create a new situation where a political settlement would be reached 'on new terms'.¹¹⁸

The model advocated by the USA in the 1970s required defence in greater depth than the Federal Republic of Germany could countenance, since it jeopardized the flank security of neighbouring German formations, deployed further forward. Equally, the USA was not prepared to accept a defence based on attrition in a mobile battle without depth: "It is precisely because of the structure, size and weight of the Soviet attacker that interdiction limited only to fire support cannot be expected to accumulate to decisive defeat; it must include manoeuvre to the Operational depth of the attacking army".¹¹⁹ In 1979, in keeping with this idea, General Bernard Rogers, Supreme Allied Commander Europe (SACEUR), tasked his headquarters to develop a means of deep conventional attack against Soviet follow-on forces.

The WP retained at least nuclear parity, and held massive overall superiority in conventional weapons. It had developed a new offensive tactic in the OMG, and aimed to

achieve victory, if possible without resorting to nuclear war.¹²⁰ It was estimated that NATO had just 400-600 aircraft available for interdiction missions; but they would need to attack 2,000 fixed targets up to 300km beyond the FEBA, as well as a multitude of armoured vehicles. NATO studies showed that these aircraft would need to fly 2,200 sorties to destroy just sixty percent of a single armoured division with iron bombs.¹²¹ Successful interdiction based on this existing technology was unlikely, and first use of nuclear weapons could be expected within seven days.

A new doctrine would have to compensate for this numerical inferiority through improved firepower, mobility, and superior technique and technology. If defensive positions in depth were forbidden, the equivalent could be created by stretching forward into the enemy's depth to the East. The former would have had to rely heavily on close fire support, but the latter would require heavy fire in depth. At the same time, US national studies were also concentrating on deep attack, and resulted in a new US Army doctrine known as AirLand Battle, which was described in TRADOC Pamphlet 525-5 *Military Operations: Operational Concepts for the AirLand Battle and Corps Operations*. It was published on 25th March 1981 under the supervision of the new TRADOC commander, General Donn Starry. This concept became accepted doctrine in *FM 100-5 Operations*, 1982.¹²²

AirLand Battle had three basic tenets. The first was the close battle, a manoeuvre battle involving armour, and following the doctrine of Forward Defence, which aimed to deny penetration of defensive positions in a belt 190km-deep along a frontier. The second was the rear battle, and the third was the deep battle, engaging the enemy's rear with air- and ground-launched weapons, destroying and disrupting follow-on forces.

The concept extended the battlefield in depth, as well as forward in time; with greater emphasis on higher levels of command, whose target acquisition and weapon systems would play a major role. If enemy follow-on echelons were not defeated, or severely weakened, before reaching friendly forward defensive positions, the latter would be likely to fall after a severe mauling by the first-echelon attack. The value of a deep target was seen to be not merely its physical strength, but its position in space, and the time that would elapse before it could bring that strength to bear. It followed that a disruption of enemy plans and timetables might prove as effective in reducing enemy combat power as physical damage to equipment. Target priorities therefore took greater account of sequencing in time and space.

Time was held to be important in as much as it affected the ability of an attacker to concentrate forces in the close battle against friendly forward positions. It was the link between the deep, close and rear battles, integrating the three – "It is all one battle".¹²³ Success in the deep battle was seen to make success in the close more likely as time went on. *FM 100-5 Operations* of 1982 stressed that manoeuvre was inseparable from firepower, "The enabling, violent, destructive force essential to successful manoeuvre".¹²⁴ AirLand Battle attempted to draw together Clausewitz's emphasis on violent 'effect' and Liddell Hart's 'indirect approach'. A study at the US Army Field Artillery School showed

that where an enemy suffered deep attack and a thwarted timetable, intervals of friendly superiority were created. These intervals were opportunities for manoeuvre, attack, counter-attack, or reconstituting the defence.¹²⁵ The goal of deep indirect attack was to create such opportunities well forward in the battle area.¹²⁶

Fire support for this deep attack was provided by artillery and aircraft; and historical precedent played a part in the evolution of these ideas.¹²⁷ AirLand Battle required the deep attack of critical targets in enemy rear areas, using both equipment and fire mobility. This encouraged the use of combined-arms operations and resources held at high level, continuing the dominant trends of 20th Century military doctrine.

Increased mobility offered a psychological boost, irrespective of tactical merit. Manoeuvre was justified on the grounds that positional warfare had become obsolete.¹²⁸ It was argued that increased weapons lethality would destroy static positions, that the increased range and performance of armoured vehicles and helicopters offered outstanding advantages, and that the greater ranges of guns increased the ability to concentrate fire in support of deep mobile operations.

Armoured vehicles offered protection and enabled troops to disperse and re-group more quickly. Mobility created a need for yet more mobility, for forces deploying forward would deplete defensive positions, and make it even more important that reserves be highly mobile in order to move laterally to deal with WP penetrations. The new doctrine was oriented to force, not terrain, and was thus significantly different to Active Defence, in which offensive action was essentially limited to counter-attack and counter-stroke.

Active Defence had magnified the importance of divisional and brigade operations at the expense of the corps¹²⁹, and there was little scope for major Operational mobility. Under AirLand Battle, the balance tipped in favour of the corps, as it had in the Second World War and during the 1950s. It envisaged a brigade fighting first-echelon assaulting regiments, and a division engaging first-echelon assaulting divisions. Divisional artillery fire would be co-ordinated with the plan of the manoeuvre commander. The corps' task would be to fight first-echelon armies and to disrupt the advance of second-echelon armies before they could enter the close battle. It was estimated that enemy target arrays would be at their highest on D-Day, out to 100km, and D+36 hours out to 50km. The corps was therefore required to play the major role in deep attack by ground forces, and in particular to destroy or at least disrupt second-echelon divisions as they moved to or from final regimental assembly areas. In terms of time and space, a brigade was responsible for a distance of 30km beyond the FEBA, for enemy forces within twelve hours travelling; a division for 60km or twenty-four hours travelling; and a corps for operations out to 150km against an enemy seventy-two hours away. The combined effect was that, "For the first time ground commanders will have the capability simultaneously to engage forces in contact as well as follow-on echelons".¹³⁰

US corps would dispatch units to penetrate up to 60km deep into enemy territory, and attack relatively soft, but valuable, targets in the rear of their first-echelon divisions, or

against leading elements of second-echelon forces.¹³¹ These operations would not in themselves be decisive, and battles of attrition were to be avoided, since light mobile forces could not match the major enemy forces they were tasked to disrupt.

The renewed importance of high-level operations was formally stated in *FM 100-15 Corps Operations* and *FM 100-16 Echelons Above Corps*, reinforcing the principles of AirLand Battle, which were the foundations for *FM 100-5 Operations* of 1982. A more ambitious view of how this doctrine might develop in a European scenario by the year 2000 was produced by TRADOC in *Air Land Battle 2000* of 10th August 1982, which envisaged operations against Soviet theatre of operations (TVD) echelons. There was an important distinction between the then US doctrine of AirLand Battle, and the more futuristic AirLand Battle 2000, planning for which was subsequently called 'Army 21' and dealt with the period 1995-2030.¹³² The former relied substantially on manned manoeuvre and aircraft to apply firepower, and relied on existing or improved equipment. The latter was a concept which relied on emerging technology, and the enhancement of firepower on a grander scale.

AirLand Battle was US Army, not NATO, doctrine. It marked as much as anything else a shift in American national mood, that made the defensive attitudes of Active Defence unacceptable. It stressed that, "Wars cannot be won without a national will".¹³³ The US Army wanted the ability to attack Soviet vulnerabilities and regain the initiative. These new concepts inevitably stirred up great controversy within NATO. Although NATO did not adopt US AirLand Battle, it accepted the need for deep attack with the doctrine of Follow On Forces Attack (FOFA) on 9th November 1984, which amounted to the full implementation of Flexible Response.¹³⁴ FOFA was a task to be carried out by air forces and the Pershing II missile at army group level, at ranges between 40km and 350km. It was not concerned with corps tactics, but there was an area of overlap with corps interests in deep attack between 40km and 150km.

Matters were further complicated by AirLand Battle's not being USAF doctrine either, although in April 1983 the USAF agreed to co-operate with the US Army in its application through training. The role of deep air attack or Interdiction was to delay the entry of enemy forces into battle, to prevent their interference in friendly operations, to act in conjunction with mobile forces deploying forward, and to hit specific high-payoff targets such as nuclear weapons.¹³⁵

NATO did not adopt AirLand Battle, and US corps in Europe were not able to act in accordance with this world-wide US doctrine as described in the US *FM 100-5 Operations* of 1982, although the 1986 edition of *FM 100-5 Operations* had apparently reconciled the differences between the AirLand Battle and FOFA. The US national concept for corps operations differed greatly from that favoured by, for example, the British, who did not accept the idea of deep penetration of enemy territory by corps forces, although the importance of corps operations was reinforced by the introduction of corps standing operating procedures in 1982, which might have been taken for granted fifty years earlier. The British corps retained the ability to withdraw and relocate

divisional artillery, unlike the Bundeswehr, which regarded divisional assets as sacrosanct. The British practice stemmed, however, not so much from the conviction that centralized high-level C2 was best, as from the realization that it was the only option when equipment was so limited. Neither did the British proclaim the idea of winning a conventional war in Europe. In 1982, General Sir Edwin Bramall said that the aim of Britain's armed forces was to present the WP with the Hobson's choice, which denied it the opportunity of winning a conventional Blitzkrieg before the West could use nuclear weapons.¹³⁶ This sounded like the mere "averting of conventional defeat", rejected by the advocates of AirLand Battle, who wished to "win" a conventional war.

British thinking developed along less radical lines than the Americans'. The British commander of Northern Army Group (NORTHAG) in 1984 criticized an "over-literal interpretation" of Forward Defence; and rejected, "a battle of attrition which can only end in ultimate if not early disaster"¹³⁷; but, instead of dispatching troops forward, as in AirLand Battle, he advocated the maintenance of a strong reserve to deal with the enemy on chosen friendly terrain. The enemy would be engaged in depth only by aircraft. Either way, NORTHAG tactics and AirLand Battle both relied on mobility, whether forward, or laterally from depth positions, to offset larger enemy forces. Both approaches were well-tried, but mobility has seldom achieved a decisive outcome in modern war unless it has been used to exploit superior firepower, rather than to compensate for its lack.

ISTAR and C4

NATO armies may have disagreed on tactics in the early 1980s and on the best use of resources, but the equipments which entered service in the 1980s shared many characteristics, and some were collaborative ventures. There was general agreement that NATO needed improved surveillance and target acquisition devices, and a system of C4I to integrate intelligence and target information with decision-making and the scheme of manoeuvre. Such a system would better exploit the increased range, accuracy and lethality of new ordnance and munitions.

If echeloned targets were to be engaged in greater depth effectively, they would have to be attacked in order of priority at corps and divisional levels¹³⁸; but in the early 1980s NATO had little real-time intelligence and scant IT resources to handle it, had it been available. NATO was slow to exploit the advantages of RPVs as transmitters of real time intelligence, a field in which the Israelis had established an early lead with their Mastiff series.¹³⁹ NATO projects were dogged by cancellations, cost over-runs and development problems, but these were being solved by the mid 1980s. In most cases, land forces rather than air forces led the development of tactical unmanned systems.

The British RPV Phoenix¹⁴⁰ was due to enter service in the late 1980s, but only did so ten years later. It was primarily intended to act as the sighting system for MLRS and to operate in conjunction with the new digitized C3 and computation system, BATES.¹⁴¹ The latter created a link from the FOO to corps¹⁴², and consisted of up to 800 cells, each with a VDU linked by Ptarmigan secure communications. The long-term aim was to give

every FOO and RPV a direct connection to guns and launchers, while imposing automatic intelligence and logistic controls from above.¹⁴³ The Bundeswehr also planned to increase its C4I capability in the 1990s with a range of new systems.¹⁴⁴ The US Army synchronized its re-equipment to occur in the late 1980s, to achieve 24-hour target acquisition, surveillance and improved C4I.¹⁴⁵

These systems produced better information, but categorizing targets was harder. The US Army concentrated on computer simulations for target-value analysis. For example, if attrition were achieved of x percent over y hours at z distance from the FLOT, how much delay would be imposed on an attacker, how much would his effectiveness be impaired, and how much fire should be imposed before the attacker's own analysis of his situation caused him to change his plan?¹⁴⁶ Planned C4I systems such as the US Army Data Distribution System (ADDS) and the Advanced Field Artillery Tactical Data System (AFATDS), the replacement for TACFIRE, were to take such factors into account and ensure the more effective application of fire.¹⁴⁷

Ordnance

The ability to attack deep targets usually forces an enemy to deploy even deeper, and so protects friendly forces from their fire. Longer range also allows the concentration of fire across a front.¹⁴⁸ In 1984 the US Army Chief of Staff declared that the US Army would not allow itself to be out-ranged by the threat. Longer-range artillery ordnance or aircraft would be required to engage targets in depth, along with the means to acquire them.

The SP 155mm M109 was NATO's primary close support system, and was due to be replaced in many European armies by the Anglo-German-Italian SP70, but this project failed. The M109 was replaced in some armies in the early 1990s, but in other cases was still in service more than ten years later. The SP70 was to have had an unassisted range of 24km, or 30km with a RAP, a burst fire capability of three rounds in ten seconds, and mobility comparable to that of contemporary tanks.¹⁴⁹ Following its demise, European armies copied US improvements to the M109, or, in the case of the Bundeswehr, fitted FH 70 barrels, giving the re-designated M109A3G a range of 24km.¹⁵⁰

US long-term plans had been based on the divisional support weapon system (DSWS), an entirely new equipment with improved survivability, responsiveness, terminal effects, reliability, availability, and maintainability.¹⁵¹ In the meantime there would be an interim upgrade for the M109, the Howitzer Extended Life Program (HELP), and the Howitzer Improvement Program (HIP). It was intended that approximately two thirds of the US M109s would be upgraded by HIP by 1995; and that the remaining third would be replaced by the Advanced Field Artillery System (AFAS) after 1997. AFAS would be a new gun, but despite the increased survivability and efficiency envisaged for it, funding for such a sophisticated system remained uncertain for much of this period.¹⁵²

NATO deployed towed pieces, but in relatively small numbers. The Anglo-German-Italian FH 70 had a range of over 24km¹⁵³, and was used primarily by Bundeswehr divisions to

fire into likely enemy deployment zones. The French 155-TR and the US M198 had similar capabilities, but like all towed equipments were highly vulnerable, and might have been forced to use their range to deploy in, rather than to fire into, depth. They also lacked an advanced munition.¹⁵⁴

Greater effects have often been achieved by adopting a higher-calibre gun; but the emphasis in the 1980s was primarily on range, rate of fire, accuracy and terminal effect. Pieces such as the US Army's 380mm piece of the Second World War were long-gone, and although most of the relatively inaccurate 175mm M107s were converted to the 203mm M110A¹⁵⁵, and later by the M110A2¹⁵⁶, the 203mm soon disappeared, once it was clear that the 155mm calibre could also accommodate ICM and 'smart' technologies.¹⁵⁷

Munitions

The value of the firepower of artillery relative to other arms declined between 1945-85. The range, power and accuracy of tank guns improved greatly, and the anti-tank bazooka with a range of just 300m was transformed into weapons such as Milan and TOW, with many times the range and terminal effect. The hitting power of the HE shell remained almost unchanged, and yet armoured targets became harder and faster and more difficult to attack successfully.¹⁵⁸ Nevertheless, the need and opportunity for artillery to acquire an anti-tank capability in the 1980s coincided with a trend against the ATGW, whose success in the 1970s had encouraged the development of counter-measures. The ATGW's relatively long time of flight allowed the target time to manoeuvre and risked identification of its firing point; while smoke dispensers, hardened compound armour, and the close support of infantry and helicopters reduced the vulnerability of AFVs to short-range AGTW.

Close support in the mid-1980s amounted to the engagement of targets at short range by observed indirect fire, however, the HE fragmentation round was largely ineffective in indirect fire against tanks. If the 155mm round could acquire a tank-killing capability, it could engage not only hard targets close to the FEBA; but, better still, it could engage them at a range beyond that of the supported arm, which was traditionally artillery's primary responsibility. Technology offered an array of options and raised controversies over the best means of guidance, whether scatterable mines were more effective than anti-tank projectiles, and whether these should be single rounds or ones containing sub-munitions.

The US Army's Copperhead, which entered service in Europe in October 1984, was the result of attempts to make a 155mm anti-tank artillery shell. It manoeuvred in flight to hit a target designated by a laser-beam directed by an observer or RPV; and it could knock out any WP armoured vehicle by attack from above with a shaped charge. This gave an observer greater flexibility, and the ability to single out high-value targets, such as bridging equipment and headquarters, or even to attack the rear of a column before its front.¹⁵⁹

There were strong arguments against Copperhead¹⁶⁰, but whatever its faults, it was

revolutionary, for it offered tube artillery the possibility of attacking armoured targets in depth accurately. It was hoped that Copperhead might in future develop a more specialized role, for example against AD weapons, if given an anti-radiation homing head.¹⁶¹

Greater benefits, however, would result from anti-armour munitions which did not rely on laser-designation, and which were 'fire and forget', using millimetric wave radar to seek out targets, striking them directly or with terminally-guided sub-munitions. Such munitions were already being developed for 203mm and 155mm calibres¹⁶², the most notable being SADARM. Developments such as these promised to increase the power and cost-effectiveness of artillery, giving it a genuine indirect anti-tank capability, which infantry, armour and helicopters could not rival. The limits of aerodynamics and metallurgy seemed likely to limit the range of the conventional HE steel shell to about 50km; but on the extended battlefield this range had become a relatively short one. These developments promised merely to enable the 155mm piece to become effective once more in the engagement of targets beyond the acquisition or range of the supported arm; but still as part of their close battle. Deep battle probably lay at ranges beyond that.

There were clearly great possibilities, but by the mid-1980s only Copperhead had been introduced, and other munitions were slow to enter service. The standard 155mm HE shell remained the principal source of close support in the division, despite its poor performance against armour; but greater progress had been made in munitions to combat Soviet artillery.

In 1978 Dr W.J. Perry, the US Under-Secretary of Defense for Research and Development, wrote, "The USSR and Warsaw Pact in general place great emphasis on the use of artillery and free-flight rockets. NATO artillery is outnumbered by a factor of three to one". This WP capability could rapidly have diminished the effectiveness of NATO's anti-armour weapons and artillery, yet limited resources prevented NATO from "offsetting this artillery superiority with howitzers".¹⁶³ NATO needed a system to hit the masses of Soviet artillery up to 15km from the FEBA, which at that time could be reached only by aircraft. NATO's answer to inadequacy in tube artillery was the collaborative, but primarily US-designed, MLRS, which entered US service in Europe in October 1983, and was fielded by other members by 1990. It provided not just greater range, but also added firepower and the element of shock.¹⁶⁴

MLRS capability expanded with the development of increasingly sophisticated munitions. Phase One was an HE munition which enabled one launcher with twelve rockets to lay down the destructive power of twenty-eight howitzers in one minute. Each warhead contained 644 M77 bomblets, each of which had a shaped charge capable of penetrating 40mm of armour. It was therefore not primarily an anti-tank system, but one designed to attack artillery, headquarters, AD equipment, missiles, and infantry vehicles. It was estimated that a salvo from two launchers could destroy a Soviet battery. The shock of such an attack would have been increased by each launcher's firing six rockets at a time, rather than in a longer 'ripple'.¹⁶⁵ Lieutenant General D.R. Keith described MLRS as,

“primarily for counter-fire, that is to be able to fire back at artillery delivery systems so they do not wreak havoc on our manoeuvre units”.¹⁶⁶ Subsequent phases of ammunition were planned to give MLRS a genuine anti-tank role, enabling divisions to start inflicting attrition early on, before an attacker came within range of forward defensive positions.

The Germans led the development of the Phase Two munition, the Dynamit Nobel AT2, which was also adopted by a number of other armies. It was a scatterable mine system with a range of 30-40km. In one minute, one launcher could scatter 336 mines in an area of 1,000m x 400m. Each mine could penetrate up to 140mm of armour, and the system gave MLRS and LARS, which already had the AT2, an area-denial as well as anti-tank capability.

In April 1984 the Conference of NATO Armaments Directors (CNAD) agreed to consider eleven new programmes that would meet the coming need to stop WP first echelon forces with indirect fire, using RPVs for reconnaissance and target acquisition, and for FOFA from stand-off ranges.¹⁶⁷ These included the JSTARS surveillance system, the MLRS Phase Three terminally-guided munition system, and various management information systems. The Phase 3 MLRS munition was to contain terminally-guided sub-munitions, which would glide horizontally, searching for targets with active millimetric-wave sensors. Each would discriminate between targets, and attack those of highest priority from above, using a shaped charge.¹⁶⁸ They promised to acquire and attack soft targets up to 150km beyond the FLOT, and it was hoped that emerging technology would make it possible to attack hard targets at over 100km beyond the FLOT. The Phase Three munition was due to start production in the early 1990s; but its funding was cancelled with the end of the Cold War.

Concepts of MLRS employment varied, particularly between the US Army and the Bundeswehr, both of which planned to deploy about 200 launchers. The US Army did not intend to use MLRS primarily as an anti-tank weapon, and so did not plan to adopt the Phase Two munition. It believed that FASCAM, helicopters, Copperhead, Lance, A10 and F16 aircraft, and in the future mortars, would provide a potentially confusing variety of options, even without MLRS. American MLRS were essentially for CF against artillery, its headquarters and communications. The Bundeswehr, by contrast, planned to issue each of its eleven divisions with one battalion of sixteen launchers, reinforced by one battalion of LARS, also of sixteen launchers. The Phase Two munition gave these a primary counter-mobility, anti-tank role.¹⁶⁹ The combination of advanced target acquisition, Phase Two 2 and Phase Three MLRS munitions would have been formidable. An enemy formation could have been identified, blocked by a barrier of mines, and then engaged by terminally-guided munitions. The damage could have been assessed and the target engaged again if necessary.

Improvements in other sources of firepower were also made. The attack helicopter had a primarily anti-armour role in most NATO armies, as a highly mobile reserve to intercept Soviet tanks breaking through defensive positions, and as an escort for assaults into enemy rear areas. The division of responsibilities became increasingly complex. Copperhead and

MLRS Phase Two munitions encroached on anti-tank tasks that might otherwise have fallen to armed helicopters; but artillery relied on swift reaction to precise intelligence, which was less important for helicopters, and the latter might have proved more suitable for some tasks. It seemed doubtful, however, that vulnerable armed helicopters would have been able to operate as successfully as MLRS Phase Three munitions against deep armoured targets, heavily protected by low-level air defences.

Plans for a successor to MLRS Phase Three munitions were initiated in 1985 under the name Joint Tactical Missile System (JTACMS). The idea was born in June 1982, at a time when the US Army favoured a ballistic weapon with a range of 100km, and target priority in the order: C31, AD and manoeuvre forces, while the USAF favoured a cruise missile with a longer range and a target priority of SEAD, anti-armour and C31. On 22nd May 1984, it was agreed that the USAF would develop a JTACMS cruise missile, and that the US Army would develop Army-TACMS (ATACMS), a ground-launched weapon with a range of 70km based on MLRS.¹⁷⁰ The six-tube pods of MLRS would be replaced by two-tube pods accommodating heavier rockets.¹⁷¹ On 16th November 1984 it was confirmed that the task of JTACMS would be to attack combat forces not engaged, and to destroy enemy capabilities which affected the close battle, but which were beyond the range of existing cannon and the Lance rocket systems.¹⁷²

In the mid-1980s it seemed reasonable to assume that future so-called 'brilliant munitions' would soon be able to discriminate between friend and foe, and be fired from autonomous launch-platforms, and perhaps even robotic turrets.¹⁷³ They would give artillery an offensive capability to engage armour effectively with indirect fire, in an area of the battlefield which other arms could not engage, and which it was too dangerous, and thus inefficient, for aircraft to attack. In the past, the advantages of using aircraft in deep attack had encouraged artillery to concentrate on closer targets, even though the other arms could sometimes tackle these as effectively. The new systems would allow artillery to reach out into an extended, deeper, Operational area. If artillery could engage deeper areas of the battlefield, aircraft could in turn concentrate on even deeper, high-value targets, with their own advanced stand-off munitions, and at less risk to themselves.

The application of emerging technology by artillery thus promised to constitute a major development in fire support, analogous to that one hundred years earlier, brought about by the development of indirect fire. It would extend the battlespace, permit simultaneous engagement throughout it, restore the lethality of artillery relative to other arms and increase the scope for artillery to expand its roles beyond the mere support of manoeuvre arms.

Organization

The introduction of so much new artillery equipment necessitated considerable re-organization in most NATO armies. The most radical changes took place in the US Army, which introduced the 'Army 86' organization in the early 1980s, "To develop the most combat-effective organization for the Army's heavy divisions in 1986, to facilitate

integration of new and advanced systems, concepts and resources".¹⁷⁴ Besides accommodating MLRS, the re-organization shifted the focus of attention to corps level, and improved target acquisition at all levels. It had been traditional to integrate assets, such as infantry, mortars, artillery and AD, at low levels; but since the 1950s such integration had been wanting at higher levels. The 'Army 86' concept sought to correct this. It also tried to satisfy the need for greater artillery support in rear combat operations, which AirLand Battle acknowledged would become more likely.¹⁷⁵ Not all the desired enhancements were easily achieved; and in 1984 the 'Army of Excellence' programme succeeded 'Army 86', designed to increase the ratio of 'teeth to tail'.

The Bundeswehr's 'Kampfwagen 90' concept envisaged the doubling of artillery stocks and the fielding of 200 MLRS, and 300 of the soon to be defunct SP70, for which a substitute would have had to be found. It entailed a radical re-organization, 'Artilleriestruktur 85', which covered artillery organization for the period 1985-95, accommodating new weapons and tactics. The Bundeswehr corps artillery, equipped only with nuclear Lance, was made responsible for engaging the WP second echelon. The M110s, which were formerly corps assets, were allocated to German divisions, in a formidable increase in autonomous firepower, unparalleled in a German army since 1899, and the Wehrmacht's re-organization of Summer 1941. The eighteen FH70, eighteen M110, sixteen MLRS and sixteen LARS which made up the divisional artillery were primarily for CF and counter-mobility, and were thus supported by a locating battalion. Each of the Bundeswehr's thirty-three brigades was supported by a battalion of SP guns to give close fire support in mobile armoured operations; but the timing of these plans depended upon the schedule for the replacement of SP70.

The most important aspect of this German re-organization was not equipment, but ideas and manning. It was a halfway stage to an organization which was intended to accommodate MLRS Phase Three munitions; but firepower was already enhanced by the provision of an observer to each company. Fire support was no longer to be co-ordinated by the battery commander (BC). This task fell to a more junior officer, while the BC became responsible for the survival of his battery and its logistic support.

The British also examined their organization in the 'Lean Look' study established to identify savings to set against increased manning of new equipment such as MLRS. They retained an organization markedly different from those of their major allies. Field guns were commanded at corps level, but in practice most fire was controlled at divisional and brigade levels. Guns over 155mm and rockets were held at corps, but might have been sub-allocated in so-called 'General Support Groups'. The British therefore lacked a whole level of artillery support which the US Army and Bundeswehr possessed, and they sought to compensate for this by greater organizational flexibility, from necessity rather than by choice.

Artillery in Deep Attack

AirLand Battle marked a major turning-point in US and NATO doctrine, envisaging offensive action and high mobility of all arms on an integrated and extended battlefield. The new doctrine required not just equipment mobility, but also fire mobility to support it. Further, artillery was tasked to act as an offensive arm in its own right, albeit in synchrony with the manoeuvre battle. Artillery had progressed beyond the mere close support of other arms. Its new long-range missiles could disrupt enemy forces so that they could be defeated at shorter range where guns were now freed to concentrate.

AirLand Battle was criticized for relying too heavily on achieving equipment mobility deep in enemy territory, where it would have been too vulnerable. Such sorties, if applied in the European Theatre could have weakened defences by concentrating attacks on the enemy's second echelon, when his first might have been the most important. It assumed that artillery had adequate means of target acquisition to engage the right targets at the right times successfully, that the battlefield could be 'managed', and that because NATO planned to fight a mobile war, a future war would necessarily be mobile. Finally, some argued that nuclear deterrence and strategic nuclear linkage might be weakened by the improving of conventional defence.

The units sent forward by US corps to disrupt WP forces in depth might have had velocity, but they would have lacked mass. There was a danger that, although mobile, they would have had slender means of concentrating significant firepower.¹⁷⁶ By choosing mobility in the most dangerous area of the battlefield, NATO forces might have surrendered the inherent advantages of defence, yet gained few of the advantages of an attacker, since strategic surprise would still, in all probability, have lain with the WP. For this reason the NORTHAG concept of the late 1980s envisaged mobility at army group level by reserves after a defensive phase. AirLand Battle improved firepower, but not to the point where it could match that of the WP. MLRS was a major enhancement, and although advanced munitions such as Copperhead and FASCAM were more effective than conventional munitions, they amounted to no more than four to ten percent of US gun battery ammunition by the late 1980s. It was accepted that battlefield air interdiction, rather than ground-based weapons, was the key to the deep battle; but NATO's air forces also lacked the appropriate weapons. AirLand Battle was designed to operate with existing equipment, but it could not achieve the important aims of deep attack without major increases in firepower, not just to attack the enemy but to defend its own mobile units.

By calling on artillery to support units attacking beyond the FEBA, AirLand Battle might actually have weakened supporting fire overall. Equipment deployed forward would have needed at least as much firepower as that held back in defence; but this would have been harder for artillery to provide, and was likely to be less effective. The quality of WP artillery fire against manoeuvre units was likely to have been high, since WP artillery would have been operating from friendly terrain, and would not have experienced the complications of movement and logistics that exist in the attack. Although techniques of survivability and CF capabilities were improving, the WP still had a significant advantage in the balance of artillery forces. By starting attrition of WP manoeuvre forces as early as

possible, NATO artillery would have compromised its own positions correspondingly early, multiplying in consequence the effects of that imbalance.¹⁷⁷ The concept was sound, but the material means did not exist to support it. The introduction of MLRS to fight the long-range battle offered the possibility that guns might remain masked to fight the close battle; and future artillery systems incorporating emerging technology promised to correct the imbalance further.

Some advocates of AirLand Battle seemed to assume that NATO defences and the WP first echelon were evenly matched, and made the valid deduction that the credibility of defence would be enhanced if the WP's second echelon were removed early. The opposing forces, however, were not evenly matched and NATO forces deploying forward early to attack the WP second echelon would have had to come either from main defensive positions or the reserves. Since the intention would have been to tip the balance in favour of forces defending main positions, it was the reserves which would most likely have been sacrificed prematurely.

It was not certain that fast-moving WP armour could have been identified, 'prioritized' and engaged at corps, much less army group level, before spreading into divisional areas of influence. These arguments favoured either the German divisional deployment of MLRS, and yet greater holdings of MLRS at divisional level in the US Army, or the granting of much greater independence to MLRS units from corps, allowing the former to respond directly to dedicated radar, with improved 'sensor-to-shooter' links. If the problems of target acquisition could have been overcome, there were great advantages in employing MLRS at army group level for this Operational battle.

It was estimated that a well-sited defence could increase its effectiveness as much as tenfold by advantageous use of ground.¹⁷⁸ The strength of Active Defence was that it forced an attacker to advance through a series of strong defensive positions. By committing reserves early to offensive tasks, that advantage would probably have been sacrificed.

Had the WP attacked in traditional echelonment, the diversion of troops to attack the second echelon might have served the WP's purposes, by deflecting attention from the primary task, the defeat of first-echelon forces. It would matter little to the WP that the second echelon had suffered disruption if the first were victorious. The priority for NATO in the late 1980s was to make up the deficit in target acquisition and firepower which hobbled the implementation of any new approach. As the Cold War ended, it was intended that emerging technology should achieve this.

If, as now seems likely, the Soviets had themselves strengthened their deep attack capability together with their first echelon, the second had indeed become less important. If the Soviets had achieved strategic surprise, NATO's deep strike forces, whether practising FOFA, AirLand Battle or a reconciliation of the two doctrines, might in any case have found themselves, of necessity, being used as a reserve to fill gaps in a ragged defence. Success in AirLand Battle, like success in all forms of forward defence, would

also have relied upon early mobilization which was hard to achieve.¹⁷⁹ Nevertheless, the value of AirLand Battle was that it broke the mould of rigid Cold War attritional thinking, and it can now be seen to lie at the root of most Western doctrinal thinking since.

Managing the Battlefield

As mobility and firepower increased, the 'management' of the battlefield became more complex. Conflicts of interest arose between air and ground forces, and different levels of command. For example, the fire support co-ordination line (FSCL) of the 1980s was typically about 25km forward of the FLOT. Beyond that, it was difficult to divide responsibilities between air and corps interests.¹⁸⁰ The difficulties of co-ordinating action on the battlefield were alleviated by the increasing sophistication of C2; and in the case of NATO commands and the US Army by centralization of both at a high level. AirLand Battle continued this trend, attempting to solve the problems of battlefield management by better information technology. The practicality of fighting a war in this manner was untested, and many were doubtful because they believed that wars were likely to be unpredictable, and needed to be fought, not 'managed'.

AirLand Battle contained potential contradictions. It led the USA towards a high-technology battlefield necessarily managed by computers, and yet it recognized the likelihood that communications might collapse. It was the influence of General G. K. Otis, who took over as commander of TRADOC from General Starry, that ensured the emphasis on low-level leadership in *FM 100-5 Operations 1982*. AirLand Battle was said to be founded on the German principles of Auftragstaktik, Schwerpunkt and Aufrollen, which relied upon individual initiative at all levels in a mobile battle, yet the US Army was trying at the same time to create a battlefield in which the control of firepower and other resources were managed automatically and at a higher level. There was an uneasy duality of management and leadership. Either would certainly be needed if the other failed, but it was not certain how successfully the two would be able to act in concert. These issues remain as important today.

Mobility

AirLand Battle assumed that engagements would take place in an extended three-dimensional battlefield between highly mobile forces on both sides. AirLand Battle was said to restore the balance between firepower and mobility, with mobility used to attack enemy vulnerabilities and to gain a position of advantage where massed fire could be concentrated. The experience of history suggests that such expectations might have been exaggerated. Before the outbreak of hostilities in 1914 and 1939 there was a general consensus that coming wars would be fought in short, highly mobile campaigns. In the event, while battlefield manoeuvre speeded up, campaigns were generally conducted at the same pace as they had been in earlier centuries. See Figure 1.

Figure 1. Comparison of Rates of Advance

Campaign/Battle	Date	Distance (km) per Day	Remarks
Ulm	1805	22	
Moscow	1812	14	
Marne	1914	20	
Megiddo	1918	56	General Allenby's Cavalry
Flanders	1940	31	
Moscow	1941	10	
Normandy Breakout	1944	28	
Korea UK Offensive	1951	19	
Sinai	1967	55	Gen Tal's Armour
Gulf War	1991	95	

Source: Dupuy (1985) and others

NATO's conventional re-equipment in the 1980s partially off-set Soviet developments of the 1970s. If it had not done so sufficiently, a future war might well have amounted to a WP Blitzkrieg across Europe, which could perhaps have been met only by a NATO nuclear response, imposing counter-mobility with massive firepower, and probably resulting in an early nuclear stalemate. If NATO had in fact succeeded in restoring the conventional balance, operations would very likely have slowed down rapidly, in a war of relative immobility, but high attrition. This would, however, have been of short duration, since materiel would have lasted for only a few days, and it would probably have been followed by a final highly mobile phase before being halted again by nuclear weapons.¹⁸¹ The victory would probably have been a logistic one, or nuclear, and thereby a failure in terms of deterrence.

The power of modern weapons and target acquisition systems seemed likely to make manoeuvre a more, not less, vulnerable operation. The sheer congestion of equipment on both sides, bad weather, urban terrain, EW, chemical weapons, and ultimately nuclear weapons tended to compound the difficulty of manoeuvre, especially for the WP.¹⁸²

Where mobility was successfully achieved in short wars in the Middle East and the Indian sub-continent, it was against an enemy either numerically inferior, lacking in political cohesion, or taken by surprise.¹⁸³ NATO appeared to enjoy none of these advantages over the WP in the 1980s, or foreseeably into the 1990s. On the contrary, many lay with the WP. US plans for manoeuvre in the 1980s and 1990s were a reaction to superior WP numbers and firepower, rather than a means of exploiting US fire superiority. More often than not, such manoeuvre against a first-rate enemy may win dazzling but limited battles, delaying defeat, but it seldom wins wars. Against a lesser opponent, it may be successful and at acceptable cost, but largely by leveraging superior firepower synchronized with movement. Doctrine since the 1950s had emphasized the importance of manoeuvre supported by fire; but from the mid-1980s it seemed more likely that future concepts

would rely more upon fire-mobility from artillery and airpower, and its subsequent exploitation by manoeuvre.

There had, however, been many premature predictions of the demise of the tank. Its declining role was forecast in the 1970s by critics who, for example, believed that resources would be better spent on enhancing defensive positions and firepower.¹⁸⁴ The tank was an expensive source of firepower, but if anything, its relative advantages grew with the introduction of improved designs in the early 1980s, such as Chobham-type armour; APFSDS (armour-piercing fin-stabilized discarding sabot) ammunition, improved power-to-weight ratios and suspension. As the Cold War ended, many further improvements were scheduled, but most forecast the long-term decline of the heavy main battle tank.

Sir Ronald Mason, former Chief Scientific Adviser to the British Ministry of Defence, believed that the tank was already no longer the best anti-tank weapon.¹⁸⁵ C.D. Bradley, former chief of the Exploratory Development Division of the US Tank Automotive Concepts Laboratory, noted that, "The technology contributing to methods of killing the tank is advancing at a much faster rate than the technology contributing to the survivability of that tank. The Abrams may be the end of the line".¹⁸⁶ Twenty years later, his analysis holds good.

The mobility of the tank was already poor, compared to the helicopter's, and would become relatively worse as all-weather flying capabilities improved. The helicopter would be used both as a highly mobile weapon platform, and as a transporter for other sources of firepower, including light armour and artillery. On balance, tanks also seemed likely to become increasingly vulnerable. It seemed, for example, unlikely that devices such as reactive armour could provide continuous protection during a 200km approach march to the IGB from the East. Field Marshal Sir Edwin Bramall predicted that the balance of advantage would shift away from the mobility and protection of the tank, to systems better able to conceal themselves and to concentrate fire at longer range.¹⁸⁷

Nuclear Linkage

It might be argued that the Third World War could only have been a short one, since neither side had the resources to fight a long conventional war; and that the 'first off the blocks' would therefore win. The effect of such an imbalance could have been to have precipitated a nuclear response, provided the linkage between conventional and nuclear weapons had been retained; and this was an area of major controversy among NATO allies, which at the time seemed set to blight debates on collective defence for decades to come.

Flexible Response, the strategy authorized by NATO MC 14/3, relied upon large-scale and possibly early use of nuclear weapons¹⁸⁸, yet the former US Deputy Assistant Secretary of Defense, Lieutenant General J.E. Hollingsworth, described AirLand Battle as a 'conventional umbrella', whose purpose was to negate WP numerical superiority. He saw

it replacing the deterrent of TNW which he and many others felt had lost credibility, if only because one, 'cannot envision the point of NATO destroying itself... by the resort to the use TNW'.¹⁸⁹ In 1983 an influential group of former NATO officials published their *European Security Study* which advocated the better use of modern technology to reduce drastically the dependence on, and early use of, nuclear weapons.¹⁹⁰

Despite this, NATO's doctrine in the 1980s and 1990s was firmly underwritten by the power of nuclear weapons, and the understanding that these were not merely to deter WP nuclear weapons, but to be used to avert conventional defeat.¹⁹¹

General Bernard Rogers, as SACEUR, asserted that FOFA was designed only to raise the nuclear threshold, and to provide the means of achieving forward defence; but others in Europe, particularly in West Germany, feared that it was an expression of a growing US desire to escape from the strategic nuclear linkage implicit in Flexible Response. If 'de-coupling' had occurred, it was feared that a war, thus limited to Europe, would be less risky for the USSR, and so more likely. General Rogers and others therefore stressed that nuclear weapons were a necessary part of a deep attack doctrine, which enhanced Flexible Response.¹⁹² The only event which European critics feared more than a conventional war limited to Europe was a nuclear war limited to Europe; and AirLand Battle or FOFA did not appear to enhance strategic linkage. Suspicions about the broad intentions of deep attack doctrines seemed unlikely to be allayed until they were seen to raise the threshold of TNW, but lower the strategic nuclear threshold, and strengthen the credibility of the link between the two.

AirLand Battle tried to offer the possibility of a NATO conventional victory and a credible nuclear deterrent to WP nuclear weapons; but plans for a possible first use of TNW were an admission of inferiority in conventional firepower. A reduced likelihood of conventional defeat and renunciation of first use of nuclear weapons, with its accompanying political advantages, could be achieved only if high-technology could produce weapons with much more effective firepower. It seemed that TNW could perhaps be greatly reduced in number, or even eventually removed from Europe as a result of negotiation; but that this would probably happen only if new technology could succeed in restoring the conventional balance of forces.

The Need for Greater Firepower

US and NATO deep attack doctrine for the 1980s and that proposed for the 1990s was not supported by sufficient firepower to make it fully effective. The imbalance between the artillery strengths of NATO and Warsaw Pact forces is illustrated in Figure 2. Future plans tacitly admitted this, and sought to make good the shortcomings, by introducing conventional weapons with equivalent effects to nuclear warheads. They would replace vulnerable equipment mobility, with the fire mobility made possible by emerging technology. Doctrine for the 1980s and 1990s was an unsatisfactory halfway stage to this, pending the development of these new capabilities; and meanwhile vulnerable manned

vehicles and aircraft were called upon to carry out tasks that in future would be undertaken by high-technology munitions.

Sir Ronald Mason, said that force multiplication by science was the right “response to the overwhelming advantage of conventional weapons systems fielded by the WP”.¹⁹³ Democracies find it hard to field large masses of men and equipments permanently, and reliance on nuclear weapons became increasingly difficult to accept, particularly in West Germany¹⁹⁴, although many West Germans also feared that reliance on conventional weapons alone would make war and its collateral damage more likely than a nuclear war.

Figure 2. Approximate Number of Artillery Barrels per 1,000 men in 1986

Barrels per 1,000 men	
USSR	16.7
Canada	10.0
USA	6.7
Netherlands	6.7
West Germany	4.0
Italy	4.0
Belgium	3.3
UK	2.8
France	2.5

Plans for future conventional deep attack amounted to a counter-preparation bombardment, fire on an enemy preparing to attack, using sophisticated air- and ground-launched weapons. The potential for advanced munitions was recognised in the early 1970s, when US ‘smart’ bombs demonstrated their advantage over iron bombs against targets in North Vietnam.¹⁹⁵ Dr Manfred Woerner, NATO’s Secretary General at the time, believed that the pace of such advances should be maintained. Whereas in the 1960s it might have taken 5,500 sorties and 33,000 tons of bombs to destroy a Soviet army group, it was estimated that in the 1980s it could be done with 600 sorties and 3,000 tons of improved munitions. He maintained that the next generation of warheads with sub-munitions could do the same with 50-100 sorties and just 500 tons. Emerging technology was seen to be capable of creating the equivalent to concentrated firepower, enabling NATO to “reduce significantly the number of short-range nuclear systems”. The advantages of emerging technology were clear; and in 1981 General Starry, the inventor of AirLand Battle, looked ahead to what might follow and urged that, “We must begin transitioning to these concepts now”.

The role of mass destruction on the battlefield, held by artillery until the end of the Second World War, was taken up by nuclear weapons. It seemed likely that by the end of the 20th Century it would be filled by weapons of emerging technology; but, as Lieutenant General

Ott pointed out, "Winning the funds to assure progress is the biggest battle to be faced by artillerymen of the future".¹⁹⁶

AirLand Battle relied upon depth and agility, synchronization and initiative to defeat the enemy in depth; but it seemed likely that the US would lack sufficient standing forces to implement it in the way intended. By the late 1980s there was discussion of an alternative 'Multi Dimensional Concept' (MDC)¹⁹⁷, employing robotic and unmanned systems to achieve economy of force. These would include robotic ground vehicles and UAVs, high intensity flash munitions and directed energy weapons (DEW). It was held to be cheap, sustainable and available by 2004. Elements of this can be seen today in the Future Combat System (FCS) and concepts of 'networked' battlespace, which could become a reality a decade after the date proposed for MDC.

In the late 1980s, General C. Vuono articulated the US Army's vision of future war with a greatly expanded battle space, and fewer troops with more sophisticated weapons fighting large but relatively short engagements, 'AirLand Battle Future'.¹⁹⁸ This was an evolution of, not a replacement for AirLand Battle of 1982, adding endurance to its characteristics. This encompassed more than mere logistic sustainability, and involved the notion of sustaining a high tempo of operations over a period of time relative to an opponent.

In the event, none of these concepts proved relevant to the European Theatre of the future, for the Cold War ended more quickly, and in a manner that few of note had predicted. Whatever the failings of NATO's doctrinal iterations over the years, in a strategic sense they had proved successful. It was in part the relentless self-criticism and search for relevant new ideas and technologies that ensured an historic, if unusual, form of 'victory' by NATO over its opponents.

These efforts bore other fruit. After large wars most societies demobilize. This was only partially true of armies after the Second World War; while at the same time military research, development and readiness continued at great expense for over forty years. Some who now claim that the WP was in truth always an insubstantial threat, see this as a tragic diversion of resources. On the contrary, this cost or 'insurance premium' may now be seen as a bargain, given the peace, stability and prosperity it secured for much of the world. It also gave the West a significant lead in military affairs which proved decisive in the years that followed, most immediately in the Gulf War of 1990-91, but surely also into the future.

3.8 THE LEGACY OF THE COLD WAR

Memory of the perceived threat during the Cold War is in danger of fading, and its intensity and immediacy even seeming unreal in retrospect. NATO and the WP maintained high levels of defence spending and an intense military focus of a duration probably unparalleled in peacetime. The Cold War produced large, well-equipped and trained forces at high states of readiness. Societies generally accepted this as 'normal', and an acceptable price to pay in view of the apparent alternative. In the mid 1980s, the

demise of the USSR and its WP seemed highly unlikely. It seemed almost unimaginable that the concepts, tactics and equipment of the Cold War, templated on the North German Plain would be validated on the desert plains of Kuwait and Iraq in less than a decade. The legacy of the Cold War was both doctrinal and technological; but as it drew to an unforeseen close, its participants were earnestly considering how to gain military advantage in what they assumed would otherwise be a continuing strategic impasse.

Although the strategic stalemate in Central Europe was forty years old, it was a time of innovative military thinking, as both sides tried to avoid intellectual stagnation and complacency. The OMG and AirLand Battle were the products of this, and there was much speculation about the military requirements and the promise of new technology.

THE SOVIET LEGACY

Looking ahead, the Soviet strategic problem after 1990 was how to achieve results in the minimum time, without provoking a nuclear response. The answer seemed to be either a full assault by WP forces, or the 'national option' of a purely Soviet assault to achieve limited objectives, and a negotiated withdrawal of both Soviet and American forces from certain areas of Europe. In either case, surprise would be essential.¹⁹⁹

The Soviet Operational problem was how to break through defences which would probably become more complex thanks to NATO's employment of emerging technology in terminally-guided munitions and scatterable mines. The Soviets would have to find a way to maintain the momentum of an advance and co-ordinate and supply it. Artillery would still be required to provide massive support to the first echelon; but it would have to develop improved techniques of CB fire against MLRS, and improve defence against helicopters. The task of co-ordinating fire support for dispersed BMP regiments and OMGs from artillery, helicopters and fixed-wing aircraft would be highly complex. The Soviets also realized that they would have to re-assess the survivability of their artillery against 'fire and forget' weapons by means of mobility, protection, counter-measures and combinations of these.

Above all, the Soviets had to decide whether the creation of firepower reliant on high technology constituted too high a risk; and whether they could afford to reduce the quantity of equipment to pay for it. The alternative was to accept technical inferiority to the West in the belief that mass would achieve a better result.

An important legacy of the Cold War was the large quantity of high-grade equipment of WP origin that resided in the inventories of many unstable states and others antagonistic to the West. Many of these states planned to employ this equipment in accordance with a doctrine which they could not live up to, or which did not suit their circumstances. Highly capable artillery of WP design continued to be effective in tactical engagements around the world, but for the most part it was readily countered, and often constituted a vulnerable target array for Western airpower and artillery which had been devised to defeat it in the hands of more competent Soviet opponents. The spiral of action and reaction witnessed

during the Cold War thus lived on in the succeeding decades. In that sense, ironically, perhaps the greatest consequence of Soviet military might after 1945 was that it precipitated defence spending, and cerebral and technological innovation in the West on such a scale that it forged an opposing military able to execute its will long after 'victory' in the Cold War.

NATO IN 1990

Nevertheless, in 1990 NATO also appeared to face challenges. The future of its FOFA doctrine, which called for attacks on targets between 25km and 350km beyond the FLOT, would be influenced by the development of more dynamic and offensive concepts in the US Army. Whereas AirLand Battle intended to neutralize second echelon forces, AirLand Battle 2000 and 'Army 21' doctrines intended to destroy them, "occupying WP territory by firepower".

Notions of non-linear battle developed. Emerging US concepts were based on the assumption that a future battlefield would be fast-moving and fluid, with battles fought by combat cells of perhaps 2,000-4,000 men, manoeuvring without any clearly defined FEBA or FLOT. Targets would be more easily acquired, and the weapon systems to attack them would have greater range and lethality, and be better co-ordinated on the ground and in the air. All arms would be better integrated, EW would be intense and operations conducted twenty-four hours per day, with NBC taken into account throughout. The essential difference between this and AirLand Battle was that mobility would be underwritten by a substantial increase in effective conventional firepower, and with greater emphasis on conventional deterrence. The use of nuclear weapons might ultimately be necessary, but "a deterrent based primarily on a nuclear response has disappeared and probably cannot be realized again".²⁰⁰

If NATO were to replace ground-launched nuclear weapons with conventional artillery, the high mobility of the conventional forces would gain greater credibility through the inhibition of Soviet firepower and mobility. The Soviets could, however, be expected to develop similar weapons to those of the West, thereby increasing the problems of equipment survivability, and possibly giving rise to a stalemate. This could be broken by a nuclear exchange, which both sides would surely make every effort to avoid. NATO's remaining nuclear weapons would therefore become deterrents to Soviet nuclear weapons, not conventional forces, and so would be less likely to be used in a conflict. Conventional war would not necessarily become more likely, because the WP could not expect to win that war, without its own first use of nuclear weapons leading to nuclear retaliation. Enhancing conventional firepower to an appropriate level might therefore enhance deterrence at all levels.

Developing NATO's Firepower

Firepower and fire-mobility were seen to be the keys to success in any future battle in Central Europe. The scope for exploiting mobility may have looked attractive, but priority

was more likely to be given to developing firepower rather than to achieving vehicle parity with the WP.²⁰¹ In 1988, one third of all new US Army systems planned to enter service by 1995 were for the field artillery.

The responsibility for providing future fire support was seen in three parts: deep attack by aircraft, artillery, and the fire of the manoeuvre arms themselves. Aircraft would rely on stand-off missiles bearing high-technology sub-munitions of the Assault Breaker variety, which would attack targets over 100km beyond the FEBA. Artillery deep attacks would be made by rockets such as MLRS, its successors, and Lance with similar sub-munitions, at up to 100km from the FEBA. These would be augmented at closer range by tube-artillery based on SP 155mm or 203mm pieces, capable of firing Copperhead, SADARM or their more advanced successors.

In the close battle, the infantry seemed likely to acquire an effective indirect fire capability of its own, based on a light rocket system²⁰², an advanced mortar, or a gun with a revolutionary propellant. Guns have a longer range and a direct fire capability, and shells a shorter time of flight, than the mortar and its bomb; but these advantages were seen to be at the expense of simplicity and cheapness. Given improvements in munitions, it seemed that mortars might take over some tasks performed by divisional close support artillery.

Some mortars already had a range of 17km with RAP²⁰³, and future heavy mortars could well dispense minelets or terminally-guided submunitions. Development of an autonomous terminally-guided anti-tank bomb was well advanced in many countries in the mid 1980s.²⁰⁴ Mortars have a high rate of fire, but this is usually reduced as calibres increase in size because loading becomes more cumbersome.²⁰⁵ This was likely to limit the size, and hence the range, of mortars, or encourage the development of automatic breech-loading weapons. Even if mortars failed to reach the ranges of guns, it was quite possible for MLRS and comparable systems to engage targets down to 10km. It was thought that improved mortars would enable artillery to concentrate still more on deep targets.²⁰⁶

It seemed that liquid propellant would probably replace traditional charge systems; and that electro-magnetic propulsion systems, firing terminally-guided munitions could revolutionize not only artillery but also infantry weapons. If guns became much smaller and easier to operate and support, the infantry could perhaps provide its own low-angle, indirect fire, anti-armour close support.

It was accepted that NATO's close support artillery would face a severe test in the 1990s. Targets would move faster and have a shorter exposure time, making them harder to hit after the first round without terminally-guided munitions; and WP artillery might be able to return fire before the first NATO round had even landed. The threat from WP artillery meant that NATO would have to practice 'shoot and scoot' tactics, with missions of no more than six to eight rounds, fired in bursts lasting perhaps two minutes by random groups of guns.²⁰⁷

NATO did not have a unified approach to the development of a new gun capable of meeting this requirement. The British and Germans had separate programmes for SP 155mm pieces, as did the French. The US Army also began work on an entirely new and more ambitious piece, the DSWS and later the AFAS.²⁰⁸ In much modified concept and form, this had still not entered service nearly twenty years later under the name Crusader. In the late 1980s there was intense debate about whether such a system could be justified, and this continued throughout the ill-fated Crusader programme, which was eventually cancelled in 2002.

The firepower of supported manoeuvre arms was increasing, and the calls for artillery to concentrate on deeper attack were growing. A highly sophisticated close-support gun was seen to be very expensive. Such a system would also be vulnerable to the advanced anti-armour munitions which the WP was expected to develop at the same time as NATO. In view of this, close support seemed likely to become the 'poor relation' of artillery by the year 2000; and although the US Army's 'Legal Mix VI' study recommended a mixture of cannon and rockets for its artillery in Europe in 1995, based on the 155mm and 203mm cannon and MLRS, it was the latter which seemed to hold the greater potential, unless close support could be revitalized with the introduction of some revolutionary system such as liquid propellant or electro-magnetic propulsion.²⁰⁹

MLRS and its successors seemed destined to become the mainstay of NATO artillery. Its Phase Three munition was designed specifically for the precision attack of moving armour, principally second line and second echelon forces, realizing the intent of AirLand Battle and 'Army 21' doctrines. In the event, funding for Phase Three munitions was terminated with the end of the Cold War, but the technologies survived, and their derivatives will appear in future Western systems.

In the Second World War, effects of fire similar to those of the First were often created by using less ammunition with greater target discrimination. Even so, it was estimated in the early 1980s that one US close support battalion would fire at 300 rpg per day in a European war, constituting a volume twice that consumed by an entire divisional artillery per day in the Second World War.²¹⁰ This would be partly because, as in the Korean War, fewer guns would have to fire more ammunition over a larger area, but chiefly because action would be highly concentrated in a short period of time. The increase in firepower that would be created by the Year 2000 would not be the result of greatly increased numbers, or weight of gun or launcher, but of the greater sophistication and lethality of fewer munitions. The resulting reduction in the logistic 'tail' was also seen to increase the opportunities for mobility, dispersion, camouflage, and hence survivability.

The Merits of NATO's Emerging Technology

NATO's concepts for deep attack in the 1990s seemed likely to develop along the lines pioneered in the late 1980s. These relied upon weapon systems which did not yet exist, yet there seemed little alternative to such faith in technology. One option was the use of large numbers of 'mini-nuclear' weapons, with effects more like those of concentrated

conventional fire. These very low-yield weapons were widely advocated in the 1970s; but the idea was politically unacceptable. Another option was to maintain NATO's existing force levels but deploy them in great depth, as in the 1950s and early 1960s, to offset the WP's numerical superiority and strategic initiative. Such redeployment was also politically impossible. NATO could construct physical barriers based on terrain features, reinforced by fortifications and supported by mobile reserves, but this option was also politically unacceptable. NATO could raise masses of relatively low-technology forces to balance those of the WP, but democracies find it hard to live in an indefinite state of mobilization, as the Israelis discovered in 1973. This option was neither economically, politically nor Operationally acceptable as a solution.

NATO was therefore left with the pursuit of a high-technology solution, a course which held outstanding advantages. "The chip is the technological key to the new doctrine, the counterpart to the Blitzkrieg's use of the gasoline engine".²¹¹ It was an option which reflected and exploited the most dynamic aspect of Western society, and promised to match and contribute to advances that would be made in any case in civil technology. Despite the traditional excellence of their artillery equipment, the Soviets were ill-placed to make best use of it because of their weakness in C4I and the technologies that underpinned it. The Soviets did not reject high-technology for its own sake, on the contrary, they followed the Western lead wherever they could. Their moderate successes in the late 1980s encouraged them to modify their concept of mass firepower, to fire less ammunition per gun, but more selectively. As advances in C4I continued, it seemed inevitable that the quantity of Soviet artillery would fall, but its firepower become even more effective. However, as in the West, the constraining factor was likely to be not so much technology as economics.

Arguments that it would be futile to follow the high-technology route because the Soviets would follow and develop counters to it seemed flawed. The Soviets were already following that route, and NATO had the option of keeping ahead or falling behind. On the contrary, it seemed clear that in any 'arms race', the West would have a comparative advantage in the decisive technologies of future battle; so much so that precipitating such a 'race' could fundamentally alter the strategic balance. Few imagined that the collapse of the USSR would be so sudden, and the widening of the technological gap between the NATO and the WP was almost certainly a factor in this.

The success of deep attack in the future was seen to depend upon the ability of emerging technology to generate the equivalent of the massive conventional fire characteristic of the two World Wars and contemporary TNW. In both cases there were doubts whether it would produce the same result, even though the result it would produce might be equally effective.²¹²

The former Soviet Chief of Staff, Marshal N.V. Ogarkov, claimed that conventional weapons now "approach in effectiveness weapons of mass destruction and can become involved immediately in active combat actions"²¹³; and it was thought possible that one of NATO's MLRS rockets, by dispersing its warhead in the form of sub-munitions, could be

as effective as a one-kiloton enhanced radiation, or standard 10-kiloton, nuclear device. It was argued that such conventional munitions would be no substitute for a 50-kiloton device.²¹⁴ On the other hand, numerous such attacks could be a substitute, and would be a preferable form of attack to a 50-kiloton blast, with its extensive collateral damage. A stronger argument was that the tactical effect on the battlefield might be equivalent to that of nuclear weapons, but at the same time lack their strategic deterrent effect. Munitions incorporating emerging technology would not carry the same momentous risks and psychological weight as nuclear weapons, and so would have less impact on Soviet perceptions. On the other hand, the problem with nuclear weapons had been that they had grown to lack credibility, and so weakened deterrence. It was precisely this credibility gap that it was hoped emerging technology would bridge in the 1990s and early 21st Century.

Some Europeans feared that if emerging technology could produce conventional effects equivalent to those of tactical or theatre nuclear weapons, this would weaken the linkage to strategic nuclear systems. But if NATO had genuinely been offered the probability of a victory over a hypothetical WP attack without resort to nuclear defence, this would have been attractive, for it would have left the Soviets with only the alternatives of peace or of a nuclear war, which they would have had to start, and which would have yielded them little benefit.

The area of greatest doubt was technical feasibility, not just in the capability of the munitions but in target acquisition, a problem which equally affected nuclear weapons. It had been calculated that NATO faced 5,000 company-sized targets in central Europe, requiring 5,000 MLRS salvoes and 5,000 ballistic missile attacks.²¹⁵ It was not certain that NATO would be able to acquire so many targets, moving at once over 200,000sq km, against counter-measures and terrain clutter. If technology should fail, however, or be too vulnerable, NATO would be in difficulty, and have very limited reserves of traditional conventional firepower on which to fall back. Equally, if the Soviets achieved a deep penetration of NATO positions, before deep attack could be effective, even brilliant munitions might find it difficult to discriminate between friend and foe, in what would in relative terms have become a close-quarters melee.

The pace of technological change was rapid, and it was acknowledged that such reservations might soon have seemed excessively cautious. The pace of negotiations on nuclear arms reductions had also been swift, and if these proved successful the whole debate might be rendered obsolete. This proved to be the case; and the whole 'theology' of nuclear deterrence in Europe now seems curiously archaic, just as threats elsewhere now seem more menacing.

¹ The 203mm M1955 was the first Soviet gun which could fire nuclear shells.

² An analogous situation obtained in the 1930s when novel theories of mobility were introduced in the West to justify a reduction in artillery strength, while in the USSR the importance, if not primacy, of field artillery remained unchallenged.

³ The last Soviet SP field gun of the Second World War was the ISU-152/ML-20S of 1944, and the Soviets did not produce another until the 122mm M-1974 (2S1) in 1974; but in the interval they produced ten new towed equipments. Hofmann (1978).

⁴ As a result, between 1953 and 1957 the Soviets produced five different models of MBRL and increased their range from 19km to 30km. The result of this development was the BM-21 which appeared in 1964 and remained in common use in various forms into the 21st Century.

⁵ Becker's interest in military rockets originated in the belief that they could be used to deliver chemical weapons. Neufeld (1996), p.6.

⁶ Strategic vulnerability to missile attack remained the USA's primary defence controversy over fifty years later, only to be superseded by that of terrorism.

⁷ Quoted in Meehan, p.18.

⁸ Department of Defense, Washington DC, 1953.

⁹ NASA was formed from the US Army's rocket forces, whose roots lay in Peenemunde, the self-styled birth-place of space travel, built by the artillery technicians of the Paris Gun of 1918.

¹⁰ On 25th May 1953, 'Atomic Annie' fired an 800lb atomic warhead at a target 10km away. It weighed 85 tons, required two tractors to move it and proved an unstable platform. It was taken out of service within the decade.

¹¹ Conventional artillery had also been deprived of resources in the 1920s, but that proved to be a time when considerable thought was given to the theory of fire support by those with recent wartime experience. A similar trend was evident in the 1950s when, despite reduced assets, artillerymen continued to pursue issues left unresolved in 1945, and adapted them to the novel conditions of the battlefield.

¹² Parson (1949).

¹³ Sallenbach (1958).

¹⁴ The tendency to disperse guns amongst the supported arms rather than concentrate them to generate decisive fire had returned. In effect, the field artillery had become the equivalent of the 19th Century's battalion guns, with SP guns like mobile horse artillery, and atomic systems in the role of the 'grande batterie' or artillery of the park.

¹⁵ Robinson (1952).

¹⁶ The British Army's experiment in the late 1970s with a Task Force, capable of 'grouping' all artillery in a division under one command post, failed for a similar practical reason. One command post, without adequate CIS, could not handle the volume of information and calls for fire; and without that, such centralized C2 had few advantages. Its demands on communications were twenty years ahead of what was available.

¹⁷ Wood (1956).

¹⁸ Wood (1956).

¹⁹ Sallenbach (1958) and Oswald (1958).

²⁰ The British Army maintained a mix of Abbot and M109 until the early 1990s, when both were replaced by the 155mm AS90.

²¹ Oswald (1958).

²² Robinson (1952), p.8.

²³ Quoted in Hofmann (1978). *Military Strategy* is analysed in McConnell (1985). See original text in Sokolovskiy (1984).

²⁴ Greater flexibility was introduced down to the tactical level of command, and firepower and mobility increased with the introduction of new helicopters. The viability of mobile operations using BMP personnel carriers, Mi-24 HIND helicopters and tanks was proven in 1976 on Exercises KAWAS and SEWER.

²⁵ Khrushchev witnessed a demonstration of ATGW against a tank in 1964 and observed with concern that, "These tanks will burst into flames even before they reach the battle line". Quoted in Karber (1976), p.11. In 1972, *Anti-Tank Warfare* by Major General G. Biryukov and Colonel G. Melnikov gave ATGW a 4:1 kill ratio over the tank, and 8:1 over the APC. Quoted in Stokes (1980a).

²⁶ Quoted in Hofmann (1978).

²⁷ Donnelly (1979a), p.19.

²⁸ Eshel (1984).

²⁹ In some respects this was a reversion to the tactics of the Second World War, with the difference that the tank now acted as an assault gun and the new SPs, while firing directly during an assault, did not lead the attack.

³⁰ Quoted in Donnelly (1979a).

³¹ Donnelly (1975).

³² Between 1973 and 1983 the artillery of a tank division increased from seventy-eight howitzers and MBRL to 144, and in a motor rifle division from 108 howitzers and MBRL to 162, Dick (1983). According to Lieutenant General V. Reznichenko, quoted in Goure (1984), and Marshal of Artillery Kuleshov, quoted in Bellamy (1983a), p.786, the weight of artillery and mortar fire delivered by a motor rifle division increased thirty times in the thirty-five years after 1945. This was partly necessary because of the increased size of the supported arms. A motor rifle division of the early 1980s, for example, had sixteen times as many tanks, and thirty-seven times as many APCs as a mechanized division had had in the Second World War. It was also necessary because the anticipated depth of enemy defence had roughly doubled.

³³ Foskey (1984).

³⁴ Bellamy (1983a).

³⁵ The 2S3 had a range of 17,300m and could fire five rounds per minute. It was an indirect fire weapon with an overall covering of just 15-20mm of armour, giving it protection only against splinters.

³⁶ The 2S1 had a range of just 15,300m, and could fire five rounds per minute, having no assisted loading. Unlike the 2S3, it was amphibious, and was designed to travel with attacking formations. Lieutenant General A. Saposhnikov explained that, "Experience shows us that assault guns can counter enemy targets with more accuracy than can field artillery in the direct fire mode. The principal qualities of assault guns are their tactical mobility, exceptional armour protection for the operators, and their operational flexibility even in zones of destruction". Quoted in Hofmann (1978). His implication was that the 2S1 was an assault gun. Certainly it was expected to travel well forward as part of a regiment; and it had a direct fire sight, but it did not have the heavy frontal armour common to assault guns in the Second World War. Crews manning Soviet SPs of the 1970s and 1980s wore the black uniform of armoured troops, but belonged to the artillery. The role of the true assault gun had been taken over by the tank.

³⁷ See Madill (1982), Bellamy (1985a) and 'More Self-Propelled Gun Designations', *Jane's Defence Weekly*, Vol.5, No.22 (7th June 1986), pp.1033-1034.

³⁸ The BM-21 had four times the salvo-weight and eight times the destructive capacity of the BM-13; but while the accuracy of MBRL systems improved, targets also became harder, and it became more cost-effective to fire heavier missiles.

³⁹ BM-27 had a range of 35-40km, delivering 720 rounds on one square kilometre in thirty seconds, and was able to fire chemical weapons and mines.

⁴⁰ Foskey (1984).

⁴¹ Hansen (1984).

⁴² Quoted in Bevilacqua (1984), pp.48-49.

⁴³ Quoted in Bellamy (1983), p.269.

⁴⁴ Donnelly (1979a).

⁴⁵ O'Hagan (1978) and Bellamy (1985), pp.40-41. The system of allocating artillery support and ammunition is further described in Bellamy (1986), pp.176-185.

⁴⁶ Colonel M. Adeev, writing in *Voyenny Vestnik* in June 1978, believed that the uncertainty which arose in mobile operations reinforced the need for the barrage, which had been used in the past to 'sweep the ground' of un-located enemy. He also challenged the Soviet liking for destruction, arguing that the most important criterion was the time for which an enemy was unable to fire his weapons, in other words, neutralization. This took less time and required less logistic support, both of which were attractive to Soviet strategy; but it was recognized that neutralizing mobile targets quickly would be difficult. Lieutenant General Stroganov noted that whereas fire against static targets should above all be accurate, against mobile targets it should be dense and effective before the target could move. Density could be achieved by firing more guns together for shorter periods on series of targets. These concentrations were termed 'fire strikes', and the view that they should replace the prolonged preliminary bombardment of the Second World War was endorsed by Marshal Peredel'skiy. Donnelly (1982a), p.19. The virtues of successive concentrations had already been appreciated by Western armies in the Second World War, but had not been favoured by the Soviets, who preferred the simultaneous saturation of all targets, if necessary over a longer period. The implication of Lieutenant General Stroganov's assertion was that the fire of a

battery over a period of time was less effective than that of three batteries on the same target for one-third of the time. The battalion fire mission therefore became standard, as it did in NATO armies.

⁴⁷ Isby (1981).

⁴⁸ It was calculated that an assault would be effective only if it progressed at no more than about 5kph. If it were faster, insufficient times would elapse for enemy targets to be suppressed effectively. A possible solution was to engage successive lines of defence simultaneously, as had been common practice in the World Wars, but this policy worked against Stroganov's principle, that fire must be swift and dense, since this solution increased the duration of fire and the number of targets to be engaged by the same number of guns. Another solution, compatible with Andreev's ideas, was so to increase the speed of an attack that the defence would not have enough time to man their weapons before the attackers were upon them. The recovery-time of infantry ATGW from bombardment was estimated at seventy-five seconds, and for heavier weapons two to three minutes. It was concluded that if the assault went in at more than 6kph the defence would not have enough time to engage effectively, and would be overwhelmed. But these recovery-times for the defence presupposed that artillery fire had been effective in the first place, and when an attack went in at more than 5kph this was judged not to have been the case. In the final analysis, it was hard to predict how effective artillery would be in neutralizing or suppressing the enemy during a quick attack.

Another factor in determining the success of an assault was the safe distance kept between artillery fire and advancing troops. The recommended safe distance for tanks was 200m, for APCs 300m and for infantry 400m, which meant that artillery support stopped just as defenders' weapons became most effective. These peacetime figures were greater than those observed in practice by any army in the Second World War, and were unlikely to have been complied with in war. The Soviets would almost certainly have advanced as closely behind their own fire as possible, and at the same time overcome the problems of duration of fire, speed of advance, and recovery-time, which had been the subject of so much academic debate.

⁴⁹ Dick (1985).

⁵⁰ Donnelly (1984).

⁵¹ Bellamy (1983).

⁵² Goure (1984).

⁵³ Bellamy (1985b), p.59

⁵⁴ For a description of HAVOC and its role, see Geiger (1985).

⁵⁵ Perkins (1978), p.13.

⁵⁶ A formidable C3 problem remained for Soviet fireplanners as formations passed through others and required simultaneous fire support from artillery and aircraft. The staff of Soviet divisions in the 1980s were too weak to cope adequately, and at front-level the scale of the problem was too great to be handled in detail by existing staff.

⁵⁷ Sweetman (1985).

⁵⁸ 'NATO Doctrine and the National Operational Priorities. The Central Front and the Flanks: Part I'. *Adelphi Paper 207*, 'Power and Policy: Doctrine, the Alliance and Arms Control, Part III', pp.12-33.

⁵⁹ The Soviets had usually maintained a higher artillery ratio than other armies since the studies of Vladimir Triandafillov, who made calculations on relative strengths in battles of the First World War, comparing frontages and suppressing capabilities.

⁶⁰ During the Vietnam the ability to locate the enemy had deteriorated; and despite an unprecedented display of firepower, the enemy was seldom adequately suppressed. In the Yom Kippur War the USA had seen Syria deploy 1,200 guns and Egypt 2,000 guns, yet in Europe the USA had just 500 field guns. Ott and Rhea (1976), p.23.

⁶¹ Davis (1977), p.21.

⁶² Robinson (1977).

⁶³ Perkins (1978), p.13.

⁶⁴ NATO increased the weight of its firepower by standardizing on the 155mm calibre piece, and its utility by favouring the SP gun. In 1965, NATO had 1,600 SPs in the Central Region, and 1,000 towed pieces. Half of all these were of 105mm calibre. By 1975, NATO had 3,000 guns, of which only twenty-five percent were towed. Medium guns rose as a percentage from fifty-three in 1965 to seventy-three in 1975.

Ironically, between 1975 and 1982 the number of SP guns rose by six percent, and towed by twenty-four percent, reversing the trend to self-propulsion with the introduction of pieces such as the FH70, providing longer range at reduced cost. Crutchley and Milam (1985), pp.34-37.

⁶⁵ The British Chieftain tank was less suited to mobile operations than tanks of other NATO armies, but was optimized for defence. British infantry was trained to dig in and hold ground, and much of the 1st British Corps was based in the UK, equipped only with soft-skinned, wheeled vehicles.

⁶⁶ The ineffectiveness of artillery against armour in the 1960s is described in Corkhill (1967).

⁶⁷ Quoted in Churchill (1980). All US Army Field Manuals (FM) are published by the United States Department of the Army, Washington DC.

⁶⁸ Flume (1985) and Scott (1971).

⁶⁹ Fairweather (1973), p.19. The subject was also discussed in the journal *Wehr und Wissenschaft* in July 1972, which described an attack by combat helicopters on armour, at corps level, on a 100-150km front.

⁷⁰ From the mid-1960s there was a flurry of development in the field of ATGW in which the USSR and France led. First-generation systems included the AT-1 Snapper, AT-2 Swatter, AT-3 Sagger, SS11, Cobra, Mamba, Malkara and Vigilant. These were followed in the mid-1970s by the second-generation weapons of many nations such as the AT-4 Spigot, AT-Spandrel, AT-6 Spiral, Milan, HOT, Swingfire, Dragon and TOW. See Goure (1984).

⁷¹ Corkhill (1967).

⁷² Robinson (1977).

⁷³ Quayle (1979).

⁷⁴ Stokes (1980).

⁷⁵ Blunt (1974).

⁷⁶ These complaints in the British Army were reminiscent of those seventy years earlier, when the development of indirect fire separated field guns from their supported arm.

⁷⁷ Davis (1977).

⁷⁸ The Israelis even encouraged the greater use of organic infantry and armour mortars, so that field artillery might be released for use en masse against deep targets. Stokes (1980).

⁷⁹ Berry (1981).

⁸⁰ Morony (1975).

⁸¹ Furlong (1983).

⁸² The French produced the GIAT 155mm AUF-1 SP, which entered service in 1982. This had greater range, accuracy and rate of fire than contemporary marks of M109, achieving six rounds in forty-five seconds using an automatic loader. The French believed that such a rate of fire over a sustained period was more effective than that of even a rocket launcher, and should be able to disrupt tanks and stop more lightly armoured vehicles. However, this was still an inefficient way to destroy armour, and high rates of fire posed daunting logistic problems in the mobile operations envisaged by the French, even if the duration of missions was short. 'The New French 155mm Self-Propelled Gun', *International Defense Review*, Special Issue No.7 (1978), pp.35-39.

⁸³ Schneider (1986) and Keegan (1987).

⁸⁴ Berry (1985). See also 'Vickers AS90: A Gunner's Gun', *Jane's Defence Weekly*, 28th June 1986, pp.1254-6.

⁸⁵ See 'Multiple Rocket Launcher for the German Armed Forces', *International Defense Review*, Vol.1 No.4 (April 1968), pp.60-65.

⁸⁶ Robinson (1978a).

⁸⁷ For a description of these ammunition types see Holmes (2001), pp.45-48.

⁸⁸ *Wehr und Wissenschaft* of July 1971, for example, described surprise action against armour at 60km, using artillery rockets and scatterable mines. Quoted in Miksche (1972).

⁸⁹ The importance of scatterable mines was noted by Miksche, who pointed out that mines could be made lighter and more effective than they had been in the Second World War; and that, whereas in 1945 it might have taken five hours and twelve tonnes of munitions to mine one square kilometre, in 1972 scatterable mines could do the same with eight tonnes in much less time. Miksche (1972).

⁹⁰ US FASCAM fell into two categories, the Area Denial Artillery Munition (ADAM), designated M692/M731, an anti-personnel system; and the remotely activated anti-tank mine (RAAM), designated

M718/M741. Both were base-ejected from an ICM with a relatively unsophisticated mechanical time fuse, were activated by trip lines and magnetic fuses respectively, and incorporated self-destruction mechanisms. Prehar (1979).

The German LARS launcher had thirty-five rockets, each of which could fire a munition containing five AT-2 scatterable mines, enabling each launcher to deliver 180 mines on a target in eighteen seconds.

White (1979) and Hofmann (1985).

⁹¹ Gray (1978).

⁹² 'The British Artillery Meteorological System', *International Defence Review*, Vol.5, No.4 (April 1972) pp.366-369

⁹³ Ludvigsen (1972). See also, 'TACFIRE: An Automated Artillery Fire System', *International Defense Review*, Vol.4, No.2 (February 1971), pp.72-76.

⁹⁴ See, 'Artillery Command and Control', *International Defense Review*, Vol.18, No.1 (January 1985), pp.39-61, and p.58.

⁹⁵ Barry (1975).

⁹⁶ The danger of relying on a few guns working harder was seen in the Korean War, and it also made them potentially more vulnerable to CB fire. For an army dependent on few artillery pieces, the marginal value of each was proportionately greater, and time spent out of action while moving to avoid being located, proportionately more expensive. This explained the British Army's preference for static, protected gun positions over frequent displacement up until the mid-1980s, when a more flexible approach was adopted. British artillery was required to concentrate its slender resources at the most advantageous tactical moments of the battle, Watson (1986); and frequent displacement was deemed the best means of surviving WP CB fire. Tomlinson (1983), p.9.

⁹⁷ The US Air Force developed unmanned aircraft from the FIREBEE target drone. This was used successfully in the Vietnam War, but development was stopped soon after the US withdrawal. Sweetman (1985a). The Canadair CL-89 reconnaissance drone, sometimes known as Midge, was introduced in most NATO armies in the early 1970s with the task of divisional reconnaissance. Pletschacher (1985) and Barry (1973).

⁹⁸ Tegnalia (1985), p.644

⁹⁹ Chaplin (1973).

¹⁰⁰ Bellamy (1984).

¹⁰¹ 'Operational Manoeuvre Group', *Defence Update International*, No.46 (1984), pp.2-12.

¹⁰² Rosser-Owen (1983).

¹⁰³ Dick (1985a).

¹⁰⁴ Dick (1985). Soviet literature of the time emphasized the importance of concentrating fire and integrating it with other arms at the tactical level. This indicated concern that small-scale, but nonetheless vital, engagements could be lost 'in detail'. This literature is surveyed in 'New Generation Weapons and the Doctrine of Tactics', *Jane's Defence Weekly*, 14th June 1986, pp.1102-1106.

¹⁰⁵ Goure (1984).

¹⁰⁶ It was likely that each of the five armies in the Group of Soviet Ground Forces Germany would have provided one division-sized OMG under front command, which might have been committed on D Day+1-D+3 and advance 30-50km before the first echelon battle had been resolved. These would have been followed by a larger army-sized OMG on D+3-D+4 to deliver a coup de grace, with far-reaching political and military objectives once NATO's defences had been fragmented. Hansen (1984) and Rosser-Owen (1983), p.97.

¹⁰⁷ Rosser-Owen (1983). Fire support for the OMG on the move is described in an article of February 1982 by Major Michalak, and in articles of May and August 1982 by Colonel Musial, both Polish officers. Quoted in Bellamy (1985a), p.63.

¹⁰⁸ Brown (1985). It was possible that each manoeuvre battalion might have been supported by a battalion of eighteen to twenty-four SP field guns, with perhaps the 240mm M-1975 SP mortar for heavy but short-range tasks. 'Heavy Mortars and Howitzers', *Jane's Defence Weekly*, 15th September 1984, pp.460-1. In this way they might have achieved ratios similar to those on critical sectors in the Second World War. An OMG would also have been supported by numerous Mi-8 HIP fire support, and Mi-24 HIND anti-armour

helicopters. These would have been particularly suitable for destroying critical targets such as MLRS, Lance, C3 installations and helicopters.

¹⁰⁹ The concept of a five-minute fire mission by one or more battalions incorporating air support was known as the 'Fire Strike'.

¹¹⁰ Quoted from *Red Star*, 9th May 1984, in Wikner (1984), p.100.

¹¹¹ Burgess (1986).

¹¹² FitzGerald (1986).

¹¹³ Quoted in Burgess (1986), p.47.

¹¹⁴ The USSR built up specialist heavy artillery brigades throughout the 1980s, equipped with self-propelled mortars, rockets and tubed artillery, at army and front levels. These were a reflection of the Soviet concern to create conventional forces capable of winning a war against NATO without recourse to nuclear weapons.

¹¹⁵ Sutton (1984), p.64.

¹¹⁶ Romjue (1984).

¹¹⁷ In the First World War it took three to four months to halt mobility with the resultant trench warfare. In the Second World War it took the Allies two years to find an effective counter to Blitzkrieg, but NATO would have had to find an immediate response to WP aggression, or resort to nuclear war.

¹¹⁸ Starry (1981), p.8.

¹¹⁹ Doerfel (1982), p.34.

¹²⁰ In 1986 the WP was estimated to have ninety divisions deployed and manned in Europe in peacetime. These were equipped with 46,610 tanks and 24,035 artillery pieces and MBRL. By comparison, NATO had thirty-eight divisions in place, equipped with 20,314 tanks and 8,974 artillery pieces and MBRL. *The Military Balance 1986-87*, IISS (London, 1986), p.226

¹²¹ Hewish (1984).

¹²² Romjue (1984). *FM100-5 Operations*, 1982 was a synthesis of much historical thought. This, and the formulation of AirLand Battle against the background of political and military events of the late 1970s and early 1980s, are described in Galloway (1986).

¹²³ Starry (1981), p.7. Fire support in the rear battle is discussed in Tredo (1986).

¹²⁴ Romjue (1984), p.13.

¹²⁵ 'Army 86: Blueprint for Tomorrow', *Army*, Vol.31, No.6 (June 1981), pp.21- 42, 37.

¹²⁶ Starry (1981), p.12, Barry (1984) and Barbara and Brown (1982).

¹²⁷ Contemporary ideas of deep attack were very similar to the planning of artillery counter-preparation fire in the First World War, when the positioning in depth and marching time of reserves for the counter-attack preoccupied both attacker and defender. In a sense, counter-preparation was the doctrinal foundation of AirLand Battle, an attempt to create a Blitzkrieg effect, but from a defensive position. It relied heavily on air-power, and drew confidence from the efficacy of deep air interdiction in the Second World War, particularly in Normandy in June 1944. As a result of these attacks, it had taken the German 2nd Panzer Division seven days to travel 240km, and 17th SS Panzer Grenadier Division fourteen days to cover 320km. Field Marshal von Rundstedt had observed, "It was all a question of air force, air force and again air force...we were prepared for various eventualities...that all came to nothing or were rendered impossible". Quoted in McCoy (1984), pp.82-83. This experience also encouraged the Germans to support deep air interdiction. Ruge (1972). However, the strength of Soviet air defences made NATO air forces more vulnerable than those of the Allies in 1944. US Doctrine for deep operations was issued in *Field Circular 100-15-1. The Plan of the Manoeuvre Commander. Corps Deep Operations*.

¹²⁸ Goldich (1984).

¹²⁹ Hanne (1983).

¹³⁰ Tegnalia (1985), p.650.

¹³¹ Holder (1982).

¹³² A description of 'Army 21' is given in Wickham (1985).

¹³³ Quoted in Romjue (1984), p.14.

¹³⁴ General Rogers repeatedly pointed out the significant differences between AirLand Battle and FOFA. The latter did not allow a first strike, or the mass-crossing of borders by ground troops. FOFA continued to recognize the distinction between nuclear and conventional forces, and that the former would be

required until banned by negotiation. Although AirLand Battle envisaged nuclear operations, many saw it as a stepping-stone to a nuclear-free deterrent. Rogers (1984) and Rogers (1985). The 1986 edition of the US Army's *FM 100-5. Operations* sought to reconcile the discrepancies between AirLand Battle and FOFA. It stressed that AirLand Battle was compatible with corps-level tactics and operations, and was not seeking to steer NATO alliance strategy. It asserted that AirLand Battle was compatible with *Allied Tactical publication (ATP) 35(A). Land Force Tactical Doctrine*, and that US forces in NATO could operate without violating the precepts of either. It claimed that AirLand Battle did not necessarily require the crossing of international borders if strategic considerations prohibited it; and that AirLand Battle's emphasis on ground forces did not clash with FOFA, which relied essentially on air assets. General W.R. Richardson, one of the architects of AirLand Battle, insisted on the compatibility of AirLand Battle and FOFA in Richardson (1986). A similar view can be found in Tuttle(1985). See also Ackerman (1985).

¹³⁵ Machos (1984), pp.20-21.

¹³⁶ Bramall (1982), p.7.

¹³⁷ Bagnall (1984), p.62. The matching concept for air operations in the Central Region is given in Hine (1984). The German and NATO commitment to Forward Defence was emphasized by the Commander-in-Chief Central Europe, General Leopold Chalupa, in Manners (1985).

¹³⁸ Mahaffey (1983).

¹³⁹ This transmitted live television pictures and could adjust artillery fire and allow assessments of damage. See Sweetman (1985a), p.1772 and Reed (1985a), p.127.

¹⁴⁰ 'British Army Orders Phoenix Target Acquisition RPV', *International Defense Review*, Vol.18, No.4 (April 1985), p.470.

¹⁴¹ See, 'Artillery Command and Control', *International Defense Review*, Vol.18, No.1 (January 1985), pp.39-61. A survey of portable artillery computers is given in Obright (1986).

¹⁴² BATES was tailored to the corps structures and relatively static concepts of the Cold War. Its capability was never fully realized when the operational requirement changed radically in the 1990s.

¹⁴³ The French had already produced elements of a similar package called ATILA which was enhanced by the Sirocco meteorological unit. See, 'The Sirocco Meteorological Sounding System', *International Defense Review*, Special Issue No. 7 (1978), pp.89-90.

¹⁴⁴ The Canadair/ Dornier CL-289 real-time transmitting drone was to be introduced at corps level and in five divisions, locating targets 75km beyond the FEBA. The CL-289 was a Canadian-Franco-German project. It was intended that film would eventually be replaced by real-time computer-based image interpretation. It was to be used by the Germans to locate targets for MLRS, Pletschacher (1985). The CL-289 went on to perform well over Kosovo in 1999. At divisional and brigade levels the KZO reconnaissance drone was to provide the commander with intelligence up to 30km beyond the FEBA. A survey of eighty-eight RPV programmes of the mid 1980s is given in Nixon (1986). The Germans also foresaw a major anti-radar role for RPVs, either by guiding MLRS munitions or by 'kamikaze' direct attack. These and a wide variety of new acquisition systems would work with the ADLER C41 system which replaced FALKE.

¹⁴⁵ 'Army 86 Blueprint for Tomorrow', *Army*, Vol.31, No.6 (June 1981), pp.21-42. The twin-phased array radar, 'Fire Finder', consisting of the AN/TPQ-36 and AN/TPQ-37 radars, entered service in the early 1980s. See, 'Implementing the AirLand Battle', *Field Artillery Journal*, Vol.49, No. 5 (September-October 1981), pp.202-207. It was hoped that by 1990 many reconnaissance tasks would best be carried out by the AQUILA RPV, which was intended to search an area 25km square in five minutes, adjust artillery fire, and designate targets for Copperhead. Hewish (1984), p.1063; and Sweetman (1985a), p.1773. Funding for AQUILA was withheld in 1988; but the requirement for an RPV remained. The development and financial problems of the AQUILA project are described in Harvey (1986) and Lucas (1987). They centred on whether the RPV should be used for laser designation, or as an artillery observer. Target acquisition was to be further enhanced by the US Army's Helicopter Improvement Program(AHIP). This was to give the divisional OH-58 helicopters, used by field artillery aerial observers (FAAO), improved survivability, observation and a laser designator. It was also planned to introduce more than 1,000 fire support team vehicles (FISTV) by 1990. Pillsbury (1984).

¹⁴⁶ Mercer (1984), and Halloran (1985).

¹⁴⁷ Wrenn (1985).

¹⁴⁸ Range may be increased by increasing muzzle-velocity (MV) with longer tubes; using higher-energy propellants or higher working pressures; using boosted projectiles; or by improving ballistic coefficient by reducing drag, or using stabilized sub-calibre projectiles. Trudeau (1977). The price is higher barrel-wear and strain on the equipment. For example, the stress on the M109A2 and A3 firing a RAP with maximum charge was too severe to allow frequent use, and so in practice reduced the maximum range of 30km by twenty percent. At ranges beyond 40km the balance of cost-effectiveness tips away from guns and shells, in favour of rockets. The tactical significance of increasing range is discussed in Ott (1987).

¹⁴⁹ Craven (1983), and Niemzig (1981). The termination of the SP70 project is reported in Schneider (1986) and Keegan (1987).

¹⁵⁰ West German improvements to the M109 are described in Schneider (1985). A comparison of fourteen SP guns of the 1980s is given in O'Malley (1985).

¹⁵¹ Furlong (1983).

¹⁵² HIP improved armament reliability, availability and maintainability, and so response time and effectiveness. It provided a cannon with a range of 22km, or 30km with RAP. This could have been increased with an Extended Range Cannon. It provided an Automatic Fire Control System (AFCS) for on-board computation to work with the Automatic Gun Positioning System (AGPS), which gave on-board position location and barrel orientation. HIP enabled the crew to stay better protected and the guns to disperse away from traditional battery positions. The decision to proceed was taken on 1st November 1984 and the equipment was in service by the late 1980s. 'Getting HELP and HIP' *Field Artillery Journal*, (September-October 1985), pp.20-21. For details of AFAS see Pengelley (1987a) and (1987c). A robotic M109 demonstrator is described in Pengelley (1987d).

¹⁵³ Pengelley (1973).

¹⁵⁴ The Austrian Noricum GH N-45 is described in Foss (1986).

¹⁵⁵ This first appeared in January 1977 and had a range of up to 29km with RAP.

¹⁵⁶ Ryan (1982).

¹⁵⁷ The development of 155mm cargo rounds such as the US M483 and M449, and Israeli and German models is described in Forrest (1986). For a fuller account of German munitions of the 1980s, see Flume (1985a). French munitions developments are described in Turbe (1987).

¹⁵⁸ Antoniotti (1983).

¹⁵⁹ Antoniotti, (1984). The shell was fifty percent longer and heavier than standard projectiles. It was claimed that Copperhead achieved eighty percent first-round hits, and that it would eventually prove more cost-effective than TOW. It was also claimed to be between three and nine times more cost effective than the M-1 tank, the M-2 infantry vehicle, and the Apache helicopter in destroying tanks, 'The Copperhead', *Journal of Defense and Diplomacy*, Vol.1, No.7 (October 1983), pp.49-52. It was, however, in effect a direct fire system, limited by an observer's laser line of sight and the 5km range of his designator. An RPV could, however, designate a target for Copperhead at 17km from the gun, and in the enemy's depth. Copperhead is also described in Antoniotti (1986), Foss (1986b) and Lang (1985).

¹⁶⁰ If Copperhead was comparable to a direct fire weapon, it was doubtful whether it was qualitatively better than other direct fire systems; and funds might have been better spent on equipments such as MLRS, mortars, a self-seeking anti-tank round, mines or ATGW. Copperhead missions took time to set up, with certain guns on stand-by, but this did not make best use of those guns. Copperhead was also thought by some to complicate ammunition re-supply and handling in increasingly automated and standardized guns.

¹⁶¹ Sundaram (1980).

¹⁶² The most promising was the XM836 Seek and Destroy Armor (SADARM). SADARM carried three sub-munitions, which used millimetric wave sensors to scan for targets as they spiralled to earth by parachute. An altimeter detonated the sub-munition, firing self-forging fragments at the top of an AFV from the correct height. If it failed to find a target, it instead became a mine. Hewish (1984), p.1055. Nearly twenty years later SADARM had yet to enter service. Developments in terminally-guided munitions and ICM in the 1980s are described in Foss (1986b) and Jackson (1985).

¹⁶³ Geddes (1980).

¹⁶⁴ A description of how MLRS operated is given in Cummings and Preczewski (1983). For a survey of artillery rocket systems around the world in the 1980s, see 'Artillery Rocket Systems: a Unique Market', *Military Technology*, Vol. XI, No.9 (September 1987), pp.22-31.

¹⁶⁵ Flume & Po (1985), p.21.

¹⁶⁶ Geddes (1980)

¹⁶⁷ Hewish (1984), p.1053.

¹⁶⁸ Flume & Po (1985). The problems faced by the Phase Three munition in overcoming reactive armour and delays to the project are described in Jenkins (1987).

¹⁶⁹ Lieutenant General H.H. von Sandrart described how scatterable mines could create barriers, which combined with manoeuvre, could defend West Germany despite limited territorial depth. See von Sandrart (1985). A futuristic concept of defence using barriers of fire in the form of artillery-delivered mines, is described in 'NATO Defense. Conventional Options Beyond FOFA', *International Defense Review*, Vol.19, No.7 (July 1986), pp.897-898. The different organization and deployment of MLRS in the US Army and Bundeswehr is described in Smith (1987).

¹⁷⁰ Hewish (1984). ATACMS was initially armed with existing MLRS sub-munitions; but these were to be replaced by terminally-guided ones.

¹⁷¹ Tegnalia (1985), p.644. TACMS Block I and Block II warheads are described in, 'The Azimuth of the Field Artillery', *Field Artillery Journal*, Vol.54, No.6 (November-December 1986), pp.21-22.

¹⁷² A description of JTACMS is given in 'Das JTACMS-Programm', *Soldat und Technik*, Vol.27, No.5 (May 1984), pp.224-246. NATO had sixteen battalions of Lance, which replaced Honest John in 1972-73. See 'The Lance Tactical Missile', *International Defense Review*, Vol.6, No.2 (February 1973), pp.199-203, 'The Lance Tactical Missile', *International Defense Review*, Special Issue No.7 (1978), pp.55-59, and Spackman (1972). Lance had a range in excess of 100km, and was generally used by corps to deliver nuclear, but also HE, warheads. At about the time that JTACMS would overlap much of Lance's range, Lance seemed likely to receive a significant enhancement of its own. It was well-suited to carry advanced conventional munitions, and by the early 1990s seemed likely to be equipped to deliver the M251 warhead, carrying 825 M-74 bomblets, able to cover an area 400m square. Hewish (1984), p.1055. With a solid-fuel rocket-motor, using MLRS propellant, Lance's range could have been increased to 300km, enabling it to reach the East German-Polish border, well beyond the planned scope of corps responsibility. The possible role of Lance as a conventional munitions dispenser is described in Bowman (1986).

¹⁷³ Lopez (1983), p.1555, and Reed (1985).

¹⁷⁴ 'Army 86: Blueprint for Tomorrow', *Army*, Vol.31, No.6 (June 1981), pp.21-42.

¹⁷⁵ The US corps was to have four battalions of MLRS, six battalions of 155mm and one of 203mm guns. The overall effect was to increase manpower by twenty-five to thirty percent.

¹⁷⁶ These units were expected to operate behind enemy lines with less artillery support than usual. A suggestion as to how a US brigade-sized Divisional Attack Force (DAF) might have been supported by artillery, including 155mm pieces and MLRS, is made in Starner (1986). This proposal had similarities with Soviet practice, with its emphasis on the deployment of SP guns, moving to provide rapid fire support on contact with the enemy. Such operations would also have been conducted inside the enemy AD envelope; and it was assumed that at least areas of local air superiority could have been achieved to protect them. It is doubtful whether such units could have survived, let alone accomplished their mission without being drawn into the battle of attrition which they sought to avoid. Avoiding such an encounter would have depended largely on the quality of intelligence available, but there would have been no certainty that the Soviets would have conformed to the echeloned formations which NATO had grown accustomed to expect. It was possible, for example, that units might have encountered a large WP formation, such as an advancing OMG, and been unable to extricate themselves. They would very likely have been defeated, and would have been unlikely to cause major damage to the OMG.

¹⁷⁷ Other NATO armies rejected the US plan to send corps units forward. On 11th November 1982, the Inspector General of the Bundeswehr, General M. Glanz, rejected the idea that his army would be logistically capable of deploying units into the depth of the enemy, Sutton et al (1984), p.56; but logistic difficulties might have been less of an obstacle than the political problems of talking about offensive

action in the East. It seemed likely that the Bundeswehr would develop some kind of mobile offensive capability in the future.

General Dr von Senger und Etterlin favoured the idea of high mobility, using helicopters to transport anti-tank and artillery weapons. They would combine high mobility and firepower, but their benefits would best be realized if they held the initiative. While mobile or deploying, they would be especially vulnerable, and would require massive cover by fire. Providing that fire would have been a major and highly complicated task; and not the least of the difficulties would have been the co-ordination of helicopter movement with fire support, and SEAD in particular. Such high mobility would have required much greater firepower to protect it than existed at that time. It would have been wise to create the firepower for highly mobile formations to exploit, rather than to create the formations and then to look for the firepower to protect them.

¹⁷⁸ Stokes (1980a).

¹⁷⁹ Greenwood (1984), p.8. Phillip Karber pointed out that the real question was not one of corps tactics, but of whether NATO could deploy in time. Karber (1984).

¹⁸⁰ Land forces preferred to have aircraft under command, while air forces preferred a high degree of C2 for themselves. The USAF did not wish to divide its TACAIR assets among corps, remembering the precedent of 1942-43, and preferred such aircraft to be held at army level, leaving corps to bid for close air support (CAS), or to use its organic helicopters and artillery. Romjue (1984). This view prevailed in NATO's FOFA doctrine, and in essence this remains the case today.

¹⁸¹ Colonel T.N. Dupuy doubted whether on such a large and dispersed battlefield, rates of attrition would be greater than those of earlier wars, despite advanced munitions. Dupuy (1985).

¹⁸² Even NATO deployment exercises of the time tended to start on a disconcerting note, with major traffic jams as vehicles sought to outload ammunition depots such as the British Army's at Sennelager.

¹⁸³ Goldich (1984).

¹⁸⁴ Ruge (1972). The effectiveness of tanks in suppressing infantry firepower was already in decline in the Second World War, by comparison with the First World War. Rowland (1986), p.40

¹⁸⁵ Mason (1984), p.7.

¹⁸⁶ Lopez (1983), p.1554

¹⁸⁷ Bramall (1982).

¹⁸⁸ Goure & Cooper (1984).

¹⁸⁹ Hollingsworth (1984), p.44 and Garrett (1984).

¹⁹⁰ Steinhoff (1985), p.24.

¹⁹¹ Others pointed out the danger of seeing high-technology as an adequate substitute for nuclear weapons: *ibid.* p.24. *FM 100-5 Operations* (1982) recognized that nuclear fire might well be the "predominant expression of combat power", with small combat forces being used to exploit these effects. Quoted in Romjue (1984), p.11.

¹⁹² General Rogers' arguments are stated in Bonnart (1984) and Rogers (1984).

¹⁹³ Mason (1984), p.7. Sir Ronald advocated the development of missile-carrying anti-tank munitions and mines.

¹⁹⁴ Manfred Woerner supported the view that technology could provide an answer to defence problems in *Aviation Week A Space Technology*, 19th July 1982, p.117. In March 1983, Karsten Voigt, an SPD member of the Bundestag expressed the view that, "Whatever security can be achieved with few risks and less expense we should attempt." Quoted in Scott (1984), p.57. However, risk and expense were the crucial issues and many believed that the costs would be prohibitive

¹⁹⁵ Hilton (1983).

¹⁹⁶ Romjue (1984).

¹⁹⁷ MDC is described in Bahnsen et al (1988).

¹⁹⁸ Described in Donnelly (1989).

¹⁹⁹ A description of Soviet preference for strategic deception is given in Dick (1986).

²⁰⁰ Tegnalia (1985), p.645.

²⁰¹ Antoniotti (1983). The problems of providing fire support for formations manoeuvring in depth are put into historical perspective in Gay (1986a).

²⁰² 'Slammer VI' was a light rocket concept which could have formed the basis for such a system. Brenner (1985). It was itself a derivative of the T66 of the Second World War. See Hedekin (1946) and 'The Rocket Field Artillery Battalion', *Field Artillery Journal*, Vol.35 (September 1945), pp.515-522. An Israeli proposal for a lightweight rocket system is described in, 'Lightweight Towed Version of LAR 160', *Jane's Defence Weekly*, Vol.6, No.6, 16th August 1986, p.261.

²⁰³ Turbe (1985). A study of mortar development in the mid 1980s is given in Fowler (1986).

²⁰⁴ The 120mm mortar was well-suited to fire a top-attack munition with self-forging fragment, or Miznay-Chardin warhead. Work on advanced mortar munitions continued in the USA. The Guided Anti-Armour Mortar Projectile (GAMP) could be fired from an automatic 81mm or 120mm mortar. It had a 'brilliant', discerning warhead for use against armour. It could be used as part of an overall anti-tank plan, but was also suited to US concepts of high mobility. If carried by helicopter, it would provide anti-armour close support for deep penetration forces. Leask (1984). However, the GAMP project was halted because of fears about its employment in the close battle. Could it engage fast-moving armoured targets quickly enough before being overrun itself? In a head-on melee, could it distinguish friend from foe adequately? See Hooten (1986), p.52. The British also ceased to fund their advanced 81mm Merlin munition in 1986. Other nations continued research into intelligent mortar rounds. Some believed that the disadvantages of a mortar could be overcome if it had longer range, was automatic and mounted on a highly mobile platform.

²⁰⁵ In the Second World War the Germans developed an automatic, breech-loading mortar, which was subsequently developed by the Swiss, Geisenheyner (1984), and by the Soviets.

²⁰⁶ In the 1970s and 1980s ATGW gave the infantry advantages over armour, but it was recognized that these would have to get much heavier to remain effective. Weapons such as the Fibre Optic Guided Missile (FOG-M) with ranges of up to 10km ceased to be true infantry unit weapons, since they were likely to require control at formation level; and they had less value in close or urban terrain. The military applications of fibre optics are described in Elliott (1986).

²⁰⁷ Breen (1980).

²⁰⁸ Furlong (1983). The DSWS was to have a range in excess of 30km, NBC protection, improved armour, a powerful engine, automatic gun-laying linked to an on-board ballistic computer, enhanced optics, special sensors to monitor ammunition temperature and variations in muzzle velocity, an autonomous survey system and automatic loading. The technology for automatic loading was already 30-40 years old and common in naval service. The advantages of automatic loading were clear. It would allow a reduction in the crew, creating more storage space. It would make it possible to use an unmanned turret and so reduce the size of the whole vehicle, making it more survivable; and safety would be further enhanced by the separation of crew and ammunition. Cornett & Morrison (1983), and Wrenn (1985), p.4. If the many advantages of automatic loading were to be exploited, it would be necessary to introduce an equally advanced limber to re-supply ammunition at speed, and in the correct mix of types.

It was believed that with such a system, fire could be massed four times faster than with the M109A2. It would give a brigade commander enough fire support to forego the help of division or corps, except in emergencies, and the fire he required would be more readily available. It was also thought that liquid propellant would be a part of the system. See, 'Liquid Propellant Charges for Gun Ammunition', *International Defense Review*, Vol.19, No.5 (May 1986), p.688; Foss (1986), and Aubin (1986).

²⁰⁹ Liquid propellant seemed likely to be in service by the end of the 20th Century. Early research was carried out in the 1940s and 1950s, but the technology was wanting. It seemed in the late 1980s that the problems could be overcome. If they could, liquid propellant would have many advantages. The entire system for thirty-four 155mm charges and containers could be held in one 55-gallon drum. There would be no surplus charge-bags wasted, as only a precise quantity of propellant would be used for each shot. It could be stored outside the crew compartment and fed in by a hose, obviating the need for manhandling, thereby improving crew safety. At ambient temperatures liquid propellant is hard to ignite and the risk of secondary explosions if hit is much reduced. The reduction in storage space and manpower would mean that vehicles could be smaller, lighter and faster, bearing little resemblance to the traditional SP field gun. Liquid propellant would also be cheap. In 1986 prices, 155mm solid propellant cost \$60 per pound, whereas liquid propellant cost just one dollar. Liquid propellant would be lighter and less bulky and reduce the burden on logistic services. With automatic loading, liquid propellant would allow guns to fire

at Rate 20, and that fire would be more accurate than with solid propellant. In addition, blast overpressures would be less because re-ignition of muzzle gases would not occur. These gases would be inert and non-toxic, and would not compromise a gun's position with a bright flash. See Lessels (1986), and 'Liquid Propellant Charges...' (1986), cited in the preceding note.

It was hoped that electro-magnetic propulsion could be applied to field artillery in either a rail gun or a coaxial accelerator. Conventional guns became bigger, heavier and more expensive as more propellant and longer barrels were used to increase range. It was hoped that electro-magnetic guns might achieve ranges of 60km without such disadvantages, using an energy output of one gallon of diesel per shot. The advantages of such a system seemed even greater than those offered by liquid propellant. Aubin (1986), and Knoth, (1984).

²¹⁰ Doerfel (1984).

²¹¹ Woodmansee (1984), p.27.

²¹² The quality of light but accurate and lethal fire is unlike that of heavy, relatively indiscriminate, saturating fire. In addition to the destructive effects on men and equipment, the most important characteristic of the latter is the shock and psychological effect created by sheer weight of explosive. It seemed unlikely that a few accurate weapons destroying their targets would achieve a similar effect on morale by neutralizing those who were not themselves hit. To be effective, emerging technology would have to destroy a higher percentage of targets to compensate for its probably reduced neutralizing effect. Equally it would be necessary to apply the concept of precision in a wider sense than geographical accuracy. Timing would have to be as precise as accuracy, and so too would the degree of effect matched to the target. Technology would have to provide effects as precisely against a variety of area targets as against a point.

²¹³ Tegnalia (1985), p.645.

²¹⁴ Goure & Cooper (1984).

²¹⁵ See 'Nato's New Strategy: Defend Forward but Strike Deep', *Armed Forces Journal International* Vol.120, No.3 (November 1983), pp.42-48.

CHAPTER 4: OPERATIONS SINCE 1945

4.1 INTRODUCTION

For nearly half a century after the Second World War, the Cold War dominated military thinking. The war for which the rival alliances planned seemed a natural derivative from the style and technology of the great wars of the 20th Century. It was the military centre of gravity, yet numerous 'warm' and 'hot' wars of lesser intensity and importance were fought concurrently with it. Care was taken to ensure that these other conflicts, often involving members of the Warsaw Pact or NATO, did not cross the threshold into wider conventional and nuclear warfare between them. The armies of these alliances were equipped and trained for the worst; but their combat experience lay in lesser conflicts.

Attempts have often been made to delineate between types of wars, conflicts and operations, using terms like 'small', 'limited', 'out of area', 'operations other than war', 'other operations', 'low-intensity', 'spectrum of conflict' and 'terrorism'. These come in and out of fashion, and have generally proved unsatisfactory, reflecting the inability of armies to find a conceptual constant, and hence a firm doctrinal foundation on which to base their operations and defence spending. Here, these military activities will all be regarded merely as 'operations'. Some have been of high intensity and long duration, as in Korea (1950-3) and Vietnam (1965-73). Some have been of high intensity and relatively short duration, such as the Gulf War (1990-91), and others have simmered for years. 'The war against terrorism' is expected to last for a protracted period, and could even come to be seen as the backdrop to everyday life. This chapter examines all operations since 1945, identifying the enduring principles in the application of fire and its effects, along with the powerful, evolving trends which often demand that these principles be applied differently.

Warfare throughout history has been 'limited' in some respect. Even in the Second World War, self-imposed limits were placed on the use of chemical weapons. The novelty of the modern strategic environment is that with the end of the Cold War and the imminent possibility of a general cataclysmic war, the limitations on wars are likely to be the greater; and yet the scope of what conflict may entail beyond mere military action may once more be expanding. At the same time, even though a war may be limited by geography, time or intensity, it may still be 'total' for one or more of the belligerents. In some senses the term 'limited' has clearly lost some of its power of differentiation, and hence utility. Nevertheless, the likelihood that operations in the foreseeable future will be subject to greater limitations has profound consequences for the employment of artillery and fire in general; for its optimal application in a new and complex environment requires a different approach to that proven in the two World Wars and for which the armies of the Cold War trained.

With the advantage of little more than a decade's hindsight, the Cold War may now be seen to have been but the largest and most limited of the 'limited wars' that have taken place since 1945.¹ It was of great length and vast economic cost, but cheap when set against some of the alternatives. It had few direct casualties, other than those sustained on

clandestine operations; but millions died as a result of wars regarded as peripheral to it, but which were in some ways its proxies. However, many of those conflicts had an enduring logic and 'life' of their own; and many new conflicts arose after the Cold War, and partly because of its demise. Wars which might once have been regarded as limited, and thus of some lesser military standing to the mainstream of 'general' war, may now be seen in historical perspective to have been surer indicators of more substantial strategic trends and longer-term evolutions in military affairs. By comparison, many aspects of the Cold War reflected a paralysis in the fading strategic dynamics of 1945.

Nevertheless, the importance of winning the Cold War and the energies and stakes involved were enormous and should not be minimized, for it was the strategic imperatives of the Cold War which most determined the manner in which force, including artillery, was applied in the last half of the 20th Century, and much of this legacy will endure. While acknowledging the all-pervading influence of the Cold War, it seems helpful to regard all conflicts since 1945 as mere evolutions of warfare, and to regard the Cold War as an aberrant military episode; although it was itself the incubator of many conflicts, and the cause for which many new technologies were developed.

The hardest operations to analyse and categorize are those involving 'Peace' – keeping it, supporting it or enforcing it. Together with other forms of intervention, these operations reflect the dynamic strategic context in which firepower will in future be deployed. If there is now a call for military force beyond national self-interest, it may be in the name of some 'New World Order' or even 'Humanitarian Intervention', for this 'Empire of Ideas' and form of universalism sounds less 'neo-imperial'.²

Many 'Peace' operations incorporate combat, and at times may only be set apart from war by their political dimension.³ While the context of recent Peace operations may appear to be new, the actual military tasks that they involve are familiar to any army which has conducted 'imperial policing' in its history. The military means applied in these Peace operations may appear to be different to 'imperial policing' of old, but often thanks only to their technological modernity. Peace operations are treated separately at the end of this Chapter. This is not to portray them in the first instance as fundamentally different to other military operations, but rather to highlight certain of their particular facets, although these frequently turn out merely to be evidence of the same trends found in other military operations since 1945, especially at the Operational level. This analysis should reinforce the view that while Peace operations may be purported to differ from other military operations, they are both products of the same turbulent environment, and consequently share much in common.

Operations against terrorists may involve traditional military combat; but international sensitivities and the need to avoid counter-productive 'overkill', will probably cause them to be 'limited' by many of the restraints that have become familiar in Peace operations.

The Changing Strategic Environment⁴

Shifts in the strategic environment since 1945 have affected the manner in which artillery has been employed and changed the consequences of its effects, the least of which may be tactical on the battlefield. The wars fought by the major powers since 1945 have not been ones of national survival. In democracies at least, Governments have been increasingly susceptible to the views of electors who have proved vocal in expressing opinions as to whether they should be involved in military operations or not. Objections may be moral, political, financial or based on a reluctance to sustain casualties. Even the Government of the USSR was vulnerable to adverse public opinion on its involvement in its war in Afghanistan in the 1980s. On the other hand, in cases such as the attacks on the USA on 11th September 2001, which stir the emotion and raise issues of fundamental principle, democracies may prove robust opponents.

The increasing interdependence of the international economy has made national economies and mass markets more sensitive to the disruption caused by conflict. The globalization of expanding news media and their technology has increased the access of journalists to conflict⁵; and the volume and accessibility of their products has created an all-pervading awareness of it. There has also been an increasing 'globalization of morality', whereby a Western standard of human rights has increasingly been adopted as the international 'bench mark', or 'default setting', against which all should be measured; and a new legal apparatus is evolving to which all may be held accountable and judged. Failure to acknowledge this standard may in itself be deemed a 'causus belli' in the name of 'peace'.

Not only has news of conflict become more commonplace, but domestic and international opinion seems also to have become more sensitive to the suffering portrayed. This has been expressed by a growing expectation of 'proportionality', not just in the absolute scale of force used against an opponent, however justified in purely military terms, but also in the relative suffering sustained by both sides. In the Second World War it was often deemed legitimate by all sides to slaughter civilians. Today, electorates do not wish their own forces to sustain unnecessary casualties, but they have also become increasingly queasy about enemy casualties if these are, or appear to be, excessive. This does not mean that Western nations are not prepared to inflict civilian casualties or sustain casualties themselves; but it does mean that they will probably have to make a convincing political case for doing so, especially to their coalition partners.⁶

Initiating, managing and sustaining operations have become more challenging, particularly for Western Governments. They must be aware of and measure domestic and international support for their actions. They must monitor and perhaps influence the media on which this feeds, and their actions will be reinforced if they can shield them with legal and at least apparent moral legitimacy. They must judge the threshold of acceptable cost both human and financial, but this may move as events develop. They can prepare for both of these. They can build sound economies, forge alliances and invest in the full spectrum of military capability and readiness in times of peace. When crises arise they will need to make the case for their actions to their electorates, who may or may not be willing to pay the advertised or actual price. All of these factors are likely to be more readily controlled if the duration of an operation is short, but above all likely to succeed.

The opportunities for factors which might once have been favourable to become adverse increase with an operation's duration. Time is thus likely to be a vulnerability of Western Governments, which are more subject to the forces described above; and to be a potential ally of their opponents. Yet rapid, decisive action may be at odds with democratic decision making, alliance building, force generation, deployment times and targeting with due care for proportionality. A 'cult of the quick' carries its own dangers.⁷

Such is the complex strategic context in which artillery firepower must be set. It is not constant, it is dynamic; and the advantage goes to whomever perceives the fundamentals in this dynamic, understands its implications and delivers military capability appropriate to its next iteration not its last. Comprehension, anticipation and the will and ability to act are at least as important as information.

The Implications for Artillery

Since 1945, artillery has been used in operations to deliver raw combat power whose intensity has often at least matched that of the World Wars. Its firepower has been an Operational as well as a tactical tool. The challenge for artillery since 1945 has usually been not so much to generate unlimited firepower, as to provide measured effects, at the right time and place, appropriate to the occasion. By 1970, the Vietnam War had shown that sheer weight of fire could have negative consequences, not so much in the form of self-obstructing battlefield damage, as self-defeating effects on domestic and international opinion. It was clear that the application of fire would need to become more discriminating, causing less material and political collateral damage.

Too much force may compromise the viability of the campaign; but underestimation of the firepower required may waste the resources which are deployed. More dangerously, it may delay achieving success; and this delay may compromise the political foundations of an operation, domestically, in an alliance, or in the court of international opinion.

The strategic and tactical reach of artillery has increased thanks to technical improvements in the capabilities of aircraft and specialized shipping. The greatest advances, however, have been in the technology of the munitions themselves. If an enemy can be engaged effectively early, and at greater distance, friendly casualties are likely to be lower, and the desired effects accomplished more quickly. The unit costs of smarter munitions and their precise effects might be higher, but the overall financial and human cost, and hence the political viability of achieving the desired effects, could be lower.

At the tactical level, precision essentially entails achieving the chosen effect on a selected target at the optimal time and location. At the Operational level it incorporates the military judgement as to what specific effect is required to create the desired military-strategic consequence that matches the definition of military success. The art of command at this level is to marshal the resources and to deliver the combat power to accomplish the military task; but to have gauged this precisely to the strategic tolerances bearing in on the

commander.

The virtue of artillery at both the tactical and Operational levels in this environment has been that its characteristics lend themselves so well to the technology and techniques of the ever-increasing requirement for precision. Precision may entail the timely delivery of massive yet accurate unobtrusive explosive effects. Equally, artillery may be used to commit precise, discrete acts of violence, forming an instrument of sophisticated psychological manipulation.

4.2 COUNTER INSURGENCY OPERATIONS (COIN) 1945-1970

In COIN operations, or others of relatively low-intensity, political considerations usually make it desirable to restrict firepower to the minimum necessary to achieve the aim, sometimes even at the risk of underestimating that requirement. In low-intensity operations it may be domestically unacceptable, or internationally counter-productive, to deploy the number of troops or quantity of equipment best suited to defeat an opponent. It may also be unacceptable to use certain advanced technologies, which may be deemed 'unfair' in some way and cast an opponent as an underdog. Equally, non-lethal weapons may have a far greater effect in such operations than they would in more intense conflicts. Much of this logic may also apply to operations against terrorists, which are likely to feature short, sharp actions with demonstrably successful outcomes, but achieved with precise and politically attuned military effects.

Mobility

Such constraints have meant that commanders have often had to control large areas of ground with slender resources. Equipment mobility, both strategic and within the theatre, has therefore usually been a more important factor than the ability to concentrate massed fire through fire mobility.

For example on Borneo in 1962, there was no in-theatre logistic support for British operations and all stores had to travel 1,300km by air or sea. There were few roads, and the only way to deploy troops and their equipment tactically was by air.⁸ By March 1965, the British had the equivalent of four regular infantry brigades supported by two regiments of artillery.⁹ Brigade fronts varied in size between 300km and 1,100km, while in Cold War Europe at the time, 16km to 20km was normal. To concentrate artillery would have been to leave most of the theatre without fire support, so dispersion was the norm. Thirty guns were often deployed singly over a 1,600km front. Coverage was thus achieved at the expense of concentration, also the expedient of the French in Vietnam. The fortunate difference for the British was the relative weakness of their Indonesian enemy, and the availability of aircraft to move guns rapidly, which prevented isolated British gun positions from becoming easy targets.¹⁰

The British relied on the deployment of artillery by aircraft in the Radfan, in the Arabian Peninsula, in 1964 for similar reasons.¹¹ The terrain was rugged, but not as impenetrable

as that of Borneo, and there was scope for improvisation. At various times guns were towed by Land Rovers, porteed on 3-ton trucks, and carried in pieces by donkey and camel. The terrain was similar to that encountered by the British in their Dhofar campaign of the late 1960s and early 1970s, where the 25pdr was the standard artillery piece. This was frequently deployed by Skyvan STOL aircraft to remote landing strips, and even the 5.5-inch gun was broken down and flown by Caribou transport aircraft, or underslung from helicopters.¹²

Firepower

In many COIN campaigns the threshold that requires artillery firepower is not crossed, and British gunners have frequently left their guns to undertake infantry tasks - a more precise application of lighter firepower.¹³ As the level of enemy firepower has increased, Government response to insurgency has tended to become more forceful. Thus artillery was used by the British in Palestine between 1948-52, and in East Africa between 1952-55.¹⁴ Artillery can, however, be a clumsy weapon when wielded against the guerrilla, and some have doubted its value in COIN operations. In Malaya in 1951, for example, artillery fire was often unobserved or used against fleeting or ill-defined targets.¹⁵

Artillery has often been used to clear the way for other arms. Artillery covered the drop of the 3rd Battalion of the Parachute Regiment on the CAP BADGE DZ in the Radfan from 30th April to 1st May 1964¹⁶, and in the Dhofar campaign artillery was frequently used to shell ridges dominating DZ's which were used to resupply infantry patrols.¹⁷ British artillery fire support bases never reached the scale of those of French forces in Algeria or US forces in Vietnam, but the principle was similar. The guns had to be prepared to defend themselves with direct fire¹⁸ around 6,400 mils; and in Arabia defences were built up in the form of rock walls or 'sangars'.¹⁹

Although the intensity of operations may be low, artillery should always be ready for surges of activity. For example, in Borneo in 1965-66, the confrontation with Indonesia escalated to the point where the British found it necessary to employ tactics similar to those used against the Japanese in Burma. Full artillery support was required to support company-sized operations, often in unacknowledged operations across the border against regular Indonesian forces; but by 1966 the campaign had reverted to what amounted to terrorism by two- or three-man units, hunted by British platoons.²⁰

British artillery firepower in COIN operations has scarcely been comparable in weight with that in conventional war. In Dhofar in the late 1960's a troop of three guns might fire 500 rounds per month.²¹ In the Radfan, J Battery RHA fired 20,000 rounds in 14 months²²; and in Kenya, 156th Battery fired only 23,977 rounds throughout the entire campaign.²³

Dispersed deployment places greater responsibility on sub-units, junior officers and non-commissioned officers (NCOs). The Borneo campaign, for example, was described as a battery commander's war, but battery organizations had to be flexible.²⁴ Artillery was most commonly used to cover light infantry patrols in attack, ambush and withdrawal. In

Borneo in 1964, the commander of one ambush laid by 2/2nd Gurkhas said that the fire support of two guns saved his position from being overrun by his prey.²⁵ Artillery was also used offensively to block enemy escape routes from ambushes. The British commanding officer of the Muscat Regiment wrote of operations in Dhofar in the 1970s that, "Timely and accurate artillery support is both the greatest saver of own casualties, and the best means of inflicting casualties on the enemy, and provides far swifter and more intimate support than strike aircraft."²⁶

Air support was, however, especially valued when guns were out of range and could not keep up with the infantry.²⁷ In operations in the Radfan on 4th May 1964, aircraft hit targets 150m from friendly positions when artillery was insufficient.²⁸ Nevertheless, when artillery was available it had many advantages. It was found in Dhofar that even if aircraft were overhead, in good weather with good communications it could take from five to ten minutes to indicate and hit a target, while a good FOO could respond in seconds.²⁹

Although COIN operations often take place in relatively unpopulated areas, the nature of such conflicts makes it even more important to avoid civilian casualties. In Malaya in 1951, it was observed that artillery fire often caused damage and casualties in friendly villages³⁰, working against British interests. Lieutenant General Sir Walter Walker, commander of the British forces during the Borneo campaign, observed that, "We went to any lengths to keep our hands clean". Precautions were taken to avoid casualties by air, artillery and mortars. "It was indelibly inscribed on our minds that one civilian killed by us would do more harm than ten killed by the enemy."³¹ The rigorous application of this policy, the antithesis of the 'body count' syndrome, helps to explain the successful outcome of that campaign.³²

4.3 THE KOREAN WAR 1950-1953

In 1945 the USA demonstrated the means and the will to employ atomic weapons. When used against Japanese cities, their direct military effect was relatively small compared to the political and indirect military consequences - the surrender of Japan.³³

However, the political consequences of employing atomic weapons could also prevent their being used to military advantage. Since the First World War, the use of massive conventional firepower has been seen at times to have military disadvantages, but never the political complications of atomic weapons. When the USA entered the Korean War in 1950, a powerful lobby in the USA advocated the use of atomic weapons; but this firepower was never used, primarily for fear of a Soviet response, adverse international political reaction, and for moral considerations. Nevertheless, American belief in the efficacy of massive conventional firepower which it had developed during the Second World War remained undiminished. The problem lay in mobilizing and deploying it in a war in which the fate of the nation was not at stake.

Mobility

The ability of artillery to keep up with manoeuvre arms was not a major issue in the Korean War. While the campaign ebbed and flowed on the Korean Peninsula, advances were generally made at the speed of the infantry soldier, and, in the event of UN amphibious landings, techniques developed in the Second World War were found satisfactory. Tactical mobility was often demonstrated in 'raids', such as those by several artillery regiments of the 1st Commonwealth Division in August 1951³⁴, but the apparent strategic deadlock, in what was expected to be a short war, caused persistent concern and demands for greater firepower to break the apparent stalemate.

Firepower

US commanders urged Washington to send more artillery to Korea. Their major deficiencies were in anti-tank guns, heavy artillery and ammunition. At the Battle of Osan on 5th July 1950, the US 2.36-inch rocket launcher, the Bazooka, proved ineffective against North Korean Soviet-made tanks.³⁵ Yet again, direct fire artillery proved the only effective anti-tank weapon, and in a letter to General MacArthur on 8th July 1950, Major General W.F. Dean appealed for the delivery of 90mm towed anti-tank guns. MacArthur was particularly concerned at the shortage of non-divisional artillery, but he was offered only one third of what he requested of Washington. "Fighting in World War Two had proven to him that a successful offence against a determined enemy required non-divisional artillery of one to one with divisional artillery."³⁶

After the Second World War, the USA possessed a large stockpile of ammunition, which encouraged the complacent belief that this would suffice in a short war. True to expectation, the early stages of the war were highly mobile on both sides; but by mid-1951 movement had slowed. The quantity of US artillery deployed in Korea rose sharply, but it was handicapped by a shortage of ammunition, of which three tons were required to produce each enemy casualty.³⁷ The role of artillery became increasingly important, as attempts were made to regain momentum; and US DAER rose above those of the Second World War as a consequence.³⁸ General Ridgway described the expenditure as either extravagance or misuse.

Doubts about the ability of US forces to sustain these high rates of fire arose during the Battle for Bloody Ridge in August-September 1951, where the US 2nd Division fired 153,000 rounds, and the 15th Field Artillery Battalion set a US light battalion record of 14,425 rounds in 24 hours.³⁹ Five battalions supporting the US 2nd Division fired over one million rounds over a three week period. The rate may have been high, but the firepower itself was less impressive and of moderate effect. The number of guns employed was small, in comparison with battles of the Second World War, hence the need for high rates of fire; and much was wasted in inaccurate high-trajectory fire against bunkers.⁴⁰

Even such high rates of ammunition expenditure were deemed insufficient against the enemy's overwhelming numbers, and by November 1951 the use of atomic munitions was being guardedly considered.⁴¹ General Mark Clark saw 'increased forces', and the 'removal of certain restrictions', as the only means of success without, "highly unpalatable

personnel costs, against an undemoralized enemy, in superior strength, in well organized defensive positions in depth".⁴² However, atomic firepower was withheld and the apparent inadequacy of available conventional firepower led to ever greater calls for artillery reinforcements.

There was no rationing of ammunition at Bloody Ridge, and such expenditure rapidly consumed the US stockpile. The first restrictions on ammunition expenditure were imposed in October 1951, and General Ridgway complained to the Joint Chiefs of Staff of the dangers of providing for the relatively low Second World War rates of fire when the number of guns had been greater, and DAER consequently less. The deluge of fire continued. On one day in Autumn 1952, 6,000 rounds fell on Hill 281. On another, 20,000 rounds of artillery and mortar fire fell on Pork Chop Hill.⁴³ In April 1953, nine battalions fired over 37,000 rounds at it in twenty-four hours.⁴⁴

General van Fleet maintained that by the standards of the Second World War in Europe the US Eighth Army was short of 70 battalions of field artillery, and that any reduction in higher compensating rates of fire in Korea would result in more casualties.⁴⁵ General Ridgway took the traditional US view that firepower saved the lives of friendly troops and, if only for domestic political reasons let alone military considerations, it should be increased: "... artillery has been and remains the great killer of Communists. It remains the great saver of soldiers, American and Allied. There is a direct relation between piles of shells and the piles of corpses. The bigger the former, the smaller the latter"⁴⁶ - the inverse of the 'body count'.

By Winter 1951-52, ammunition rationing had become strict, and this continued into the Summer, at a time when Communist artillery fire almost doubled.⁴⁷ Belief in the merits of fire superiority was shared by the USA's allies, and where artillery was lacking, ways were found to increase it by other means. For example, greater use was made of mortars. The British 4.2-inch mortars operated in batteries in the same way as field guns⁴⁸ and the US Army used them increasingly as a substitute for guns.⁴⁹

The other major source of firepower was aircraft. When ammunition was short, B-29 bombers, otherwise assigned to Air Interdiction, were tasked to engage close targets, a trend resisted by the USAF, which believed this to be a misuse of aircraft. Despite this, close air support (CAS), coordinated with artillery fire became routine, and techniques improved throughout the war.⁵⁰ Air superiority yielded many benefits besides close supporting fire. On 25th September 1950, following the Han River crossing and capture of Seoul, aircraft were used in conjunction with corps artillery to attack withdrawing enemy columns. Air-power made up for the lack of heavy artillery, and enabled air OPs to operate with relative impunity on CB tasks.⁵¹ It did however lead to a stiffening of Communist AD, and the need to coordinate SEAD. In September 1952, artillery delivered a major SEAD fireplan in preparation for CAS by 5th USAF. The latter suffered only twenty percent of anticipated casualties, and subsequently detailed SEAD planning became routine before major air operations.⁵²

Tactics

UN artillery tactics during the Korean War followed a traditional pattern. Artillery and air-power were used wherever possible to break up enemy attacks by counter-preparation fire, before they could close with friendly positions.⁵³ Speed of response was critical, and the 1st Commonwealth Division expected its artillery to respond to calls for divisional fire in just over one minute, and for regiments to do so in slightly less.⁵⁴ When failures occurred, they were often the fault of poor fireplanning.⁵⁵ The role of manoeuvre arms in protecting the source of their supporting fire became more pronounced. In 1950, US forces found that North Korean infiltration tactics effectively did away with any concept of a front line. Gun positions had to be prepared to defend themselves and the supported arms had to be prepared to move to support them.

Although individual artillery pieces were a match for UN artillery, communist artillery was substantially outnumbered⁵⁶, and resorted to massive protection and cunning concealment as a substitute.⁵⁷ It was clear to the Chinese that if they concentrated they would merely present targets. They tried to disperse as much as possible in small units, with the consequence that their tactics became focused on limited objectives such as the destruction of company or battalion sized units.⁵⁸ The primary mission of Chinese artillery was close support, provided by guns moving frequently between prepared concealed positions. In May 1952 it was estimated that there were 500 concealed positions opposite the South Korean II Corps area alone. CB fire assumed at least as high a priority as close support, and the value of locating equipment increased as a result.⁵⁹

Conclusion

US conventional firepower during the Korean War at times matched, or by some criteria surpassed that generated in the Second World War; but it was severely restricted for other than tactical reasons. These were the withholding of nuclear weapons, the shortage of guns deployed in the theatre, and the failure to supply the quantity of ammunition to satisfy the military appetite.

The US Army emerged from the Korean War convinced that as firepower grew, American casualties fell; that both tactical and strategic aircraft could and should carry out close support tasks, in addition to artillery; and that ammunition expenditure norms established in the Second World War were lower than those required in a war in which numbers of troops and guns were limited for political reasons.

The experience encouraged the assumption that wars outside Europe would be against enemies over whom the USA held air and fire superiority. Such future conflicts would require the maximum ratio of firepower to manpower, and methods of delivering that fire in the greatest quantity that political constraints would allow.

4.4 THE INDO-CHINA WAR 1945-1975

US involvement in Vietnam began on a small scale with the provision of advisers to the South Vietnamese Army, fighting a COIN campaign. The commitment of combat units to this theatre in 1964 caused the US Army to re-think much of its tactical doctrine, including that of artillery; but the long-standing principles behind that doctrine did not change. The challenge was to find the appropriate means of applying them.

In Vietnam, it was seldom practical to concentrate artillery against the enemy, since the latter usually avoided presenting a massed target. There was no readily identifiable tactical front line. The front line in the strategic sense was the border between North and South Vietnam, which US ground formations were forbidden to cross. Ground combat was restricted for political reasons to the South, where the enemy was potentially ubiquitous, and operations were continuous, widespread and often on a relatively small scale.

Artillery battalions leaving the USA had to adapt to battalion, battery and section tactics in a '6,400 miles' environment. The priority was not so much the concentration of fire so much as the dispersal or mobility of assets, in order to provide coverage over a large area. For this reason fire control, which in Europe was increasingly focused at battalion level, was reinforced in Vietnam at battery level. Batteries tended to move with their affiliated infantry battalions; and as the British found in their colonial experiences, this tended to reinforce the relationship between the two, at a time when elsewhere it was becoming less important.

Area coverage could be maintained by a combination of high mobility and dispersion, reinforced by air and sea power. The coordination of air-mobility, rotary and fixed-wing fire, NGS and artillery therefore became extremely close, and was the primary concern of artillery commanders at higher levels. The task was complex, requiring considerable ingenuity and flexibility to accomplish.

The ostensible aim of US operations was to benefit the people of Vietnam; and yet the enemy sheltered among these people. The avoidance of civilian casualties has always been desirable for humanitarian reasons; but in Vietnam, as in other COIN campaigns, it became an important factor in achieving war aims; and yet it was singularly difficult to achieve in view of the US predilection for massive firepower following the Korean War.

In 1966 US forces in Vietnam expanded greatly, artillery alone doubling in size. The COIN campaign assumed a more conventional aspect when the enemy deployed regular troops; but until her withdrawal, the USA remained in the uncomfortable position of fighting a war which was generally COIN in character, with forces trained, equipped and inclined to fight a conventional one. The consequence was almost always local military success, but ultimately strategic failure.

Area Coverage: Mobility

The US Army estimated that in COIN operations government forces needed a manpower superiority of ten to one. Unable to match this in Vietnam, the USA attempted to make up for lack of numbers with superior firepower and mobility. Despite being a war of unprecedented mobility, the US Department of Defence estimated that forty percent of combat took place in static positions. In such cases, the Communists were 'fixed' and rendered themselves vulnerable to overwhelming firepower.⁶⁰ The reach of guns and hence their firepower was increased by augmenting their range with high mobility of equipment.

The US Army in Vietnam was the most mobile in history, and often used the manoeuvre of infantry in order to apply firepower, rather than fire to facilitate manoeuvre. Light units with fire support would seek out the enemy and then disengage, so that the enemy could be destroyed by fire, with the minimum American casualties.⁶¹ General D.R. Palmer maintained that in time the US Army forgot how to manoeuvre in contact and pursuit.⁶²

Roads were few and Vietnamese terrain was ill-suited to an army hitherto reliant on motor transport.⁶³ Nevertheless, roads were the primary means of US mobility throughout the war, proving the most effective, albeit a vulnerable means of logistic support. However, road movement alone was never adequate for artillery to provide the fire support expected of it. Guns needed to fire on targets in all directions. It was therefore important that they be positioned at locations of maximum advantage, and these positions could often be approached only by helicopter.⁶⁴ In a war where helicopters became a regular mode of infantry transport, the guns could give satisfactory support only if they travelled in a like manner.⁶⁵

The Vietnam War saw the first major use of helicopters, both as a means of transport and for aerial fire support.⁶⁶ US helicopter doctrine was the product of the vision of Generals J.M. Gavin and H.H. Howze. The requirement for an airmobile brigade had been established in 1962, and in 1964 the US 11th Air Assault Brigade was formed, incorporating three artillery battalions and 434 aircraft. Further development led to the creation of the 1st Cavalry Division (Airmobile), equipped with the 105mm field gun.⁶⁷

The predominant US tactic was the highly mobile search and destroy operation. Operations such as CEDAR FALLS, from 8th to 26th January 1967, and JUNCTION CITY, from 22nd February to 14th May 1967, exemplified the search and destroy concept on the grand scale. The latter was supported by seventeen artillery battalions.⁶⁸ At battalion level, search and destroy operations might last for a few days or a week. Guns would move out of their FSB to support the infantry, who would rely for heavier fire on longer-range artillery in other FSBs, or on aircraft.⁶⁹

US forces conducted 'artillery raids', combined-arms operations designed to support field artillery rather than manoeuvre forces. The intention was to bring artillery fire to bear on enemy sheltering out of range of FSBs in remote areas.⁷⁰ Mobility was also used on the few occasions when concentrations of artillery were required. For Operation BIRMINGHAM in 1966, for example, the US moved seventy-two guns at short notice

50-100km to Tay Ninh Province by air and road⁷¹; and major moves of artillery were also undertaken to support operations in Cambodia in 1970, and Laos in February-March 1971.⁷²

Area Coverage: Dispersal

Equipment mobility was a means of bringing fire to bear by surprise in remote areas of Vietnam, albeit in relatively limited quantities. Where possible, however, the US preferred the benefits of fire-mobility from dispersed and fortified FSBs which could dominate critical areas of operations, and together with highly mobile firepower from the air, provide US troops with the support to which they had become accustomed in previous wars. US forces were also able to learn from the earlier mixed fortunes of the French.

During the French war in Vietnam in the early 1950's, the First Indochina War, static artillery bases had been foci of vulnerability, because they lacked sufficient guns and air support.⁷³ The French, and later the South Vietnamese Army who copied them, tried to provide route security between bases by placing two or three guns at positions along major roads. These were also extremely vulnerable, but their absence would have left road movement still more so, and without helicopter support, the guns were indispensable as a source of fire support. Artillery bases did have some advantages. It was, for example, better to protect a hamlet with guns already in place than to rely on their moving to an incident in time.⁷⁴ The French had elaborate plans to ensure mutual support between their bases; but in the event, the fire from these was generally ineffective because an agile foe was able to outpace their ponderous adjustment procedures.⁷⁵ The Viet Minh also showed an unnerving ability to absorb punishment when hit.

The French did, nevertheless enjoy some significant victories when their enemy 'fixed' himself upon these fortifications and massed firepower was available to the defenders. The Viet Minh suffered appalling casualties from artillery, bombs and napalm when they attacked in human waves at Vinh-Yen in January 1951. French firepower was also decisive in March 1951 at Mao Khe where a French battalion held off a force six times its size thanks to heavy Joint fire support. General Giap learned from these experiences and sought to avoid situations where the French advantage could be brought to bear. Instead, he attacked vulnerable convoys where he could concentrate the effects of his own firepower and create temporary superiority in time and space. He did, however, aspire to strike a decisive Operational blow against a French base.

The French were encouraged by another disastrous attack by Giap on a large French garrison at Na-San in November 1953, and decided to construct a similar 'anvil' at Dien Bien Phu. This dominated an area of the country which it was assessed Giap could not abandon. In the event, the French overestimated the effect of their own fire against a tactically innovative enemy, and underestimated General Giap's astute political understanding of this type of conflict.⁷⁶

At Dien Bien Phu in 1954, the French suffered only two thirds of the casualties suffered by the Vietnamese, and less than four percent of their overall strength in the theatre, while Giap lost a quarter of his combat strength. Its fall, however, signalled the downfall of French interests in South East Asia. The means of mobility available to the Viet-Minh in 1954 were less sophisticated than those of the French, but more effectively employed; and Dien Bien Phu fell to superior firepower as a result. The Viet-Minh's supply route to Dien Bien Phu was 800km long, yet they transported their artillery and ammunition along it in unforeseen quantities.⁷⁷ The French General Navarre realized that success depended upon his ability to block that supply route.⁷⁸ Seventy-five French aircraft were tasked to cut it and dropped 650 tons of bombs, but this was wholly inadequate for such a massive task.⁷⁹ How much so became clear later, given the weights dropped on the Ho Chi Minh Trail by the Americans.

The Battle of Dien Bien Phu demonstrated the vulnerability of light infantry and unsupported field positions to artillery fire⁸⁰; and General W.C. Westmoreland noted the French blunder in accepting battle in a remote region with minimal air support or resupply.⁸¹

The USA was undeterred by the French experience and constructed FSBs throughout the country, confident in the ability of its forces to repel surprise attacks, and of superior firepower in battles of attrition.⁸² The FSB proved remarkably successful in military terms, given the aim of providing a secure base from which to guarantee fire support; and none was ever overrun and lost, although some were abandoned.⁸³ Whereas remote bases offered the Communists the chance to achieve material and numerical superiority over a relatively more sophisticated opponent, they offered US forces opportunities to fix an elusive enemy who might thereby present a valuable target for superior firepower.

The epitome of this balance of opportunities occurred at Khe Sanh. Valuable experience of such operations had been gained in previous years at the defence of Plei Me Special Forces camp. On 19th October 1965, the North Vietnamese were broken by US firepower and had to acknowledge their failure to take this fortified base. A similar failure occurred the next month at LZ X-Ray.⁸⁴ The siege of Khe Sanh between 19th January and 31st March 1968 demonstrated the superiority of US artillery, and most devastatingly of air-power. The US garrison started with a strength of 6,680 men against 20-30,000 besiegers. The North Vietnamese calculated that they would have sufficient troops to overrun the base, but failed thanks to overwhelming US firepower.⁸⁵

The most destructive firepower came from the air, but both air and artillery support were controlled from Khe Sanh's Fire Support Control Centre (FSCC) with its Fire Direction Centre (FDC) and Direct Air Support Centre (DASC). The aim of the fire controllers was to break up waves of attacking North Vietnamese before they reached the perimeter of the base. The targets presented were similar to those in many battles of the First World War. Masses of lightly armed infantry formed up in predictable locations, and advanced against positions defended by bunkers and wire. It is not surprising that many fireplanning techniques, and the phrases used to describe them, evoked those of the First World War.⁸⁶

The greatest weight of firepower available to US forces came from the air.⁸⁷ General Westmoreland awarded Khe Sanh the highest priority for air support. B-52s from Guam and Thailand flew undetected at 40,000 feet, each dropping 108 mixed 500lb and 700lb bombs. Ninety-five percent of these missions were targeted by the FSCC, which often then called on artillery to rake the target area to hit dazed survivors.⁸⁸

North Vietnamese human-wave attacks failed because their firepower was too weakened to wear down the garrison defences, and their reserves were destroyed by US firepower before they made contact with the US defenders.⁸⁹ An average of 1,800 tons of munitions fell around Khe Sanh every day of the siege. In seventy days of air operations, aircraft dropped nearly twice the total tonnage dropped by the USAAC in the Pacific in 1942-43. Major General Ott maintained that the defence of Khe Sanh “demonstrated that good fire support could effectively neutralize a superior force.” Perhaps he should have said a larger number of men.

The US learned the lessons of Dien Bien Phu in 1954 better than did the North Vietnamese, and as a result of Khe Sanh’s experience in 1968 came to see the usefulness of FSBs as offensive bases.⁹⁰ They were used to lure an elusive enemy onto prepared positions, where he could be despatched by superior firepower.⁹¹

The Value of Air-power Versus Artillery

FSBs achieved area coverage by fire mobility from static positions, and the flexibility of US air-power compensated for their immobility and frequent lack of mutual support. Air bombardment was undoubtedly effective, and although its close integration with ground operations was regarded as a novelty at the time, precedents had been set in Korea and the Second World War. Although the French lacked the air-power enjoyed later by the Americans, they had occasional successes. For example, at Vinh-Yen in 1951, the Viet-Minh tried to break through French positions towards Hanoi, but were halted by the fire of three artillery groups and 250 aircraft. The real novelty of the American experience was the degree of control exercised over it by military fireplanners and the sheer scale of operations.⁹²

The use of helicopters as a source of firepower was an innovation which matched the development of helicopter-borne ‘air cavalry’.⁹³ Aerial artillery was an extremely flexible form of fire support – “the success enjoyed by the aerial artillery battalion has been astounding”.⁹⁴ It was ideally suited to the engagement of awkward targets in contact with friendly troops in close country. On occasions it could engage targets just 50m from friendly troops, by firing across the front of the FLOT.

There were, however, critics of the growing dependence of ground troops on air-power as a substitute for conventional artillery support.⁹⁵ Air-power was susceptible to bad weather conditions, and fixed-wing attack was also often less accurate than tube artillery, which was an important consideration in densely populated areas. Air-power became an integral

factor in all US fireplanning, but it was not always an adequate substitute for artillery. For example, artillery was particularly important in the Battle of Long Tan on 18th August 1968 because severe weather meant that only one air mission was flown to support the Australian position.⁹⁶

Air-power was a great asset to US forces where artillery was weak; but the power and availability of aircraft was such that they were often used excessively in place of artillery.⁹⁷ This was an uneconomic use of resources, since it risked pilots and expensive aircraft, when shells would have sufficed. Wherever artillery was deployed in range, it was a more flexible weapon, able to concentrate measured fire in a given area, over a fixed period of time, in all weathers, 24 hours per day, and able to respond in seconds. The response time of aircraft was likely to be minutes, even if they were overhead.

The South Vietnamese Army was particularly prone to ignore artillery in favour of air-power, and there were many cases in 1970 when critical time was wasted in waiting for air support when artillery was in range and ready to fire. As US troops withdrew, the South Vietnamese proved even less likely to summon support from their own relatively inept artillery, relying even more on US air-power, although this had become a diminishing asset.

The Benefits of Firepower

The firepower of artillery and aircraft ensured that, arguably, US forces never suffered a military defeat in Vietnam. As early as 1967, General Giap realized that he needed to minimize the effects of US firepower and he focused his efforts against the US Marines in the I Corps area who had less firepower available. On the few occasions when the war developed a conventional character, the US forces prevailed, albeit, as in crushing the Tet Offensive, at some political cost. As US firepower increased, the North Vietnamese paid an ever greater price. Following their massive losses during the Tet Offensive, they increasingly 'hugged' the Americans and their casualties fell in proportion to those of Government and US forces.⁹⁸ The firepower wielded against them in the Tet Offensive thus forced the North Vietnamese to return to a form of guerrilla operations. They were only able to return to more conventional tactics once American firepower began to withdraw from the theatre.

The US hoped that, as its forces withdrew, the South Vietnamese would rely more heavily on their own artillery, but the latter's survey, registration, meteorology, ammunition handling and C2 were below US standards and, more importantly, were inferior to those of the North Vietnamese. As US firepower withdrew from the theatre, the North Vietnamese themselves deployed conventional firepower against the demoralized South Vietnamese and won the war. The South Vietnamese had the equipment to match the firepower of the North Vietnamese, but lacked their skill and determination.

With the departure of US artillery, South Vietnamese artillery had to cover a larger area, and often resorted to dispersed two-gun positions, as it had in the early and mid-1960s.

The South Vietnamese Military Region I was overwhelmed in April 1972 by a conventional attack against which they seemed incapable of making an integrated all-arms response. FSBs fell, and the weight of enemy fire usually made air evacuation impossible. Road evacuation was out of the question, and in Military Region I alone 113 guns were lost.⁹⁹

In the counter-attack of June and July 1972, the South Vietnamese abandoned the FSB tactics favoured by the US, which depended on dispersed firepower, and launched a mobile conventional offensive; but the South Vietnamese forces were doomed, and the hope that US air-power would save the day proved vain, as it had in 1954.

The Costs of Firepower

US firepower won military victories, but the manner and quantity in which it was applied imposed a heavy cost, which probably contributed to overall defeat. On the Somme, at Passchendaele, Monte Cassino and Caen the penalty of excessive firepower was military; in Vietnam, as so often in COIN and 'Peace' operations, it was political.

The basic problem was the danger of massive firepower to the friendly civilian population. It was estimated that sixty-five percent of all bombs dropped and shells fired in 1966 were unobserved. Without precise intelligence of the enemy's whereabouts 'area saturation' became common practice, and units tended to be judged by their ammunition expenditure rates. Huge resources were wasted in unfocused attacks against an ill-defined enemy.¹⁰⁰ The surest way to identify a target was to make ground contact, to manoeuvre in order to apply fire; yet only fifteen percent of artillery ammunition fired and four percent of bombs dropped in Vietnam were in support of friendly ground actions. The most effective shell was the Improved Conventional Munition (ICM), and yet ICMs accounted for only one thousandth of those fired during the War.

The US Army War College study, *The Dynamics of Fire and Manoeuvre* of 1969, concluded that firepower dominated the battlefield. Some found this phenomenon disturbing, for it encouraged the application of fire when other solutions might have been more effective. In the 25th Infantry Division, all available fire assets were dispatched to the scene as soon as a contact was reported. All contacts thereby became divisional battles. Elsewhere it became standard that a commander was required to explain and justify why he had not called in artillery or air support. Firepower became the protective shield that reduced casualties, although not necessarily with the most beneficial military outcome at any level of war.¹⁰¹

Between January and June 1967, forty-five percent of all artillery missions were harassing or interdiction fire, the primary US tactic for pre-empting attacks on bases by Communist indirect fire. Tons of ammunition were wasted on empty ground, advertising "the futility of our CF efforts and adding to the tremendous cost of the Vietnam War." The risk of civilian casualties from harassing fire was especially high, and the "excitement and haste of the conditions under which CFs are conducted further enlarges the risk".¹⁰²

CF proved most effective when its response was rapid, preferably within seventy-five seconds of the enemy's first round. Delays could be serious if clearance was required, despite efforts to keep maps up-to-date with friendly locations and areas safe for firing. Major General R. McC. Tompkins, one-time commander of 3rd Marine Division in Vietnam said, "Most harassing and interdiction fire is utterly worthless. It is a great waste of ammunition".¹⁰³ Besides this, two percent of shells were duds and gave the Viet Cong an estimated 800 tons of explosive for re-use every month. Lieutenant General F.T. Mildren, Deputy Commander US Army in Vietnam, stated, "In my estimation pure harassing and interdiction fire in the Vietnam environment has little if any value while doing practically no damage to the enemy".¹⁰⁴

Some believed that harassing and interdiction fire achieved a moral advantage over the enemy, but it was expensive in ammunition, and the key to good results was good targeting.¹⁰⁵ Fire often missed the enemy anyway. For example, in Operations PERSHING and PERSHING II, which ended on 29th February 1968, "Even under artillery fire the enemy can reorganize and attempt an escape with his main force through many avenues such as hedgerows, tunnels, stream beds, paddies or sugar cane".¹⁰⁶

The collateral damage of such US firepower was severe. For example, the operations of Task Force Oregon in Quang Ngai Province in 1967 destroyed enemy positions but caused excessive destruction; and it was estimated by one forward air controller that half the civilian casualties were women and children.¹⁰⁷ Operation CEDAR FALLS devastated a densely populated area of the Iron Triangle, flattening villages, bulldozing tunnels and destroying jungle cover with herbicides. Thousands of refugees fled from the area, but the US commander estimated that the Viet Cong headquarters in the area was out of action for only six months.¹⁰⁸ In 1967, the Agency for International Development's representative in the US I Corps asked the commander to stop 'generating' refugees. The military command agreed, it is alleged, but instead of stopping the bombing and shelling of villages, stopped issuing warnings to villagers of impending attacks.¹⁰⁹ Frances FitzGerald maintained that, "Harassment and interdiction, the creation of 'Free Fire Zones', the use of artillery to replace patrolling in the populated areas - these and other bombing and artillery practices would have been unthinkable for US commanders in occupied France or Italy during the Second World War".¹¹⁰

South Vietnamese and South Korean troops acquired a similar addiction to firepower, using it "as a substitute for, rather than in support of, infantry forces"; and much of the time they seemed quite oblivious to the destruction and suffering these weapons inflicted on the civilian population. General Westmoreland observed that Korean units "were sensitive about keeping (their own) casualties down, which resulted in a deliberate approach to operations involving lengthy preparations and heavy preliminary fire".¹¹¹ In depopulated areas this may have been effective, but in crowded areas it was disastrous for the pacification programme. One US officer observed, "What the Viet Cong did was occupy the hamlets we pacified just for the purpose of having the allies move in and bomb them out. By their presence the hamlets were destroyed".¹¹² As many other guerrilla

forces before and since, they succeeded in turning the superior power of their opponent against himself.

The worst effects of mass destruction followed the crushing of the Tet Offensive by US and Government forces. Large sections of cities such as Hue, Cholon, Kontum, My Tho and Ben Tre were flattened. After three weeks of fighting, the US estimated that 165,000 civilians had been killed and 2 million refugees created.¹¹³ The actions of the North Vietnamese and Viet Cong also created numerous refugees sometimes deliberately, but seldom through the application of excessive firepower.¹¹⁴

US forces were aware of the problem, and tried to strike a balance between immediate military requirements and longer-term interests by imposing controls on fireplanning. In some areas 'No Fire Zones' were established to curtail the massive weight of fire that was often the automatic prescription for even minor targets.¹¹⁵ Elaborate clearance procedures were imposed, recognizing that while a short round may be a disaster in conventional war, a long round may be equally unfortunate when fighting guerrillas, not least for friendly troops.¹¹⁶

Many have blamed American 'addiction' to firepower for strategic failure and seen it as a symptom of a misappreciation of how best to fight such a war. It is ironic that despite the unprecedented firepower deployed by the US and the counter-productive damage which frequently resulted, it was considered by many that lack of firepower was to blame. Lieutenant General D.E. Ott maintained that the enemy "could not be destroyed - only repulsed - because of the restrictions imposed".¹¹⁷ To their cost, US forces never achieved a successful balance between military requirements and political constraints.

C3

The control of fire to moderate civilian casualties was just one aspect of what became the most complex fire support operations in history. Along with tactical mobility and the use of air support, the US handling of C3 was one of the prime military achievements of the war.

The scale of the problem became apparent when the US commitment increased in 1967¹¹⁸, and failure to coordinate fire adequately could be seen to have dire consequences.¹¹⁹ On the ground, the battlefield was full of ordinary supported US units, reconnaissance units, South Vietnamese troops and the enemy; in the air were close support aircraft, drones, helicopters on reconnaissance, and aircraft resupplying bases, transporting troops, evacuating the wounded, ferrying VIPs and later on performing a fire support role. The factors in C3 became more complicated, and the decisions as to where 'No-Fire' or 'No-Bomb' lines should be drawn became more awkward. The answers lay in creating air corridors for aircraft, plotted to avoid the trajectories of fire missions at particular times, and in establishing priorities for their use.¹²⁰

Calls for fire were carefully monitored and a slower response time accepted in exchange

for greater accuracy. This was particularly important in heavily populated areas where the target lay between friendly troops and civilians and it was not possible to adjust fire. The need to hit only confirmed targets, and with greater accuracy, resulted in the proliferation of forward observers and in turn in the expansion of low-level communications, which needed greater control. In Europe at the time, US Army corps artillery communications ended at artillery group level; but in Vietnam corps communications often went down to battery level. This reflected the general proliferation of radios and telephones.¹²¹

Tactical control of field artillery was centralized, but missions were executed at the lowest level possible. Brigadier General W.D. Crittenberger described it as a battery commander's war.¹²² Whether a particular type of artillery unit could be used in support of an operation often depended upon its air-portability or mobility over given terrain. In those circumstances, the lighter towed 105mm often proved more useful than the 155mm SP, which was becoming the dominant piece in Europe at that time.

Although large numbers of guns were occasionally concentrated, these were relatively small compared to those frequently massed in the world wars.¹²³ Nevertheless, the US Army was better suited by inclination and ability to managing the complexities of battlefield firepower than most, in particular the South Vietnamese Army. The most complicated C3 problems of the war arose in the fire control for Operation TOAN THANG in April 1970 in Cambodia. This entailed the deployment of seventy-nine US and South Vietnamese battalions supported by eighty-one US batteries and all South Vietnamese guns available. The operation brought together the largest concentrations of artillery, tactical air support and B-52s of the war, and was controlled by task force commanders in the air.

In 1968, in the aftermath of the Tet Offensive, General Westmoreland created two new headquarters to coordinate actions in I Corps and the Capital Military District; and reorganized assistance to the South Vietnamese Army.¹²⁴ After 1968, the US was keen to update the equipment and mobility of the South Vietnamese artillery, but increases in its size never made good the reductions in US artillery, which was gradually withdrawn. As a result, by 1969 South Vietnamese artillery became even more dispersed in weak static locations. The South Vietnamese never achieved the ability to concentrate fire, either by equipment and logistic mobility or by C3. The US Army had the materiel, if not political strength, to win the war - the South Vietnamese had neither.¹²⁵

The problems of locating an elusive enemy in difficult terrain caused the US to adopt special techniques of target acquisition and indication. Some of these were based on past experience. For example, where it was hard for aircraft to identify a target on the ground, artillery would often pinpoint it with smoke rounds. When artillery itself was unsure of the enemy's map coordinates or even its own, guns could fire at a known safe target and adjust fire from that onto the new target.

The FOO was the principal means of target acquisition and on occasions, as at Da Nang in June and July 1966, observers were able to identify the flash of enemy mortars, and return

fire promptly. A range of sophisticated equipment was, however, soon developed by the US Army to improve locating.¹²⁶

Conclusion

After the First Indochina War, a French commander noted the complexity of 'limited' warfare, "...success is fundamentally more dependent upon political action than upon firepower."¹²⁷ It is also clear that in such scenarios the application of firepower is but one element in a symbiotic relationship in which political utility should determine the effects that are to be created, and those effects may in turn change the political environment in which further decisions are made. When this relationship is fractured, success is likely to prove elusive.

The experience of the Vietnam War caused the US to turn away from contemplation of similar involvement in lengthy 'limited wars', where military power alone could not achieve national objectives.¹²⁸ The War taught US fire coordinators numerous lessons. Helicopters and fixed-wing aircraft proved their worth in support of ground operations. Improvements were needed in target acquisition, which had not kept pace with other equipment capabilities and mobility. The three-dimensional battlefield made C3 problems ever more complex, but these could be alleviated by combining sophisticated technology and management techniques; and the US needed strategically mobile 105mm and 155mm guns, with ranges at least comparable to those of Soviet manufacture.

The US Army suffered a decline in morale and equipment in the mid 1970's; but it was clear nonetheless that a so-called 'Out of Area' capability was still required.¹²⁹ The ability to intervene in the most strategically important areas of the world called for an expeditionary force with high mobility and a light conventional role; but it was not the intention to commit this to protracted COIN operations.

The perception that the USA needed to maintain such an intervention force was stimulated by a number of short wars, or wars of lesser intensity, elsewhere in the world during the 1970s. Some were struggles for national existence, but the resources deployed and the areas of conflict were restricted. Although the intensity or duration of these wars may have been less than those in Korea or Vietnam, the importance of artillery firepower was demonstrated in each.

The greatest consequence of the Vietnam War for the US forces was much broader and more important than the implications for any particular capability. The war produced a generation of officers, scarred by their experience, who were determined to change the 'culture' and doctrine of their forces; and their drive was matched by the resources to build anew. The forces this mixture produced did much to determine the outcome of the Cold War, and the military triumph in the Gulf War was its most impressive consequence.

4.5 WESTERN POWER PROJECTION IN THE 1970s AND 1980s

After 1945, the British, French, Portuguese and Belgians fought numerous 'small wars', the rear-guard actions by which they extricated themselves from imperial commitments. Decolonization and the centralization of military forces in the home base did not, however, diminish the need for contingency forces to take part in overseas operations. The loss of major overseas bases in former colonies created the need for specialized forces capable of rapid strategic deployment, and self-sufficiency for limited periods in a hostile environment. By the beginning of the 21st Century, the debate about such power projection with updated technology was expressed in the terminology of 'medium forces' and 'rapid effects', although the basic concepts were already well-tried.

The United States, France and Britain were amongst those nations which maintained such expeditionary forces. During the 1970's these tended to be small and to specialize in light-scaled intervention operations such as the rescue of citizens trapped in hostile countries. The Franco-Belgian Kolwezi operation (11th May 1978) was a model of that kind; but artillery seemed to have a relatively minor part to play in this type of mission.¹³⁰

The most significant developments in the 1970s occurred in the USA. After the withdrawal from Vietnam, it took time for the appreciation of overseas threats to overcome isolationist sentiments and opposition to high defence expenditure. The process was assisted by a number of international incidents. The first was the 'Mayaguez Incident' of 1975, which reinforced the view that whatever the climate of national opinion, the USA should retain at least a small capability to act unilaterally anywhere in the world.¹³¹ The Israelis' action at Entebbe (3rd-4th July 1976) and the Franco-Belgian operation at Kolwezi confirmed the need to be able to rescue US citizens in an emergency. The Soviet invasion of Afghanistan in 1979, and the shock that resulted around the Gulf from the Iran-Iraq War in the 1980s, caused the USA to create a much larger force, capable of major intervention, but designed to win a quick victory rather than to fight a damaging lengthy war as it had done in Vietnam.

The US Rapid Deployment Force, later renamed Central Command (CENTCOM), was the product of President Carter's 'Gulf Doctrine'.¹³² Logistics held the key to success, and British operations in the Falkland Islands, described below, showed that sustaining long operations over great distances was possible, even for a country of more modest means than the USA. The scale of US resources, matched by a massive strategic transport force, made CENTCOM a potent, integrated all-arms force.¹³³ It practised the same doctrine of AirLand Battle as US forces in Europe.

The philosophy behind global operations outside the NATO area emphasized speed in execution to maximize early military success and reduce the political penalties of a prolonged campaign. They were designed primarily to operate against relatively small conventional threats, which were nonetheless capable of serious strategic damage to Western interests if undeterred or unchecked. Artillery in a force designed for such operations required high strategic mobility to reach the theatre, and high tactical mobility for battlefield deployment. It needed to make the best of relatively small numbers in a hostile terrain by means of firemobility from improved target acquisition, ranges, rates of

fire, C3 and the benefits of advanced munitions.

The USA believed that towed artillery equipment was more suited to rapid global deployment than SP pieces¹³⁴, and US forces were equipped with the 105mm M119 field gun, the British 'Light Gun', and the towed 155mm M198. The USMC's direct support batteries consisted of eight M198s with a range of over 18km, 24km with charge 'Super 8', and 30km with RAP.¹³⁵ The M198 could fire DPICMs, nuclear shells, chemical rounds and FASCAM. Its range and the ability to split a battery of eight guns into two troops¹³⁶ helped to provide continuous fire support in mobile operations, which had not been possible with previous shorter-range equipment.¹³⁷ It relied upon helicopter lift for its tactical mobility, and inclined to depend on the protection of hardened positions rather than on 'shoot and scoot' tactics.¹³⁸ The M198 cannot, however, be lifted by the Blackhawk helicopter and was deemed too heavy for the strategic and tactical requirement.¹³⁹ In December 1985, the USA began the search for a lightweight replacement for the M198 to support five light divisions.¹⁴⁰

US expeditions to Grenada (Operation URGENT FURY) in October 1983 and to Panama (Operation JUST CAUSE) in December 1989 tested the theory and effectiveness of the new capabilities in the aftermath of the Vietnam War. On Operation URGENT FURY, there was criticism that guns were left unused on the dockside; but the most serious flaws were deemed to be the failures of Joint fireplanning.¹⁴¹

By contrast, there was criticism not only of the number of US casualties in Operation JUST CAUSE, but also of the use of field artillery in populated areas and the collateral damage that resulted. Tight rules of engagement virtually ruled out indirect fire, but artillery direct fire was used extensively in Panama City and Colon.¹⁴² Maj Gen R.J. Hallada noted that, "Historically field artillery has been used as an area weapon system of mass destruction with little regard for collateral damage...avoiding collateral damage caused this perception to fade in Panama. Fire supporters had to choose either direct fire weapons or precision weapon systems to accomplish the mission."¹⁴³ Edward Luttwak, however, described the US approach as a "grossly excessive use of firepower".¹⁴⁴ It was clear that a growing international intolerance of such damage would be a growing feature of future operations.

The greatest test of the USA's ability to project its power with expeditionary forces came with the Gulf War (1990-1) against Iraq, which was mounted on a scale scarcely imaginable in the context of the Cold War which had just ended. Much of the thinking behind that Operation drew on the developments of the previous fifteen years, even though that had tended to focus on more modest intervention operations.

4.6 THE CHINESE EXPERIENCE 1962-1979

The Chinese were undeterred by their experiences against UN firepower in Korea, and relied on massed infantry with light artillery support to overwhelm Indian forces in September and October 1962. Equipment mobility, particularly of mortars, enabled the

Chinese to concentrate fire with greater ease than the Indians, whose artillery lacked both equipment and fire mobility.¹⁴⁵

When China invaded Vietnam on 17th February 1979, her style of operations had hardly changed since the Korean or Indo-Chinese wars.¹⁴⁶ The balance of advantage appeared to lie with the Chinese, but other factors worked against them. Most Chinese artillery was towed and committed to road movement; but in the rugged terrain of Yunnan and Guangxi Provinces and the Vietnamese border areas there were few roads. The Chinese did not possess the enormous capacity of US forces to airlift whole formations by helicopter. They had to concentrate their forces on narrow fronts, dependent on a few vulnerable roads, or to advance across country, forgoing normal artillery support.¹⁴⁷ In either case, it was not possible to manoeuvre masses of troops to large decisive engagements.

It was hard for artillery to support Chinese infantry, which faced prepared and well-defended Vietnamese positions. In other circumstances, artillery's task would have been to reduce these before the infantry assaulted; but in this campaign Chinese artillery was not able to play its proper role.¹⁴⁸

The failure to provide sufficient artillery with forward troops was felt especially in the urban fighting after 27th February, when the Chinese needed to reduce Vietnamese bunkers in towns. By then the Vietnamese had brought up heavier US-made 155mm and 175mm, and Soviet-made 130mm M-46 pieces, which outranged the lighter Chinese guns. The US had appreciated the value of long-range artillery in its Vietnam War, and the Vietnamese reaped some of the benefits in their war against the Chinese.

The war demonstrated, not surprisingly, that light infantry needs artillery support to advance against prepared positions manned by efficient defenders. It showed that, as so often in the past, the pace of an advance may have to be slowed to bring forward artillery, and that only by the lavish and expensive use of helicopters can artillery achieve adequate mobility in rough terrain. This, and the exposure of other shortcomings, help to explain the reported Chinese belief that the People's Liberation Army (PLA) had "not been able to conduct a modern war".¹⁴⁹ Firepower is useless if artillery firing platforms cannot move to and on the battlefield to apply its effects – 'reach' is more than the range of the munition.

Whereas the Korean War had perhaps erroneously reinforced the Chinese predilection for infantry manoeuvre in the face of overwhelming firepower, war against the Vietnamese had convincingly demonstrated the limitations of such tactics. The experience may well have been the genesis of ideas that China needed an alternative approach, one which might have to accommodate enemy superiority in a conventional sense and which would have to be countered by more subtle means.

4.7 SOUTH AFRICA'S ANGOLAN WARS 1975-1988

South African forces supported the National Union for the Total Independence of Angola (UNITA) against the Movement for the Liberation of Angola (MPLA) during the Angolan Civil War of 1975-6, and found their artillery of Second World War vintage to be outranged by that of their opponents who were equipped by the Warsaw Pact (WP).¹⁵⁰ Cuban forces arrived in Angola in the late 1970s and came to play a major role in the War. This brought them into combat with the South African Defence Force (SADF) on a number of occasions. The South Africans could only successfully counter the fire of the Cubans' WP pieces by bold forward deployments. It was such experiences, combined with an international arms embargo, that caused the South Africans to develop their own arms industry, pioneering many of the advances in field artillery, such as long-range 155mm pieces firing long-range rocket assisted projectiles (RAP) and base-bleed (BB) rounds, and wheeled 155mm SPs.¹⁵¹ Many of the wheeled 155mm guns being introduced at the beginning of the 21st Century have their conceptual and technical genesis in these developments; and in that sense are belated conceptual and technological consequences of the Cold War.

The effectiveness of South Africa's new artillery inventory was demonstrated in the late 1980s. From September 1987, the SADF's Operation HOOPER subjected Cuban and Angolan Government forces to months of air and artillery bombardment.¹⁵² By 30th January 1988, UNITA forces, supported by the South African Army, had surrounded Angolan government forces at Cuito Cuanavale; and between 10th-30th January the latter were subjected to a bombardment of between 170-200 shells per day, concentrated mainly on knocking out Angolan air defences.¹⁵³ It was this attack that eventually led to the Cuban withdrawal from Angola and a negotiated settlement.

4.8 THE SOVIET-AFGHANISTAN WAR 1979-1988

The Soviet Union intervened in Afghanistan in December 1979. By Spring 1980, the Soviets' major installations in Afghanistan were secure and by late Summer 1980, they had begun to develop a wider-ranging network of firebases, rather as US forces had in Vietnam. These bases generally contained a mixture of 130mm guns, 122mm rocket-launchers and mortars. Where possible, these were usually about 10-15km from each other so as to offer mutual support. The size of the country, however, meant that many of the most important locations, such as at the Salang Tunnel and the entrance to the Panjsher Valley, were isolated.¹⁵⁴

The Soviets began their campaign in Afghanistan using conventional tactics, and the ratio of artillery to manoeuvre arms was high.¹⁵⁵ At times they fired traditional massive fireplans, lasting up to five hours, but they seldom found or fixed targets commensurate to their potential firepower.¹⁵⁶ It is unlikely that these large fireplans caused much damage; but they did have the effect of keeping the Afghan guerrillas' heads down. As a precaution against ambushes, the Soviets also used barrages to sweep the margins of roads ahead of convoys, which were increasingly accompanied by the SP 152mm 2S3, armed with flechette rounds. These ambushes were, however, often over before accompanying guns and mortars could be brought into action.

Soviet artillery in Afghanistan was not employed to save lives so much as to support the main effort; and therefore differed from the US experience in Vietnam, in which the smallest contact had unleashed all available resources. The Soviets were frequently unable to apply their superior firepower, given that their opponents could usually choose the ground on which to ambush them. Soviet experience seldom matched the doctrinal premise on which its artillery operations in Europe were based; and it became clear that the main effort might indeed be some small engagement which at least had the chance of 'fixing' an elusive enemy. The Soviets therefore increasingly decentralized their artillery, attaching fire units to the lowest tactical level.

Mortars and howitzers were often more use than guns in rugged terrain, and rockets were more effective than either against the dismounted and dispersed Mujahideen; but the Soviets usually lacked tactical intelligence and accurate target data to make the best of these capabilities. Soviet battery commanders were normally located close to the forward manoeuvre battalion headquarters, too far back to make the level of decision required in fast moving guerrilla operations.

By 1985, the Soviets had adopted a tactical model based upon the battalion with its own organic artillery support. Rather than advance into an area by a single vulnerable road, they preferred to fly in by helicopter, or advance across country on a number of axes with armoured vehicles accompanied by the SP 122mm 2S1. They could not hope to achieve or sustain the densities that they recommended for a European battlefield, and artillery planning norms were adjusted accordingly.

The Mujahideen fought a typically dispersed guerrilla campaign, but once in contact they tried to 'hug' their opponents closely to prevent them using their artillery. Even when a Soviet commander knew his location to within 50m, supporting artillery often refused to fire without greater precision.¹⁵⁷ The Soviets often responded to an ambush or raid solely with artillery fire, rather than the deployment of ground troops. This fire was often ineffective and the tactical initiative remained with the guerrillas.¹⁵⁸ Even where tactical coordination was successful, the efforts yielded little of lasting consequence as the Mujahideen returned to reoccupy terrain.¹⁵⁹

Heavy reliance upon artillery had disadvantages in this type of warfare. The effects of indiscriminate fire on the civil population militated against hopes that the Soviets and their Afghan Government allies might gain the support of the people. Strangely, it was often the Soviets' specific intention to attack the civilian population. For example, long-range artillery was employed at an Operational level to shell and depopulate remote villages, draining the 'sea' so that the 'fish' could not swim in it.¹⁶⁰ Louis Dupree labelled this policy, 'migratory genocide'.¹⁶¹ The Soviets also cleared large areas of troublesome cities by artillery fire. In 1982, three battalion-bases were constructed in Kandahar, and in March 1984 the Soviets started firing into the south-west corner of the city, causing ninety percent of the population to leave. Herat also suffered and villages close to vital cross-roads were often depopulated by artillery to prevent ambushes.

The role of air-power grew steadily throughout the campaign. Hind helicopters replaced fixed-wing aircraft in the CAS role; and they, rather than artillery, became the most reliable source of fire for ground commanders in mobile operations. Convoys and airmobile infantry all had direct communications with these helicopters. If the Soviets managed to fix guerrillas, Hinds could not be used at night, because the enemy crept too close to friendly forces to be engaged safely. Rather than allow the guerrillas a pause, the Soviets kept up their attacks using mortars which were flown in by cargo helicopters.

By 1984 the Soviets commonly delivered a preliminary bombardment by air rather than artillery.¹⁶² However, air support was often not available, and artillery was often out of range. Even when it was in range, the failure to deploy forward observers to adjust fire at night meant that fire was often wasted in ineffective area bombardments of an archaic sort.¹⁶³ Occasionally however, the Soviets did succeed in conducting well-coordinated Joint fireplans such as that for Operation MAGISTRAL in November 1987, which had high-level Operational objectives.¹⁶⁴ Ironically this accomplished, set-piece operation was essentially a 'face-saving' measure before the Soviet withdrawal - almost an admission that theoretical fire superiority was not enough.¹⁶⁵

The Afghan Mujahideen used rockets¹⁶⁶, mountain guns and howitzers to attack Government bases and constructed multiple sites from which to fire, sometimes for up to two hours, before dispersing before CF could be applied.¹⁶⁷ The light shelling of Government bases by Afghan guerrillas was in many ways more effective in accomplishing their aims than was the heavier firing of the Soviets and their allies in accomplishing theirs. The Soviets and Government forces constituted a better target and tended to adopt a 'bunker mentality' which discouraged the garrisons of small posts from venturing out and seizing the initiative from the guerrillas. Government forces sometimes waited until outposts had fallen, and the enemy was withdrawing, before saturating the area with fire.¹⁶⁸ Occasionally, the Mujahideen mounted more complex operations, in which access roads to a base were cut, and an artillery preparation was fired for perhaps seven days before an infantry assault.¹⁶⁹

The Soviets are thought to have lost 433 guns and mortars in their Afghan War. Their experience provided evidence corroborating that gathered in the Vietnam War: "Absolute supremacy of firepower did not guarantee victory. Native knowledge of the terrain and detailed study of a known adversary offset that advantage."¹⁷⁰ This lesson appeared not to have influenced the Russian approach in their First Chechen War which began in 1994 and which saw firepower applied on a massive, albeit traditional scale.

4.9 THE FALKLANDS WAR 1982

The Falklands War of 1982 was dominated by the manoeuvre of light infantry against prepared defences. Few would have predicted that a Western army would be involved in such an anachronistic, or 'Third World', military scenario on such a scale.

Outside Port Stanley there were no roads. The British Army deployed only a very few light tracked vehicles to the theatre, and there was consequently little vehicular movement at all. Without the bulky, vehicle-born computers of the day, ballistic computation reverted to manual methods, and was without meteorological input. Guns and ammunition were only able to keep up with the infantry thanks to helicopters, even when the latter advanced on foot. The weather, workload and lack of air superiority placed great strain on helicopter resources; and their availability, rather than the speed of infantry, dictated the pace of the campaign.¹⁷¹

British artillery operations fell into two major categories: deep attack by CB, harassing and interdiction fire; and close support.¹⁷² The major contribution to depth fire was made not by artillery but by naval guns, and to a lesser extent aircraft; and the coordination of Joint fire was an important factor in the success of the campaign.

NGS proved its worth in US operations in Vietnam, where warships acted as invulnerable FSBs. In the Falklands Campaign, British warships were far from invulnerable but, at some cost, delivered effective fire onto enemy positions which British artillery could not engage.¹⁷³

The success of NGS in the Falklands was due in large part to the skill of the Army's artillery naval gunfire forward observers (NGFO), who were the first British troops ashore. Without the intelligence they produced, and their adjustment of fire, sometimes to within 100m of friendly positions at night, NGS would have been largely wasted.¹⁷⁴ Despite such operations, NGS was complementary rather than an alternative to field artillery. NGS cannot be guaranteed, as naval operations and the safety of a ship will generally override considerations of the land battle. Naval guns make up for their lack of numbers by a relatively high rate of sustained fire.¹⁷⁵ The consequences of one gun's being put out of action are therefore more severe than those following the loss of one gun in a field battery. The primary role of the field artillery is to support troops in combat, if necessary without regard to its own casualties; and the close support of field artillery is therefore usually preferable to NGS - but both is better.

Air support proved devastating when available, and perhaps decisive when demonstrated to the Argentines at the Battle of Goose Green. It was a valuable source of firepower when artillery was not available, particularly against enemy artillery out of range of British guns; and cluster bombs proved the most effective aircraft munition to be used against ground targets.¹⁷⁶

The Falklands Campaign featured a series of battalion-sized attacks, mostly at night, by which the British concentrated their inferior numbers against an enemy whose positions were eliminated piecemeal. Superior mobility and coordination brought greater force to bear than the Argentines could muster with resolution at any one time or place.¹⁷⁷

Argentine guns were tied to the vicinity of the few roads and tracks, and coordination of fire above battery level was not achieved. Worse, the guns of A Battery of the Argentine

Air Transportable Artillery Group had no observers with communications to the guns. The battery fired only predicted fireplans and ended the War firing directly over open sights. The few Argentine 155mm pieces which could have proved devastating if handled properly, fired single rounds in a desultory fashion.¹⁷⁸ On 12th June, in a rare example of Joint planning, Argentine artillery fired smoke onto Mount Kent to mark targets for Pucara ground attack aircraft, but these failed to appear. Argentine artillery also seemed to lack ammunition. A typical mission for the British 97th Field Battery of 4th Field Regiment was 'Continuous Fire', which sometimes amounted to 300rpg. On the same day, a typical Argentine mission in the Mount Longdon area was 10-15 rpg. The total ammunition used by the Argentine 3rd Artillery Group on 12th June was 2,500 rounds.¹⁷⁹

The Argentine guns were apparently unable to move tactically to avoid CB once located and they were systematically destroyed.¹⁸⁰ Some were so mired in the boggy ground that they became immobile, facing the wrong way. C Battery of the 4th Airportable Artillery Group was prevented by CB fire from manning its guns at the critical moment when British infantry advanced towards it at 1,500-2,000m.

The war was unusual in modern times for its lack of civilian casualties. The theatre provided a barren environment in which land forces, virtually bereft of vehicles, armour, computers and the heavy technical paraphernalia of modern war, fought each other in isolation from society and the rest of the world; and yet even here, political as well as humane considerations for the few civilians had military penalties.¹⁸¹

The British deployed only thirty 105mm light field guns to the South Atlantic, and although their individual ammunition expenditure for phases of the campaign was comparable to those of major engagements in the World Wars, the absolute volume of fire generated was relatively small. On the other hand, the available firepower was employed efficiently, and whenever guns were in range and ammunition available, the concentration of fire was maximized, which was not the case with the Argentines.¹⁸² Little British artillery was available for the battle for Goose Green on 28th May 1982, and it was badly missed. After that battle, the British always ensured that they had substantial artillery support for their attacks.¹⁸³

Although it was a 'small war', the Falklands Campaign had moments of relative intensity, and the artillery used in support of 42 Commando's attack on Mount Harriet on 11th June 1982 was the first British regimental fire mission since the Korean War.¹⁸⁴ Artillery was usually employed in short, timed preliminary bombardments, and then against a series of 'on call' targets, matching the infantry advance. Although British artillery teaching traditionally emphasized detailed preparation of closely-timed fireplans, lists of 'on call' targets and 'continuous fire' were generally preferred in the Falklands¹⁸⁵.

The Falklands Campaign demonstrated the value of light artillery with strategic mobility and the need for helicopters to provide tactical mobility on the battlefield. It showed, if there had ever been any doubt, that however artillery may be undervalued in peacetime training, supported arms demand its support in war. The extent and effectiveness of that

support is determined largely by logistics and the degree of successful Joint coordination.

4.10 ISRAEL AND HER NEIGHBOURS: HALF A CENTURY OF CONFLICT

Introduction

The Israeli Defence Force (IDF) has always lacked space, and therefore time to conduct its operations; and has enjoyed little margin for military error. Israel has, therefore sought solutions to its strategic predicament through short, sharp campaigns with decisive outcomes. Israeli national culture, and the brilliant international reputation of the IDF, have consequently been rooted in brisk military victories on the battlefield, and Israel's frequent wars have apparently been short by historical standards. In reality, however, Israel and her neighbours have been in a continuous and on-going conflict of varying intensity for more than fifty years. Their wars have amounted to no more than brief episodes of intensity between long 'phoney' wars and the two 'Intafadas'. Just as time has been the enemy of the Israelis, so the Arabs have found ways to make it their ally. Their hopes have lain in prolonged conflict, ensuring that even defeat in a war is not a defeat in the extended time scale they have set, thereby denying the Israelis strategic success from their Operational victories in the field. Equally, some might argue that Israel's only chance of achieving a state with expanded 'biblical' borders lies in prolonging the conflict and winning it.

Disasters on the battlefield have often caused Israel's neighbours to feel that they have little to gain from further conventional wars with an IDF, well-equipped and trained for its 'Blitzkrieg' style. They, or at least the Palestinians who have the greatest stake in conflict with Israel, have instead developed methods of challenging on other terms, where Israel's conventional power has been rendered inappropriate or counter-productive. The IDF was perhaps a victim of its early, dazzling successes in conventional war, and was ill-prepared doctrinally and by training, to contend with the more complex and subtle challenges posed by its enemies as a result. Two contrasting approaches to the utility of artillery have resulted.

The Utility of Artillery: Two Approaches

Israel has generally employed its artillery in a conventional tactical manner in conjunction with other arms and services. By contrast, since 1968, Israel's Arab enemies have probably been the world's most sophisticated users of artillery at the Operational and strategic levels. It has been the primary arm in their wars of psychological attrition. 'Habituation', when troops become accustomed to attack by shelling, is a recognized effect of artillery fire. Between 1968-73, this phenomenon was exploited at the Operational level by the Egyptians to erode Israeli readiness in preparation for the Yom Kippur War. They operated just below the threshold of all-out war in their relentless artillery duelling with Israel, conditioning the Israelis to lower their guard, as war approached on Egyptian terms and timings. In that sense the Egyptians fired a 'preparatory bombardment' for over six years prior to their attack. This sophisticated

fireplan proved extremely successful, the epitome of artillery employed at the Operational level, using carefully measured effects in space and time, including non-lethal, psychological ones to yield complex military-strategic consequences.

Since the mid 1970s, Israel's Arab enemies have honed artillery as a weapon of psychological warfare. Geographical target accuracy in this sense has almost no significance, and the tactical details have been almost inconsequential. In the strategic context of the last twenty-five years, success has lain in actions which turn the effects of their enemy's combat power precisely against himself.

The rocket launcher has often been Hezbollah's weapon of choice, used in conjunction with the 'manoeuvre' of its own urban operations and those of the Palestinians. Rockets have done relatively little material damage in attacks on northern Israel, but have had major impacts on the politics of the region. The long-term intent of such organizations may be the elimination of Israel, but in the meantime such actions reinforce the morale of their supporters, influence international opinion, and wear down the resolve of the Israeli population to hold onto territory occupied since 1967.

The Israelis' use of artillery in their short wars has been successful in many respects. They have not, however, been as successful as the Arabs in 'leveraging' artillery firepower as a psychological weapon, except in the sense of remorseless retribution, and the creation of an aura of military invincibility. In 'peace', artillery has often been Israel's means of striking back in revenge, and to deter, but in Operational terms this seems usually to have failed, or been counter-productive.

A tough Israeli response has been so predictable that Arab attacks appear often to have been targeted precisely to have this desired effect, knowing that the Israelis would rather respond as expected than abandon their traditional policy of appearing strong at all times. Far from deterring further attacks, provoking harsh retaliation by the Israelis seems to have been the purpose of most Arab attacks, for the Israeli actions have often been so imprecise, or deemed so excessive, that they have had an adverse international reaction, losing Israel the moral 'high ground' she seeks in strategic affairs. The Arabs have set the Israelis a conundrum. If they take retaliatory action harsh enough to be a true deterrent at the tactical level, they face heavy penalties at the Operational and strategic levels. If they take lesser measures, they fail to deter; and if they fail to act at all they jeopardize the military reputation they have established over fifty years and suffer adverse domestic reaction. The Arabs thus induce the Israelis to claim compulsion, justification and even satisfaction for tactical actions which reduce the likelihood of a beneficial strategic outcome for Israel.

During the Gulf War of 1990-91, Iraqi Scud missiles were used to attack, not so much the Israeli cities against which they were targeted, as the cohesion of the Coalition opposing them.¹⁸⁶ On this occasion and under intense international pressure, the Israelis understood the 'game' and did not respond as Iraq hoped, thwarting another highly 'leveraged' use of artillery by the Arabs.

Despite these shortcomings, Israel's military reputation has been high; and the lessons of her conventional wars with her neighbours have had profound effects upon artillery doctrine in other countries, which have taken them as reference points for their own planning.

Early Experience

Between 1945 and 1948, Jews and Arabs in Palestine fought a guerrilla war which saw the occasional use of artillery by the Arabs.¹⁸⁷ The new Jewish state rapidly armed itself, and its newly-formed units of 65mm howitzers were in action almost immediately against the Syrians south of Degania on 20th May 1948, causing the latter to withdraw. On the other hand, supporting artillery fire may have compromised surprise when the Israelis attacked Latrun on 25th May 1948, and along with poor communications, it was blamed by some for the Israeli failure. However, the Israelis demonstrated competence in combined-arms operations as early as July 1948, when they encircled and attacked an Egyptian brigade at Faluja, supported by air and artillery.¹⁸⁸

During the Sinai Campaign of 1956 the Israelis mounted an armoured 'Blitzkrieg'. They had only a single battery of self-propelled 105mm AMX which supported their 27th Brigade. The remainder of their artillery was predominantly made up of towed 25pdrs which could not keep up with their armour.¹⁸⁹ In this concept of combined-arms combat, Israeli artillery seemed to have but a minor role.

The Six-Day War 5th-10th June 1967

The character and equipment of the Israeli Army of 1967 reflected the experience of 1956. It was built around a highly mobile force of tanks, and artillery was tasked to provide fire support as best it could. There was seen to be little scope for lengthy, supporting bombardments, instead the Israelis fired a number of short, intense bombardments to suppress or neutralize their enemies as manoeuvre forces advanced.¹⁹⁰

Israel's SP artillery was generally used to accompany armour. For example, each of General Tal's three mechanized brigades, which broke through near Rafa, was supported by an SP battalion; and General Yoffe's two brigades, which cut off Egyptian forces at the Mitla Pass, were supported by an SP artillery battalion. Nevertheless, the role of Israeli artillery in 1967 was not decisive, and support of manoeuvre was not its primary task. Instead, Israeli artillery undertook a variety of other missions, including attacks on Palestinian commandos, Syrian guns, Egyptian oil refineries and the cities of Suez and Ismailia. It also succeeded in preventing workers trying to divert the River Jordan.¹⁹¹

Despite the overall success of the campaign from an Israeli point of view, deficiencies were revealed. For example, Israeli artillery lacked sufficient OPs. The Arabs failed to make the most of their artillery equipment although much of it was excellent. Their C3 was poor and their reactions slow. Egyptian and Jordanian target acquisition was very

limited, and the Syrians diverted too much effort to the shelling of kibbutzim. Although Israeli guns were used for CB, Arab guns were more often overrun from a flank by armour, neutralized by paratroopers, or destroyed by 1,000lb airburst bombs. In this way Arab artillery, like Arab air forces, was hamstrung before it could take advantage of its superior numbers.¹⁹²

The Six-Day War increased Israel's confidence in the efficacy of high-speed armoured operations; but this had been premised on air superiority and the fire of Offensive Air Support (OAS). After the War, growing Arab air defences threatened this concept. As a result, the Israelis provided more SP artillery to bolster the firepower of manoeuvre units called *ugdas*; and by 1973 all *ugdas* were supported by the 155mm M109 or 175mm M107. The Israelis also became convinced of the value of the 120mm mortar, but in some respects this was a dangerous lesson. If they held the initiative on the offensive, they could choose where to concentrate mortar fire at short range; but this would not necessarily be the case if that initiative were lost and they were thrown on the defensive. The Israelis were generally unimpressed by Arab artillery, but had great respect for the MBRL. Quantities of these, particularly the 240mm BM-24, were captured and incorporated into the IDF which displayed an appreciation of rocketry ten years ahead of most NATO armies.¹⁹³ Thus, even though the Israeli style of warfighting still did not place a high value on artillery compared to other arms, the Israeli artillery almost doubled in size between 1967 and 1973.¹⁹⁴

Phoney War 1968-1973

After the Six-Day War, a phoney war of psychological attrition was waged across the Suez Canal between July 1967-October 1973, in which artillery was the primary weapon.¹⁹⁵ The Israelis deployed experimental super-heavy, short-range rocket launchers opposite Suez and Ismailia, capable of firing half-ton warheads 2km.¹⁹⁶ The Egyptians responded with a massive artillery attack on 8th September 1968, in which 150 batteries fired 10,000 rounds. This in turn resulted in the Israelis attacking oil refineries at Suez and Ismailia. The Egyptian attack was repeated on 26th October. The rebuilding of Egyptian forces continued, and by the end of 1968 they contained more artillery than they had had before the Six-Day War one year earlier.

The Israelis found themselves locked in a static attritional confrontation dominated by artillery, and studied the Battle of Verdun of 1916 to try to understand its dynamics.¹⁹⁷ They constructed the Bar Lev Line, judging that a defence based on mobile armour could not hold back an Egyptian crossing under massive artillery fire. A fortification was required which could survive and engage the crossing sites, buying time for mobile forces to deploy across the Sinai.¹⁹⁸ The Bar Lev Line came to constitute a psychological target in its own right, and was subjected to heavy attack by artillery for eighty days beginning on 8th March 1969.¹⁹⁹

Egyptian artillery was also used for more conventional missions. On 19th-20th July 1969, Israeli commandos attacked Green Island in the Gulf of Suez. The Egyptian commander

called for fire onto his own position and the Israelis were driven off. By December 1969, the Israelis had some cause to feel that they were winning the phoney war. The Bar Lev Line had held and the Egyptians were paying a heavy price for their attacks; but the battle of attrition was to last another four years. Egyptian artillery continued to harass the Bar Lev Line in order to study Israeli reactions. This 'reconnaissance by fire' from static positions also allowed the Egyptians to register targets covertly for their eventual attack on 6th October 1973.²⁰⁰

The Yom Kippur War 6th–24th October 1973

The Israeli military aim in the Yom Kippur War of 1973 was similar to those of 1948, 1956 and 1967, to win a quick victory led by mobile armour. In 1973 artillery still played a relatively minor part in Israeli concepts; and the practice of combined-arms combat did not meet even the theory. The assumption of air superiority and CAS still cast artillery in an auxiliary role. Like the Wehrmacht between 1939–41, the IDF regarded tanks and aircraft as the decisive combination, and like the Wehrmacht, experience would force it to revise this analysis. The new factors in 1973 were that Arab air defence, which was twenty times denser along the Suez Canal than WP air defences in Central Europe at that time, made Israeli air support for ground forces too expensive; and that Arab infantry was armed with new anti-tank guided weapons (ATGW). Unsupported armoured operations could be extremely costly if these were not suppressed by fire.

On the morning of 6th October 1973, 2,000 Egyptian artillery pieces fired 3,000 tons of explosives in fifty-three minutes across the Suez Canal, on a front of 173km. Their fire was complemented by that of 1,000 anti-tank guns. Major General Mohammed el Mahy, Chief of Egyptian Artillery, planned for 10,500 shells to fall on the Bar Lev Line in the first minute of the War.²⁰¹ The fireplan attacked Israeli C2, infantry strong points and likely Israeli concentration areas. Artillery was also used to weaken the sand banks of the Canal in preparation for the engineers' water-cannon. Egyptian fire fell on the crossing sites, then moved on to Israeli positions in depth to deter counter attacks, focusing on more C2 targets, artillery positions, roads and logistics. Egyptian long-range artillery was intended to keep Israeli tanks from reaching the Bar Lev Line, giving artillery sufficient time to suppress the fortifications while a crossing was constructed over the Canal and a bridgehead established.²⁰² The bombardment proved generally successful in its objectives. Meanwhile the Israelis struggled with mobilization problems, and their armour was unable to concentrate in time to counter the crossing. The Egyptians also mounted an extensive and successful SEAD operation, allowing them to fly 250 aircraft against Israeli artillery and C3.

The Egyptians crossed the Suez Canal and their artillery observers moved forward, some infiltrating deep behind Israeli lines. The aim was to use artillery to separate Israeli armour from its accompanying mechanized infantry, and to prevent the latter from attacking the ATGM traps into which the Israeli tanks were to be lured.²⁰³

Although Egyptian artillery was initially successful, its deficiencies were subsequently revealed.²⁰⁴ It was largely confined to road movement and was unable to support armoured engagements, lacking effective target acquisition beyond the Canal. The Israeli Airforce remained intact, blocking aerial reconnaissance; and Egyptian long-range artillery fire became less accurate once it moved on to engage opportunity targets. The Egyptians acquired few fresh targets of value, and after serious early disruption, Israeli armour succeeded in breaking through the screen of fire to attack the crossing sites. Several Egyptian bridges were disabled by shellfire as soon as Israeli artillery had come into range, and Egyptian artillery proved unable to locate and suppress it. The Egyptians also lacked artillery commanders and observers for rear area operations, and once Israeli armour had infiltrated Egyptian rear areas, there was little to protect their artillery from it.

The Israeli reaction to the initial Egyptian attack was to take drastic action to destroy the bridgehead as rapidly as possible. Israeli armour often plunged into unsupported attacks on the newly established Egyptian anti-armour kill-zones, only to be broken up by Egyptian aircraft, artillery and the new ATGM.²⁰⁵ Some Israeli divisions lost about a third of their strength in such actions.²⁰⁶ The arm best able to neutralize or destroy Arab air defences and anti-tank weapons was artillery, for which this was a traditional task. Israeli artillery was, however, found wanting; and on one occasion an Israeli division could find only four howitzers to support it. One Israeli divisional commander observed ruefully that tank units would need more artillery support in future.²⁰⁷

Israel's 105mm field guns proved ineffective against armour, although they achieved some successes against landing helicopters. Even 155mm shells proved relatively ineffective unless used in massive concentrations, and they were an expensive and relatively inefficient way to stop armour. As an emergency measure, Israeli 155mm pieces were withdrawn from close support missions, placed under centralized control and fired in units of thirty-six guns. This use of concentrated artillery against hard targets surprised many observers who had become unused to such tactics, although such groups were only half the size of General Montgomery's 'seventy-two-gun battery', thirty years earlier. The greatest merit of Israel's 155mm SPs was revealed to be, not so much their ability to keep up with armour, as their ability to move position frequently, and thus survive against the less agile Arab artillery. The latter was towed and unprotected, and proved vulnerable to Israeli artillery, which was forced to undertake more CB tasks in the absence of sufficient Israeli aircraft.

As the battle tilted in the Israelis' favour, they pushed long-range guns forward to attack deeper targets.²⁰⁸ On 13th October, Israeli artillery shelled Damascus airport and did so for the next ten days, having a psychological impact as the war drew to a close. By 18th October, the Ismailia Road was almost unusable thanks to the fire of Israeli M107s which had been sent forward to engage SAMs and other targets.

The experience of 1973 caused the Israelis to re-assess the role and importance of artillery. The need for greater artillery support for manoeuvre units was clear, and it was no longer envisaged that tanks would fight on their own. The primacy of armour was

replaced by the close integration of all arms, and by the recognition that manoeuvre with inadequate fire support could be disastrous if strategic surprise were not achieved.

Events of 1973 reinforced the judgement of 1967 that 120mm and 160mm mortars were excellent close support weapons. The Israelis were keen to issue the mortar as a weapon organic to infantry and armour, recognizing that field artillery was too valuable to reserve for close support, and that its concentration under centralized C2 achieved better results against an armoured enemy. The 105mm field gun was revealed to be obsolete in armoured warfare, and it was clear that the 155mm piece and the rocket should predominate. The Israelis were impressed by the effect of their captured BM-24 MBRLs, used in Sinai and on the Golan Heights²⁰⁹, and after the war they developed MBRL of their own.²¹⁰

The lessons of the Yom Kippur War of 1973 had a profound influence on the development of subsequent WP and NATO doctrine. The WP recognized the merits of SP guns, and the War confirmed the need to protect its armour by suppressing NATO's anti-tank missiles. The WP and NATO both recognized the benefits of centralizing C2 and concentrating fire on high-value targets, if necessary at the expense of close support; and NATO armies recognized what the Soviets had known since the Second World War, that the MBRL was an effective means of delivering an intense, heavy weight of fire rapidly with maximum shock effect.

NATO armies were surprised to find that artillery ammunition expenditure rates were many times greater than those on which they had theoretically planned, let alone those that could be sustained by stocks actually in place. It was clear that firing large quantities of ammunition at a high rate of fire per gun was an inefficient way to stop or destroy armour, and was a diversion of efforts which would be better directed against enemy anti-tank forces.²¹¹ The Yom Kippur War therefore proved a major stimulus to the development of improved anti-armour artillery munitions.

Israel and the Lebanon

By 1982, artillery had become, in effect, the newest combat arm of the IDF.²¹² In 1973 it had 300 pieces, many of which were 105mm in calibre, and most were towed. By 1982 it had 958 pieces, most of which were SP, and of 155mm or larger calibre. Before 1973, artillery had tried to support tanks, but had often lacked comparable mobility. By 1982, the Israelis could field fifteen artillery brigades to accompany tanks and APCs.

On 6th June 1982, Israel launched Operation PEACE FOR GALILEE. The IDF entered the Lebanon to fight the PLO, but became embroiled with Syrian forces. Israeli artillery proved effective against slower-moving Syrian artillery; and it was valuable in breaking down fortified positions in rough terrain, and in urban areas in support of infantry-heavy *ugdas*. In Beirut, the M109 was sometimes used to fire directly at strongpoints.²¹³ If tanks were isolated, they became very vulnerable, especially at night, and on occasions they were saved by bringing down defensive artillery fire.

The targeting and speed of response of Israeli artillery was enhanced by the intelligence-gathering of new RPVs and the Rafael DAVID fire control computer. The logistic system needed to be yet more flexible to feed increasingly mobile artillery, and problems were eased by resupplying forward gun positions directly by helicopter.²¹⁴

Artillery firepower proved its worth, but the campaign in Lebanon was unlike those of 1967 and 1973, and was a harbinger of the changing strategic environment in which Israel would have to operate thereafter. It was conducted within tighter political controls, which hindered efficiency in purely military terms.²¹⁵ Even so, it attracted intense political criticism at home and abroad which grew more intense the longer the campaign lasted. 'Blitzkrieg' had become a thing of the past – the Arabs had changed the 'rules of the game'.

The onslaught of Israeli firepower in a densely populated area, where winning 'hearts and minds' was necessary to achieve broader strategic objectives, showed once more that victories on the battlefield do not necessarily constitute success in more complex situations. A record of earlier military successes led the Israelis to apply over-simplified military criteria to the use of force, in a campaign where political intricacies touched military tactics as well as strategy. Israel faced new Operational predicaments. This complexity has permeated all operations involving Israel and her neighbours since; and the use of Israeli artillery has not always taken this fully into account.

Artillery has also been used in the region to influence 'hearts and minds' on an entirely different premise – to create fear and to deter. Syrian artillery proved ruthlessly effective in urban operations on 2nd February 1982, in an internal security operation against Islamic extremists in Hama, Syria. Artillery pounded the city for days, and Amnesty International estimated that between 10,000 and 30,000 casualties were inflicted, mostly civilian. "The whole town looked as though a tornado had swept back and forth over it for a week – but this was not the work of mother nature."²¹⁶ The Syrian Government was not bound by the same strategic logic as the Israelis, and consequently the utility of its artillery also differed.

The political utility of artillery firepower was widely understood by other parties in the Lebanon. In July 1989, the Christian Lebanese forces of General Michel Aoun engaged in prolonged operations against the Syrians, using artillery as their primary means of attack. Their aim was to put political pressure on the international community to intervene or assist them, and the scale of their operations was impressive.²¹⁷ The positioning of guns around the city and the psychological attrition they inflicted, the 'moral effect', was much greater than any destructive effect, although that was substantial. Artillery duels and bombardments became attractive to the media, and much of the fighting was viewed, and its intensity measured, in terms of artillery action. Artillery had the dramatic power to engage the attention of the international community and policy makers in a way that less potent image-makers could not. The sense of international crisis and its resolution was played out to the beat of artillery, as it would be in subsequent sieges of cities in the Balkans a few years later.

Tensions between Israel and her neighbours reached a fresh peak of violence in April 1996, when Israel launched Operation GRAPES OF WRATH against Hezbollah guerrillas in Southern Lebanon, whose weapon of choice had become the artillery 'Katyusha' rocket.²¹⁸ Hezbollah guerrillas would typically emerge from a house, set up a launcher, fire at Israeli positions in Northern Galilee and depart, in an operation taking perhaps sixty seconds. Israeli weapon locating devices would trigger a rapid response by Israeli guns into this populated area.

It was reported that Israeli officials accepted that the avoidance of military casualties in ground fighting, and their reliance instead on CF, would result in higher civilian casualties.²¹⁹ It highlighted the importance of the debate on rules of engagement (ROE) and collateral damage that became increasingly sensitive, particularly in Western nations. What was notable about this Israeli action was the apparent willingness to risk antagonizing international public opinion by ROE that accepted such high and inevitable civilian cost, irrespective of whether or not they were permissible under the Law of Armed Conflict, which they probably were.²²⁰ So long as the campaign to keep international opinion at bay held, this tough approach might have worked; but when those civilian casualties became too great and the threshold of acceptability was crossed, the whole strategy 'unwound'.

On 18th April 1996, Hezbollah set up a Katyusha rocket and a mortar about 400m from the Fijian-manned UN base at Qana, where 800 refugees had taken shelter. Israel had previously shown-off its UAV technology by flying over and identifying Hezbollah positions, yet was apparently unaware that the refugees were in and around Qana. Presumably in response to a detection by radar, the Israelis fired nineteen 155mm artillery shells towards the Hezbollah weapon site, of which five missed it by 350m and hit the crowded base instead. One hundred and two occupants were reported to have been killed. The Israelis were caught in a perception trap, either they had targeted the base, as Amnesty International claimed, and struck it successfully, or their military machine was flawed and they had missed the target by 350m.²²¹

Mr Zeev Schiff, writing in *Haaretz*, noted that whatever the operational causes, the massacre had damaged Israel's ambitions for the operation.²²² This example demonstrates how a single tactical artillery mission can have adverse Operational, even strategic consequences. Hezbollah's greatest triumph was not any physical damage it may have caused to Israel with its rockets; but to goad Israel into inflicting a 'psychological injury' on the international community. Israel's Deputy Chief of the Defence Force, Maj Gen Matan Vilna'i conceded as much in his comment, "...Hezbollah are doing their utmost to get civilians killed by sheltering among them and by firing their Katyushas and mortars close to UN or civilian positions."²²³ Hezbollah's action succeeded in provoking what was seen to be a disproportionate or an incompetent Israeli response, which was seen around the world on television and undermined Israel's entire operation, leading US President Clinton to call for an immediate ceasefire.²²⁴

Mr Schiff and others noted that the use of such Israeli firepower was ineffective against small targets such as the Katyusha rocket launcher, “like a tiger trying to catch a mosquito in its teeth.”²²⁵ Such incidents present modern armies with stark conceptual, moral and technical challenges. What is the utility of their hi-tech weapons against targets such as fifty-year-old rockets, carried on a donkey’s back, concealed in a bush and fired remotely by a cheap timer? An effective response probably requires a more imaginative approach, and certainly not one based on equipment and methods designed for other tactical circumstances in a very different Operational environment.

Retaliation and retribution for acts of violence against Israelis have remained a feature of Israeli policy. Sometimes this has been carried out at close quarters against individuals suspected of involvement, or with the heavier firepower of helicopter gunships and artillery. For example, Israeli guns fired on suspected Hezbollah positions in Southern Lebanon on 26th November 2000, in retaliation for a bomb attack in the Shebaa Farms area.²²⁶ Such attacks placed Israel in the difficult position of having to choose whether to retaliate harshly, drawing further international criticism and perhaps escalating the ‘Katyusha War’ with Hezbollah, or resorting to shelling empty ground in a face-saving operation. According to some observers, Israel apparently sometimes chose the latter, perhaps perceiving the disadvantages of obliging with an automatic and predictable response.²²⁷

Further missile attacks were launched by Hezbollah on 14th April 2001, apparently intended to complement those of the Palestinians in Gaza²²⁸, and resulted in Israeli artillery and airstrikes. On 16th April 2001, the Israeli response escalated as the Israeli air force attacked the Syrian Dahr el-Baidar radar station in Lebanon – “The rules of the game have changed”, said Mr Ben-Eliezer, the Israeli Defence Minister, emphasizing Israel’s determination once more to retaliate.²²⁹

By 2002, the implications of a ‘second front’ on Israel’s northern frontier seemed more serious, given the escalating conflict on the West Bank and in Gaza. Attempts were made to stretch the IDF’s resources on a second, northern front in support of Palestinians, overrun by the IDF in the West Bank. For two weeks from 31st March 2002, Hezbollah launched ‘Katyusha’ rocket attacks on Israel from the Lebanon, the first since the IDF’s withdrawal in May 2000. Hezbollah’s bombardment wounded seven IDF soldiers on 7th April 2002, and struck the Golan Heights for the first time since 1973. This resulted in fiercer CF by IDF artillery and deeper attacks into Lebanon by aircraft. Lebanese observers claimed that Hezbollah appeared to be doing its best to provoke Israel to retaliate²³⁰, presumably to provoke an adverse international reaction.

Israel, however, refrained from invading the Lebanon, Minister Vilna’i claiming that, “Israel won’t play into its hands”.²³¹ On 10th April, Hezbollah escalated the conflict attacking an outpost on Mount Dov with infantry supported by artillery fire. Minister E. Yishai insisted that Israel’s lack of response should not be interpreted as weakness.²³² The eventual withdrawal of Hezbollah artillery from the border on 4th-5th May 2002 was reported to be in response to pressure on Syria by the USA rather than Israeli military

action.²³³ In this case, the Israelis succeeded in suppressing Hezbollah fire asymmetrically – the rules had changed again.

Israel and the Palestinians 2001

Over the last hundred years, the field mortar has proved its lethality in numerous wars; but in the Balkans in the early 1990s and in Israel's conflict with the Palestinians, it proved to be a weapon with wider utility and highly potent non-lethal effects. The Palestinians adopted indirect mortar fire as their preferred Operational method against Israel in 2001, combined with very 'close' suicide bomb attacks, and concurrently with Hezbollah operations mounted from Lebanon. They proved extremely artful in the application of the mortar's effects.

In essence, the Palestinians mounted a prolonged bombardment of very low intensity against the Israelis. Given the slender resources available, it was extremely effective. Its intent was not so much to inflict material attrition as to have psychological effects, with political outcomes, changing perceptions about the state of Israel and the international context in which Israel operates. While some may assert that this was an intuitive rather than a conscious plan by the Palestinians, its evolutionary pattern, sculpted by fifty years of conflict, seems clear; and the products of evolutionary experiences are not necessarily the agents of the process itself. Given the probable 'concept of operations', the elements within it of action, reaction and consequent effects are clear, whatever the merits or otherwise of that concept from a political or moral point of view.

The Palestinians mounted mortar attacks on Jewish settlements in Gaza on 10th April 2001, demonstrating their potential to reach into Israel itself. The local IDF commander noted that these fifty bombs were in effect home-made mortars with insignificant effect, but others saw the attacks as tantamount to a declaration of war. Israeli forces did not respond by shelling this densely populated area but entered Gaza and fired anti-tank rockets at selected targets. Some commentators reported that this new Palestinian firepower, "...has had a deep psychological effect in Israel."²³⁴

These events even caused Israeli commentators to mull over the possible parallels between the Palestinians' aspirations and those of their own people fifty years earlier. Eitan Haber wrote, "One primitive pipe - 50 centimetres long and a few thingamajigs - is driving a whole army berserk, tormenting thousands and engaging a government day and night. Every one of our Hagana and IZL museums has a few such pipes, and if David Leibowitch, the inventor of the Davidka mortar in the War of Independence, were alive today, he could explain how easy it is to build. The Palestinian mortar is our Davidka from those days...A shot here, a shot there -- and the State of Israel is pulling NIS 50 million out of its empty pocket to fortify windows. The whole country is a front line. And this is just the beginning."²³⁵

Presumably the Palestinians took heart from such reaction; but the purpose of their mortar attacks was clearly not merely to undermine Israeli morale. It was also intended to

provoke as harsh an Israeli reaction as possible, thereby bolstering the Palestinians' sense of victimhood and international outrage, outweighing that over the mortar attacks themselves.

On 16th April 2001, five mortar bombs landed near Sderot in the Negev, close to the farm of the Israeli Prime Minister, Mr Ariel Sharon. This led to calls for dramatic action which was forthcoming that night as Israeli ships bombarded targets in Gaza; and Israeli troops entered areas governed by the Palestinian Authority for the first time since 1994, amidst a barrage of international condemnation.²³⁶ By firing five 'ineffectual' mortar bombs and provoking the inevitable reaction, the Palestinians earned Israel a rebuke from the US Secretary of State, Colin Powell, who described Israel's actions as, "Excessive and disproportionate."²³⁷ The Israeli forces withdrew almost immediately, despite earlier asserting that this operation could last for months. As they left on 18th April, the Palestinians fired another volley of mortars at Israeli settlements at Nir Am and Kfar Darom, causing the Israeli Prime Minister to suffer domestic criticism for a premature reaction to pressure from the US Government,²³⁸ for giving "...the impression that they had abruptly turned tail in the face of unexpectedly stern American criticism."²³⁹ More mortar bombs were fired over succeeding months and the Israeli response became more severe.²⁴⁰ A greater awareness of the intent of Palestinian operations became evident that Summer as the IDF began to consider media reaction and international opinion when planning its operations.²⁴¹

The strategic utility of relatively light artillery fire was increasingly appreciated by Israel's enemies. The firing of rockets by the Palestinians early in 2002 graphically highlighted the sophisticated application of surface-to-surface fire, using relatively unsophisticated technology. Rockets had a longer range than light mortars, and this gave their attacks a greater psychological effect. Israelis could be made to feel vulnerable everywhere from an unseen enemy, a psychological effect comparable to that of the infantryman on 'the empty battlefield' one hundred years earlier.

In mid-February 2002, the Palestinians launched attacks from Gaza into southern Israel with Qassam-2 rockets²⁴². If such pieces were fired from the West Bank, they could strike the heart of Israel's population centres; and with a short time of flight, there would be little warning time. It seemed likely that such rockets might be used to attack targets such as Tel Aviv's Ben Gurion Airport, "It would not take more than a few shells, before airlines began refusing to fly here".²⁴³ The rockets proved a potent weapon, of relatively minor physical consequence but formidable psychological effect. This was recognized by Major General S. Arad (Retd), the former head of the Israeli Home Front Command, who noted that, "There's no question that the Palestinians see this as a strategic weapon." One commentator noted that Qassam-2 represented no great increase in firepower, "The only real difference is the psychological element."²⁴⁴

Israeli fears extended to the possibility that Israel might once more face an attack by SCUDs from Iraq.²⁴⁵ They coincided with heightened sensitivity following the reported seizure by Israel of rockets with a range of 20kms, on the *Karin A* in the Red Sea, on the

4th January 2002.²⁴⁶ Anxiety was exacerbated shortly afterwards by reports that Israeli Foreign Minister, Shimon Peres, claimed that Iran had provided Hezbollah with 10,000 missiles with ranges of between 10-70kms²⁴⁷, and by Hamas claims to be working on producing the Qassam-3, with a range of 20kms.²⁴⁸

Prime Minister Ariel Sharon had promised retaliation for rocket attacks, and the Palestinian side "...despite everything decided to throw down the gauntlet".²⁴⁹ Mr Sharon was reported to have said that attacks on Israeli population centres would, "...bring about a complete change in our entire mode of operation."²⁵⁰ Yet these rocket attacks set the IDF a challenging task, if it was to locate and destroy the launch sites in heavily populated areas. It was also presumably the firers' hope that such Israeli retaliatory attacks should take place with consequent collateral damage, both physical and to Israel's international reputation. Retaliatory fire might be less effective than an attack by ground forces, yet what would be the strategic cost to Israel of semi-permanent operations in the West Bank?

At the same time there was a growing Israeli understanding of this Palestinian ploy, and arguments were voiced that Israel should not 'cooperate', but should rather break out of its own strategic logic and do something different, not least dampen the ardour of its public opinion for revenge. Some Israeli officials noted that "inflating" the threat posed by Qassam-2 attacks, 'locked' the Israeli Government into inflicting sharp reprisals, playing into the hands of those who fired them specifically to achieve this reaction. It was pointed out that the rockets were inaccurate and few in number.²⁵¹ On the other hand, it was hard to see what appropriate response the IDF could make to such attacks, other than to clear a buffer zone around Israel which would probably be politically damaging; and if such a buffer were created, what would happen when new rockets were used with ranges that could traverse the whole of Israel?

Further attacks by Qassam-2 missiles, but especially suicide bombings, seemed to cross the threshold of Israeli tolerance on 16th February 2002. The IDF launched operations into the West Bank and Gaza the following day to prevent rockets being fired from the area near the 'Green Line'. By March, the IDF had launched large combined-arms operations to find and destroy the workshops where Qassam rockets were being manufactured.²⁵² As a consequence, the UN Secretary General Kofi Annan condemned Israel's "illegal occupation" of the West Bank and Gaza, and the IDF's use of excessive force: "Such actions gravely erode Israel's standing in the international community." This was the first time that Mr Annan had termed Israel's presence in those areas 'illegal'.²⁵³ This may well have been deemed a high-value effect by those who fired the relatively few rockets that provoked the Israeli operation.

Despite the IDF raids, two further rockets were fired south of Ashkelon on 18th March 2002, and in response to these, and a number of suicide bomb attacks, the IDF launched a major operation throughout the West Bank in mid-April. However, the role of Israeli artillery in operations against the Palestinians in 2002 was minimal. "Fighter jets, advanced artillery and other staples of military might have become virtually irrelevant in Israel's ongoing campaign against Palestinian terror...".²⁵⁴ General S.M. Mofaz claimed

that a number of Qassam rocket factories were destroyed in these Israeli operations;²⁵⁵ but the long-term strategic price for Israel has yet to be audited.

4.11 THE IRAN-IRAQ WAR (1980-8)

The 'First Gulf War', between Iran and Iraq, offers insights into the relationship between mobility and firepower, the part played by mass and technology in the provision of firepower, and the role of artillery in its generation. The War was certainly not limited so far as the belligerents were concerned, but it was confined to a relatively small theatre of operations. In many ways the War was a military anachronism; but the scale of the fighting and the quality of the equipment deployed made its lessons seem relevant at the time; and these did much to inform Coalition judgements in preparation for the 'Second Gulf War' of 1990-91.

At the start of the War in September 1980, Iran had 1,000 guns and Iraq 800; but it was armoured forces that were expected to produce an early and easy victory for Iraq. They did not. The importance of tanks was not diminished so much by their short supply as by their evident vulnerability, and thereafter the Iraqis relied increasingly upon artillery. By July 1982, the balance of firepower had shifted, and Iran had just 800 guns and the Iraqis 1,800.²⁵⁶ By then, however, Iraqi population centres were in range of Iranian guns, and in August 1982 Iraq acquired FROG 7 missiles to retaliate.²⁵⁷ It became a war of attrition, in which infantry had superseded armour as the leading manoeuvre arm, and in which artillery had become decisive over both. For years the two sides blasted each other, guided by their domestic hybrids of Soviet artillery doctrine.²⁵⁸

By 1986, artillery had become the Iraqi Army's decisive arm, providing firepower as a substitute for a shortage of manpower and as a salve to a growing political sensitivity to casualties.²⁵⁹ The deadlock was reminiscent of the First World War, with both sides measuring their success by the capture or recapture of small areas of blasted desert or marshland. In the attack, artillery was tasked to destroy field defences, to allow the advance of massed infantry, while armour waited behind the lines for the breakout which might follow. In defence, artillery was to annihilate the attacking masses of infantry.

The balance of firepower continued to tip in favour of the Iraqis, and by 1987 the Iranians had just 750 guns to the Iraqis' 2,800. The Iraqi Army did on occasions demonstrate a limited capacity for all-arms tactics. Gazelle helicopters searched for Iranian formations, and when these were located, the Iraqis called in Mi-24 Hind attack helicopters, rather as reconnaissance units in the Second World War had called in tank destroyers. The Iraqis then hit the target again with artillery.²⁶⁰ At times, such battles gave the Iraqi Army the appearance of sophistication, but when pitched against 'First World' forces in 1991, this was seen to be an illusion.

In the Iran-Iraq War, the value of armoured manoeuvre was seen to be questionable in the face of modern firepower; but even the value of modern sophisticated weapons was shown to be limited, when faced by masses of highly motivated troops. These phenomena were

noted and were factors in some of the forecasts of casualties prior to the Gulf War of 1990-91. The apparent triumph of technology and training in Coalition operations in 1991 appeared to have rebalanced the equation; but the survivability of Yugoslav ground forces in Kosovo 1999 against a sophisticated aerial onslaught begs a less simplistic analysis.

There was one unusual feature of technical and strategic interest in artillery developments in Iraq at this time. Iraq embarked on 'Programme Babylon', which incorporated Saddam Hussein's 'Supergun', designed by Dr Gerald Bull.²⁶¹ This had a 1,000mm calibre barrel of 40m length, in thirteen sections; and it was probably intended to fire chemical and perhaps even nuclear weapons several hundred kilometres.

4.12 THE GULF WAR 1990-1991

The employment of artillery in the Gulf War of 1990-91 demonstrated nothing conceptually innovative, rather that the Joint Operational and strategic context in which artillery operated was changing rapidly. These changes accelerated over the following decade. The War was remarkable for showing the continuities and soundness of the principles of Joint fireplanning which were firmly rooted in the early years of indirect fire in 1917-18. It followed the pattern of much fireplanning of the Second World War, and had striking similarities to that for the Egyptian crossing of the Suez Canal in 1973.

The essence of Coalition fireplanning in the Gulf War may not have been original, but its appearance was novel, thanks to the impressive technical upgrades that were available to make this old model more efficient, most notably in the capacity of air-power. It was remarkable for the competence with which it was accomplished and the disproportionate outcome. The scale of the success was largely attributable to the fact that most of the Coalition forces involved had been specifically equipped and configured for this style of conventional operation, and had personnel of high quality and training. The NATO contingents of the Coalition had trained intensively and at great expense for forty years to match a first class adversary. The Iraqi Army was a dangerous opponent, but hardly its peer. It possessed years of recent battlefield experience but suffered the misfortune to have spent those years shaping itself to win against an enemy, Iran, whose approach was often characterized by primitive human wave tactics.

The War followed a readily recognizable historical pattern. It started with a period of deployments, the marshalling of forces and a static stand-off, as each side considered the other and prepared for battle. One side adopted prepared defence. The other planned to attack after winning the firefight with air and artillery, the new 'artillery duel', before executing a decisive manoeuvre. In these essentials, it would not have been extraordinary in 1870, and an analysis falls readily into the traditional historical structure.²⁶²

Strategic Context

By 1990, NATO doctrine had reached a peak of sophistication; but the war for which its forces trained, and thereby deterred, never took place. Instead, these resources were

available to be applied against Iraq, a wealthy but third-rate power. Iraq possessed a large army, equipped by the WP, and with a mass of other weapons acquired during its war with Iran. It practised a hybrid version of Soviet doctrine and its human resources were of dubious efficacy. This mismatch, of Iraqi making, resulted in a decisive military victory, unequalled in the 20th Century.²⁶³ It was perhaps both the first of the wars of the 'Information Age'²⁶⁴; and thanks in part to its completeness, it was predicted to be the last of the wars fought by armies of the 'First World' that had been designed and equipped in the 'Industrial Age'.

Although the NATO members of the Coalition were fortunate in being able to fight in the style of war for which they were uniquely well trained, most were less familiar with offensive operations, let alone the climate and geography of the theatre. Merely to exercise an offensive concept in Europe, in the thinking of the Cold War, would have been regarded as politically provocative.²⁶⁵ The Coalition plan called for rapid advances, more in keeping with those for which the WP had trained. Fortunately, in the closing years of the Cold War, NATO's doctrine had called for greater manoeuvre and an emphasis on fighting Close, Deep and Rear battles simultaneously. In addition, commanders were perhaps better educated in the need to think Operationally than ever before.

Nevertheless, the circumstances often called for novel approaches to problems, not least in the practice of artillery. New rocket launchers were fielded along with various new munitions, surveillance and target acquisition devices, communications, logistic and survey equipment. Some of these were tried for the first time, and desert conditions required changes in tactics and procedures. In devising the techniques to provide artillery support for fast moving armoured units, bringing artillery into action off the line of march, the British Army certainly learned much from its assessments of Soviet techniques.²⁶⁶

Strategic air-power was a key factor in the overall success; and Operational and tactical fires delivered by air played a proportionately greater role than in any other major conflict to that date. In a sense, air-power provided the majority of the sustained preliminary bombardment over several months, wearing down Iraqi field forces, C2, logistics, and morale.²⁶⁷ Manoeuvre was indispensable to the success of the mission, and it was paralysing fire, primarily from the air that made it possible at acceptable cost. It fell to field artillery to provide the tactical fires to support air and ground manoeuvre, undertaking tasks for which aircraft were ill-suited, unavailable or an inefficient means of delivery.

Equipment

The Gulf War was the first occasion on which many elements of major weapons systems had been used in combat. The most notable advance was in the intelligence, surveillance, target acquisition and reconnaissance (ISTAR) supporting attacks by smart munitions, such as the Stand-off Land Attack Munition and Tomahawk cruise missiles, most of which were reliant on the Global Positioning System (GPS). The Joint Surveillance and Target

Attack Radar System (JSTARS), in targeting mode, was able to search an area of 4x5km with sufficient accuracy for artillery to attack, passing data in real time.

Many in the manoeuvre arms were astonished by the sheer destructive power of MLRS; but then so too were many who manned the system.²⁶⁸ In training, few had seen the quantity or concentration of rockets fired in their first operation. The same was true of the new British L15 shell, which created an over-pressure with which many were unfamiliar. Some captured Iraqis tended to dismiss the effects of bomblet rounds, but commented on the dreadful effects of L15 on troops in trenches.²⁶⁹ The most appreciated technical upgrade to the field artillery was probably the availability of GPS as a navigation aid, particularly in complex manoeuvres, advancing in unfamiliar, featureless terrain at night. It was also used to synchronize the TOT for fire missions. Brigadier General C.W. Abrams, commanding VII Corps artillery later noted, "It didn't just tell us where we were, it did so in terrain where the other side had no idea where they were, and thought we would get lost out there...before August 1990 very few of us had ever heard of GPS."²⁷⁰

At the other end of the spectrum, much remained low-tech. The 8-inch M110 was brought out of retirement, dumb shells remained the primary munition, and artillery often fired with meteorological data which were eight hours old and bore little relation to prevailing conditions. Despite this, observers were satisfied with the accuracy achieved; and thanks to the accumulation of numerous technical improvements over many years, for the first time in history, the kill radius of artillery was greater than its radius of error.

The Preliminary Bombardment

The first element of the fireplan was the preliminary bombardment. This was initiated by the air and maritime components of the force which reached the theatre first, and had the longest reach with which to apply fire to the enemy's vulnerable rear areas.²⁷¹ This Joint, strategic and Operational attack by fire was highly successful; but it also raised some difficult issues. It was not clear whether the Land component commander or the Air component commander had primacy in determining the crucial Fire Support Coordination Line (FSCL) on which both depended to ensure the safe and efficient application of their fires. "The dialogue between ground and air commanders soon began to look more like litigation than combined-arms warfare, with each side marshalling its evidence and trying to score points."²⁷² "After the war, it became clear that the positioning of the boundary (the FSCL) was one of the most important miscalculations of the war."²⁷³ The Air component believed it should have the right to make such decisions, because it provided the majority of the resources at that stage of the campaign, and thus the criteria for the success of its operation should take priority.²⁷⁴

The view of the Land component was that targets attacked should be coordinated with its own plans for manoeuvre. It was particularly keen to avoid littering its future routes with the unexploded submunitions which eventually became a major hazard to friendly manoeuvre. Reconciling the sometimes differing interest of the components became a major topic of debate in the USA after the War. During the air operation which

comprised part of NATO's Joint campaign against Yugoslavia in 1999, it became clear that the problems of Joint coordination in a complex multinational command had not been solved.²⁷⁵

Once the Land force had deployed into theatre, the closer, tactical element of the fireplan was executed in preparation for the ground assault. This was designed to wear down those Iraqi forces that would eventually be engaged in ground combat and to assist with the Operational deception plan.²⁷⁶ The attrition was both material and psychological. This multi-faceted preliminary bombardment was prolonged, heavy and of unprecedented precision against an enemy most of whose dispositions had been identified in great detail. The duration of the bombardment could not compromise strategic surprise because a Coalition offensive was the obvious purpose of its deployment. The issue was merely one of Operational and tactical surprise in time and place. The longer the bombardment lasted, the less the blinded Iraqis were able to see, and the greater the possibility that the attack could come anywhere. At the same time, the greater were the Coalition's apparent options and scope for deception.

Mobility enhanced the survivability of Coalition artillery during its preliminary bombardment. It conducted raids, moving forward to attack high-value targets such as headquarters and signal intelligence units before withdrawing out of range.²⁷⁷ Such raids required detailed coordination with ground protection and air-power. They also required air defence, NBC reconnaissance, engineers for mobility and to dig rapid protection, medical evacuation and electronic warfare systems to jam Iraqi detection systems. In the event, the Iraqis did not return fire, confirming their inability to 'see' what their opponents were doing.²⁷⁸ The raids were a good example of artillery delivering combat power in its own right, supported by manoeuvre arms, rather than the other way around.

On 7th February, the US VII Corps initiated a series of artillery raids near the Wadi al-Batin both to reinforce the deception that the Coalition attack would be made in the East, and to erode Iraqi artillery strength on that sector. The US 1st Cavalry Division conducted a series of artillery raids and feints on its right to pin down four Iraqi divisions.²⁷⁹

On 13th February, artillery raids became more intense. Twenty-seven MLRS launchers fired 216 rockets, dropping 140,000 bomblets onto Iraqi batteries. One of the US batteries was linked to a Q-37 counterbattery radar in case of CF, but there was none. The largest raid occurred on the night of 16th-17th February when VII Corps artillery supported Apache helicopters of the 11th Aviation Brigade. Five battalions of artillery opened a 2km corridor, saturating Iraqi air defences with artillery fire. Artillery continued to fire at targets to the flank and beyond the helicopters' objective.²⁸⁰

British reconnaissance drones had been flying since 28th January 1991, identifying targets for attack. Over five days from 18th February, 1st (UK) Armoured Division conducted twelve artillery raids.²⁸¹ They were carried out on radio silence and were supported by radar and sound-ranging against the threat of CF. These raids also constituted a form of training for artillery prior to the advance into Kuwait.

The attack on deeper targets by air and maritime systems continued during the period of the artillery raids, ensuring that the enemy was engaged simultaneously throughout the battlespace. On 17th February 1991, US Central Command (CENTCOM) announced that Coalition airforces had destroyed more than 1,300 of the 4,000 tanks in the Kuwait Theatre of Operations, 550 in the previous five days.

The Preparatory Fireplan in Support of the Breaching Operation

Having fired a preliminary deep and close fireplan, the Coalition then fired its preparatory fireplan in support of the breaching of the Iraqi defensive positions. This integrated artillery fire with long-range missiles, air, aviation and psychological operations.²⁸² On 23rd February, the 210th Field Artillery Brigade fired for nine minutes to cover the engineers of the US 2nd Armored Cavalry Regiment as they cleared holes through the border berm.

The US VII Corps artillery Commander, Brigadier General Abrams, massed two divisional artillery groups of 350 howitzers and ten MLRS batteries on the breakthrough sector – twenty-two pieces per km of sector. He had scheduled a three-hour fireplan to support the breaching operation of the US 1st Infantry Division on 24th February, G-Day.²⁸³ This was reduced to sixty, and later thirty minutes, as confidence grew that the Iraqis were weaker than had been originally assessed.²⁸⁴ Simultaneously, other artillery attacked the C2 of the opposing Iraqi corps whose reserve also came under air attack.

Fire Support for Offensive Manoeuvre

Support for offensive manoeuvre was typically provided by short fireplans from artillery deploying rapidly off the line of march to support the momentum of the advance.²⁸⁵ In at least one US field artillery battalion the idea of breaking down batteries to fire by platoons was soon abandoned to make C2 easier. Equally troops had to get used to the notion that firing less than a battalion at a target did not constitute ‘massing fire’.²⁸⁶ Typically, artillery was brought down 200-300m from friendly forces. During the 100-hour offensive the US element of the VII Corps artillery fired 12,821 shells, 5,634 MLRS rockets and twenty-five ATACMS rockets.²⁸⁷ Not an artillery shell or rocket was fired in response.²⁸⁸ It was, however, often difficult to acquire target data for such missions. The value of UAVs in providing this service was appreciated when, on 24th February, the 1st Infantry Brigade of the US 1st Infantry Division used their imagery to plan its scheme of fire and manoeuvre.

The difficulty in providing timely intelligence to brigades and divisions was evident on 26th February when US troops ran into an Iraqi brigade in prepared positions on the ‘73 Easting’ and had to engage it without the preferred level of artillery support. Observers in Bradley fighting vehicles often found that their direct observation range was the same as the range of a direct fire engagement, and that the latter erupted before they could bring

down indirect fire support. The need to introduce longer-range observation devices was noted.²⁸⁹

In the British divisional battle, fireplans were not originated by FOOs. All originated from brigade or battle group level and the main task of the FOOs was to stop the firing at the last safe moment. Such a fireplan typically had one hour's warning and consisted of a 'cocktail' of bomblet and L15 HE, fused to detonate at nine metres above the ground. On the night of 25th-26th February, for the attack on Objective BRONZE, one gun from 26th Field Regiment fired illuminating rounds for the benefit of the attacking UK 4th Armoured Brigade, to find that this in itself prompted a mass surrender of Iraqis. That gun fired a total of 66 rounds of illuminating to encourage the practice. On 26th February, 4th Armoured Brigade attacked Objective TUNGSTEN following a bombardment by 100 guns and MLRS. The attack by the UK's 7th Armoured Brigade on Objective LEAD on 26th February met with resistance, and aircraft were brought in to complement the MLRS of 39th Heavy Regiment which was firing at very short range.

There were many excellent examples of Joint and all-arms cooperation. On the morning of 26th February, the artillery of US 1st Armored Division fired a heavy bombardment of 155mm shells and MLRS immediately prior to its ground attack. As 1st Armored Division swung east, it came into contact with the Tawakalna Armoured Division of the Republican Guard, and the 52nd Infantry Division, which were attacked by aircraft. Meanwhile 1st Armored Division's artillery fired MLRS against the Iraqi Adnan Division, forcing it to withdraw, and Apache helicopters made deep attacks against the Medinah Division which had taken up positions of hasty defence.

On 26th February, the US XVIII Corps advanced into the Euphrates Plain supported by concentrated artillery fire. Artillery was directed not "...to waste time or ammunition on targets of less than battalion size, but when you do find a suitable target, bring everything to bear with an immediate crushing bombardment – then move out."²⁹⁰ Corps artillery attacked deep targets and divisional artillery fired a bombardment for thirty minutes. It is thought that this destroyed three Iraqi artillery battalions. On the final night of the War, the US 24th Infantry Division identified seven Iraqi tank battalions, five mechanized battalions and thirteen artillery battalions. These were attacked by artillery and fled, pursued by American armoured units.²⁹¹

The Iraqi Perspective

The Iraqis faced a 'First World' force with superior capabilities in fire and manoeuvre. These were underwritten by information dominance, logistic superiority, greater skills in Joint operations and a powerful Coalition. If the Iraqis concentrated in static positions, as they chose to, at least in the initial stages before their surrender or flight, they became targets for fire. If they dispersed, they were outmanoeuvred. In either case, they lacked the intelligence to conduct effective fire and manoeuvre; and field fortifications, camouflage and deception proved to be inadequate shields against Allied firepower in barren terrain.

On paper, Iraq appeared a formidable opponent. Its artillery was assessed to have up to 3,500 artillery systems and had been the backbone of its Army in its war against Iran. About 3,000 Iraqi guns were towed. Pieces such as the GH N-45 and the G-5 were highly capable, with an assisted range of 40km which outranged the field guns of the Coalition. It is thought that the Iraqis deployed over 600 pieces of artillery to Kuwait, and these were mostly positioned in a continuous belt along the border, between 14km and 20km north of the berm. Once separated from their vehicles towed guns could not move to survive, and were in effect abandoned to their fate in fortified positions. Iraqi self-propelled artillery was mainly held to the north with manoeuvre forces. Iraqi artillery did not possess much of the technology required to exploit its potential advantages. It lacked adequate target-locating devices and aids to accuracy such as meteorological data, survey and computation equipment; and it was essentially only capable of conducting large, pre-planned fireplans. The target-locating radars which the Iraqis did possess were seldom switched on because they would merely have acted as beacons attracting Coalition fire.

The Iraqis were tactically blind and when they did fire, caused little damage. One of the few occasions when the Iraqis managed to fire back with any effect was against the 2nd Brigade of the US 3rd Armored Division on 26th February. After some delay coordinating the fire of corps artillery across the boundary with XVIII Corps, MLRS eliminated four Iraqi battalions, and in the next twenty-four hours destroyed another seventy-two Iraqi guns.²⁹²

Iraq's surface-to-surface fire was generally insignificant in tactical terms, but her Scud missiles were influential at the strategic level, when attacks on Israel threatened the integrity of the Coalition. They were also damaging at the Operational level, diverting up to 300 Coalition air sorties per day and most of the scarce special forces effort to 'Scud-hunting'.²⁹³

Conclusions

The Gulf War taught little of note about the handling of artillery at the tactical level, rather it validated many of the lessons of the previous seventy-five years. Its primary interest lay in broader developments at the Operational level and its strategic context. The outcome seemed at once so certain, and yet beset by fresh uncertainties. The importance of field artillery, the Land component's prime contributor to Joint fires, appeared to some to have diminished along with the importance of Land operations in a Joint campaign. Coalition artillery fired only about a quarter of the ammunition expected, thanks largely to the short duration of the ground war. This was in large part due to the effectiveness of the preliminary air bombardment. Air-power would clearly play a larger role in future Joint considerations when the USA was involved, and the Air or Maritime components would presumably be first into action. Airmen claimed a commensurate increase in decision making, in campaign planning and the coordination of Joint fires. Their claims to primacy in designing the Joint fireplan and the delineation of FSCM became more strident.

The Gulf War seemed to some to mark a fundamental shift in the way wars of the future would be fought as air-power and space-based systems became dominant. It was now perhaps possible for Western powers, or at least the USA, to fight its wars at a safe distance, with only minimal risk to ground forces as they occupied territory once held by an enemy who had been defeated from the air. The old aspiration of troops occupying ground without a fight seemed almost to be realized, but the fire that would make it possible would be from the air not artillery. Later evolutions of such air-power theories called for radical reassessments of the readiness and peacetime deployment of US ground forces. Air-power, some said, could react quickly to hold off an aggressor while ground forces deployed to the theatre and then advanced against an already defeated enemy.

Yet many had doubts. The ground war had been made much easier thanks to a highly effective air operation, but there had still been vicious ground combat, requiring manoeuvre supported by fire. Air-power alone had not been sufficient, let alone the most efficient means of eroding Iraqi forces when these lay within range of Coalition artillery. There was also the nagging suspicion that, despite the unusually poor weather conditions at the time, fighting a war on a generally flat, unpopulated desert was not a reliable model when planning for future conflicts. Would air-power really always be that effective in other theatres, in poor weather conditions and over complex terrain? Would a future enemy always cooperate and present himself to air-power in such monstrous target arrays? Could a future enemy's powers of deception outdo the power to acquire him as a target? Could the Land component really afford to be shrunk in order to free resources to pay for the new 'silver bullets' in the Western armoury - or rather hangar? Were the new theories of the air-power constituency a sound basis for an entirely new direction in 21st Century doctrine?

Nevertheless, even if assertions of dominance were moderated, it was clear that the significance and potential of air-power had changed in some new and obvious way. Its role in the provision of Operational, let alone strategic fires in depth, would be an invaluable asset in the hands of the West, thanks primarily to the USA. Dominant air-power permits both the attack of ground targets and the protection of the force from enemy air attack. Air superiority when fighting a ground war became almost an assumption, the condition without which such combat would not be conducted. Unfortunately, as a result, the importance of ground-based air defence (GBAD) came to be questioned, just as the threat from UAVs, cruise missiles, theatre ballistic missiles (TBM) and AH began to grow.

There remained doubts about how effective air-power had really been against Iraqi ground forces; and even though that effect, whatever it was, had clearly been outstanding by any military historical criteria, air-power had seemed disturbingly ineffective against the most dangerous Iraqi threat, the Scud missile. Coalition attempts to hunt and destroy Scuds had been extremely disappointing despite the massive diversion of efforts from other tasks. The Iraqis had leveraged significant utility from this relatively cheap asset, without using the fearful WMD warheads they might have carried. The lesson for Iraq, and other nations of similar inclination, in the future might be: Never fight a 'First World' military

power on its own terms. Fight below the threshold of conventional military operations, or move above it to deterrence or hostilities, underwritten by surface-to-surface artillery such as the Scud and its successors, armed with WMD. The initiative over what sort of military challenge a 'rogue state' might make, rests with that state and is not easily gauged.

The West and its allies appeared to have won a startling victory, almost without historical precedent; but the very scale of that victory seemed to ensure that it would not soon be replicated. It was a model of military accomplishment in many ways, but one which had possibly made itself obsolete. At the same time it became the benchmark against which Western nations had to measure their future military capability, for they might some day have to fight 'Gulf War II'. The dividend from investing in this heavy, high-tech warfighting capability was to close, or at least reduce, the attraction of this option to a potential opponent. Maintaining a major warfighting capability has also assured the West's military lead over some future peer competitor for some decades. The price may have been the 'locking up' of resources in a style of warfare that may have passed, and a delay in diverting resources to forms more relevant to the future, if they could be divined. This debate over the utility of force and balance of investment dominated military thinking at the turn of the Century and remains unresolved.

The West also learned that, after the predictability of the Cold War, conducting unexpected expeditionary operations had become its greatest challenge. 'Out of Area' operations were now the mainstream, and high readiness, rapid deployment and rapid effects were critical to them. It was highly unlikely that the logistic resources of a future host nation would match those of Saudi Arabia, or that an enemy would give his opponent so much time to deploy, marshal his forces, build-up logistics and train, while presenting himself for attack by fire over a prolonged period. The West would need the ability to create military effects more rapidly, and not merely from the air, to succeed against a faster-moving opponent than Iraq had proved to be.

Military victory in 1991 seemed overwhelming. Iraq had apparently been defeated, massively and disproportionately, and yet perplexingly, even that had not amounted to strategic victory. Air operations against Iraq continued more than a decade later. On the one hand, this validated the unique role of air-power as a tool of coercion to control and deter, and yet at the end of it, the gains of the war seemed relatively limited, and the regime of Saddam Hussein endured and he remained a threat to his own people and neighbours.

The Iraqi regime's survival was partly due to the reluctance of the Coalition to press on to Baghdad to 'total victory'. The international reaction to the bombing of the Al-Firdos bunker in Baghdad on the night of the 12th February, which may have killed 300 people, had made commanders and political leaders realize that civilian casualties to the enemy were unacceptable if they appeared disproportionate, unnecessary and were graphically portrayed by the press. Similarly, the scale of the carnage shown on television on 27th February of the Basra Highway, the 'Highway of Death', also had a major effect on Western electorates and international opinion.²⁹⁴ The increasing availability of information

enabled Western nations to fight more effectively, but it also enabled the international community and their electorates to scrutinize their actions more critically. The battle for perceptions had become more akin to judo than boxing. The greater the military power, the greater the risk that its force might be turned against itself. The Gulf War revealed the growing force of these trends in whose context future wars would be fought and firepower applied. They were amplified by experience in the Balkan conflicts of the following years.

The Gulf War changed the setting in which firepower would be applied in future conflict. New factors were evident: The rise of air-power, albeit with doubts about the extremes with which it was evangelized; the likelihood that a 'Gulf War II' would not be fought in the near future, if only because Western readiness deterred it; an appreciation of the growing threat from theatre ballistic missiles with WMD; the realization that an opponent might choose to attack Western interests below the threshold of general war, and that the scope of operations for main forces was expanding. Above all, it was clear that future operations would be conducted against a background of an increasingly sensitive international opinion, beset with legal ambiguities and hazards which would place greater strains on commanders and those who applied firepower.

4.13 RUSSIA'S CHECHEN WARS 1994-2000

Russia's wars in Chechnya (1994-2000) were often characterized by lack of restraint in the application of fire, but the techniques of applying it became more sophisticated with bitter experience. During the First Chechen War (1994-6), Grozny was heavily shelled between December 1994 and January 1995 as Russian commanders sought to maximize the effects of fire before committing troops to close battles in the devastated urban terrain.²⁹⁵ This was only partially successful, for the Chechens left the upper stories of buildings unoccupied and constructed defensive positions in basements. From these positions they remained a lethal threat for much longer than expected, ready to engage Russian manoeuvre units in close combat.

Despite the lavish use of fire, the Russians still committed armoured units to urban operations before their opponent had been adequately subdued, and they suffered high and politically damaging casualties as a result.²⁹⁶ It could be argued that such attritional tactics were inappropriate; but given a plan based on the elimination of the enemy rather than something more subtle, the answer from a Russian perspective lay in increasing the weight of fire until the desired effect had been achieved.

After costly early experiences in the First Chechen War, the Russians reorganized their forces, 'repackaging' and re-balancing the components of fire and manoeuvre. For example, a battalion tactical group formed around a naval infantry company from the Black Sea Fleet included a reconnaissance company, a Nona 2S9 mortar battery from the Caspian Flotilla, a 2S1 self-propelled artillery battery, an engineer company and other subunits. Mixed units of artillery were formed including tube and rocket subunits. Some

of these were integrated with tactical manoeuvre units and others held at higher level to reinforce critical sectors.²⁹⁷

In the Second Chechen War (1999-2000), the Chechens again intended to fight the Russians at close quarters in complex urban or mountainous terrain of their own choosing. They hoped to inflict sufficient casualties on the Russians to cause their withdrawal, rather as the Afghans had succeeded in doing a decade earlier. The Russians sought to keep at greater distance from their enemy than they had in the First Chechen War, trying to avoid the human attrition caused by manoeuvring in urban terrain. They relied to an even greater extent on firepower, relative to other arms, than at any time in their history. The ability of artillery to fight 'at arms-length' gave it a crucial role in the new approach: 'Long-range fire destruction'.²⁹⁸

Russian artillery was highly effective in early manoeuvres, supporting 'set-piece' advances across the plains south to the Terek River. South of the Terek, in the woods and urban areas, the Russians chose to employ the fire-planning techniques they had developed in Afghanistan. They created 'Fire Blocks' to prevent the enemy from escaping, 'Fire Sweeps' to harass and damage him in otherwise inaccessible regions, 'Box Barrages' to ring and protect friendly positions, 'Fire Corridors' to integrate the fire of many units on a variety of targets and 'Target Boxes' to saturate suspected enemy positions. Most of these missions consumed huge quantities of conventional ammunition, but some also required the limited use of precision, laser-guided munitions.²⁹⁹

The Russians reached Grozny at the end of November 1999 and subjected it to weeks of artillery and air bombardment.³⁰⁰ The Russian commander of the operation to take Grozny, General G. Troshev, was reported to have described his tactics thus, "This time everyone knows what we are fighting for. We are avoiding the heavy casualties we suffered during the last war, so we won't storm Grozny. We will strangle it and besiege it with air strikes and artillery".³⁰¹ The Russian Army possessed large quantities of arms and ammunition to match a doctrine based on overwhelming fire superiority, generated by heavy bombardments, pre-planned at high-level. They also appeared to make good use of sophisticated surveillance and target acquisition technology such as the Story-P UAV which will form a larger component of their future force structures.

There were significant changes in the manner in which air and artillery strikes were commanded. In the early stages of the First Chechen War, the strict regulation of fireplanning and execution at high level had been found to be insufficiently responsive in complex guerrilla operations, whether urban or rural. In the Second Chechen War, tactical commanders were permitted to make fireplans in a way fundamentally at odds with the Russian tradition. Colonel General Karatuyev, Chief of the Rocket Troops and Artillery was a keen advocate of the new decentralized approach. Under the new 'zonal-territorial' method, every force from battalion upwards had a defined zone of responsibility for reconnaissance and 'fire destruction', giving low level commanders much greater freedom of action. Every company was supported by an artillery or mortar battery for use at close quarters, and artillery was allocated to every level above that. One fifth of

artillery ammunition fired by the Russians is reported to have been smoke or white phosphorous.³⁰² One informed commentator also judged that there was probably a higher proportion of direct fire in these operations than in any conflict in Europe since 1914.³⁰³

In a sense, however, this was a very traditional Russian approach, making artillery fire available at all levels, but now with decentralized control. This firepower was substantially augmented by air-power, both fixed-and rotary-wing. Its responsiveness to tactical demands was improved by a large increase in the number of Forward Air Controllers (FAC), sometimes provided at even company level.

On 6th December 1999, the Russian forces gave an ultimatum to the residents of Grozny to leave by a safe corridor, prior to their assault on the city. Rather than send infantry and armour dashing forward to secure key points as they had attempted to do, at a very high price, in the First Chechen War, the Russians circled the city with tanks and artillery, and infantry infiltrated in to identify strong points. They then held back while these were systematically destroyed by artillery and aircraft. The Russians' predilection for heavy firepower was seen in their use of very heavy mortars.³⁰⁴ They also used fuel-air, 'thermobaric', weapons against guerrillas sheltering in cellars.³⁰⁵ Chechen positions that survived were quickly engaged by the artillery of the advancing company in whose zone they lay. On seizing an area, the Russians constructed defensive strong points, and advanced once more from these bases, in the wake of a further 'fire destruction'. It is estimated that eighty percent of this fire was generated from the air and just fifteen to seventeen percent by artillery.³⁰⁶

The Russian approach was similar in essence to that practised on the Western Front towards the end of the First World War. Provided sufficient firepower could be massed, it was virtually certain that a limited piece of terrain could be seized at the price of appalling devastation in what was termed a 'bite and hold' operation. Artillery tactics in urban operations became very sophisticated. Sometimes assaulting infantry would forgo artillery support in order to maintain surprise. Artillery would fire at a constant rate over a prolonged period to deprive defenders of sleep. A lull would follow and attacking Russian infantry would then catch Chechen defenders unprepared at dawn, 'biting off' a limited objective of perhaps a couple of city blocks. The predictable Chechen counter attack would be held off by massive defensive artillery fire.

The ruined city of Grozny eventually fell, much later than expected, in the first week of February 2000 after four months of bombardment.³⁰⁷ With its capture, Russian artillery, air and helicopters switched their fire to the villages to the west of the Grozny.³⁰⁸ The elusive Chechens dispersed to the mountains to avoid Russian fire and to exploit their ability to manoeuvre. This exceeded that of the Russians upon whom they continued to inflict humiliating attrition using guerrilla tactics.³⁰⁹ On the other hand, the Russians had captured the Chechen capital and their domestic political requirements had been satisfied - up to a point.

The Russians may have become more sensitive to friendly casualties, but in contrast to Western countries they do not appear to have developed the same inhibitions about the collateral damage resulting from their fire. Although their approach seems to have achieved their military goals in the short term, it remains to be seen whether inflicting damage on such a massive scale will help to achieve a satisfactory long-term solution to their Chechen problem. In such wars the lessons of Vietnam remain telling. Optimal fire is that which is the minimum necessary to achieve the desired effect on the target. Anything greater than that is likely to have negative side-effects on the campaign. It must also be certain that the need to destroy or neutralize the target outweighs the consequences of any side-effect, even from optimal levels of fire, whatever the mere military justification for so doing. If this is not acknowledged, the entire Operational concept may be undermined. Complex military-political judgements have to be made, and these should be factored into the campaign plan, and not left solely to either military or political decision makers.

4.14 SMALL WARS AT THE TURN OF THE MILLENNIUM

At the turn of the Millennium, artillery continued to be used around the world in numerous wars many of which had been simmering for decades. Artillery remained the primary 'currency' of the long-running, 'warm-war' along the 776km 'Line of Control' in Kashmir between India and Pakistan.³¹⁰ Peaks in the Kargil and Drass areas were contested in infantry engagements, supported by artillery bombardments; and fighting was particularly intense on the Siachen Glacier, where artillerymen on both sides contended with unique environmental challenges. The Indians fired 130mm guns at altitudes of 18,000 feet in temperatures that fell to -50C in Winter.³¹¹ It was also reported that they fired between 500,000 and 700,000 artillery rounds.³¹²

Artillery was also an important element in the forces on both sides in the Sri Lankan civil war, and used intensively in May and October 2000.³¹³ In 2000, the war between Ethiopia and its former province of Eritrea erupted once more in conventional fighting, and artillery played a crucial role in the Ethiopians' breaking through Eritrean defences.³¹⁴

Artillery may have caused as many as 50,000 casualties in Kabul during the Afghan civil war in 1996; and it was also a major factor in clashes between the forces of the 'Northern Alliance' and the Taliban rulers of Afghanistan in September and October 2001.

The issue of whether Western ground forces deploying to Afghanistan in 2001-02 should take their close support artillery with them became a contentious issue. Could airpower and mortars carry out the tasks previously inherent to field artillery?³¹⁵ Did the logistic burden of artillery, given limited helicopter lift, outweigh the advantages of responsive close support field artillery? Should close support always be regarded as an essential part of the ground combat system? The 1,200 US ground troops taking part in Operation ANACONDA (February-March 2002) did not take their close support artillery with them, preferring 60mm, 81mm and 120mm mortars, given the limited helicopter-lift available.

These apparently performed well, destroying a number of enemy mortars and 122mm D-30 gun positions which had caused twenty-eight of the forty-six American casualties.³¹⁶

There were, however, apparently problems coordinating Joint fires. A first sergeant from the 101st Air Assault Division noted that, "The problem with our mortars was there was a 24-hour CAS cap. And (attack aircraft) wouldn't fly near us if we were firing indirect, even though our max ordnance was far beneath their patterns. The other problem was the Air Force could never hit small groups of personnel...I watched and called corrections on numerous sorties and they could never hit the targets...Every time (the direction of attack) was perpendicular to us, we were hit with shrapnel. Not to mention the time they dropped a 2,000-pound bomb in the middle of our company that didn't go off by a sheer miracle."³¹⁷

Many A-10s had been placed in storage and some noted the contribution that the A-10 could have made in Operation ANACONDA. US Navy SEALs trying to rescue SEAL N. Roberts were pinned down by mortars with a longer range than their small arms. After more than one hour F-15E Strike Eagles arrived to provide support, but "They've never trained to do this CAS task".³¹⁸ The area was not secure for fifteen hours. The F-15Es were designed as strike aircraft and were using the air-to-air 20mm Gatling guns for ground attack, and flying too fast to be effective. The A-10, with a loitering capability, heavier armour and slower speed would have been a more effective aircraft for this task. Another problem with air strikes was that Al Qaeda soldiers could hear the aircraft and hide in their caves and it was not always possible to hit those caves with precision from the air. The US Army's view of Joint fire coordination on operation ANACONDA have been contested by the US Air Force, which cites lack of prior planning as the cause of many difficulties.³¹⁹

British commandos took their 105mm guns with them on Operation JACANA; and by May 2002 had fired over 100 rounds to support assaults on cave and bunker complexes in Afghanistan, although these turned out to be unmanned. The weapon locating radars which deployed with the British guns proved valuable in identifying firing positions, following attacks on Kabul and Khost. Guns at Bagram airfield fired daily to deter potential attackers.³²⁰ The base of British troops serving with the International Security Assistance Force (ISAF) in Kabul was hit by 107mm rockets on 7th April 2002³²¹, and coalition forces in Bagram air base was hit on 26th April 2002. US troops were similarly attacked elsewhere in Afghanistan, such as Gardez and Kandahar, and they deployed the Q-36 counterfire radar at Kandahar airfield. Once a target had been located, great care had to be taken to ensure that no collateral damage was caused; and rather than reply with mortars, whose range was shorter than the rockets being fired at the base, a patrol or AH-64 was often sent to deal with the attacker.³²²

By September 2002, US forces based in Kandahar were supported by six field guns and weapon-locating radar as a force protection measure, creating a defensive arc with a radius of 15km. Major General R. Scales (Retired) commented that, "You can have rounds going back at the enemy (mortar) before that (incoming) round actually lands on

you.” M.E O’Hanlon noted that, “If they are able to lob a shell at you and run, you can’t call air power quickly enough to go after them. The only way to deprive them of that is to be able to respond really fast, and artillery is very quick in its response time.” Another observer noted that, in March 2002, neither airpower nor mortars had proved an adequate response to enemy mortars which succeeded in inflicting casualties on US soldiers.³²³

4.15 THE NEW WORLD ORDER: PEACE OPERATIONS

The Strategic Environment

During the Cold War, there were numerous limited conflicts ‘sponsored’ by the great ideological rivals, who skirmished with each other in relative safety through their proxies. The end of the Cold War removed much of the logic for these conflicts, although some had a dynamic of their own. On the other hand, the removal of Cold War inhibitions encouraged some latent conflicts from which the great powers had deliberately remained detached for fear of escalation into more widespread warfare. These often erupted into open hostilities for a variety of nationalist, ideological or socio-economic reasons which the international community sought to bring under control. So-called Peace Operations have been conducted in various forms for many years under UN and other auspices.³²⁴ Their scope and frequency grew rapidly in the aftermath of the Cold War, as the UN tried to ‘police’ what some heralded optimistically as ‘The New World Order’.

The Gulf War (1990-91) presented the Coalition with few conceptual military challenges, other than those of a rapidly evolving strategic environment. The operations which followed shortly afterwards seemed radically different. By the mid-1990s, modern cities in Southern Europe had experienced sieges by hundreds of artillery pieces lasting years, while elsewhere on the Continent life was untouched by these local horrors. Even in the late 1980s, such events would have seemed far-fetched, a doctrinal regression unrelated to the ‘modern’ world. In two Chechen Wars, which were regarded either as civil wars, wars of liberation, wars of secession, peace operations or ‘police’ actions against organized crime, Russia deployed her firepower on a massive scale. NATO chose to apply equally impressive firepower in 1999 in its strategic assault on Yugoslavia from the air, yet at the other end of the spectrum also fired artillery in Kosovo to counter criminal activity.³²⁵

It is difficult to classify and analyse the components of the broad span of Peace operations and to define how or whether they necessarily differ from warfighting. The semantic challenge accurately reflects the lack of conceptual and doctrinal clarity that has pervaded them.³²⁶ Peacekeeping operations, in which the parties to a dispute consent to the presence of an outside intervention, create particular challenges regarding the utility of force and the application of firepower. Peace Enforcement, where some or all parties may not consent to the presence of an outside force, is more akin to warfighting, although the political context is likely to be rather different. Operations in the Balkans in the late 1990s, whether under UN or NATO command, encapsulated those challenges. These were especially acute when operations appeared to slide unpredictably across distinctions between warfighting, Peace Enforcement and Peacekeeping. The power to determine

which of these obtained at any one time often seemed to lie with the local actors, rather than the international force, which may not have been best configured to deal with some of the contingencies which arose.

Peace Enforcement and Peacekeeping operations entail many military tasks common to warfighting; and the pressures of the rapidly evolving strategic environment apply equally to all. Some considerations in Peace operations, such as minimizing casualties on both sides, seem also to have become established factors in warfighting. These new complexities are most apparent in the application of firepower by artillery and from the air, and they entail tactical and Operational nuances which can sometimes appear daunting.

Command in Multinational Peace Operations

Multi-nationality creates particular advantages and disadvantages. NATO armies have long experience of working together, and have detailed procedures to ensure interoperability. This yields immense political and military advantages when they deploy on operations of any type. During the Cold War, multi-nationality in NATO seldom went below corps level; while in Peace operations, in an extreme example, there can be multinationality even at the lowest.³²⁷ Peace operations are very likely to include non-NATO nations in the force, even though they may be led by NATO.³²⁸ The contingents of these other nations are likely to try to follow NATO procedures³²⁹, but they may well not have interoperable equipment, and their soldiers may have very different levels of training. It is relatively unimportant if they have different platforms and munitions. More serious problems arise if they have incompatible communications systems, but even these can be overcome by the human interface of a liaison officer.³³⁰

The most difficult and even dangerous aspect of multi-nationality in Peace operations is likely to be, not incompatible technology or procedures, but rather a different understanding of the mission. For example, there may be disagreement within a multinational force as to the nature of the shared operation, especially when the contingents' political and legal viewpoints and military doctrines do not coincide. One national contingent may regard the operation as an armed conflict, while others may not. Some may believe that the Law of Armed Conflict applies, while others may not. The use of legal force may therefore be assessed differently by the various elements of the force, leading to different ROE, creating potential difficulties in the provision of fire support between national contingents.³³¹ There may be different interpretations of policy as to whether a target may be engaged, given the risk to civilian life, collateral damage and even environmental hazards.³³² Such disagreements could have political consequences affecting the cohesion of the force and the continued viability of the mission.

These are not bizarre, marginal considerations. They are part of the new strategic reality in which commanders and fireplanners have to operate. These sensitivities seem likely to become even more acute, except in societies which believe themselves to be engaged in struggles of national survival, when atavistic, rather than legalistic attitudes, are more likely to prevail. Particular problems arise for Western societies when they are engaged in

operations, regulated by such sensitivities, against an opponent who perceives himself to be fighting for survival by almost any means.³³³

In a NATO 'Article 5' operation, the roles played by member nations in combat and the chain of command are clear. In Peace operations, the situation is likely to be very much less so, even amongst NATO members. For example, the very participation of a NATO nation in a Peace operation is discretionary, as is the size and nature of its contribution. A force commander, of whatever nation or alliance, has no guarantee that he will have a force with which he has trained, or with the capabilities he might like. In NATO, nations react to requests for such forces through the 'Force Generation' process, and the commander may have to report that the force generated fails to meet the minimum required to execute his mission, or he may have to devise a different plan using the force that is allocated to him.

Even if the force of a multinational commander were to contain all the elements that he might wish for, he may not be able to use those capabilities in the most efficient way – from his point of view. In the case of artillery, for example, he would wish to have as much as possible as 'force artillery', under Operational Command (OPCOM).³³⁴

If there were no force artillery, the commander would face even greater challenges. For example, if the force consisted of a number of national or multinational brigades, and the only artillery in the force consisted of artillery organic, or subordinated at some other state of command to those brigades, the force commander would probably find it difficult to deploy those pieces and apply his firepower as flexibly as he would wish. Some brigades might have too little, or even no organic artillery, if the force generation process had failed to provide it. Should the need arise to provide supporting fire to one such brigade, the force commander could not in theory order the movement of artillery from a brigade with organic artillery, which was perhaps not in contact, to one that needed it.³³⁵

Experience has shown that the surest way to derive maximum military effectiveness from a multinational force is through the personality of the commander. It is probably unreasonable to expect nations to commit their forces under less restrictive command states, or to give a foreign commander 'carte blanche' in the missions he gives to them. The commander will, however, be able to use the force of his character to influence subordinate national commanders, and encourage them to 'interpret' their state of command in such a way as to assist him accomplish the mission. This conclusion may sound uncomfortably imprecise and even unconstitutional to some, but it was a successful feature of operations in the Balkans in the 1990s. It has long been a major element in the 'art of command', and a key attribute found in multinational commanders such as the Duke of Marlborough in the 18th Century and General D.D. Eisenhower 250 years later.

A commander will seldom embark on a mission with the force of his precise choice, and uncertainty and complexity of this sort are inherent in Peace operations. The record of such operations is also that the mission will almost certainly evolve as political developments unfold. A force might be generated and configured for one very low-

intensity operation, but escalate with little warning, and almost certainly more rapidly than the decision-action cycle of the force-generation and deployment processes.³³⁶

Care should be taken to avoid inadvertent 'mission creep', but maybe 'mission creep' is the name given to 'mission evolution' by those who cannot handle dynamic situations. The deliberate commitment of an inadequate force would be foolhardy, but the tidy military mind should be cautious about a rigidity that demands certainties, and seeks to govern inherently 'chaotic' political situations. If the political situation was predictable and firmly under control, the force might not have been required in the first place.

There are risks in burdening commanders with such imprecision, and failure has its price, but success may also demand it. Maybe success goes to those who can dominate rapidly changing circumstances and adapt their posture and *modus operandi*. Perhaps this is the equivalent in Peace operations of the qualities of agility and tempo in warfighting, where success may go to those who can exploit opportunities and turn them to their advantage. Commanders and staffs will have to be inventive and radical, unafraid to devise new techniques to be effective with given resources, where solutions in manuals prove inadequate. This requires a military culture that regards 'doctrine' and 'tactics, techniques and procedures' as guides rather than regulations, and gives fresh life to the 'Auftragstaktik' that many profess to follow but dishonour in practice.

Artillery Tactics

Artillery became the most potent arm in the Balkan Wars of the 1990s, not merely on account of its physical power, but because of its psychological influence. In Peace operations, commanders must often play the role of the diplomat, reinforced by military superiority. The presence of guns can calm an unstable situation. The effects of artillery and air strikes, especially when broadcast by the press, can have other more significant consequences than the actual physical damage might entail, creating psychological effects upon intransigent politicians. This is in a sense the 'Moral effect' of artillery applied, not to the field commander, but through the power of the media in the Information Age, directly to the strategic leadership, and perhaps more importantly, to its electorates, power bases and national psyches.

The application of fire may seem an attractive option at the time, but it can create counter-productive obstacles to future progress. Misjudgement may merely stiffen resistance, rather as the aerial bombing of cities seems to have done in some cases in the Second World War. Fire which bolsters resistance is, by analogy in the Information Age, the virtual equivalent of the rubble obstacles of the shelled cities of Caen and Ortona or Monte Cassino. As in all operations, it is the carefully measured application of effects, given the total context of the Operation, that is crucial rather than mere immediate tactical utility.

Relatively small numbers of guns can have decisive effects in Peace operations and artillery will probably be deployed in relatively small groups. Artillery can achieve a variety of effects in operations which are likely to be non-linear in character, in which the

forces of all parties are likely to be of a low density, and the need for a heavy weight of fire unlikely. It can deter by deploying and exhibiting the means to use credible, decisive, military force against transgressors. That credibility may require that it be used, or at least demonstrated on occasions. It can support the deployment of ground manoeuvre forces which may be required to deploy into potentially hostile areas; and it can reach into areas from which they may be threatened, but against which their direct fire weapons cannot be brought to bear.

If fire is to be seen to be discriminating and proportionate, identification of targets is a particularly sensitive matter, requiring detailed analysis and political judgement. NATO tactical targeting has become the standard means, at least in the West, by which the allocation of fire resources is optimized. This methodology requires commanders to Decide their priorities, Detect and Track the highest-payoff targets, Deliver fire onto them and Assess the damage that results.³³⁷ This process was devised originally for high intensity warfare, but has proved just as applicable to Peace operations, where careful judgement and precision is required before attacking a target. The need for greater certainty when opening fire means that a force is likely to need more STA assets per fire unit than in general war. Even so, the hope of achieving an adequate recognized ground picture is likely to be very limited. A greater number of ISTAR equipments may be needed, not merely to confirm accurate target data and BDA, but also to establish an auditable evidential trail to support the commander in subsequent investigations of his actions. A consequence of the targeting process will be the selection of a particular system to achieve the desired effect in time and space. Precise munitions may be as useful in Peace operations for their avoidance of collateral damage as they are for their military efficiency in general war.³³⁸

In conventional war, physical targets such as headquarters, guns and missiles are likely to be the immediate priority. In Peace operations, the most valuable targets are the minds of leaders, the local population and international opinion. The highest pay-off targets are therefore likely to be those that affect perceptions and 'play well' in the media.³³⁹ The intent of fires is less likely to be to destroy or neutralize per se, although these may be the necessary physical effects selected, than to produce a Moral Effect upon the will of the various actors and influence their subsequent behaviour. Weapons effects are therefore measured not so much in terms of fragmentation efficiency, lethal distance or depth of penetration as by the emotional impact of the graphic image created, and its global distribution through the media to electorates and decision makers.

In Peace operations and in some warfighting, the primary danger to artillery may not be from indirect CF but from ground attack by guerrillas, sniper fire, ambush on deployment, mines, local people living in close proximity, direct fire or indirect rocket attack. The circumstances in which friendly fire is authorized will probably be transparent, and the conduct of missions is likely to be analysed at leisure by international opinion, judging its legality and care for collateral damage.³⁴⁰ Tactical actions by all sides can have Operational consequences. Close scrutiny means that, along with physical threats, the most effective CF against the international force is likely to be non-lethal; and may take

the form of self-imposed ROE. Prohibitions on firing, a form of suppression, may also be inflicted by media pressure, possible conflict of interests with NGOs, including charities, or legal constraints. Strict controls on firing will also be imposed to prevent fratricide/amicide.

In operations such as those in the Balkans in the 1990s, restrictive ROE and sensitive political circumstances meant that in most cases prompt and overwhelming force was unlikely to be the best response by artillery, contrary to norms of gunnery in other types of conflict.³⁴¹ A more sophisticated, graduated response of credible deterrence, followed by minimum force proved more likely to be appropriate. This minimum force might nevertheless entail a rapid response to a situation with overwhelming fire; but symbolic and limited fire, demonstrating proportionate response to a given act, may well be the political imperative.³⁴²

The task of protecting a humanitarian convoy from attack by indirect fire illustrates some of the problems which could face artillery in a Peacekeeping operation to deliver humanitarian aid. The primary task is to deter or to strike the source of the indirect fire, but artillery would accomplish little more than direct fire systems if it accompanied the convoy itself. The challenge is to locate a weapon before it fires and to be prepositioned to strike it when required. Artillery might not, however, be permitted to fire at a threatening weapon before it commits a hostile act.³⁴³ If a weapon did fire, or rather a round land on or near a convoy, what certainty would there be that that round came from that weapon rather than another nearby which had also fired, perhaps on some other unrelated target in a conflict in which the peacekeeper was not permitted to become involved? Those two weapons might belong to different forces, and firing at one might have entirely different political consequences to firing at the other. Over a long route in complex terrain, radar might not be available to provide adequate evidence. Would a mere supposition of guilt provide legal protection to the artillery commander who decided to kill those who might have been the firers - but then, might not have been?

What is the gunner's legal position? Will the man who fired the gun that killed unintended victims, always be exempt from legal culpability? In the past, the man who originated the order to fire has been legally accountable. The man who fired the gun many kilometres away may have had no knowledge of what he was shooting at on a complex fireplan. Will he always be able to say that he fired and killed innocent people because he was ordered to do so? Will he always be able to claim that he was not responsible? Can he escape a charge of reckless firing that endangered innocent lives on the grounds that it is not his responsibility to know about, or to be accountable for the consequences of his lethal actions? At any other time in military history, this legalistic approach would have been deemed absurd, but it may not be so in future, if soldiers are brought before international courts to take individual responsibility for their actions. Blaming the orders of superiors to fire may prove an inadequate defence.

It has been suggested that the very possession of precision weapons may render their owner legally vulnerable. Should they decide to use 'dumb' munitions instead of their

'smart' ones and cause collateral damage in the process, they might face legal action as a result of that conscious choice that would not be open to an opponent who had no 'smart' munitions – 'smart' weapons may require 'smart use'.³⁴⁴ This might appear implausible today, but it would probably be unwise to discount the rate at which such legal 'friction' will impact upon military operations.

In Peace operations, mere considerations of legality may not be enough. Perceptions about 'proportionality of response' can become paramount. Even if the firing of artillery is strictly legal, commanders will have to consider whether it is also wise, given the manner in which collateral damage might be presented in the press, and used by the propaganda machines of those on its receiving end. The presentational and emotional complexity of peacekeepers killing people, intentionally or by accident, remains a perilous factor in calculations about the application of fire.

Croatia and Bosnia

Cities under siege by artillery became symbols of the entire Balkan crisis. The precise accounting of the numbers of guns and their locations came to have the highest Operational significance in the construction of cease-fires. The monitoring of their fire, along with that of mortars, came to determine and mark the points of policy shift, both within the UNPROFOR mandate in Bosnia, and in the transition to NATO's IFOR. What in other modern guerrilla campaigns has often been termed the 'politics of the last atrocity', became the 'politics of the last shelling' – or at least alleged shelling. Concealment and deception when firing were not merely a matter of survival for the piece, but a means by which international opinion and decision-makers could be manipulated or induced to apportion blame and punishment. The verification that particular guns had or had not fired came to have diplomatic importance at the highest level. A single mortar round could have military-strategic as well as tactical significance; and the ability of artillery and aerial acquisition systems to provide this information had commensurate importance. Equally, the skills of crater-analysis by UN or NATO forces could have strategic significance.

Cynical observers soon realized that in the Balkans sides might even shell themselves, knowing that this could cause outrage and lead to Western action against their enemies, outweighing any consideration of the price in casualties to their own side.³⁴⁵ The power of artillery magnified through the lens of the media could thus generate Operational and strategic outcomes, beyond any immediate effects on the target.

Artillery played an important role in the hostilities resulting in and from the break up of Yugoslavia, and soon captured international attention. The first 'cause calibre' was the siege of Dubrovnik which began in September 1991 and was graphically reported by the Western press.³⁴⁶ Such coverage played a major part in influencing international opinion, making political decisions to intervene more likely. Attacks on other cities followed, such as that on the Croatian town of Osijek, where shells were at one time reported to be falling at the rate of one per minute.³⁴⁷ Artillery became an essential weapon for all sides, and

played a notable role in the Croatian Army's Operation STORM, 4th-5th August 1995, the largest conventional offensive in Europe since 1945. It 'cleansed', or led to the 'voluntary withdrawal', of over 150,000 Serbs from the Krajena area of Croatia.³⁴⁸ As so often in the Balkans, the choice of term depends on the politics of the observer.

The Western media regarded artillery as the key equipment in the campaign of the Bosnian Serbs. Once this had been firmly registered in the political consciousness, dealing with it seemed increasingly to become a military, political, and apparently humanitarian necessity. Western opinion and resolve to intervene were further energized by press reports that the Serbs were using artillery to attack Muslim and Croat villages before going in to conduct 'ethnic cleansing'.³⁴⁹ The British public was told, "It is these guns which give the Serbs their power. Against them the Muslims - and the Croats involved in Bosnia - have no recourse. Unfortunately, artillery is difficult to destroy from the air. The guns themselves are robust pieces of equipment, usually only disabled permanently with demolition charges. They can also be easily hidden and quickly moved... Their (the Serbs) power to do harm derives almost exclusively from their possession of artillery."³⁵⁰

Reports claimed that the shelling of villages by Serb artillery was deliberately intended to kill civilians.³⁵¹ The artillery siege of Gorazde, which started in 1992 and lasted for more than two years, received particular international publicity. There was outrage that on one occasion about 200 shells were reported to have landed in a UN-declared 'safe area'. Mrs Lyndall Sachs of the UNHCR called this shelling by Bosnian Serbs, "Random violence directed against a civilian population".³⁵² Artillery made the concept of 'safe areas' essentially meaningless, unless there was a physical force, and the will, to make them safe by controlling the locations from which they could be shelled.

The siege of Sarajevo in the early 1990s became an even more intense drama. Bosnian Serbs besieged the city with relatively few guns and very little ammunition, firing for many months from static positions. The guns were usually well dug-in, in concealed positions close to inhabited buildings. Serb observers knew the ground well and usually communicated by means of buried line. Their shortage of manpower meant that their gunners often moved around from position to position to fire small amounts of ammunition from static guns, although at critical moments they were able to increase their rate of fire.³⁵³ The purpose of the foot-soldier, when not sniping, was to provide local protection for these guns. The bombardment became so intense and international opinion so inflamed that on 25th May 1995 NATO was granted permission by the UN to respond with air strikes which destroyed eight ammunition bunkers near Pale. In response, the Serbs fired rockets into the Tuzla 'safe area', killing seventy-one people, and took UN personnel hostage.

Artillery played an important part in the Bosnian Federation's advance across northern Bosnia in September 1995 which coincided with NATO air strikes. "NATO aircraft served as de facto close air support for the allied (Federation) forces, complementing the ground attacks", seizing about thirty percent of the territory held by the Serbs.³⁵⁴

Artillery was deployed by the peacekeeping forces of UNPROFOR, the Implementation Force (IFOR) and the Stability Force (SFOR)³⁵⁵. In each case, novel roles emerged. UNPROFOR artillery deployed on Mount Igman on 23rd-24th July 1995³⁵⁶, and by 31st August had identified 255 targets.³⁵⁷ Artillery had primacy in the mission to protect the Sarajevo safe area by fire, and on the first day of Operation DELIBERATE FORCE fired 931 rounds on thirty missions. This demonstration of the resolve to use force influenced the perceptions of those who had to deal with British artillery as part of IFOR in December that year. The role of infantry in the UNPROFOR operation was to protect this artillery, and all had to relearn the skills of long-term surveillance, in what amounted to 'trench-warfare with radar and night vision'.³⁵⁸

The British Army's 19th Regiment which was part of that force on Mount Igman, faced an unconventional type of artillery threat which did not meet the criteria of traditional CB doctrine and procedures.³⁵⁹ At the same time, all its OPs which were established to dominate the Serb positions were routinely attacked by snipers and heavy weapons. Its problems were complicated by unclear ROE, international law, and whatever the legal position, the political wisdom of opening fire in a particular situation. Targets were engaged, not to ensure their destruction, but with a sense of proportionality, sufficient to suppress them with minimal collateral damage. Many targets were extremely difficult to engage and some could not be for fear of creating unacceptable collateral damage.³⁶⁰ Artillery and mortar locating radars played a crucial role in operations in Bosnia, not only in detecting firing by factions in the conflict, but also in force protection, guarding bases against attack by a variety of threats.³⁶¹

By mid-September 1995 a combination of NATO air-power, UNPROFOR artillery and ground operations by the Croat and Bosnian Federation forces had helped bring about the Dayton Peace Accord. The key to Serb power had been artillery, and this had been neutralized by superior Joint fires.

Kosovo and Macedonia

Artillery was used during Yugoslav operations in Kosovo in 1998-9.³⁶² Yugoslav forces seldom pursued units of the Kosovo Liberation Army (KLA) into forests. When ambushed from the edge of a wood, the Yugoslavs held back and shelled the KLA as they withdrew through the trees. The KLA claimed to have suffered most of their casualties of the War in such artillery actions.³⁶³

NATO nations contributed the bulk of the forces comprising Kosovo Force (KFOR) which entered the Province in June 1999, following the Military Technical Agreement (MTA) at Kumanovo. This followed a NATO air bombardment in which no surface-to-surface artillery played a part.³⁶⁴ It was not politically acceptable to use KFOR's surface-to-surface fire against Yugoslav forces. These difficulties reveal the complex characteristics of various types of Joint fire, their qualities and disadvantages, all of which must shape decisions in optimizing effects. On the other hand, it seems probable that the threat of an imminent land offensive was a factor in the Yugoslavs' consent to the

MTA.³⁶⁵ The air operation proved controversial at the time, and debate about the effectiveness of aerial fires and the ability of land forces to deceive and escape it continued long after it ended.³⁶⁶ The contention was over how much damage air-power had been able to inflict on Yugoslav forces deployed in the field; and whether campaign planning had indeed been Joint between the Air and Land component commanders, as it had been assumed after the Gulf War that they would necessarily be thereafter.

The Yugoslav Army proved unexpectedly successful at making itself invisible to the military technology of the day. It protected itself physically and through NATO's inhibitions over collateral damage, and shielded itself with innovative techniques of deception. It also became apparent how long it can take even a large modern air force to have a decisive effect in difficult terrain and weather, and how difficult it can be to make accurate assessments of the battle damage to units in the field. There was some public disquiet during the air operation at the unexpected time it was taking to show results, some of it by well-known military commentators.³⁶⁷ Short campaigns tend to entail fewer political risks and frictions, and the time taken to erode Yugoslav forces did much to encourage the subsequent debate about the need for Western nations to develop the means to achieve more rapid effects.

Given the likelihood that a ground force would eventually enter Kosovo, with or without Yugoslav agreement, it was important to ensure that air-power was focused not only on strategic ends, but also on the requirements of the subsequent Land operation, for which it provided merely the enabling Preliminary Bombardment. Despite the lessons of Grenada and the Gulf War, the land component was not represented during most of the planning of air operations in 1998-9, and the air bombardment consequently sometimes lacked a land perspective.³⁶⁸

Roads and bridges which KFOR planned to use to enter Kosovo were hit, and empty barracks designated for occupation by KFOR were destroyed. A large number of munitions were also scattered in areas where KFOR troops would have to operate. This may have implications for future artillery systems using similar munitions.

Artillery continued to play a major part in subsequent operations. In December 1999, US artillery in Kosovo fired illuminating rounds as a demonstration of solidarity with neighbouring Russian units and to deter further attacks on them by Albanians.³⁶⁹ In mid-March 2001, Macedonian forces used light artillery against Albanian rebels in the hills above Tetovo. In early April, KFOR deployed British 155mm AS90s both as a deterrent and to fire illuminating rounds in support of infantry operations.³⁷⁰ The Macedonian Army continued to use artillery against Albanian rebels throughout the Summer of 2001, sometimes coordinated with tanks and helicopter fire, amid accusations that the rebels were deliberately holding civilians as human shields in the villages being shelled.³⁷¹

¹ The end of the Cold War was precipitate in a way few, if any, had predicted. In some ways, the sudden collapse of the USSR and the fortunes of its components in the final decade of the Century were analogous to the sudden collapse of the German Second Reich in 1918, and the fate of Germany in the 1920s. Both

resulted in a fundamental degradation of the structures and effectiveness of the state's military apparatus, and both saw the dismemberment of the state under a variety of national flags and political ideologies.

² On the other hand, neo-imperialism is mustering some advocates. Robert Cooper believes that 'imperial' interventions often bring stability and prosperity to weak states. Cooper (2001).

³ Terminology can be politically and financially sensitive. For example, British operations against Communist guerrillas in Malaya 1948-54 were only ever termed an 'Emergency'.

⁴ An official British analysis of trends in the future strategic environment is given in *Strategic Trends*, Joint Doctrine and Concepts Centre (Shrivenham, 2003)

⁵ On 26th June 1999, there were reported to be 3,842 registered members of the press approved to operate in Kosovo. Nevertheless, it still proved difficult for the press to gain access to Israeli operations on the West Bank, in towns like Jenin in April 2002; and many within the press corps considered that the Israeli operation was far from being a transparent peace operation.

⁶ The Coalition partners in the Gulf War of 1990-91 faced challenges to the prosecution of their air operation when Iraqi civilian and military casualties were seen to be disproportionate. NATO air operations against Yugoslavia in 1999 faced some similar criticisms. 'Blue on blue' incidents also caused controversy.

⁷ Hughes (2001).

⁸ Between November 1964 and December 1965 a monthly average of 19,000 men and nearly four million pounds was airlifted to Borneo. Walker (1969), p.8.

⁹ A British artillery regiment equates to a battalion in most other armies, although at times it can contain up to thirty-two guns, in four batteries.

¹⁰ The 105mm Pack Howitzer, for example, could be moved 30km in less than an hour. On one occasion a platoon of Argyll and Sutherland Highlanders and a Pack Howitzer were successfully helicoptered forward to cut off a retreating enemy patrol. Lyon (1972), pp.11-12.

¹¹ For example, 105mm Pack Howitzers were lifted by Belvedere aircraft for Operation NUTCRACKER in January 1964, and helicopters enabled guns to be placed on otherwise inaccessible peaks such as the 4,000-foot COCA COLA. Lee (1977), p.356.

¹² Colley (1971).

¹³ In Kosovo in 1999-2002, some British artillery units had both artillery and infantry roles. Others had purely infantry tasks, for example, batteries acted as extra companies for infantry battalions serving in Pristina.

¹⁴ In Palestine in 1948, Jewish and Arab terrorist firepower increased to the point where the British decided to use SP guns in the direct fire role against strong points in Haifa, rather than to risk unnecessary infantry casualties. Similarly, when the Bulak Nizam organization increased its attacks on Britons in Egypt, and seized the villages of Tel-el-Kebir and El Hammada in January 1952, resistance was crushed by 26th Field Regiment, using 25pdrs in support of an infantry assault, helping to reduce British casualties. Lyon (1972), pp.1-2.

In the East African campaign of 1952-55, British gunners were employed initially on infantry tasks, but in 1954 they were eventually given a limited artillery role. At first, two guns were deployed with an air OP, but this unit expanded to three guns. In January 1955, a bombardment of 525 rounds was fired in twenty-five minutes in support of Operation NUTCRACKER against the Mau Mau headquarters. Throughout the period, however, 156th East Africa Battery deployed only once in a true battery position, when supporting Operation DANTE on the Kikuyu Escarpment in July 1955. Stacpoole (1980).

¹⁵ In the operations following the assassination of Sir Henry Gurney on 6th October 1951, aircraft and 25pdrs were used in an attempt to drive terrorists onto infantry 'stop lines'; but there was little evidence that this was effective. Lyon (1972), p.3. On the other hand, artillery demonstrated its worth when handled well in the swamps of Southern Selangor, where it was directed by air OPs and carefully coordinated with air support and naval gunfire support (NGS).

¹⁶ Lee (1977).

¹⁷ Thwaites (1971), p.42.

¹⁸ Lambe (1967).

¹⁹ Colley (1971).

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- ²⁰ Walker (1969).
- ²¹ Colley (1971).
- ²² Stagg (1965), p.49.
- ²³ Stacpoole (1980).
- ²⁴ A battery might have had anything from four guns and two forward observation officers (FOOs), to ten guns and seven FOOs over a 150km front. There were seldom enough FOOs to accompany infantry patrols. In the early days of the Dhofar campaign there was only one FOO per supported battalion. In Borneo the problem was solved by training all infantry NCOs in directing artillery and mortar fire, air support and air resupply.
- ²⁵ Lyon (1972).
- ²⁶ Thwaites (1971), p.45.
- ²⁷ For example, the advance of the 3rd Battalion, The Parachute Regiment, from CAP BADGE to Wadi Taym in the Radfan in 1964 had to rely on Hunter aircraft for fire support; and in Dhofar it was often necessary to rely on air support to bolster meagre artillery fire. Stagg (1965), p.41.
- ²⁸ Stagg (1965), p.49.
- ²⁹ In Borneo, the British Green Archer radar enabled artillery to respond to mortar fire in under thirty seconds. Beaton (1969), p.16.
- ³⁰ Lyon (1972), p.3.
- ³¹ Walker (1969), p.9.
- ³² A similar approach was adopted by the British elsewhere. For example, in the Radfan during an operation on 1st May 1964, care was taken to avoid civilian casualties from bombing. Stagg (1965), p.44. Before troops entered an area, leaflets were often dropped warning civilians to leave. Even then, all targets had to be positively identified as hostile. This limited tactical surprise and made the FOO's task harder, but paid greater dividends in community relations. Nevertheless identifying military targets can be a problem. British artillery using the ZB298 radar in Oman in 1971 found that at times the harassing fire they were directing against guerrillas sometimes turned out to be hitting wild camels.
- ³³ The material damage was also relatively small compared to that inflicted by incendiary attacks on other Japanese cities.
- ³⁴ Pike (1953), p.199. Infantry battalions would advance to about 10km from the enemy line supported by three artillery regiments. By September 1951 these raids were conducted in brigade strength, re-supplied by air when necessary.
- ³⁵ Appleman (1961), p.68.
- ³⁶ Schabel (1972), pp.96-97. General Ridgway made further requests for heavy artillery, which were granted in October 1951, and in September 1952 a number of 105mm pieces were converted to 8-inch.
- ³⁷ Hermes (1966), p.228.
- ³⁸ Hermes (1966), p.225.
- ³⁹ The three batteries of the British Army's 20th Field Regiment fired 13,400 rounds on 28th May 1953 in defence of the Hook feature. 20,000 North Korean rounds fell on the defending battalion prior to and on the day of the attack, which failed. 20th Regiment fired 300,000 rounds in seven months. Fawcett (1996), pp.68-9.
- ⁴⁰ The latter were defeated only when 8-inch howitzers firing delay-fused 'concrete-busting' shells were brought forward in the direct fire role.
- ⁴¹ Dastrup, p.259.
- ⁴² Hermes (1966) p.332. The US Army had grown accustomed to military superiority, and was disturbed by the relative strength of North Korean, and later Chinese, forces. At the outset of the war, the South Korean artillery was outnumbered three to one, and the North Koreans' 122mm howitzers, 76mm towed and SP guns all outranged the South Koreans' M3s by at least 4km. The North Koreans also handled their artillery competently. For example, at Taejon Airfield on 16th July 1950, and on the Kum River, they generated firepower comparable to that of Second World War battles.
- ⁴³ Robertson, p.107. After two days, US forces had fired 77,349 rounds. S.L.A. Marshall wrote, "Never at Verdun were guns worked at any such rate as this. The Battle of Kwajalein, our most intense shootout during World War II, was a lesser thing when measured in terms of artillery expenditure per hour, weight

of metal against yards of earth and the grand output of the guns. For this, at least, the operation deserves a place in history. It set the all-time mark for artillery effort." Quoted in Jaffe (1989).

⁴⁴ Dastrup, p.258.

⁴⁵ Hermes (1966), p.228.

⁴⁶ Hermes (1966), p.227.

⁴⁷ A US 155mm gun with a planned DAER of forty rounds was rationed to fifteen, and by July it was suggested that this might be reduced to five. It was claimed that the US Eighth Army never ran out of ammunition, but the truth is that it often ran short. Although ammunition was judged by many US commanders to inhibit their firepower, this far exceeded that of their opponents, and by December 1952 the ratio of artillery rounds fired was 19:1 against the Communists. Hermes (1966), p.352.

⁴⁸ Calvert (1954).

⁴⁹ The US Under Secretary for the Army, E.D. Johnson, claimed that mortars caused the most casualties in the Korean War. Military staff contested this claim, but the increasing value of mortars could not be denied, particularly in the rugged Korean terrain.

⁵⁰ These were demonstrated at Hill 303 in August 1950. On 5th November, US forces assaulted Howitzer Hill with massive air and artillery support, causing what the Chinese reported as "crippling casualties". Appleman (1961), p.743.

⁵¹ Hailes (1954).

⁵² Hermes (1966), p.353

⁵³ The Variable Time fuse proved particularly effective in these operations at, for example, the Nam River on 1st September 1950. Hermes (1966) p.353. The South Korean 1st Division adopted tactics similar to those often demonstrated by the Germans in the world wars. Their forward positions resisted the enemy assault for about ten minutes, then withdrew, letting the enemy advance onto known positions which would be heavily shelled before a strong counter-attack. Hermes (1966), p.284.

⁵⁴ Pike (1953), p.202.

⁵⁵ On 14th August 1950, at the battle of Cloverleaf-Obong-ni, it was intended that an air strike be followed by an artillery bombardment before an assault. Bad weather prevented flying, the ten minutes of artillery bombardment proved inadequate, and the attack failed. On 17th August, after a reinforced fireplan that raked the feature from top to bottom, the attack was successful. Appleman (1961), p.314. The setback of Heartbreak Ridge in September 1951 was blamed on the failure to coordinate fire support; but it was followed by a successful fireplan in Operation TOUCHDOWN, which coordinated all divisional assets, including tanks, machine guns, mortars, artillery and Marine Corps Corsairs. Hermes (1966), pp.92-94. This set the pattern for success which was repeated in March 1953 at the 'Nevada Complex', when preliminary bombardments, CAS, DFs and counter-preparation fire were employed, using all available resources. Many close quarter battles were fought over rugged terrain at night. This added to the confusion which was largely responsible for the frequent amicide by supporting artillery. Shrader (1982).

⁵⁶ Hermes (1966), pp.79-80.

⁵⁷ Thomas (1953).

⁵⁸ Bjorge, p.119.

⁵⁹ Stott (1955). Although relatively weak, Chinese artillery strength continued to grow, and by Spring 1952 numbered 884 pieces. In April 1952 it fired a daily average of 2,388 rounds, but by June this had risen to 6,843. The effects of this fire could be severe. In the US IX Corps sector, both sides seized the Triangle Hill-Sniper Ridge feature, only to be driven off again by artillery fire. General van Fleet determined to destroy enemy artillery with the combined fire of the I, X and IX Corps before resuming the attack. The idea was sound, but it met with only moderate practical success. Many targets were hit, but thanks to the strength of opposing field defences only thirty-nine enemy pieces were destroyed.

⁶⁰ Vietnamese bunkers proved resilient and often survived intact unless they received a direct hit, which was a rare occurrence. The 152mm gun of the Sheridan tank proved an effective 'bunker buster' in what amounted to a traditional assault-gun role, but it was often not available. A common tactic was to fire 105mm airburst shells to keep the enemy under cover while 155mm and 203mm guns broke the bunkers with delay-fused ammunition. Even then they would have to be assaulted, and the assault was least costly when it followed as closely behind the artillery bombardment as possible. Aircraft were also often used,

but were harder to coordinate than artillery fire. The best sequence was considered to be: artillery fire, followed by 500lb napalm bombs, more artillery and finally an assault. Carafano (1988), p.39.

⁶¹ The prime advocate of using infantry manoeuvre in support of fire was General W. DePuy, commander of the US 1st Infantry Division in Vietnam 1966-67. His case is described in Scales (1999), p.37. Scales maintains that, "Pressure late in the war to reduce casualties served to pervert DePuy's intent. As the war dragged on, firepower was misapplied to a wasteful or counter-productive degree. Manoeuvre commanders began to complain that a firepower-intensive doctrine had become a millstone around their necks."

⁶² Palmer (1978). The argument that over-reliance on firepower undermined US willingness to manoeuvre is also presented in Scales (1986).

⁶³ US Marines arriving at Da Nang in April 1965 found poor roads with weak bridges that prevented deployments, or which, if blown up after deployment, left units isolated and vulnerable. Ferguson (1966). All batteries consequently carried bridge repair equipment.

⁶⁴ Australian artillery preferred helicopter movement to time-consuming and insecure deployments by road. Burge (1968), p.89.

⁶⁵ For example, on 19th October 1965, the US special forces base at Plei Me was besieged by an NVA division. B Battery of 2nd Battalion of the 17th Artillery was deployed by helicopter to support the base and the relief column. An artillery observer in the leading tank placed a rolling barrage in front of the column. Dodge (1988).

⁶⁶ Ott (1976e). The price of helicopter mobility was high. The USA lost 4,900 helicopters in the Vietnam War. IISS *Strategic Survey* (London, 1972), p.50. The French also pioneered the tactical employment of helicopters in Algeria in the preceding decade.

⁶⁷ Ott (1975b). The introduction of the CH-54 in 1966 enabled even the 14,000lb towed 155mm piece to be deployed by helicopter. Ott (1975c), p.49. The first large mobile operation across corps boundaries, Operation MASHER/WHITE WING in 1966, was possible only because of the helicopter. For a description of operations by the US 1st Air Cavalry in Vietnam see Dodge (1986). The effects of the division's artillery was greatly increased by the availability Dual Purpose ICM (DPICM) rounds which contained anti-armour and anti-personnel grenades. At times, seventy percent of all artillery rounds fired by the US 1st Cavalry Division were DPICM.

⁶⁸ Ott (1975d).

⁶⁹ Most patrols were accompanied by an observer who could expect to engage a variety of targets, from a two-man patrol, to a Viet Cong regiment. When targets were engaged, they were often unseen, and fire was adjusted by ear.

⁷⁰ Ott (1976c). These operations were usually controlled at brigade level but initiated at divisional headquarters. An infantry company usually provided security and the division would provide air support. The teeth of the force would be a battery of 105mm guns and three 155mm pieces, landed by CH-47 or CH-54 helicopters. The guns would fire several hundred rounds and then retire to base. Hay (1974). As US troop levels declined in the early 1970s, such raids increased, using mobility to enhance firepower, and other arms in support of artillery.

⁷¹ Ott (1975c).

⁷² For Cambodia, see Ott (1976e), for Laos, see (Fulbrook 1986, 1986a and 1986b).

⁷³ Although they lacked adequate concentrations of firepower, they accounted for a large amount of ordnance in absolute terms. In Tonkin these bases contained over 400 artillery pieces.

⁷⁴ Ironically, the US Army, which was so critical of Vietnamese artillery in the early days of the war, was itself later obliged to adopt this same 'platooning' of artillery. It seemed the only way to increase area coverage, when US troop levels were falling; and US artillery suffered many of the same penalties previously experienced by the French and South Vietnamese.

⁷⁵ The French also built artillery FSB in Algeria from 1954-62.

⁷⁶ Scales (1990), p.52, quotes a study that noted the relative ineffectiveness of bombs and shells against a determined enemy in Vietnamese terrain. In 1951, the French fired one third of a million rounds in Vietnam, while in 1969, US forces fired ten million. French ammunition expenditure soared as attempts were made to bolster infantry morale

⁷⁷ The scale of the Vietnamese achievement may be appreciated by comparing the length of this supply line with the 'Burma Road' in the Second World War which was a mere 200km long.

⁷⁸ The Viet-Minh made good use of bicycles, sometimes carrying as much as 400lbs each. They managed by such means to move 10,000 tons, equal to the amount flown into the base by the French. Brown (1986), p.23. The French nevertheless also managed to drop 49,000 gallons of wine to the garrison.

⁷⁹ Brown (1986), p.23.

⁸⁰ Brigadier General Christian de la Croix de la Castries, the French commander at Dien Bien Phu, noted that, "Our defences had been founded on the fact that planes would be able to detect and destroy the (Viet-Minh) guns". Quoted in Hamilton and Kaplan (1983). The French hoped that US air-power might save their garrison. They estimated that sixty B-29 bombers, each loaded with eight tons of bombs, and 150 fighter escorts, could raise the siege; but by 5th April 1954 they had concluded that only activation of Operation VULTURE, which included the use of atomic bombs, would suffice. Smith (1984).

⁸¹ Tactical defeat for the French led to a strategic victory for the Viet-Minh. Ironically, it was to be the tactical defeat of the North Vietnamese Tet Offensive that precipitated the US strategic defeat. This indicates that the significance of battle in limited war may be not so much its military outcome, as the relative trauma the experience itself inflicts on the social and political fabric of the participants.

⁸² The concept provided force protection matched by the ability to generate massive, coordinated firepower from and around FSBs. For example, from 14th-17th November 1965, during the Battle of Ia Drang, twelve howitzers in LZ Falcon fired 18,000 rounds, sometimes right up to the perimeter of LZ X-Ray.

⁸³ One reason for this was the care taken to ensure mutual support of FSBs, which proved vital, for example during the defence of FSB GOLD on 21st March 1967, Ott (1975d), pp.30-31, the defence of FSB PIKE VI on 11th May 1968, and that of FSBs RITA and DOT on 1st November 1968 during Operation FISHHOOK. Ott (1976b).

⁸⁴ For an account of the four days of air and artillery strikes in defence of this camp see Scales (1986a).

⁸⁵ The North Vietnamese brought up numerous artillery pieces in an attempt to crush resistance and put the airstrip out of action. In one eight-hour period on 23rd February they fired 1,307 rounds at the base. Despite this, US guns were so well protected that during the whole siege only three were lost. In reply, the garrison fired 158,891 rounds during the siege, augmented by fire from the 175mm pieces in mutually supporting bases at Rockpile and Camp Carroll. The US base commander, Colonel D.E. Lownds, said that the side which kept its artillery intact would win the battle. Quoted in Hamilton (1984), p.19.

⁸⁶ Whenever possible, US forces would engage the enemy with counter-preparation fire on his FUPs. As a North Vietnamese formation advanced, the garrison would engage its head, and three artillery batteries fire a box barrage on its flanks and rear. A fourth battery would fire a rolling barrage back and forth on the formation itself, like a piston in a cylinder. Further out at 500m, two 175mm batteries would fire linear missions parallel to the advance, and A6 Intruder aircraft would drop bombs on the reserves following behind.

By night, US artillery fired pre-planned counter-preparation missions, increasing the shock effect of nine batteries' fire by a common time-on-target (TOT). The response to a call for fire became well-practised and its time reduced to forty seconds for any target in range.

⁸⁷ Nalty (1973).

⁸⁸ At their peak, airstrikes rose to sixteen a day with three B-52s arriving overhead every ninety minutes. The North Vietnamese calculated the USAF safety distance to Khe Sanh and moved within it, but were caught when this was halved. During the siege B-52s flew 2,000 sorties, and tribesmen reported finding groups of North Vietnamese bodies 200-500 strong lying in the approaches to Khe Sanh. Miller (1978). Areas of 100 x 500m were plotted for lower-level attack by A-4 and A-6 aircraft, which flew a total of 4,989 missions, striking as close as 200m to the base. The A-6 could drop twenty-eight 500lb bombs, with an accuracy of ten metres. The fall of these bombs was coordinated with the fall of shellfire to give a common TOT for maximum effect. The 175mm guns fired sixty rounds on half of the plotted area, and 155mm, 105mm and 4.2-inch pieces from Khe Sanh would fire 200 rounds on the other half. During the siege 12,430 tons of supplies were brought into the garrison by air, a capacity greatly underestimated by the North Vietnamese. The resupply of Khe Sanh was one of the greatest logistic feats of the war. Hamilton (1984), p.18.

⁸⁹ A lesson acknowledged in US AirLand Battle doctrine of the 1980s.

⁹⁰ Ott (1976b), p.55.

⁹¹ FSBs were used in this way in Operation FISHHOOK in November 1968 and in the defence of FSB CROOK in June 1969, a ploy which led to the defeat of a Viet Cong regiment.

The Fire Support Surveillance Base (FSSB), such as FSSB FLOYD, was a development of this by 173rd Airborne Brigade. A so-called 'Total Interdiction Base' was created, covering a whole valley, using sensors and radar, enabling quick reaction to enemy movement. It met with success on 29th August 1970, inflicting heavy casualties on an enemy battalion, without close infantry contact at all. This was termed an 'economy of force measure', an operation that achieved the US ideal of maximum enemy casualties from heavy firepower without American casualties.

The French built an 'interdiction line' of field defences supported by radars and artillery on the border between Algeria and Tunisia in 1959-60. This proved militarily successful in preventing infiltration across the frontier. The British Hornbeam Line and the nearby Iranian Damavand Line in Oman in 1974-75 proved to be major contributors to the defeat of insurgents. Israel built a high-tech defensive line along her northern border, following her withdrawal from southern Lebanon in May 2000. This was equipped with a range of novel surveillance systems. Opall-Rome (2001b), pp.23 and 30.

⁹² Between 1966 and 1968 the US delivered 2,865,808 tons of air munitions, compared with the 2,057,244 tons of all bombs dropped in the Second World War, and air support increased to a peak in April 1970 in operations over Cambodia. Between January 1969 and March 1971 the USA dropped 2,539,743 tons of bombs in Indo-China, FitzGerald (1973), p.626, Note 15.

⁹³ In 1968 the AH-IG (Huey Cobra) was equipped with rockets. It was used as an escort aircraft for surface vehicles and vessels, to give direct fire support to ground units, to provide security for observation helicopters, to engage opportunity targets, to adjust tube artillery, and then to engage the enemy it had flushed out. Picou (1967), p.20 and Hay (1974), p.16. The terms Aerial Rocket Artillery, and after 1970, Aerial Field Artillery, reflected its tasks; and its C2 was the same as that for field artillery. For a description of US helicopter tactics in Vietnam, and the evolution of ideas from them, see Fulbrook (1986, 1986a, 1986b).

⁹⁴ Picou (1967), p.19.

⁹⁵ In 1966, success in the Central Highlands was widely attributed to US air-power which broke up and dispersed enemy formations, but such force was not so widely applicable elsewhere, for instance, in the North and Central coastal zones, where flying was hindered by the 'Crachin' fog between February and April.

⁹⁶ Observers brought down fire very close to friendly positions and then 'walked' it back and forth over the NVA attackers. Later analysis showed that the majority of NVA casualties were caused by artillery shells bursting in trees. On one occasion the infantry called for fire on their own position. The weather was unusual in that heavy rain fell without any wind. As a result, a cloud of toxic gas built up over the gun positions. Ammunition expenditure was very high and men from other units were used to augment gun detachments. Gun positions at Nui Dat were resupplied by Chinook helicopters, dropping their loads at night on sites illuminated by vehicle lights. McAuley (1987), p.70.

⁹⁷ Dye (1968).

⁹⁸ See Scales (1999), p.37. During the Battle of Lam Son 719, in Laos 8th February-9th April 1971, the North Vietnamese used 'hugging' tactics, getting to within ten to twenty metres of US and South Vietnamese forces, causing the latter to consider it unsafe to apply their firepower against their enemy. Taddonio (1985), pp.28-9.

⁹⁹ Ott (1977).

¹⁰⁰ Large amounts of munitions were dropped in Vietnam with very poor return. From August 1969 to February 1970, US artillery in the Central Highlands Region fired 1,600,000 rounds, 270,000 per light and medium battalion, achieving one kill per thousand rounds. Scales (1990), p.143.

¹⁰¹ Scales (1990), pp.77-82.

¹⁰² Love (1968), pp.36-37.

¹⁰³ Lewy (1978), p.100.

¹⁰⁴ Ott (1976c), p.43.

¹⁰⁵ Lieutenant General Mildren replaced harassing and interdiction fire with intelligence and interdiction. This proved effective when used with a single TOT for the fire of several batteries rather than single rounds fired in succession.

¹⁰⁶ Lewy (1978), p.72.

¹⁰⁷ Lewy (1978), p.71.

¹⁰⁸ FitzGerald (1973), p.459.

¹⁰⁹ FitzGerald (1973), p.503.

¹¹⁰ FitzGerald (1973), p.502.

¹¹¹ Lewy (1978), p.97.

¹¹² FitzGerald (1973), p.525.

¹¹³ FitzGerald (1973), p.524.

¹¹⁴ The Vietnamese did, however, make heavy use of artillery firepower in their operations in Cambodia in the 1980s, causing large numbers of civilian deaths and creating many refugees. See report 'Children of the Killing Fields Await Their Fate', in the London *Daily Telegraph*, 11th September 1989.

¹¹⁵ Hay (1974), p.31.

¹¹⁶ In 1965, for example, it was estimated that fifty percent of artillery missions supporting the US 1st Cavalry Division were fired towards friendly forces. Picou (1967), p.17. The difficulty of firing in close country without hitting friendly forces is described in Shrader (1982), pp.16-24.

The US recognized that ultimate success would depend on the pacification programme and rooting out Viet Cong from the villages. Those responsible for the pacification programme in respect of seven million inhabitants between Quang Tri and Phan Rang in 1967 realized that, "However essential to military success, supporting firepower must be handled with precision". Quoted in Eliot (1967), p.472.

Curfews were imposed in hours of darkness in many areas, but these were so often broken by innocent civilians that fire controllers had to exercise restraint when engaging targets, even though the curfew had been intended to make fireplanning easier.

Attempts to clear targets to ensure civilian safety before firing often caused delays running counter to artillery convention which requires a speedy response to calls for fire; yet what controls were imposed often failed to achieve their aim.

¹¹⁷ Ott (1977a), p.33.

¹¹⁸ Ferguson (1966).

¹¹⁹ The failure to use artillery to sweep the route marched by the 2nd Battalion, 7th Cavalry on 16th November 1965 has been blamed for its sustaining 279 casualties in a major ambush. Leonard (1998), pp.17-20.

¹²⁰ The complications of C3 in a battalion engagement using artillery, fixed-wing aircraft and helicopters were evident in the combat at Loc Ninh, on 11th October 1967. Hay (1974), p.42. Problems became worse at night, when it would often be necessary for guns to illuminate and fire on targets until helicopter 'flareships' arrived. The appearance of helicopter gunships further complicated the trajectory and flight-path problems. Hall (1972).

¹²¹ In the Second World War there would usually have been four channels of communication from corps to division. In Korea that rose to eight, and in Vietnam it was common to find thirty channels going down to a single brigade. Hay (1974), p.32.

¹²² Hay (1974), p.54.

¹²³ During Operation MASHER/WHITE WING, for example, US artillery fired only 141,712 rounds between 25th January and 6th March 1966, Ott (1975c). This was slight compared with the 3,200,000 fired in the first three days of the Soviet 1st Belorussian Front's offensive on the Vistula/Oder in 1945; but the rate of fire of relatively fewer guns had often to be comparable as a result. For example, the US deployed seventy-seven pieces for the battles around Dak To in October and November 1967, and these fired just 150,000 rounds in thirty-seven days, but at an average of over 2,000 rpg over that period, Ott (1975d).

¹²⁴ South Vietnamese artillery was in poor condition. In 1967, for example, in II Corps' tactical zone, which covered 30,000 square miles, the South Vietnamese artillery was deployed in two-gun, or split battery, positions, and was unable to manoeuvre at all. A study showed that artillery provided support for less than half of short-term operations, and that those which were supported could count on just two guns per battalion.

¹²⁵ The inability of the South Vietnamese artillery to master C3 was evident in the performance of 24th Special Tactical Zone in Operation DAN QUYEN in May 1969. Ott (1976d), p.13.

¹²⁶ The AN/MPQ-4A radar proved valuable in identifying enemy fire during attacks on neighbouring FSBs. Radars were often used by the 101st Airborne Division in 1969 on so-called 'radar raids', moving forward to dominant terrain features to provide intelligence for FSBs. Morelli and Ferguson (1984). Flash spotting, sound ranging and radar were augmented by Unattended Ground Sensors (UGS), which used seismic, magnetic and acoustic devices to detect enemy movement. Many sensors were placed along the so-called McNamara Wall on the De-Militarized Zone to trigger fire support by air and artillery. It was hoped that these would reduce dependence on search and destroy missions. UGS were later used with success at FSBs such as MALONE in March 1969, and CROOK in June 1969.

¹²⁷ Quoted in Scales (1990), p.36.

¹²⁸ Morelli (1984).

¹²⁹ 'Out of Area' was the term in common use referring to expeditionary operations by NATO nations outside the territory of NATO.

¹³⁰ In the case of the UK, just one battery was allocated for such missions. The experience of the Falklands War caused a more ambitious assessment of roles and the allocation of resources to project power. The revised organization for the UK's amphibious and airborne capabilities and their artillery support are described in Mountford (1986). France's rapid deployment force of the 1980s is described in Turbe (1987b).

¹³¹ McCollum (1976).

¹³² Harvey (1984).

¹³³ The intention was to ensure that by 1989 CENTCOM comprised two amphibious marine divisions and five army combat divisions. Iungerich (1984), p.95. Many potential enemies in CENTCOM's area of responsibility were heavily armed. In the 1980s Libya had 1,100 artillery pieces, Syria 2,600, and Iran about 1,000. Without adequate conventional weapons, CENTCOM would have had to rely on nuclear deterrence, which would have been likely to prove inappropriate or ineffectual in the scenarios envisaged. Saunders (1984). CENTCOM was therefore allocated substantial organic conventional artillery support. A survey of the US Army's light division of the 1980s is given in Lopez (1987a).

¹³⁴ The USA considered wheeled self-propulsion in what amounted to a portee by truck. This was similar to the British modification to the 2pdr in 1941. The USA considered a number of SP options including the South African G-6SP. Foss (1987). The South African concept of operations for this equipment is described in Heitman (1987).

¹³⁵ See Williams (1984), Pengelley (1979) and Moore et al (1979).

¹³⁶ The history of the organization of US field batteries is given in Keenan (1986).

¹³⁷ The M198 replaced the M114A2, which had a range of just 14,600m, and the M101A1, both of which were outranged by contemporary Soviet pieces.

¹³⁸ Ott (1983). Many of CENTCOM's light-weight mobile systems were developed in service with the US 9th Infantry Division which was used from 1981 as an experimental test-bed for a mass of new equipment. Berry (1984).

¹³⁹ The M198 weighs 16,000lbs. In the 1980s, it was thought that its replacement should weigh about 9,000lbs. Stability at that weight can be achieved only by reducing the recoil by half, which in turn requires new materials and technology. Voight (1986).

¹⁴⁰ Fifteen years later, the BAE Systems M777 was selected to provide this capability for the US Army and USMC.

¹⁴¹ No representatives from the US 82nd Airborne Division's fire support element participated in pre-deployment Joint planning. No US Navy representative assisted in Ranger fire support planning to coordinate NGS and air support, and the ANGLICO and TACP personnel became involved too late. Grandin (1998), p.45.

¹⁴² US forces were highly sensitive to this problem before launching the Operation. Troops were issued with wallet-sized cards outlining the rules of engagement, and a large proportion of this was concerned with fire support. At Fort Amador, 105mm howitzers fired at empty buildings to encourage the enemy to surrender. Wood (1991), pp.14-17.

¹⁴³ Quoted Wood (1991), p.16.

¹⁴⁴ Quoted in Brodie (1990).

¹⁴⁵ Ruffner (1984). The experience caused the Indians to form a mountain division, among other reforms; and in the September 1965 war with Pakistan, Indian artillery had considerable success at, for example, Ichhogil Canal and Usal Uttar.

¹⁴⁶ China committed about 80,000 men to combat in Vietnam out of approximately 300,000 made available, Jencks (1979). Each infantry battalion was supported by six 85mm Type 55 guns, and sometimes the 122mm Type 54 guns held at regimental level. In addition, each division had eighteen 107mm or 140mm rocket launchers. The Vietnamese defenders were of roughly equal numbers, but initially had only a few 76mm and 85mm guns and mortars with which to reply. Jacobs (1983).

¹⁴⁷ Jencks (1979), p.813.

¹⁴⁸ Most attacks were by dismounted light infantry at battalion level, like those of the British three years later in the Falkland Islands, facing similar difficulties with terrain and manoeuvre. Unlike the British, the Chinese attacked with little artillery support. Most were preceded by a light five-minute bombardment, which failed to dislodge the defence, and the Chinese suffered unexpectedly heavy casualties as a result.

¹⁴⁹ Jencks (1979), p.812.

¹⁵⁰ Steenkamp (1989), pp.49-57. Turner (1998), p.48.

¹⁵¹ South African artillery of this period, such as the G5, G6 and the Valkiri rocket launcher is described in Heitman (1987). The requirement for rapidly deployable expeditionary forces in Western armies, particularly in the USA, has caused many to seek innovative solutions to strategic and tactical mobility; and they continue to look at South African wheeled systems developed from those of the 1980s which were ahead of their time. The excellence of much of South Africa's artillery equipment was thanks to the involvement of the maverick Dr Gerald Bull, later assassinated in Brussels. South Africa remains a world-class producer of artillery, especially of ammunition.

¹⁵² Steenkamp (1989), pp.152-6.

¹⁵³ Heitman (1988). In June 1988, artillery was used to knock out Cuban SA-6 missiles. Steenkamp (1989), p.164

¹⁵⁴ The application of firepower during the Soviet intervention in Afghanistan is described in Scales (1990), Chapter 4.

¹⁵⁵ It was typical to find a motor rifle regiment supported by an extra two artillery battalions, or an infantry battalion supported by a battalion of artillery. On at least one occasion, an infantry battalion was supported by an anti-tank battery, two SP howitzer battalions, a battery of 220mm BM22 MBRL, a squadron of Su-25 Frogfoot ground attack aircraft and a flight of Mi-24 helicopter gunships. Grau (1996), pp.20, 37-8. The Soviets made frequent use of the Vasilek SP 82mm mortar which could fire 20-30 rounds per minute out to a range of 5km. They also found artillery useful in the direct fire role against buildings. In October 1984, on the outskirts of Herat, the Soviets used 152mm, 2S3, SP howitzers and BM21 rockets in this role.

¹⁵⁶ Such fireplans were provided for Operation 'PANJSHER VII' in 1984, the abortive relief of Khost in 1985 and the drive on Zhawar in early 1986.

¹⁵⁷ Grau (1996), p.18.

¹⁵⁸ Jalali and Grau (1995), p.87.

¹⁵⁹ A futile operation such as this is described in Grau (1996), pp.24-6.

¹⁶⁰ Isby (1987).

¹⁶¹ Scales (1990), p.196.

¹⁶² At the peak of their campaign, the Soviets mounted approximately one hundred sorties per day.

¹⁶³ A good example of this occurred near Abdullah-e Burj on 5th-6th October 1980, Jalali and Grau (1995), pp.30-33. Soviet inability to apply artillery fire and air-power accurately at night caused the Mujahideen to make most of their attacks in darkness. By 1986, major Soviet operations were conducted around the clock, supported by air-delivered illumination.

¹⁶⁴ This required the deployment of divisional and army artillery groups with BM21 and BM27 MBRL, and the seizure of key pieces of high terrain for use by light guns. Over a period of five days the Soviets surprised the Mujahideen and inflicted significant losses on them. Soviet troops tried to make artillery observers' tasks easier by painting numbers on large rocks as reference points. Grau (1996), p.289.

¹⁶⁵ From April-July 1989, 15,000 Afghan guerrillas besieged Jalalabad, creating attractive targets for the Government forces which were successful in hitting these concentrations with BM-21, aircraft and 420 Scud missiles. Adams (1989).

¹⁶⁶ Rocket attacks could be highly effective. On 11th August 1988, guerrillas fired 107mm BM1 rockets at a Government storage area at Baghlan, containing two years' supply of fuel and ammunition. The secondary explosions and fires lasted for two days, and it is estimated that the Soviets and their allies sustained over 600 casualties. Fowler (1988).

¹⁶⁷ Grau (1996), Chapter 3: 'Shelling Attacks'. The Soviets managed to fire back, but they found it hard to engage mortars in reverse slope positions. In September 1982, the Mujahideen bombarded the district capital Panjwayee for two days before withdrawing under counterfire. Sometimes the Mujahideen fired rockets remotely from unmanned, exposed positions which they had set up by night. Ibid, p.115.

¹⁶⁸ An example of this was the raid on Lataband outposts in September 1985. Grau (1996), pp.93-96.

¹⁶⁹ The Afghan Government's Bagh-e Mumtaz Brigade broke after just one day of such bombardment, even though it was located just 15km from Kabul. Grau (1996), pp.134-137.

¹⁷⁰ Jalali and Grau (1995), p.vii.

¹⁷¹ All but one British Chinook helicopter were lost when the *MV Atlantic Conveyor* was sunk by Argentine aircraft on 24th May 1982. Movement over land was therefore heavily reliant on Royal Navy Sea King helicopters. The final assault on Argentine positions around Port Stanley was delayed until artillery and its ammunition had been flown forward. The Israelis also found helicopters an important means of resupplying gun positions in Lebanon in June 1982, (Schnell 1984).

¹⁷² This would have been much more effective if the British Task Force had possessed a drone system to identify targets. Such a system was available in the UK, but contrary to the drone battery commander's expectation, it was not deemed necessary when the Task Force sailed, and was left parked at the roadside outside Southampton, the port of embarkation.

¹⁷³ Long before British ground troops invested Port Stanley, the Royal Navy engaged Argentine positions, wearing down the morale of the defenders before their land battle had even begun. Morgan (1983). Fifty percent of the naval rounds fired had VT fuses, which proved particularly effective in this respect. Argentine soldiers later reported the demoralizing effect of airburst rounds detonating at random intervals over their positions by day and night.

The effect of NGS was demonstrated in the first British success of the War, the recapture of South Georgia. In Operation PARAQUAT of 25th-26th April 1982, after a heavy naval bombardment the Argentine garrison surrendered without a fight, rather as the Axis garrison of Pantelleria had done in June 1943 after air bombardment.

¹⁷⁴ NGS also proved extremely accurate. At Port Howard on West Falkland it was too accurate, with twelve rounds falling within 25m of each other, when a greater spread would have been desirable. Morgan (1983), p.90. The US Army lacked an adequate NGS liaison at this time, and discovered the penalties in Operation URGENT FURY, the invasion of Grenada in October 1983. McMichael (1985). The value of NGS was also demonstrated by the Israelis in June 1982, north of Tyre, in support of their advance on Sidon, and in support of their advance on the Damur River. Schnell (1984), p.24.

¹⁷⁵ One British 4.5-inch naval gun could generate fire equivalent to that of a field battery of six 105mm guns of that time, thanks to automation.

¹⁷⁶ On one occasion, the effectiveness of laser designation for an HE bomb was proven, but this was an inefficient and excessive means of destroying the occupants of a single trench.

¹⁷⁷ Apart from the early reinforcement of Goose Green, they never attempted major manoeuvre across East Falkland.

¹⁷⁸ During the Battle for Port Stanley, the Argentines fired just 1,700 rounds in seventy-five missions. They often had no means of locating British guns, but between the 10th-11th June, Argentine 155mm guns fired at the 105mm British batteries around Bluff Cove. They failed to drop their rounds into the fold in the ground in which the batteries were positioned, and their airburst shells burst too high to cause damage. It seems that they could not apply an appropriate correction for the 'angle of sight', the difference in height, and were eventually knocked out by British aircraft.

¹⁷⁹ Mottino (1986). For the final battle for Port Stanley the Argentines had only 60 rpg, although C Battery of 4th Air Transportable Artillery Group had 2,000 rounds at its ammunition point. Mottino noted

the effects of counter-battery fire and the supreme difficulty in carrying out missions at night, with poor target data and guns sinking up to the axles in the mud. The British experienced similar frictions.

¹⁸⁰ The battery of the Argentine 5th Marine Infantry Battalion was knocked out by CB fire at 1530 hours on 12th June 1982. The Argentines remarked on the serious effects of VT-fused CB fire.

¹⁸¹ The Argentines had little to gain, and much to lose politically, by mistreating the Falkland Islanders, and generally they treated civilians fairly. The British fought the campaign to protect the Falkland Islanders, and it would have been hard to justify even militarily sound actions which were careless of civilian lives. Concern for civilians did not stop the Argentine artillery from deploying in the cover of Goose Green and Port Stanley, safe from British CB fire; and on 29th May HMS ARROW had to cancel a harassing fire programme around Goose Green for fear of hitting civilians. Morgan (1983), p.87. It was equally important to avoid hitting friendly troops. The difficulties of directing fire in the 'fog of war' are described in Bailey (1983).

¹⁸² The view that concentrated "firepower broke the back of Argentine resistance" is expressed in Scales (1986), p.21.

¹⁸³ An exception was the early stages of a deliberately 'silent attack' at Mount Longdon on 11th June which soon became 'noisy'.

¹⁸⁴ Vaux (1983), p.43.

¹⁸⁵ Rice (1983).

¹⁸⁶ Iraq fired about ninety missiles at Allied forces and Israel during the Gulf War of 1990-91.

¹⁸⁷ The Arab Legion used artillery in its attacks in Jerusalem on 20th May 1947, and Syrian artillery attacked Jewish settlements at Mishmar Hayarden on 9th July 1947. On 4th April 1948 seven Syrian guns attacked Mishmar Haemek, but with little effect. Artillery played a significant role in operations around Jerusalem on 18th April; and Arab guns shelled the Jewish quarter of Safad on 5th May 1948. The Jewish Harel Brigade suffered heavy casualties from artillery when it tried to seize Beit Machsir on 9th May 1948.

¹⁸⁸ They had a similar combined-arms success at Sasa on 29th October that year. By contrast, artillery support for Egyptian attacks in May 1948, for example at Kfar Darom, was often poorly coordinated. The Egyptians were more successful at Nitzanin 6th-7th June; and artillery on both sides played a major role in the fighting at Iraq el Manshiyya on 15th October 1948, and between the Egyptian 10th Motorized Infantry Battalion and the Israeli force under Adnan. Dupuy (1984).

¹⁸⁹ The 25pdrs of 7th Brigade, based at Abu Agheila, fired the opening barrage but remained in their original position throughout the War. Eshel (1985) p.55. Despite its misfortunes, Egyptian artillery delivered accurate fire, slowing the Israeli advance on Hills 29 and 30.

¹⁹⁰ The largest, and for the Israelis the most successful, set-piece attack of the Six-Day War was at Abu Agheila on 5th June 1967, where General Sharon deployed six battalions of guns against six regiments of Egyptian guns and mortars, sheltered behind heavy field fortifications. He intended to attack at night to prevent Egyptian artillery from returning fire accurately. Israeli guns fired on forward positions and a battalion of Israeli paratroopers attacked Egyptian gun positions from the rear. Sharon recalled, "half an hour of tremendous fire, the like I have never seen in my life", Campbell (1968), p.133. Israel massed 220 guns to prepare the way for two battalions of Colonel Gur's paratroopers on the Jordanian front on 6th June. On the same day, a Jordanian relief brigade was caught on the move by Israeli artillery and aircraft, and suffered severely. The Israelis caused controversy that day when their artillery hit a UN command post in Gaza killing fifteen Indians.

¹⁹¹ This was probably the first time since the bombardment of Paris in 1918 that tubed artillery, as opposed to rockets, had been used as a strategic system. Gudmundsson (1993), p.156.

¹⁹² It is thought that the Egyptians may have lost over 400 field guns in the Six-Day War.

¹⁹³ Eshel (1984a).

¹⁹⁴ By 1973 the Israelis had more than 570 pieces of more than 100mm.

¹⁹⁵ Jordanian artillery scored a notable success at Kerama on 21st March 1968, when it helped to repulse an Israeli attack on a Fedayeen camp on the West Bank of the Jordan River.

¹⁹⁶ Dupuy (1984), p.357.

¹⁹⁷ They invited Alistair Horne, the author of *The Price of Glory – Verdun 1916*, to assist, saying, "The Egyptians are shelling us night and day, and we are losing two to three men each week – which Israel can't afford. So we want to explore which side got it right at Verdun, the Germans or the French".

Quoted in Alistair Horne, 'The Danger in Sharon Using my Book on the Algerian War', *The Daily Telegraph*, London, 1st June 2002.

¹⁹⁸ The alternative would have been to hold a very large force of armour forward in range of artillery, or to abandon the idea of forward defence on the Canal and to fight closer to Israel's centres of population. Having bought space at such a cost, it seemed unwise to trade it again so cheaply. There was also a debate as to whether funds should be allocated to construct the defensive Bar Lev Line, or to build new military roads across the Sinai to speed reinforcement of the Suez Front.

¹⁹⁹ The Egyptian Army's Chief of the General Staff, General Riadh, was killed near Ismailia by Israeli counterfire.

²⁰⁰ Artillery was also used as a means of psychological attack by Syria in the aftermath of the Yom Kippur War. The Syrian Foreign Minister, Abdel Halim Khaddam, said on 3rd February 1974 that continuing Syrian shelling was part of a deliberate war of attrition to paralyse the Israeli economy. This was intended to put pressure on Israel to yield occupied territory.

²⁰¹ The Syrians had 600 pieces on a front of 65km. Syrian artillery on the Golan Heights could fire more than ten tons of shells per minute from 265 guns. The Syrians had large numbers of MBRL to defend their 15km-deep defensive lines. In the event, on 9th October, their artillery fire was so devastating that the Israeli 7th Brigade was ordered to withdraw from its forward positions.

²⁰² Egyptian artillery failed to defeat all the Israeli forts in the initial attack, and some held out for many days.

²⁰³ Gawrych, pp.131-33.

²⁰⁴ A notable success for Egyptian artillery later in the war occurred on 12th October when it sank the boat carrying Israeli commandos trying to land at Hunghada Island. Dupuy (1984), p.563.

²⁰⁵ Morony (1975). After early mistakes, the Israelis were forced to adopt combined-arms groupings and coordinated tactics. The value of these, incorporating tanks, infantry, artillery, engineers, helicopters, naval support and CAS was demonstrated during the Israelis' Operation GAZELLE, the crossing of the Suez Canal at Deversoir.

²⁰⁶ As late as 24th October, Israeli armour made unsupported attacks and suffered heavily from ATGM and artillery concentrations.

²⁰⁷ Weller (1974), p.35.

²⁰⁸ The role of artillery grouping in support of Israel's counter-offensive against the Egyptian Third Army in 1973, and details of the subsequent provision of corps artillery to reinforce divisional artillery, are described in Gay (1986a).

²⁰⁹ Eshel (1984a).

²¹⁰ Israel produced the heavier IMI 290mm MBRL mounted on a Sherman, and later on a Centurion tank chassis. Each vehicle carried four rockets with a range of 40km. They also produced the LAR-160 with fifty light rockets for area saturation at shorter range. See, 'Lightweight Towed...' (1986), p.261. The South Africans, with whom the Israelis had close military relations, similarly observed the merits of MBRL when used against UNITA forces in Angola in 1976, and also developed a system of their own. Dodd (1977), p.237 and Pretty (1983).

²¹¹ This same conclusion was reached by all armies in 1942, after three years in which manoeuvre had been emphasized.

²¹² Gabriel (1984). The reform of Israeli artillery and its subsequent operations in Lebanon in 1982 are described in Eshel (1985a).

²¹³ At times, the Israelis fired fifteen to twenty batteries at a single target. Schnell (1984), p.32.

²¹⁴ Lewis (1983), p.9.

²¹⁵ For example, in the West, Israeli artillery proved less militarily effective because of the care that was taken to avoid civilian casualties. Gabriel (1984), p.57. Surprise was often lost when leaflets were dropped urging the civilian population to flee and so reduce casualties. Lewis (1983), p.10.

²¹⁶ Thomas Friedman, reporting his visit to Hama in 1982, in 'Arab States Must Tell it Straight', *The Guardian*, London, 22nd September 2001.

²¹⁷ On the night of 28th July 1989, the Christians claimed to have fired 10,000 rounds, and both sides used 152mm and 155mm guns. Gumichio (1989).

²¹⁸ Hezbollah had fired more than 750 rockets of between 80mm and 240mm into Israel and the Israeli 'security zone' in Lebanon.

²¹⁹ On one occasion, casualties in a Lebanese village were reported to exceed one hundred. Goldberg (1996). 165 people died and 340 were wounded during the Operation. No Israelis were killed. 'Israel Defends Record on Grapes of Wrath', *Jane's Defence Weekly*, 5th June 1996, pp.20-23.

²²⁰ The same willingness to inflict civilian casualties at the risk of losing international sympathy was evident in Israeli operations against Palestinian crowds in October-November 2000 and in operations on the West Bank and against targets in Gaza in 2002.

²²¹ Arie O'Sullivan wrote in the *Jerusalem Post* that more than 12,000 rounds were fired into Lebanon in the first eight days of the operation and that, despite the showing-off of Israel's sophisticated precision weaponry, "It took just five deadly rounds from a 155mm howitzer to bring the meticulously planned operation crashing down. The shelling of innocent refugees will go down in history as the turning point in Israel's latest foray into Lebanon." Walker (1996), p.9. This Israeli fire mission is probably the most analysed in military history. A *Yahoo* web search in 2001 revealed over 1,000 items on the subject. Many explored details such as the charge temperature and other ballistic data. Hezbollah appear to have appreciated the growing political utility of their rockets, and it was reported that by 2000 they had hundreds of Iranian-made rockets with ranges of up to 100kms. *Jane's Defence Review*, 13th September 2000, p.15. The London *Sunday Times* of 8th July 2001 reported that Iranian soldiers were thought to be based in Southern Lebanon armed with 240mm Fagr-5 rockets with a range of 80km, making Haifa a possible target.

²²² Walker (1996), p.9.

²²³ Quoted in, 'Israel Defends Record on Grapes of Wrath', *Jane's Defence Weekly*, 5th June 1996, p.20. He blamed the use of 155mm artillery, rather than helicopters assisted by UAVs, on the poor weather at the time.

²²⁴ In the immediate aftermath of the Qana incident, the Israelis nevertheless intensified their air and artillery strikes to attack as many hostile sites as possible before they were stopped by rapidly mounting political pressure.

²²⁵ Quoted in Walker (1996), p.9. Many saw this public relations disaster as a consequence of the hubris of overplaying the effectiveness of new technology. "...The military brass did not take account of the way that television has transformed modern warfare, especially so-called, low-intensity warfare." Walker (1996), p.9. The NATO Allies were also judged by some to have been guilty in 1999 of over-estimating the sophistication of their technology when judging the likely duration and costs of the air operation against Yugoslavia. Critics commented on the contrast between early optimism and later assessments of the actual damage caused to the Yugoslav field army in Kosovo.

²²⁶ The exchange was repeated on 3rd January 2001

²²⁷ Timur Goskel, the UN spokesman for the UN Interim Force in Lebanon noted that, "In the old days, you could predict Israel's snapping point with almost a 100 percent success rate. Now the dynamics are not so clear." Blanford (2000), p.21.

²²⁸ Reported by David Rudge in *The Jerusalem Post*, 15th April 2001. The mortar attacks on Mount Dov on 3rd October 2001 were thought by some to be linked to Palestinian circumstances. D. Rudge in *The Jerusalem Post*, 4th October 2001

²²⁹ Reported in the London *Daily Telegraph*, 17th April 2001. Israel also constructed an 'electronic Bar Lev Line' on her border with Lebanon. This compensates for the depth lost when Israel withdrew from her security zone in southern Lebanon in May 2000. It employs electronic fences, aerial and ground-based sensors and a computerized C3 system. It is supported by 100km of roads and gun positions. It places high reliance on optical images to give commanders the confidence to act in sensitive situations. Brigadier General S. Schahror describes the Total Area Control System (TACS) in Opall-Rome (2001b).

²³⁰ On 3rd April 2002 IDF guns returned fire when Hezbollah attacked with heavy mortars. D. Rudge, 'Hizbullah Fires Katyushas at North', *The Jerusalem Post*, 4th April 2002.

²³¹ The IDF claimed that Hezbollah had thousands of missiles on the border with a range of up to 30km. A. O'Sullivan, 'IDF: Hizbullah Determined to Open Second Front'; and D. Rudge and H. Keinon, 'Hizbullah Continues Attacks', *The Jerusalem Post*, 9th April 2002. Hezbollah's method of firing 'Katyushas' is described in 'Hizbollah's Katyusha Rockets', *albawaba.com*, dated 14th April 2002. It was

also reported in October 2002 that Iranian Revolutionary Guard units in the Bekaa Valley had been equipped with the Zelzal-2 missile with a range of perhaps 200km and carrying a 600kg warhead. Blandford (2002).

²³² M. Dudkevitch, 'Hizbullah Barrages Strike at North', *The Jerusalem Post*, 11th April 2002.

²³³ S. Lackey, 'Syria Plays the Long Game', *Jane's Defence Weekly*, 5th June 2002, p.18.

²³⁴ A. Philips, 'Conflict is Turning into War in Middle East', *The London Daily Telegraph*, 11th April 2001. Others noted the long-term damage that such conflict was doing to Israeli society, turning it into a 'Sparta'. See, 'For Israelis, Endless War and Sharon Put Peace Off Agenda', in *The New York Times*, 13th April 2001.

²³⁵ Eitan Haber, 'The Mortar that Torments Us', in *The Jerusalem Post*, 15th April 2001.

²³⁶ See 'Five Mortar Shells Hit Sderot' and 'Reasserting Israeli Deterrence', *The Jerusalem Post*, 17th April 2001.

²³⁷ Quoted by A. La Guardia in the *London Daily Telegraph*, 18th April 2001, p.11.

²³⁸ Reported by W.A. Orme, 'Palestinians Again Shell Israeli Posts in Gaza Strip', *New York Times*, 19th April 2001. Two more bombs were fired at Nir Oz on the evening of 19th April, taking the total number of mortars fired by the Palestinians in 2001 to over one hundred.

²³⁹ "The brief reoccupation caused friction between Israel and the United States, and provoked European censure and wrath in the Arab world. It generated tension between the government and the army, and within the government, because many ministers learned about it from the news media. It earned Prime Minister Ariel Sharon criticism from settlers for retreating, and from leftists for advancing in the first place." D. Sontag, 'Israeli Operation earns Rebukes from All Sides', *The New York Times*, 20th April 2001.

²⁴⁰ Mortar bombs continued to fall on Israeli settlements, for example at Kfar Darom on 27th April and on Nisanit on 28th April 2001. Five Israelis were wounded in a mortar attack on Gush Katif that same day, at Netzarim and Neveh Dekalim on 7th May 2001, other communities in Gaza on 18th July and Netzarim again on 29th-30th July 2001. The first mortar attack on a Jewish community in the occupied territory near Jerusalem took place at Gilo on 17th July 2001, and attacks continued into late August. Many were followed by retaliatory Israeli helicopter strikes and the seizure of Palestinian key points.

²⁴¹ Major General G. Eiland described the impact of the media and international opinion as factors like terrain, weather and intelligence when evaluating the effectiveness of military operations. He specifically cited the mishandling of the Israeli response to a suicide bus attack in November 2000, "For us this was a learning episode". Opall-Rome (2001a).

²⁴² The 120mm Qassam-2 rocket was first fired into Israel on 10th February 2002. See Dudkevitch and O'Sullivan (2002). It had a range of about ten kilometres. The Qassam-1 rocket was reportedly home-made in the Gaza Strip by Hamas, and first used against an Israeli settlement in October 2001. It had a longer range than Hamas' mortars, allowing them to be fired from a safer distance at a greater target area. 'Israeli Arrest Draws Attention to Hamas Rocket Artillery' (2002).

²⁴³ Ze'ev Schiff quoted in Burston (2002). Schiff maintained that the Palestinian intention was to escalate the level of violence to such a degree that the international community would get involved, which might be to the Palestinians' advantage.

²⁴⁴ Reuven Pedhatur, quoted in Burston (2002).

²⁴⁵ Burston (2002).

²⁴⁶ See, 'Israel Seizes Weapons Ship, Accuses Arafat' *Al Bawaba* (2002).

²⁴⁷ See, 'Peres: Iran Provided Hizbollah...' *Al Bawaba* (2002).

²⁴⁸ See, 'Palestinian Rockets...' *Al Bawaba* (2002).

²⁴⁹ Ze'ev Schiff, quoted in Burston (2002).

²⁵⁰ See, 'Palestinian Rockets...' (2002).

²⁵¹ Harel (2002)

²⁵² A. O'Sullivan, 'On the Offensive Before the Ceasefire', *The Jerusalem Post*, 13th March 2002. One workshop in Gaza was reported to have been blown up by the IDF on 12th March. A. Harel et al, '31 Palestinians Killed in IDF Operations in Ramallah, Gaza Strip', *Virtual Jerusalem*, 13th March 2002.

²⁵³ Quoted by M. Radler in 'Annan Blasts Israel's 'Illegal Occupation'', *The Jerusalem Post*, 13th March 2002.

²⁵⁴ Opall-Rome (2002).

²⁵⁵ A. O'Sullivan, 'A War in Defense of Our Homes', *The Jerusalem Post*, 17th April 2002.

²⁵⁶ Hiro (1989), pp.44 and 88.

²⁵⁷ Iraq is thought to have fired more than 600 surface-to-surface missiles into Iran during the War. The enmity lived on. On 19th April 2001 it was reported that Iran had recently fired fifty-six SCUD missiles at camps inside Iraq belonging to Iranian rebel groups.

²⁵⁸ The human-wave tactics of Iranian Revolutionary Guards in the Majnoon Offensive offered ideal artillery targets and resulted in heavy casualties. On 11th March 1985, the Iranians broke through Iraqi lines in their 'Badr' offensive, but were caught in lethal Iraqi fire-traps. Many judged Iraqi forces to hold a "qualitative superiority, in a target-rich environment". Evans and Company (1985), p.43. For a report on the shelling of Basra, see 'Black Banners of Death Fly over Baghdad', in the London *Sunday Times*, 25th January 1987, p.12.

²⁵⁹ Iraqi artillery tactics were demonstrated in the battle for the Hawizah marshes between 11th-18th March 1985. On 14th March an estimated 12,000 Iranians were surrounded in the Tigris Loop and annihilated primarily by artillery fire. O'Ballance (1985). The importance of artillery in Iraqi tactics was demonstrated one year later, in March 1986, on the Faw Peninsula. Laurence (1986). The Iraqis marked off 'killing zones' for the destruction of Iranian infantry by artillery fire. They concentrated masses of artillery to saturate whole areas, rather than engage pin-point targets. The Iraqis enjoyed air superiority which enabled them to observe targets from the air, and to scorn manoeuvre as a means of survival. Major General Tala'al-Douri of the Iraqi Seventh Army Corps said that his "guns cover the whole area invaded by the enemy, and I do not need to move there. I will use the number of shells I need to destroy them." Progress was slow, and ammunition consumption high. Iraqi infantry played a limited role, holding ground while, as General Al-Douri maintained, "We attack with our artillery. We are patient." Ibid. Artillery was regarded as an independent offensive arm, not merely one in support of others.

²⁶⁰ Timmermann (1986). Iraqi artillery played a major role in stemming the Iranian offensive on Fao, 9th-10th February 1986, although at first it faced tough opposition from Iranian artillery which had recently been resupplied with French 155mm and 203mm ammunition. The Iraqi artillery was equipped with the Astros 2 MBRL, with a range of 30km, and the G-5 155mm gun with a range of 40km.

²⁶¹ Dr Bull was murdered on 22nd March 1990, shortly before the parts of his gun were impounded en route to Iraq. The story of the gun, its likely derivation from the German 'Begonia' project and his death are considered in Bonsignore (1990). Had the Supergun ever come into service, its fixed installation would have been highly vulnerable to attack. The Supergun appears to have been just a part of a larger contract, signed on 6th June 1988, to develop a sophisticated family of artillery pieces, including 155mm (Majnoon) and 209mm (Al-Fao) SP guns. The latter was said to have a range of 57,340m. Kemp (1990). On 9th October 2002, *The Wall Street Journal*, p.1, reported that the Iraqis were continuing to develop the Al-Fao. In 1989, Lieutenant General A.G. Trudeau suggested that Dr Bull's High Altitude Research Project (HARP) could form the basis for a NATO attack system, with a range of over 2,000km, if Pershing rockets and cruise missiles were ever withdrawn from Europe. HARP is described in Trudeau (1989), pp.26-9.

Interest in 'super guns' appears to have lived on in China. In 1995, the Chinese were reported to have built a 'super gun', based on the designs of Dr Gerald Bull, similar to the Iraqis'. They are also reported to have produced a 'super range rocket gun'. The 406mm system was said to carry six launch-tubes and missiles with a range of 360km. There has been continuing speculation about the possibility of building 'super guns' to launch satellites into space, the purpose for which Dr Bull's gun was originally designed. M. Glaskin, 'Supergun Launch for Space', in the London *Sunday Times*, 12th May 1996, p.11.

²⁶² Familiar issues arose, such as the ability of close support artillery to keep up with faster moving manoeuvre arms. The M109 lacked the speed and cross-country performance to keep up with the US Abrams tank and the Bradley infantry vehicle. The position of artillery in the line of march, and whether it should move as a 'column' on its own, or distributed with other arms also had to be considered. In the US 24th Infantry Division, artillery travelled in a mass rather than split up with various manoeuvre units. The aim was to ensure that when required it was all available to hit battalion-sized targets hard, the essential lesson of 1866.

²⁶³ Major General Barry McCaffrey, who commanded the 24th Infantry Division was asked by the US Senate Armed Services Committee how the war had been won in 100 hours. He replied, "This war didn't take 100 hours to win, it took 15 years." Quoted in Scales (1993), p.35.

²⁶⁴ The means of handling the growing masses of information remained primitive. In the Gulf War, the Joint Communications-Electronic Operating Instructions used to allocate more than 35,000 frequencies, call signs, call words and suffixes weighed over eighty-five tons in paper form. McLendon (1995), p.185.

²⁶⁵ During the Cold War, the notion of NATO launching offensive operations into East Germany was taboo, and manoeuvres which might have been construed as such were not exercised.

²⁶⁶ The British experimented with a new 'Recce Strike' concept adopted from Soviet doctrine. The divisional artillery commander commanded the divisional reconnaissance force which included a battalion of MLRS. An account of British artillery's role in the War is given in Durie (1991), the artillery commander in 1st (UK) Armoured Division. The intent was to ensure that any enemy located could be struck decisively at short notice so as to maintain the momentum of the advance. At times MLRS was used in what amounted to a direct support role. At first light on 26th February 1991, the divisional reconnaissance unit, 16th/5th Lancers, called for MLRS fire and air support onto Objective LEAD, in the face of Iraqi counter attacks. This followed numerous historical precedents of heavy artillery moving well forward in an advance, and was also a way of shortening the 'sensor to shooter' link between reconnaissance and the weapon platform.

²⁶⁷ Air-power is taken here to include maritime aircraft and cruise missiles.

²⁶⁸ MLRS was widely praised by officers such as Major General McCaffrey, commander of the US 24th Infantry Division. He said that its primary contribution was to the CF battle, but that it also played a vital role in providing SEAD for missions by Apache helicopters. He also noted the terrifying effect it had on the enemy. He claimed that an attack by four artillery brigades of MLRS on the Republican Guard Hammurabi Division between 0100 and 0330 hours on 27th February, "...essentially broke the will of that enemy armoured division, causing their soldiers to begin fleeing to the rear before we actually made contact with their manoeuvre forces. MLRS was right on the money." McCaffrey (1994), p.4.

²⁶⁹ When the L15 round was first used on the NATO artillery ranges at Munsterlager in Germany, some civilians living around the range, who had become familiar with the sound of exploding shells over many years, reported that rounds were falling outside the range area, such was their surprise at the 'crack' of its detonation.

²⁷⁰ Abrams (2001), p.9.

²⁷¹ The first long-range precision tactical missile strike in history was fired on 18th January 1991 to disable the al-Abraq SA-2 SAM site in Kuwait. Scales (1993), p.193.

²⁷² Gordon and Trainor (1995), p.320.

²⁷³ Gordon and Trainor (1995), p.412.

²⁷⁴ After the War, Michael Gordon and retired Lt Gen G. Trainor described the effect of this dispute in their book, *The General's War*. "It became clear that the positioning of the boundary was one of the most important miscalculations in the final hours of the War. Moving the line east and north was correct if the Army followed through on the ground. But if the Army attack was delayed, the line should have been moved back so that Allied warplanes could concentrate their firepower on the fleeing forces. CENTCOM did neither. As a result, much of the Iraqi Army was shielded from the sort of punishing bombing raids it endured during its retreat from Kuwait City. A doctrinal technicality and inertia took precedence over common sense." Quoted in Applegate (2000), p.18.

²⁷⁵ The Land component played little role in the planning of air operations against Yugoslavia, even though these had a major impact on the Land scheme of manoeuvre and subsequent operations in Kosovo.

²⁷⁶ Artillery played a major role in General Schwarzkopf's Operational deception plan. While his manoeuvre force moved west to positions from which it would swing round to prevent Iraqi forces from escaping back into Iraq, Coalition artillery continued to fire on positions to the immediate south of Kuwait. This caused the Iraqis to reinforce that sector in the belief that it would receive the brunt of the Allied attack. Naval manoeuvres and bombardments in the Gulf reinforced this belief. The USS *Wisconsin* and the USS *Missouri* fired 16-inch shells onto Iraqi positions on the Kuwaiti coast to deceive the Iraqi's into thinking that an amphibious landing was imminent. At 0100 hours on 24th February they

joined in an intensive bombardment of Iraqi defences prior to the land assault of the US 1st Marine Expeditionary Force. Watson (1991), p.97.

²⁷⁷ Iraqi guns were between 14-20km north of the berm which the Iraqis had constructed as part of their fixed defences. The conduct of raids by the 1st US Marine Expeditionary Force (MEF) is described in Burgess (1997), pp.21-22.

²⁷⁸ The initial British assessment was that guns engaging these should remain on their firing positions for no more than fifteen minutes to avoid Iraqi counterfire. Durie (1991), p.23.

²⁷⁹ Amongst the targets was a 12m Iraqi observation tower. It was 'lased' and destroyed by a single Copperhead round, followed by bomblet rounds to kill surviving personnel. A further six towers met the same fate. Scales (1993), p.203. On 19th February, the 4-41st Field Artillery Battalion fired a single Copperhead round which destroyed a border post illuminated by a laser. This was part of an operation by the US 24th Infantry Division to prepare its crossing points into Kuwait. Another post was destroyed in the same way on 21st February. Scales (1993), p.200.

²⁸⁰ A further example of all-arms cooperation was the fire support from 1-201st Field Artillery Battalion on 18th February, supporting air and attack helicopter operations by the US 82nd Airborne Division against Objectives Rochambeau and White. In another example, the same battalion fired 227 rocket assisted projectiles in support of French troops. Scales (1993), pp.199-200.

²⁸¹ A-10 pilots reported that the action by the MLRS of 39th Heavy Regiment on 18th February had destroyed three battery positions and some tanks. Durie (1991), p.23.

²⁸² Scales (1993), p.226.

²⁸³ They fired 414 rockets and 11,000 shells, dispersing 600,000 bomblets over an area of 20x40km. Scales (1993), p.226.

²⁸⁴ The effectiveness of the artillery bombardment was described by captured Iraqis. The commander of the Iraqi 48th Infantry Division Artillery Group, captured by the UK's 4th Armoured Brigade, claimed that he had lost eleven pieces during the air campaign, but eighty-seven pieces in the artillery bombardment. *Operation Granby* (1991), p.5-18.

²⁸⁵ On 26th February, the US 1st Armored Division took al-Busayyah after an intense bombardment of just fifteen minutes. Scales (1993), p.243. The same day, the 1st Brigade of the US 3rd Armored Division advanced to take a bunker complex, supported by a heavy bombardment by artillery and aircraft. Copperheads were used, as was white phosphorous which ignited fuel tanks causing huge secondary explosions. Scales (1993), p.274. On 28th February, the artillery of US 1st Armored Division fired for forty-five minutes prior to the attack by Apache AHs and the ground brigades on the remnants of the Medinah Division. *The Desert Jayhawk*, p.20.

²⁸⁶ Davis (1993), p.46.

²⁸⁷ *The Desert Jayhawk*, pp.5, 16, 19, 20, 33, 34.

²⁸⁸ Abrams (2001), p.7.

²⁸⁹ Davis (1993), p.47

²⁹⁰ Quoted in Watson (1991), p.111.

²⁹¹ McCaffrey (1994), p.4

²⁹² Typically a US radar would locate Iraqi firing, and MLRS respond within two minutes with fire from twelve launchers and a battalion of 8-inch cannon. Scales (1993), pp.298-9.

²⁹³ The hunt for Iraqi Scuds is described in Scales (1993), pp.184-7. Scud hunting received close attention in subsequent US military training. Kinnamom (1998), p.18

²⁹⁴ The debate over the military imperative of 'decisive force' versus the 'jus in bello' requirement for proportionality is analysed in Obenhaus (2000).

²⁹⁵ Glenn (2001). There were reports of dozens of Grad rockets being fired into the city. Aircraft also attacked the city. The most common of these was the Su-24, often armed with laser or TV-guided munitions. See Renfrew (1995), p.12.

²⁹⁶ The 131st Motorized Rifle Brigade was reported to have lost 102 of its 120 vehicles in the disastrous assault on New Year's Day 1995. Celestan (1997), p.46. It has been claimed that the majority of Russian casualties in the War were caused by Chechen mortars and artillery. Celestan (1997), p.47, quoting N. Novichkov. Operations in Chechnya in 1995 are described by the Russian commander at that time, General A.S. Kulikov in 'The First Battle of Grozny', in Glenn (2001), pp.13-57.

²⁹⁷ Orr (2000). Western armies are also considering the merits of such mixtures to provide a variety of effects, from a tailored package of equipment, for a given contingency.

²⁹⁸ The Russians were particularly vulnerable, as they had been in their Afghan War, to attack from an enemy within 300m, the range of the RPG anti-armour weapon. They tried to keep the area around them clear out to this range. Equally, the Chechens tried to get inside this range, not only to attack the Russians, but also to 'hug' them to deter them from bringing down fire for fear of fratricide. Russian artillery tactics in the Second Chechen War are described in, Orr (2000a).

²⁹⁹ The most common delivery systems were the BM21 and BM22 MBRL and the 9K-58 Smerch with its 300mm rockets. The SS21 and Scud B surface-to-surface missiles were also used. Russian artillery technology employed in the Second Chechen War is described by Grau (2000). The Russians also fired laser-guided 152mm 'Krasnopol' rounds from the 2S19 SP howitzer at stubborn defensive positions in and around the city. This munition may also have been used in the First Chechen War in conjunction with the IL219 target acquisition radar. It is thought that the Russians did not use the expensive 'Smelchak' precision mortar round or 'Santimetr' artillery round in Chechnya in 1994-5. Celestan (1997), p.47.

³⁰⁰ Whittell (1999).

³⁰¹ Quoted in 'Ring of Fire Closes Round Grozny', in the London *Sunday Times*, 5th December 1999, p.23.

³⁰² Grau (1999)

³⁰³ Orr (2000), p.4.

³⁰⁴ The 240mm, breach-loaded, SP mortar, 'Tulip' (2S4) can fire a RAP 18km. It seems that the Russians also used heavier tactical rocket systems in Chechnya, such as the Tochka and Tochka-U systems as well as the older Scud.

³⁰⁵ Reported in the London *Daily Telegraph*, 7th December 1999. Russian operations around Grozny, prior to their forces entering the city, are described by M. Franchetti in the London *Sunday Times*, 12th December 1999. Thermobaric munitions create fireballs which are followed by massive destructive overpressures. They were originally designed to clear minefields, but were then developed as a form of massive firepower to break through NATO defences in Northern Europe. They are intended for use against troops in field defences or in urban areas, and their effects can be similar to those of a tactical nuclear weapon without the residual radiation. It is thought that Russia, the USA, China and India have such weapons which can be delivered as a bomb by aircraft, as a rocket from a helicopter or by surface-to-surface artillery such as the Russian 300mm Smerch rocket launcher, the 220mm Uragan rocket launcher and other systems. In 2000, there were calls in the press for thermobaric weapons to be banned. In the Second Chechen War, thermobaric weapons were fired against defences in Grozny by the tracked, 30-barrelled, 220mm 'Buratino' (TOS-1), which had also been used in Afghanistan and in the First Chechen War. It has a range of 3-5km and achieves destruction over an area of 200 x 400m. Grau (2000), p.104. The Story-P UAV was regarded as a vital component of this strike system. The early model Pchela-1 UAV had been used in 1995.

³⁰⁶ Orr (2000a), p.94. Expensive precision munitions such as the KAB-1500L and KAB-1500 TK bombs were occasionally used.

³⁰⁷ Some Russian soldiers attributed the blame for the delay to inadequate artillery support and the failure to reduce strong points manned by Chechen snipers. London *Daily Telegraph*, 30th December 1999.

³⁰⁸ The effects of the artillery bombardment on Grozny are described by M. Franchetti in the London *Sunday Times*, 6th February 2000, p.23.

³⁰⁹ The loss of eighty-four men by a single Russian company fighting in the area of the Argun Gorge, and other incidents, were reported by D. Williams in the *International Herald Tribune*, 11th – 12th March 2000, p.4.

³¹⁰ In July 1998, artillery duels lasted for ten days and killed about 100 people. Bedi (1998).

³¹¹ The Indians deployed 155mm Bofors FH-77B. At 3,660m, these could achieve a range of 42km with base-bleed (BB) ammunition. Sawhney 1997, pp.58-61. Special skills had to be learned to cope with these abnormal meteorological conditions and special logistic techniques developed to deploy and sustain the force. Thomas (1989), p.31. Guns could often only be deployed in pieces by helicopter and reassembled on site. Some soldiers died from avalanches set off by the firing. It was also common practice in Alpine warfare during the First World War to cause avalanches deliberately.

³¹² It has been suggested that a precise laser-guided round such as Krasnopol might be more cost-effective for the Indian Army than ordinary cheaper rounds. Fewer are required for a given effect, barrel wear on the gun itself is consequently reduced, as is the logistic burden. Williams and Holthus (2002), p.32.

³¹³ In early May 2000, Jaffna in northern Sri Lanka was besieged by Tamil Tiger separatist guerrillas. Government forces used artillery and mortars to try to reopen the supply line to the city through the Jaffna Peninsula, which had been cut at Elephant Pass on 22nd April 2000, leading to the withdrawal of 10,000 Government troops. It seemed likely that the Tamils would try to capture further ground so that they could hit the strategic Government airbase at Palaly with 122mm guns captured at Wanni six months earlier. See 'Tamil Tigers Lay Siege to Jaffna', *The Sunday Times*, London, 7th May 2000. On 10th October 2000, the Tamil Tigers also used artillery to shell polling stations in an attempt to disrupt elections. The Government of Sri Lanka believed that it had been 'outgunned' by the Tamil Tigers' M-46 130mm artillery pieces and sought to buy a range of new artillery equipment for CB operations. 'Where Artillery is King', *Armed Forces Journal International*, July 2000, p.18 and *Jane's Defense Review*, 8th November 2000, p.21.

³¹⁴ 'Ethiopia Advances in Border Battle', in the *London Times*, 17th May 2000.

³¹⁵ The commander of the US 10th Mountain Division, Major General F.L. Hagenbeck, made the case for mortars over guns and explained some of the shortcomings of airpower in Hagenbeck (2002). He praised the effects of the Apache AH-64, A-10s and AC-130s in the CAS role, but noted the problems that fixed-wing aircraft had in finding and attacking fleeting targets. He also noted the inflexible tasking procedures for CAS. He claimed that it took at least 26 minutes to calculate the desired mean point of impact and that it was sometimes hours before the target was hit. The problems associated with the Air Tasking Order (ATO) which operated on a thirty-six hour planning cycle are also discussed in Bentley (2002), p.13. The USAF contested Hagenbeck's views. See 'After Leaving USAF Out of Anaconda Planning...' (2002).

³¹⁶ See Prochniak and Yates (2002), p.15. The debate was particularly intense because seven US soldiers were killed in Operation ANACONDA; and any suggestion that lack of close support artillery was a factor in those deaths was seen to carry weight in the arguments over the wisdom of cancelling the US Army's 155mm SP Crusader programme. See Novak (2002).

³¹⁷ Grange et al (2002), p15.

³¹⁸ Grange et al (2002), p14.

³¹⁹ See 'After Leaving USAF Out of Anaconda Planning...' (2002).

³²⁰ The guns also adjusted DFs in support of 45 Commando's advances to contact, and illuminating rounds in support of Australian special forces. *Gunner*, Royal Artillery, Woolwich, October 2002, pp.4-5.

³²¹ J. Strauss, 'Missiles Shake British Base in Kabul', *The Daily Telegraph*, London, 8th April 2002.

³²² Prochniak and Yates (2002), p.16.

³²³ Loeb (2002). An observer team from Britain's 148 Battery was involved in a contact during Operation BUZZARD, and although they did not fire their supporting guns, they appreciated having immediate fire available when air support was fifteen minutes away. *Gunner*, Royal Artillery, Woolwich, October 2002, p.4.

³²⁴ For example, the multinational ceasefire monitoring operation in Rhodesia in 1979-80, Operation AGILA, was led by Britain, but authorized by the Commonwealth.

³²⁵ US and Netherlands artillery units in Kosovo Force 1 (KFOR1) in the Summer of 1999 fired illuminating rounds to deter looters. Illuminating missions were also fired by US artillery in Somalia in December 1992 in a force protection role. A few guns were based at Mogadishu Airport, but the majority of those in the force were left on ships, and the troops used for other tasks. In operations in Sierra Leone in 2000, the British fired illuminating rounds from 105mm guns to deter rebels from approaching too close to their positions.

³²⁶ Categorizing Peace operations and developing military doctrine for them has been difficult. Even, the intervention by the Coalition in the Gulf War, authorized by the UN, was in its way a Peace operation, enforcing the will of the international community. Some nations such as Russia have labelled their internal counter-insurgency operations as Peace operations. UK national doctrine, developed in the mid 1990s, tried to distinguish between Peacekeeping and Peace Enforcement. It saw the former as an activity undertaken with the consent of the parties to a conflict. Peace Enforcement, on the other hand, was seen

as an intervention without consent of all the parties to the conflict, probably involving the greater application of force and requiring a very different force structure. In Peacekeeping the force should seek to maintain consent, lest it find itself engaged in hostilities for which it is ill-equipped. Most nations have produced working definitions, and there is a vast literature on this subject which will not be discussed here. For a British view, see *Peace Support Operations*, Joint Warfare Publication 3-50 (JWP 3-50), Joint Doctrine and Concepts Centre (Shrivenham).

³²⁷ For example, five nationalities were represented in a single infantry section of ten men in the UNFCYP reaction force in Nicosia in 2000.

³²⁸ Some UN led operations such as those in Cambodia in the early 1990s, Bosnia in the mid 1990s Rwanda in 1994 and East Timor in 1999 contained troops from NATO nations. Others such as that in Liberia in the 1990s did not. The UN operation in Sierra Leone in the late 1990s and early 2000s did not contain NATO forces, but was morally reinforced by the presence of a NATO nation (UK), which deployed troops in the country on a purely national mission.

³²⁹ NATO Fire Support Coordination Measures (FSCM) may be clear to those who have studied and exercised them, but the forces of say, Russia or some Arab states, may not share a common understanding of them with NATO members. A difference in interpretation could be lethal.

³³⁰ In 1997 in Bosnia, the Divisional Artillery Group of Multinational Division (South West) (MND(SW)) had to operate through thirteen liaison teams.

³³¹ Within one force during Peace operations in Bosnia in the mid-1990s, there were times when different national forces had different ROE, but the same mission.

³³² Military damage to the environment can cause controversy and restrict operations. Examples of such damage include: The leakage of toxic pollutants from damaged enemy chemical ammunition and industrial sites, smashed oil wells and refineries, wrecked water sources and fires. Unexploded munitions can delay a return to normal life after a conflict.

³³³ The prolonged absence of a threat to its survival tends to increase a society's reluctance to use force, and the legal restrictions it places upon it. Western nations have their own experience of how rapidly peacetime sensitivities can evaporate under the stresses of war. Apparent legal impediments to the practice of submarine warfare before 1914, and the failure of the British Army to demolish vital bridges over the Mons Canal in 1914 because they were privately owned, seemed morally compelling at the time, but rather quaint shortly afterwards. Equally, the restrictions in 1939 against bombing private property in Germany seem bizarre in the context of the saturation bombing, firebombing and atomic warfare which followed. In December 1939 twenty-four British Wellington bombers flew to attack the German naval base at Wilhelmshafen. They found eight warships tied up to the docks, but fearing that their bombs might injure civilians, merely took photographs. Ten of them were shot down. Murray and Millett (2000), p.53. It is reported that statues of Saddam Hussein were not destroyed by air attacks in February 1991 on legal advice that they were 'cultural monuments'. Murray (1998), p.35. After the bombing of the World Trade Centre (WTC) on 11th September 2001, it became clear that public acceptance of curbs on some civil liberties in the interests of security might be more flexible. It became apparent that aspects of the European Convention on Human Rights, so recently accepted into British law, might have to be reviewed. On the other hand, it was reported that early in the Coalition bombing operation in Afghanistan, US bombers did not attack a vehicle carrying the Taliban leader, Mullah Omar, on the advice of a CENTCOM legal adviser. B. Fenton, in the London *Daily Telegraph*, 15th October 2001, and W. Murray in the London *Evening Standard*, 25th October 2001.

³³⁴ NATO has a complex system to define the powers of a commander over elements of his force. OPCOM would empower him to move that force artillery about within the boundaries of his Area of Operations (AO) and give missions to subordinate parts of each force or unit at that state of command. Thus, if he had a battalion of MLRS at OPCOM, he would be permitted to move a battery of that battalion from one flank of his AO to another, and give it a specific mission. If that battalion was under Operational Control (OPCON), the most common state for troops of another nationality, he could not.

³³⁵ In Kosovo Force (KFOR) in 1999, ad hoc arrangements had to be made for unique command structures. Before entering Kosovo from Macedonia, many elements of the force were at times under threat from Yugoslav artillery across the Yugoslav/Macedonian border, and later across the Kosovo border with the rest of Yugoslavia. Fire support was required for the whole force. Many parts of it had no

organic artillery, yet the artillery of those which did have it was under restrictive command states. Purdy (1999), p.7-12.

³³⁶ However much the force may seek to avoid it, there is always the possibility in Peacekeeping that consent by one or more parties may be withdrawn for some reason beyond its control. It is in such circumstances that the skills of commander will be most tested.

³³⁷ An effective STA capability is important in Peace operations not merely as part of a fire system, but also as a means of compliance monitoring.

³³⁸ This was evident in 1993 in the planning of the US 24th Infantry Division's artillery for operations in Somalia. Whereas the normal unit basic load included a high percentage of dual-purpose improved conventional munitions (DPICM), these were likely to cause widespread collateral damage if employed in Mogadishu. Priority was given to precision HE rounds. Out of seventy-two rounds of Copperhead in the Division's war reserve, sixty-four were shipped to Somalia and eight used in pre-deployment training. It was the range of Copperhead and the opportunities for lasing targets by OH-58D helicopters that determined the manner in which US guns were deployed. Lennox (1994), pp.14-17.

³³⁹ Perception operations now form a major part of Peace operations. In operations where lethal fireplanning, especially at high levels of command, is minimal, the task of planning Perception operations has sometimes been given to fire coordinators. This has been deemed appropriate because the use of such 'non-lethal fire' bears a striking similarity, conceptually and in procedure, to that of lethal fire, albeit at an entirely different level of intensity. The 'target' to be influenced may be an individual, group of people or an organization. The desired outcome is determined, the precise effect to achieve this is assessed and the most appropriate means of influencing the target selected.

³⁴⁰ One US artillery commander who served in Bosnia in the Implementation Force (IFOR), noted that, "If we have to fire, the effects of our fires will be felt around the world, so accountability is crucial. There's no doubt that CNN would assess the battle damage for the world. Therefore, the system is in place to document the fire mission process – from target acquisition through mission approval to execution. We have to be prepared to show beyond a doubt that the target was legitimate, the fires were accurate and we made every effort to minimize collateral damage". Corpac (1996), p.38. The measures to ensure that CF was fully accountable are described in Hodges et al (1996), p.39.

³⁴¹ The appropriate choice of munition can also be a problem in Peace operations. Political pressure built up in the 1990s to make some militarily effective weapons illegal, and anti-personnel landmines were banned. Aircraft munitions scattered bomblets across Bosnia and Kosovo, and thousands of these failed to explode on impact but caused numerous casualties after hostilities had ended. International pressure to ban depleted uranium (DU) ammunition gathered pace in 2000, and similar pressure in future could obstruct the use of other surface-to-surface systems such as thermobaric weapons and lasers.

³⁴² When firing is infrequent, it naturally attracts attention, which can of itself prove useful. American artillery in Kosovo in 1999 found that when it fired illuminating missions, faction radio operators reported their action, betraying the location of their radio transmitters. Stramara (2001), p.39.

³⁴³ British UNPROFOR artillery in Bosnia in 1995 was authorized to fire at targets whose 'threatening behaviour' was deemed to constitute a 'hostile act'.

³⁴⁴ Schrage (2002).

³⁴⁵ The infamous mortar bombing of the marketplace in Sarajevo on 28th August 1995 which killed thirty-seven civilians, had a similar Operational consequence. The United Nations delivered an ultimatum to the Serbian General Mladic demanding that he withdraw his artillery from the Sarajevo 'exclusion zone', which had a radius of 20km. He refused. Air strikes were launched against Serbian installations, and UNPROFOR artillery, which had deployed on Mount Igman one to two months earlier, opened fire. Some have claimed that this and similar attacks on 27th May 1992 and 5th February 1994 were perpetrated by the Bosnian Muslims themselves. If this were the case, it would illustrate a striking combination of cynicism and skill in the use of indirect fire at the Operational level. See 'Did Government Forces in Bosnia Shell their own Civilians?', Sean MacMathuna, *flamemag.dircon.co.uk* 1999.

³⁴⁶ For example, 'Dubrovnik Pounding Fuels Hatred of Serb 'Butchers'', in *The Sunday Times*, London, 27th October 1991, p.2. The headline of the *London Daily Telegraph* of 13th November declared, 'Dubrovnik Faces Death by Shellfire' and reported that 'Like the barbarian hordes advancing on Rome, the federal forces have abandoned all restraint.'

³⁴⁷ See, 'Vital Croat Town Shelled as Ceasefire Fails Again', in the London *Daily Telegraph*, 21st November 1991, p.9.

³⁴⁸ The role of American advisers and the influence of US military doctrine in Croatia and subsequent operations by the Bosnian Federation are described in: Clark (1999). See also Malcolm (1996), p.265.

³⁴⁹ In the second week of April 1992, Serb artillery shelled Zvornik for days before paramilitaries moved in.

³⁵⁰ John Keegan writing in the London *Daily Telegraph*, 16th December 1992, p.17.

³⁵¹ A bombardment of Srebrenica on 12th April 1993 was said to have moved systematically across the town killing fifty people. Another eight were said to have been killed the following night. Brown (1993), p.11.

³⁵² 'Gunners Lay Waste to Western Gorazde', in the London *Daily Telegraph*, 20th April 1994, p.12. Serb artillery also besieged Bihac for years, with particularly intense fighting in November 1994.

³⁵³ On 16th May 1995, it was assessed that 800 shells and rockets landed in Sarajevo over a six hour period.

³⁵⁴ See Clark (1999).

³⁵⁵ The mission of UNPROFOR was to protect the supply of humanitarian aid within Bosnia. IFOR was to implement the Dayton Peace Accord between the warring factions, and SFOR was to provide stability in the country while its institutions developed.

³⁵⁶ French mortars had already fired by this time, but French 155mm guns did not arrive until August.

³⁵⁷ These guns were part of an ad hoc artillery force which included French and Netherlands artillery, facing more than 300 guns and mortars of the Serb besieging force. These operations are described from a French perspective in Biegala (1995).

³⁵⁸ A British armoured infantry company was allocated to this artillery unit for its protection. The recollection of Lt Col S.G James RA.

³⁵⁹ The experience of this unit deploying to Bosnia in 1995 is described in Nicholls (1997), pp.11-21.

³⁶⁰ For example, the Serbs used anti-aircraft guns in the direct fire role against convoys entering Sarajevo. One such 40mm piece was located in a barn, in a well-populated area, maintained by a septuagenarian. It was fired intermittently from within the building, through a small camouflaged aperture, against a 400m sector of the route at a range of 2km. Other sectors were engaged by equally well-sited pieces. Attacking these from the air over dangerous terrain and in hazardous weather conditions was an unattractive option. However, in such a complex situation, if infantry cannot close with the offender, how should artillery best engage such a target, yet avoid collateral damage?

³⁶¹ Sometimes the ability of these systems has been overrated, and they cannot detect all that some imagine. Kimmit (1998), p.29. The complexity of determining which of thousands of acquisitions are valid targets is described in Campbell (1997).

³⁶² In May 1999, Yugoslav artillery also fired across the border at villages in Albania, thought by the Yugoslavs to be bases for the Kosovo Liberation Army (KLA).

³⁶³ A point made by KLA commanders in conversation with the author in August 1999.

³⁶⁴ US and Dutch artillery fired illuminating rounds shortly after entering the Province to deter looters.

³⁶⁵ The NATO Operation ALLIED FORCE (24th March-10th June 1999) against Yugoslavia saw the first air deployment of a multi-role force by the USA including tanks and MLRS. This deployment of Task Force HAWK to Albania was made possible by the lift capacity of the C-17, but at huge cost. The deployment required 737 flights. The deployment of MLRS and ATACMS tested their ability to support Apache AH. Hennes and Cory (2000), pp.20-5. It was reported that at least thirty pods of Extended-Range Rockets (ER-MRLS) for MLRS were deployed to Albania, along with between thirty-two and eighty ATACMS Block I missiles, probably incorporating the Improved Positioning Determining System (IPDS). ER-MRLS carries 518 M77 DPICM to a range of 45.5km, and ATACMS Block I has a range beyond 300km. Gourley (1999), p.5. In the event, the Apaches never flew and MLRS did not fire. Whether it would have been politically acceptable to fire ATACMS at targets in Yugoslavia, with the attendant risks of collateral damage, or whether the Apaches would have flown, but for the threat from many cheap machine-guns and shoulder launch missiles, has been a matter of much debate. The scale of the challenge was revealed in exercises, where it was found that a SEAD mission in support of the Apaches might require the attack of eighty-one targets by ATACMS.

³⁶⁶ The extent to which the Yugoslav forces escaped physical damage became immediately apparent on KFOR's entry into the province, but was not widely debated in the press until Spring 2000. NATO was keen to avoid pitfalls which might arise from the untelegraphic aspects of firepower in its operations against the Yugoslav Forces in 1999. Most of the backlash came after the operation, with stories in the press about the editing of the television footage shown to the international media, the effectiveness of the bombing, collateral damage, civilian casualties and the attack on the television studios in Belgrade. On the other hand, there was surprisingly little adverse comment at the time about the number of people who were killed or injured as a result of the large number of dud bomblet rounds left scattered over Kosovo. It was estimated that after the NATO air bombardment there were more than 15,000 unexploded submunitions scattered across the province. It has been estimated that 30,000 tons of unexploded munitions were left on the Gulf War battlefields of 1991, including those from MLRS. Lloyd (2000), p.20.

³⁶⁷ Of the NATO air operation over Yugoslavia, John Keegan, a major critic of the 'apostles of air-power', noted, "...the apparent failure of high-performance aircraft and a tried and tested bombing force to achieve any of the campaign's aims." Keegan (1999), p.3. Keegan later 'recanted' admitting that in many respects his judgement in this article was wrong.

³⁶⁸ Given the long-standing acknowledgement of the importance of a Joint approach and the sophistication of many mechanisms to achieve it, the absence of this was one of the more surprising aspects of the Kosovo campaign. Until the ARRC-led KFOR entered Kosovo, it was not clear who was the Land component commander for the operation. COMKFOR was merely a subordinate commander in the theatre, responsible for troops in Macedonia and his line of communication back to Thessaloniki in Greece. Others who might have had claim to be the Land component commander during the air operation included COMSFOR in Bosnia and COMAFOR in Albania. Some have assumed that it was COMARFOR, the US national Land commander in Albania.

³⁶⁹ These missions are described in Stramara et al (2001), pp.38-41.

³⁷⁰ Three AS90s fired thirty-six rounds over three days. Such missions were planned forty-eight hours in advance of firing and cleared through the local US brigade headquarters. The firing of illuminating rounds by British artillery between January and April 2001 is described in Williams and Monks (2001), pp.11-16.

³⁷¹ See the London *Daily Telegraph*, 4th, 5th, 25th and 26th May 2001; and *Jane's Defence Weekly*, 4th July 2001, p.6.

CHAPTER 5: INTO THE FUTURE

5.1 THE STRATEGIC ENVIRONMENT¹

At the beginning of the 21st Century there is one superpower, the USA, but one that must almost of necessity operate in an environment of alliances or coalitions. It is influenced by the constraints of international institutions and opinion², even when wounded, as it was on 11th September 2001. The USA shares many of the interests and values of other Western nations and is frequently cast in the role of their champion, acting either through NATO, or with its support and that of ad hoc coalition partners. Whether these values will also find expression through a more clearly defined European military identity is under review.

There is an apparently widening variety of other lethal threats to Western interests which may be less focused and dire than that perceived during the Cold War, but whose very diversity and even 'disembodiment' present perhaps an even greater intellectual challenge. Even the definition of military success, not to say 'victory', may be elusive.

At the end of 2000, the Chairman of the US Joint Chiefs of Staff, General H. Shelton astutely observed that, "As the diversity of threats and non-state actors increases, so too will the complexity of our military tasks. Future adversaries may try and stay below the threshold of clear aggression, further complicating appropriate response options. We can expect more failed states as people struggle for independence, for political legitimacy, economic and resource advantage, all done in climates of violence, repression and deprivation."³

Less than a year later, on 11th September 2001, the 'threshold of clear aggression' was crossed; and even if the tactical adversary was identifiable, his strategic roots were less tangible even though General Sheldon had described them well. President G.W. Bush declared "the war against terrorism" to be the first war of the 21st Century; although the character and extent of this lengthy 'war' has yet to unfold.⁴ The military capabilities required to meet such threats, and the concepts and manner in which these capabilities may be most effectively applied are matters of unresolved debate, although trends are clearly identifiable.

Against this background, the dynamism of military technological innovation matches that of civilian life with which it is ever more inextricably entwined. The Age of Chaos is also the Information Age. At the same time, Western nations do not feel, at least for the present, that their very survival is at stake, even though they may believe that their values are under attack, and their citizens may be the victims of 'terror'. There is fierce competition for Government funding in most countries. Defence spending is generally lower than during the Cold War; and decisions about which technologies and equipment programmes will yield disproportionate strategic political advantages are perhaps even more contentious than they were then, particularly as it is hard to determine which tools will achieve best purchase on new problems.

If most democratic societies are less willing to spend their wealth on defence; they are also less willing to sacrifice their fellow citizens for matters of mere national interest. If their emotions are engaged, they may be prepared to pay a higher one. Few armies will retain conscription; and even in the case of volunteer forces, public sensitivity to casualties is likely to become greater not less. Military operations remain an essentially human endeavour; and finding, motivating and training the human resources to conduct them effectively will become increasingly difficult. Nevertheless, given the political support for a well articulated cause of merit, which also strikes a chord with public sentiment, democracies are well able to make sacrifices without undermining their political stability.

This is the environment in which firepower will be employed in the 21st Century, and the characteristics of firepower lie at the heart of the debates about the very nature of military power, the utility of force and the structures and mind-sets that support it – which elements are malleable or ephemeral, and which are enduring principles?

Firepower will be applied in very different ways by different national forces depending upon their resources and strategic situation. Until perhaps 2025, it seems reasonable to assume that Western forces will command the most effective sources of firepower and manoeuvre for ‘traditional’ warfighting, if not necessarily the most assets in absolute physical terms. Thereafter, it is unclear whether a ‘peer competitor’ will emerge who is capable of matching them. Some might argue, as Jan Bloch did a century ago, that the sheer cost and destructiveness of modern warfare between states has made it prohibitive and unthinkable.⁵ Bloch was right in many respects, but in totality his thesis was soon found wanting. Could Bloch be right after one hundred years?⁶

The critical issue for Western forces is whether an advantage in ‘traditional’ ‘symmetric’ warfighting will deliver the decisive outcomes in the 21st Century that it usually did in the 20th Century. That very success should be the cause for others who seek to challenge the West to do so on other terms, avoiding the ‘middle ground’ of conventional battlefield engagements. Potential rivals are likely to buy fewer forces that mimic those of a superior Western opponent, although many countries around the world will wish to maintain substantial conventional forces to match their neighbours’ in regional rivalry.

Those states or non-state actors who see the West as their possible opponent are more likely to fight on other terms. Some Chinese analysts maintain that, “Warfare no longer is an exclusive imperial garden where professional soldiers alone can mingle...it is precisely the diversity of the means employed that has enlarged the concept of warfare...warfare is in the process of transcending the domains of soldiers, military units, and military affairs, and is increasingly becoming a matter for politicians, scientists and even bankers.”⁷

On the one hand, missiles with conventional warheads or delivering ‘weapons of mass destruction’ might seem to them to offer valuable leverage. Such systems generate massive effects, both physically and in political perception, and they could do so rapidly, getting inside the decision-making cycle of democratic nations and their alliances. They are hard to find and intercept, produce a high yield for a given investment and complicate

calculations of strategic risk. They might be used as an alternative to conventional ground forces or as a deterrent to Western intervention, giving their possessors freedom of action in other military operations.

On the other hand, firepower may be employed below the threshold at which Western forces can operate, or so close to it that their actions run the risk of appearing disproportionate or even of dubious legality. Long drawn-out harassing fireplans of low intensity fired by small rockets or mortars can achieve outcomes far beyond their immediate physical effects. Incremental actions over time may in themselves be insufficient to precipitate external intervention. The 'habituation effect' of these over time may be to inure the international community to their cumulative effect and not provoke intervention, when a more spectacular and shocking operation in a shorter timescale might energize a different reaction.

The bombing of the World Trade Center (WTC) was shocking and galvanized just such an effect. It has yet to be discovered whether this 'asymmetric attack' was indeed a strategic misjudgement on the part of the perpetrators, causing 'collateral damage' to the perception of their own cause, or a deliberate escalation in the intensity of their 'fireplan', an act of propaganda designed precisely to provoke a reaction that would change the international situation to their advantage.⁸

The development of long-range missiles by so-called 'rogue states' has shown that it is not necessary to maintain a full spectrum of military capability to exert telling political leverage. Non-state actors and terrorist organizations may need only to possess a narrow yet precise capability, such as the control of an airliner in vulnerable airspace for a few minutes to achieve their desired effects. The electro-magnetic spectrum, cyberspace and biological operations present similar opportunities for exploitation. Conversely, it may also be possible for states of slender means to generate powerful conventional military capabilities based on sophisticated electronics which have become relatively cheap. These could come to constitute a force sufficient to act as a deterrent against Western intervention in some situations.

Those who would challenge the West may also find advantage in the dimension of time, a luxury that is likely to be especially precious to it. The speed and intensity of media coverage, combined with a sensitized, alert, yet inconstant domestic and international opinion, have 'compressed' time, making it more valuable. Governments and alliances which are democratically accountable will probably require overt popular support for military action. History offers many examples where the objectives of the belligerents changed with the circumstances of conflict. The longer a conflict lasts the greater is the scope for objectives to change, along with the popular perceptions of the conflict which sustain its continuation.⁹

Western powers may hold greater military power in absolute terms, but it may prove hard to apply it when only their interests are at stake, against those who feel that their very survival is the issue. Where survival is at stake, or the force in question is not

democratically accountable, time is less likely to erode political support, indeed history suggests that it may have the very opposite effect and that a grim resolution to succeed may grow.¹⁰ Time is the friend of such forces and prolonging a conflict is likely to be a critical part of their plan. In this sense, time is the fourth dimension of battlespace and offers some the potential for greater freedom of action. Equally, speed of action should not necessarily be seen in absolute terms, but rather as relative to that of other dynamic factors.

The majority of the wars of the 20th Century witnessed artillery and other fire being employed in mass, over long periods, consuming great quantities of materiel and inflicting large numbers of casualties. Those who seek to fight 'limited wars' against those fighting 'total wars' of 'national liberation' or survival, may experience particular challenges. The attempt to reduce casualties by expending huge resources over a protracted period proved unsuccessful for the USA in Vietnam, against an enemy for whom time seemed of little importance, and who skilfully obviated the worst effects of fire by dispersing or 'hugging' his opponent, denying him a timely victory.

Modern Western forces have largely been designed to be 'one-shot weapons'. Equipment is often sophisticated in order to avoid the need for masses of it, and to make it more rapidly deployable. The great arsenals of the Industrial Age no longer exist, and the great 'smoke-stack' industries which could be converted to wartime industrial production are no longer geared to such eventualities.

Both time and materiel have become too precious to expend on a large scale, and unless vital national interests are at stake, long and costly commitments will seem unattractive. In future operations the virtue will be not speed alone, but tempo, speed relative to strategic and Operational decision-making and Operational capability. The great commanders always appreciated the value of time; but strategic decision-makers now have less time to act and achieve an acceptable outcome than they might have had in the past. The draining passage of time has, in a sense, become the 'barren steppe' of space that faced Napoleon and Hitler; and should be seen as a form of attrition.

It may be possible to reduce this attrition by compressing the strategic, Operational and tactical levels of war into each other. Western forces are likely, in the first instance, to be reacting to events; and control over the tempo of operations and the thresholds of escalation will be the most immediate requirement. This will be particularly acute when responding to terrorist acts and in this respect a doctrine of 'pre-emptive' intervention has attractions.

If Western forces can 'rewrite the rules', and escape from the tyranny of time by winning acceptance of a long war on their terms, their centre of gravity will have been secured.¹¹ A campaign of such duration will nevertheless almost certainly require a 'low density' of military events, each of which may be rapid and of high intensity, but should be demonstrably successful. Seizing and holding the initiative is to time as seizing and holding vital ground is to manoeuvre. 'Pegging' out the boundaries of this battlespace and

turning the attrition of time on an opponent is an accomplishment of strategic command and Operational art; but a daunting task. The terrorist in turn will wish to suck his opponent into prolonged and ineffective operations of high density, which ultimately prove self-defeating.

The consequence of this strategic logic is that Western forces and their allies will wish to achieve ever more rapid effects, with decisive outcomes at times of their choosing, at all levels of war, defeating an enemy's will, his forces in the field or both, before their own 'centre of gravity' collapses, wherever that point may lie in time. This has now become axiomatic in much of Western military thinking. The Gulf War largely met this aspiration, but merely heightened the consciousness that the generous amount of preparation time permitted to the Coalition forces by an incompetent opponent was unlikely to recur. It seemed more likely that in future a Second or Third World opponent, or even a non-state entity, would try to revalue the factor of time in the strategic equation. They would not allow their opponent the luxury of a long period in which to deploy and train, followed by a short war – better for them the other way around.

The challenge for Western forces is to achieve objectives by new techniques in these evolving novel circumstances. A Western force will seek to react as quickly as possible once a political decision to act has been taken. Battlespace has expanded in absolute terms but has shrunk in relative terms, given the improvements in global communications and transport; and relative to the contraction of time the challenges of dominating that battlespace remain daunting. Maritime resources and airlift may have improved, but the perceived need to lift large quantities of men and equipment further and quicker has also grown. The contraction of time means that lighter and more fragile logistics must supply combat effects more quickly. In the past, a large battlespace and lengthy operations consumed vast resources. In the future, the contraction of time may reduce the ability to deploy and employ them on such a scale; and even though the logistic burden to achieve a given effect may be lighter, it may also be more fragile with less built-in redundancy.

For their opponents, the key will be to find means to avoid or prevent Western forces deploying in the first place, or to ensure that they do and expend their energies and political capital inappropriately. They will withdraw into their hinterland of time, as they try to suck their enemy into a protracted negotiation or conflict of lower intensity, even seeking to win merely by avoiding defeat, while Western will dissolves. They may disperse and employ sophisticated techniques of camouflage and deception to reduce rapid effects; and much greater knowledge of intentions and dispositions will be required if tempo is to be maintained against such forces. The inferior combatant is unlikely to challenge superior firepower directly, but will protect himself against a superior force by denying it a target, or turning it against itself through the generation of hostile or at least negative perceptions. Time, numbers, casualties, perceptions, legal constraints and political will may be his allies, and these constitute forms of 'virtual manoeuvre' to avoid superior firepower.

5.2 CAPABILITY AND EFFECTS

The strategic environment informs decisions about which capabilities to build and maintain at what readiness to achieve determined effects. Western nations will wish to maintain a range of capabilities to match the varying importance of their interests. They will wish to keep 'traditional' ground forces that over-match a given symmetrical threat.¹² If they do not, then this capability will once more present an attractive investment for potential enemies. Warfighting will remain the most challenging role for field artillery. Experience in the Balkans in the 1990s showed the need for artillery in Peace operations as well, despite the limitations on the use of indirect fire imposed by ROE and the need to avoid collateral damage. Above all, capabilities will be assessed in terms of precise effects in time and space and not just primary, physical damage. Secondary effects on perceptions, especially those of enemy commanders, strategic leaders and public opinion may be the more important.

One important consideration is whether or not the balance between fire and manoeuvre has fundamentally shifted once more. There was a major shift at the beginning of the 20th Century when warfare underwent a revolution that placed firepower in the ascendant; and for the remainder of that Century, in conventional war at least, firepower was still usually the dominant element. This seems likely to remain the case, for firepower gives the West its unique advantages; and others will try to find a way of neutralizing it if they can.

Western forces will wish to create rapid and precise effects throughout the whole battlespace, for this ability will probably deliver valuable strategic outcomes. Early action can paralyse an opponent's decision making capability, buying time in relative terms. The massing of large amounts of equipment may be unachievable, either because they cannot be deployed in time, or increasingly because states will not actually possess them. Massive destructive effects may be logistically impossible to achieve, and militarily and politically counter-productive. Western nations will therefore develop ever more capable equipment with greater 'reach', the combination of firing platform mobility and munition-range, and precise effects.

The consequences for artillery, as a partner in the delivery of Joint effects, are that it must be more rapidly deployable, yet not so light that it cannot achieve the required early effects. While supporting fire could come from any source at any achievable range, it is likely that at least some artillery would deploy with an expeditionary land force. These fewer platforms and their logistic support would have to be lighter, yet ranges and precise terminal effects greater.

On the other hand, if accuracy is to a lesser degree a function of range; and if firing platforms do not need to deploy tactically into potentially hostile territory, it will be safer and logistically cheaper if some remain at a distance, perhaps at sea, in the air or protected in some distant 'bastion'. This will be no more conceptually surprising than the withdrawal of artillery from the front line to 'behind the hill', as occurred in the early 20th Century. The critical matter will be constructing the optimal C2 to coordinate their effects.

The issue of who operates the firing systems on land, sea or in the air will be less important, although no doubt contentious, as capability rather than 'legacy structures' become the dominant consideration. While separate Land, Maritime and Air components may continue as the providers of capabilities, commanders will increasingly be Joint commanders of specifically packaged Joint forces. They will need ready access to a full spectrum of effects supplied by all systems, whether hand-held or from satellites. The notion of what is 'organic' will be seen less in terms of permanent structures, and more in terms of ephemeral C2 arrangements. It will also be less significant. This is also not conceptually revolutionary, for field artillery has long been used to reinforce other units for given periods; and it was the C3 of field artillery in the First World War that constituted the first sensor-decider-shooter network in the modern sense. Equally, armies have often had their own air wings, just as navies and air forces have had their own land forces.

All armed forces are more likely than ever to operate in a Combined environment. The political risks of a nation undertaking military action unilaterally without allies are likely to be high. For all, including the USA, the military risks are also likely to be formidable. The very scale of US military capability, or rather its modernity, adds to the challenge of Combined operations. Its increasing lead in most areas of technology is in danger of diminishing interoperability with its allies. This is not an argument for the USA to hold back, rather to note the imperative to devise the means of operating with others, technically and doctrinally; and the obligations to achieve this lie with all parties.¹³

The arguments about interoperability also apply within national forces. The cost of new systems is such that armies run the risk of building 'two-speed' forces, led by a high-tech element which may operate uneasily with the remainder. Some engaged in the 'Transformation' of the US forces argue that, as with the Wehrmacht of 1940, only perhaps ten percent might need to be of the highest technological calibre to deliver decisive outcomes. On the other hand, the persuasiveness of this argument also encouraged the Germans to make poor decisions. The Wehrmacht only reached Moscow in 1941 at the speed of the horse not the tank, and disaster followed. The need therefore is to succeed before reliance on the 'horses' becomes critical. Those forces most required in the 'Age of Chaos' appear to constitute only a small percentage of the total forces maintained, and have been described as 'high demand/low density'. Questions arise as to the utility of the remainder – the 'horses'. Perhaps they will have to deal with 'aftermath operations'.

The precise effects that forces, or a given capability, seek to achieve is not merely a physical one in time and space. Neither is it one based on the effects of current munitions.¹⁴ Full-dimensional precision must include 'psychological precision', shaping attitudes, beliefs and perceptions amongst the enemy, observers, non-combatants, global audiences and domestic constituents. In operations in the Balkans in the 1990s, non-lethal information operations were planned using the same methodology as for lethal fireplanning, and often by the fireplanning cells who had no lethal role at the time. The

development of the technology of psychological manipulation raises potentially severe ethical and legal issues, and it is unlikely to be pursued in the West. Problems may arise if others choose to deploy such non-lethal fire¹⁵, and no appropriate means of CB/CF is available.

Achieving the desired effects will remain a challenge. Western nations are likely to find their expensive conventional forces less effective in operations short of general war against targets which are 'opaque', either because they are well-concealed, because they are shielded by an environment such as complex urban terrain, or because in the eyes of the international community or law their very status as targets may be questionable. The opposition may even create such targets deliberately in the hope of miscalculation beneficial to themselves. Determining how to apply the effects of fire, both lethal and non-lethal, in such situations will probably constitute the greatest military challenge to those who possess superior firepower in absolute terms.

The most important factor in maintaining freedom of action will be both political resolve at the military-strategic level, and absolute compliance by the military with the legal requirements of the day. Wisdom in judging what perceptions will bear, when even these criteria have been met, also lies in the realm of Operational art. Equally, in cases where 'propaganda of the deed' creates a wide sense of outrage, such as the bombing of the Pentagon and the WTC, acceptance of what response is legal or not may in itself be 'elastic'.

The notion today of what is a 'precise' effect may come to seem somewhat quaint. The ability of munitions to loiter and make their own 'intelligent' decisions, not merely about what type of armoured vehicle to hit, but perhaps the identity of the individual being targeted and the lethal or non-lethal effect required in the circumstances, could transform some operations. This does not imply that munitions will necessarily be small. If a precise effect is required in a deep subterranean bunker, the munition required will probably be large, directed by a sophisticated acquisition system and use special penetrating technology. On the other hand, if the target lies beneath a sensitive civilian area, an indirect approach requiring more guile is likely to be required.

Artillery has always found it difficult to attack troops sheltering in trenches, larger field fortifications or in urban terrain. It will probably be difficult to locate and engage them, and hard to achieve the desired effects. If they are dispersed over a large area, the problem is compounded, and precision attack is extremely challenging. In the past, the solution lay in saturation bombardments or 'carpet-bombing', relying on the probability of lethality from massed fire, just as canister and shrapnel did in the days of direct fire. Many armies already see fuel-air explosives as a solution to this problem, using precision of a different character. How such powerful effects may be countered presents a stark problem.¹⁶ Other future forms of indirect fire against area targets may include RF radiation and microwave energy, projected deep into enemy battlespace.

However rapidly a force deploys, and however technologically superior it may be in comparison to the bulk of an opponent's force, the theatre ballistic missile (TBM) may be the great equalizer for those who wish to balance Western superiority by 'placing a finger on the scale'. If unchecked, TBM could ensure that the rapid deployment of an opposing force was matched by rapid and unacceptable losses. This in itself might act as a deterrent to deployments. Long-range missiles will be relatively cheap. They will remain hard to detect and destroy, and maybe only a few have to survive for their purpose to have been accomplished.

Those with slender resources who seek a disproportionate dividend will also shelter in the 'complex terrain' of the fear of collateral damage, international law and public opinion. 'Human shields' can balance an opponent's stealth technology, and successful perception operations can 'suppress' fire systems. A precise capability with acceptable effects to counter such ploys in these circumstances may be hard to achieve. Where asymmetric attacks are carried out with extreme effects, such 'protection' may be stripped away, creating collateral damage to the cause of the perpetrators, unless they have already determined that this is irrelevant to them, or that it will soon be restored by the severity of the counter-measures against them.

The long reach and accuracy of an expensive, high-tech munition is a capability that can be matched by the reach of a relatively inaccurate, cheap, short-range missile or mortar, if it can be successfully emplaced close to its target, in extremis, even by a suicide bomber. It is generally only those who cannot risk such propinquity that have to invest in more expensive, long-range systems.

The importance of force protection as a capability will encourage the development of passive techniques such as camouflage, more rapid displacement and higher rates of fire. Active force protection with CB/CF against the enemy's fire system will be increasingly important, especially against munitions in flight. In particular, many nations will wish to devise methods to protect their forces against a 'check-mate' by TBM; and will need to merge or at least develop greater coherence between their CB/CF and air defence capabilities. Commanders will therefore require the ability to engage high-payoff targets simultaneously throughout their battlespace, 'above' as well as deep, close and rear.¹⁷ In so much, the apparent geographical discernment of those terms may lose much of its usefulness.¹⁸

Once deployed, a ground force must be able to accomplish three-dimensional manoeuvre if it is to exert leverage throughout its battlespace. Many nations today are building air-mechanized or air-assault formations to achieve this capability.¹⁹ The key to success will lie in information superiority and the 'meshing' of precise fire and manoeuvre.

Air forces acquired the technologies for heavy and sustained long-range battlefield attack, both CAS and interdiction, during the Second World War. This capability became ever more precise and highly valued, and from the 1970s onward it soon took precedence over that of the less advanced land systems in what historically might be termed the 'artillery

duel'. Ironically, airforces often bridled at these tasks, believing that strategic attack was a more efficient use of resources, which may sometimes have been true. Air-power went on to demonstrate its capabilities in the Gulf War of 1991, in Bosnia in 1995, against Yugoslavia in 1999 and the Taliban in 2001-02. The potency of air-power and its rapid effects mean that large numbers of ground forces may not need to be committed early, but that they almost certainly will once the 'firefight' has been won. In future that firefight is increasingly likely to be Joint, and to be fought from the sea and by land forces, as they both acquire more of the sophisticated long-range precision munitions previously the preserve of airforces.

Air-power retains unique capabilities in range against strategic targets, at higher altitudes and in space. Artillery cannot often reach into strategic battlespace, while maritime forces may be able to achieve both range and responsiveness. In many ways the viewpoints of those who deliver fire from the air and those who deliver it from the surface should be similar. Air, artillery and NFS/NSFS provide complementary fires, and all try to achieve decisive outcomes at maximum range and at minimum cost to friendly forces, to reduce the necessity for potentially attritional ground manoeuvre. However, as the component capabilities grow more alike and commanders are offered a greater choice of fires as a result, frictions arise over ownership of resources, structures and C3. Prioritizing resources in a strategic context, and synchronizing the effects of fire and manoeuvre must be a Joint command function.

General R.E. Eberhart, commanding US Space Command, maintained that the Gulf War of 1991 was, "The first war where we truly understood how we could leverage space capabilities, capabilities that were built and designed for national reasons, and how we could use that at the tactical and operational levels."²⁰ Little was done to exploit the military potential of space during the 1990s, but by 2002 the USAF was developing a doctrine for the control of space. The aim is to integrate airborne and space-based sensors into one seamless system.

Space is becoming the new 'high ground' to be exploited with new capabilities; but it could also be a vulnerability if others find ways to attack the 'space-to-surface continuum'. Communications, navigation and intelligence systems in space inform forces where they are, where the enemy is, and guide munitions to attack targets. CB/CF capabilities are reliant on various space systems, but will become much more so. Joint fires will increasingly be directed from, or at least through, space. "Space will help the US Army of 2010 maneuver fires for massed effects."²¹ The US Army's Effects Control Centers (ECC) will control fire from space and the air onto the ground and vice versa; and future headquarters are likely to contain cells dealing with space issues.

5.3 CONCEPTS OF OPERATION

At the beginning of the 21st Century, many in the USA see the offensive as the dominant form of warfare, although the early phases of an offensive might have to take the form of defensive actions. To seize the initiative and succeed in a full range of contingencies, the

USA needs a full spectrum of capabilities. This should exploit its technological and cultural strengths, with emphasis on global power-projection; battlespace dominance; long-range precision-strike to deter, assure and dissuade; and information operations. Most other Western nations have similar notions or aspirations. The object of those they might face will be to obviate or neutralize these capabilities. This may be achieved by expanding the battlespace itself unexpectedly. For example, the USA lost air superiority for a short but significant time over New York and Washington DC on 11th September 2001. Other 'quiet sectors' of three-dimensional space, or cyber-space, may also be attacked in future.

The US Army's plans for 'Transformation' assess that US forces need to be able to mount a massive strike at short notice out of the continental USA and by submarine. Within ninety-six hours, forces would take control of the littoral and its air defence. As this area of control extended inland, ground forces would execute decisive offensive manoeuvres.²²

The principles of fire and manoeuvre against an inferior force will apply. Prior to offensive manoeuvre, during a defensive phase of an operation, superior fire can exert great leverage over a less sophisticated opponent who is manoeuvring. It can force the enemy to disperse and 'fix' him, while a ground force manoeuvres to positions of advantage. If he concentrates to meet this, he presents an optimal target for superior fire, unless he chooses to do so in complex terrain, or where fire is constrained for other reasons. Manoeuvre should not be an attritional activity giving the enemy an opportunity to fight on equal terms, although this has often been the case. In close battle, friendly forces should still seek to overmatch an opponent and engage him at ranges beyond those of his own weapon systems. This approach would be equally applicable in limited operations against terrorist forces.

The application of these principles to modern and future conditions requires a much greater Intelligence Surveillance Target Acquisition and Reconnaissance (ISTAR) capability than hitherto. It is knowledge, combined with understanding, that will render the enemy vulnerable to superior fire and manoeuvre. A commander must be able to orchestrate various sensors to detect and track targets, or at least have timely access to their products. Pre-emptive, perhaps non-lethal, strikes on enemy ISTAR systems may by analogy replace the 'artillery duel' as the necessary preliminary phase of a campaign.

The skill of a commander will lie not so much in the positioning of firing platforms as in the control of ISTAR resources, and making judgements about the optimal distribution of precise effects against high-payoff targets. This will require the precise packaging of resources for specific contingencies. It will also require alertness to the imaginative deception and concealment of an opponent who will seek to operate on other terms.

The balance of decisive capabilities appears to have shifted to fires; but if too much emphasis is placed on precision-strike, and the enemy has found ways to survive, a decisive early, or rather timely, outcome will not have been achieved. The manoeuvre of ground forces is therefore likely to play a vital role in future conflict; but it seems

increasingly unlikely that such manoeuvre will occur without every opportunity being taken to lessen its inherent human cost with preparation by fire. This fire may be of very limited duration, because, as has so often been found, rapid if smaller effects may be more rewarding than massive ones over a longer period of time. In this sense, few of the dynamics of the interaction between fire and manoeuvre have changed, merely their appearance. Ideally, sudden simultaneous precision-strikes throughout the enemy's battlespace will be mounted, coincidental with dominant manoeuvre.²³

Most armies produce ready doctrinal formulas for success, amended with each revision of their manuals. Most are deeply rooted in historical experience and contain the essence of some or all of the following: Seize the initiative, maintain momentum and exploit success with the synergy of all resources, Joint and Combined. This will require superior information, optimized C4 systems, the efficient use of resources appropriate to the mission, agility and the synchronizing of effects throughout battlespace. Fire plays a vital role in all of these, and at times may be used alone and decisively.

The US Army expects its artillery to deliver a full spectrum of effects, from massed fires to precision-strikes and the disabling of equipment with non-lethal fires.²⁴ The latter includes broad information and psychological operations, and entails deception. Others aspire to achieve much the same, if on a smaller and less comprehensive scale. The source of such fire will be Joint, Combined and from a variety of platforms: cannon, launchers, UAVs, manned aircraft, satellites, the mouse and the keyboard. The important consideration will be their effects created throughout the battlespace, rather than their origin.

A key issue in debates about rapid expeditionary operations is how much firepower and its effects should come from the Air component and how much from the Land. Air-power can provide theatre commanders with the potential to apply stand-off fires at ranges greater than those achievable actually or politically by surface systems. The issue of whether air is best suited to attack strategic targets, or to attack fielded forces remains a matter of hot debate.²⁵ Much will depend upon the weight of the ground force, whether it can deploy in the timeframes deemed necessary, and whether air-power has to fill the gap if it cannot.

This also raises age-old inter-Service rivalries, and some see the 'over-investment' in airborne precision, stand-off strike as a threat to the ground force's capabilities to manoeuvre.²⁶ There is still a lively debate over the fundamental roles of the two components. Who is supported by, and who is supportive of?

Despite the existence of the US Joint Publication 3-0, *Doctrine for Joint Operations*, both the US Army and US Air Force appear to have their own interpretations of its contents. The nub of the problem is C2. Air forces tend to believe that they require overriding control of interdiction given the complexity of airspace, targeting and execution, thus subordinating ground force deep operations. Land forces tend to see air interdiction as but a part of overall interdiction; and that their relationship with the manoeuvre battle means that land forces must play a major role in the coordination of all interdiction. The

pragmatic solution is to allocate an area for surface-to-surface interdiction. During the Cold War, that was largely the purpose of the FSCL and the RIPL, and setting them was relatively uncontroversial. In less predictable circumstances, the decision is more problematic and must fall to the Joint commander – but whose advice will he seek?²⁷

Surprisingly, the real costs of achieving an effect seldom seem to be taken into account when making decisions about balance of investment in military systems and their employment. The real cost of an effect delivered by air includes the costs of the airbase in war and peace, personnel, forward deployment, the aircraft, supporting aircraft and their supporting costs and, perhaps least of all, the munition itself. The cost of an effect delivered from the sea will include the costs of the carrier or gunship in war and peace, its home base port facilities, its personnel, its deployment, supporting vessels and their costs, the launcher or aircraft and the munition itself. In the case of artillery, the real cost of a delivered effect will include the costs of maintaining the firing unit in war and peace, at home and in the field, its deployment, its personnel, the gun or launcher and the munition. In all cases costs will also include the ‘opportunity cost’ of what other effects of higher-payoff might have been achieved, in other words the comparative advantage in using a particular system, and whether its selection was optimal. Without understanding these real costs, it will be hard to select the most appropriate system within the joint system of fires to achieve a given effect.

5.4 TECHNOLOGY

Advances in technology have lured many into false assumptions about enduring changes in warfare. In 1932 Hitler asserted that, “The next war will be quite different from the last world war. Infantry attacks and mass formations are obsolete. Interlocked frontal struggles... will not return. I guarantee that... we shall regain the superiority of free operations.”²⁸ Some caution that the USA’s unassailable technological lead may encourage false notions about how to achieve military success. Colin Gray has noted that it is hard to find clear examples in war where decisive victory has been achieved thanks to superior weaponry. It may give its owner an edge, but it is unlikely that some new formula has now been found to change that historical pattern. General N. Schwarzkopf emphasized that the Coalition would have won the Gulf War of 1990-91, even if the two sides had swapped equipment. “What matters is how weapons are used and by whom.” Lessons ‘learned’ from the ‘Afghan model’, “...may be hard to replay elsewhere”.²⁹ Nevertheless, technological advances offer promising opportunities.

The primary areas of technological development for artillery are target acquisition, munitions, firing platforms, logistics, the C4I systems that bind them effectively, and training. Distinctions between these are made readily today, but in future these will become harder to discern. Important elements of the target acquisition system will lie in the munition itself. Platforms and munitions will constitute a lesser proportion of the system, but munitions a higher proportion of its cost. The munition has generally been regarded as distinct from the platform which fires it; but in many cases in future it will be

harder to make a useful differentiation. Platforms will fire munitions containing other platforms which themselves fire sub-munitions.

A greater proportion of the fire system and its cost will lie in surveillance and target acquisition (STA). Knowing the exact location of platform and target will be less important, because greater discrimination and precision will lie in the munition itself. The emphasis in military thinking will be less on any piece of equipment or munition, and increasingly on the precise effects which they can create in space and time. Those effects will also increasingly be non-lethal. The source of effects will be less relevant, as will the 'ownership' of the platforms which deliver them.

Technology will also reduce the vulnerabilities of all parts of the system, yet it cuts both ways, for all technologies contain the seeds of their own vulnerabilities. The advantage will go to those who occupy the 'high ground' of new technologies, relative to their opponents; but they will still be vulnerable to those who understand the essentially human nature of war, let alone technological counter-measures.³⁰

Many of the key questions don't change in essence over the centuries, but rather in the degree to which technology allows them to be answered at any particular time. For example, what is the balance of advantage between guns and rockets, how can firing platforms be made more mobile, how can range, accuracy and effects be increased and logistic 'drag' reduced? How can C3 systems best serve the implementation of the highest commander's intent, and yet remain responsive to the tactical requirements?

C4I

The command of fires, the marshalling and allocation of resources against targets to best achieve the commander's intent, is likely to remain at high level, assisted by Joint Targeting Boards, often in a Combined environment. These are held at theatre level to accommodate the requirements of the Land and Air component commanders in executing a campaign as effectively as possible. This form of centralized high-level consultation and decision-making about the effects required, where and by what means, seems likely to continue in principle. Increasingly, however, the control of the application of fire to achieve the required effects will be conducted, not only by human observers, but by computers, and in the case of terminal-guidance by intelligent devices in the munition itself.

Some elements of C4I systems are already incorporated into some munitions, and this will become increasingly common in future. On-board acquisition systems will identify targets, select those designated for attack and de-conflict targets with other munitions. As ranges and times of flight extend and the situation changes during flight, so the ability to change the 'orders' for a munition in flight will become more important. The ability to abort a mission, change target and make Battle Damage Assessment (BDA)³¹ will be crucial. Will the munition be armed and controlled by a human on the ground or in the air, or automatically; and if the latter, working to what criteria and what tolerances?

Future munitions may also have to carry a selection of defensive aids to protect themselves in flight from enemy CB/CF/AD; and it may also prove difficult to protect the communications on which all this depends. Munitions may have to be of modular design, not just to vary range and effect, but also to protect themselves. Deciding what proportion of a payload can be self-defensive at the expense of the mission will be a command decision.

The command of fires and the exploitation of battlespace will, in the future, also be greatly assisted by digitization. Ideally, it will permit the seamless engagement of targets, irrespective of which fire units are involved – full integration. This is analogous to the situation one hundred years ago, when indirect fire was introduced. Guns removed from the close action of a supported manoeuvre unit could engage an enemy attacking that unit, even though they could not see that enemy or the troops they were themselves supporting, by fire. The supported troops came to be more appreciative of the effects delivered than knowing the location or identity of the fire-units producing them. Digitization merely represents a technological upgrade to support this conceptual model.

The US Army intends to create automated Effects Coordination Cells (ECC) as part of the Strike Force command post, linking widely dispersed fire delivery systems. The old relationships of fire units to supported manoeuvre units, such as ‘general support’ or ‘reinforcing’, seem likely to disappear. Instead, a package of Joint fire assets, perhaps including guns, missiles, aircraft and non-lethal systems will be tailored for a specific mission. Commanders of equipment will command their movement, sustainment, survivability and firing; but the choice of targets and the command of the volume and time of firing will be the responsibility of the ECC working to the overall commander. In many ways this will merely reinforce the historical trend towards higher level command, moderated by responsive solutions to achieve low-level control of fire when required.

Most armies are introducing digitized C4I systems to assist in meeting these challenges. The Army Field Artillery Tactical Data System (AFATDS) is the US artillery component of the US Army’s Army Battlefield Command System (ABCS), and is expected to be in service with all US field artillery units before 2010. It provides the tools to plan, execute and synchronize fire support in a US national, but also Combined environment, thanks to the Artillery Systems Cooperation Activities (ASCA) organization which started work in 1991.³²

It is likely that AFATDS will encourage a change in the manner in which effects are achieved by US forces. The question is how much should AFATDS and equivalent systems do automatically, and how much should be controlled directly by humans ‘in the loop’. AFATDS is not an automated decision maker, it manages and organizes information, presenting critical data to help decision makers support the commander’s intent. It will enable the Fire Support Coordinator (FSCOORD) to use Intervention Points (IP), to override the automatic AFATDS ‘guidance’ on the provision of fire.

The emphasis in the US Army to date has been on a well-trained FDC supported by a well-trained Fire Support Element (FSE). With AFATDS, the Fire Support Officer (FSO) will become more important in both planning and executing the focusing and massing of fires for chosen effects. The balance of responsibility will therefore fall more to the FSE, supported by a well-trained FDC.

This view of C2 relationships is certainly shared by the British Army, which has always structured artillery C2 to ensure that effects coordinators are themselves the senior decision-makers, collocated with the all-arms commander. The British artillery will field a new Fire Control Battlefield Information System Application (FC BISA) by 2006. This will eventually be replaced by a Joint Fire BISA.

The plethora of new C4ISTAR systems bring its own problems. Throughout the 20th Century, fuel was the primary constraint on manoeuvre, and ammunition supply was the primary limitation on firepower. Greater efficiency, novel energy sources and increased precision have helped to salve these problems. In future, the availability of bandwidth will be the primary limitation on C4ISTAR, and analogous solutions will have to be found.

Target Acquisition

In the days of direct fire, the placing of the guns was the primary test of a commander's skill in bringing his firepower to bear. In future, the deployment of artillery observers or target acquisition devices, rather than guns and launchers, will be the more important command consideration, as the latter's maximum range increases, yet therefore often becomes less critical. The acquisition system will be in space, aircraft, including UAVs, and use numerous forms of radar, acoustic and seismic systems, thermal detection and human observation. The commander's skill will lie in deploying these, constructing networks for them and devising ways to respond efficiently to their products in order to meet his information requirements.

A target may be successfully acquired, but it may still be hard to engage it accurately. This may be especially difficult at long range when the target is moving, possibly in complex terrain, and may be protected by a variety of active and passive measures including deception. The issue is whether future target acquisition systems will outperform developments in force protection. Is information dominance really achievable; and is it realistic to expect improvements in target acquisition to disperse the 'fog', and to 'oil the frictions' of war? If it can, how long will this historically aberrant period last, and at what cost?

In the 1980s and 1990s, it seemed that the importance of the observer was likely to decline as sophisticated technology became more widely available, although the need for effects to be coordinated seemed ever more important. Most nations will continue to place a high value on the 'man in the loop', in the target acquisition system. This will be particularly important in cases where target identification carries legal sensitivities, and perceptions are at stake.

In the British Army, the artillery commander has always been placed forward at every level of command from company to corps, as close to the commander as possible. He is the principal adviser on fires, allocates resources in accordance with the commander's plan, observes targets if necessary and coordinates the effects of the fire that he himself orders. Artillery commanders/observers at all levels have been responsible for coordinating the effects of all fires including air, NFS³³, mortars and EW. Essentially, they have been commanders and effects coordinators, and in future they will probably play a larger role in tactical battlespace exploitation. This has not been the international norm. Elsewhere artillery commanders have more often been to the rear, commanding their platforms rather than the effects they create; and junior officers have undertaken target observation and the adjustment of fire.

Observing the target, calling for fire and correcting the fall of shot used to be a more challenging task than it is today, especially in combat. Sophisticated technology which is simple to use will make it easier for all to summon firepower from diverse sources. "Rather than a 'shooter', the infantryman could become a 'spotter'."³⁴ The work of a 'spotter', however, was and will be relatively menial compared to the greater challenge of coordinating effects with an understanding of the commander's intent.

Artillery observers have flown in aircraft for nearly one hundred years, but their vulnerability in hostile airspace caused this practice to decline. Aerial observation and the direction of fire may now become more feasible from attack helicopters (AH). The advanced technology of AH makes them more survivable than slow, fixed-wing 'spotter planes' of earlier decades; and AH will in any case need to be able to call for fire for SEAD. Observers in AH will also be able to observe and direct fire remotely via UAVs which they control.

Remote observation may also be carried out using other platforms. Observation devices can be carried as cargo in projectiles, descending by parachute or glider, or as part of the projectile itself. One of the 300mm rockets in a pod of the Russian Smerch system carries the R-30 UAV which navigates using GPS, and can loiter over potential targets for thirty minutes at 9,000m. Several nations are studying the feasibility of mounting cameras in 155mm projectiles, using their spin to give a constant image of a strip of sky and ground.³⁵

The most promising platforms for visual observation from the air are UAVs. UAVs will continue to develop as essential elements of Indirect Fire Systems, both in warfighting and other operations. Hundreds of UAV programmes are currently under development.³⁶

The merits of UAVs were first publicly and dramatically demonstrated in the early 1980s by the Israelis in operations in Lebanon and their potential value was noted on Operation JUST CAUSE in Panama in 1989. Since then, the USA has led the way in much of the technology and concepts for the employment of UAVs; and this extends beyond their use by US ground forces, and beyond mere reconnaissance and target acquisition.³⁷

Just as with manned aircraft nearly a century ago, UAVs will acquire roles far beyond mere unarmed ISTAR, to include a wide variety of attack missions.³⁸ UAVs will acquire air-to-air combat, CAS, anti-armour, SEAD and strategic strike roles. It will seem increasingly perverse to use expensive, manned, strike aircraft to deliver precision munitions when UAVs could complete the entire task. The US National Defense Authorization Act for FY 2001 stated that, "It shall be a goal of the Armed Forces to achieve the fielding of unmanned, remotely controlled technology such that by 2010, one third of the aircraft in the operational deep-strike force aircraft fleet are unmanned."

Technical progress towards combat roles is rapid. Over Kosovo in 1999³⁹, a US Predator became the first UAV to designate a target for an A10-launched, laser-guided bomb. On 21st February 2001, a trial was conducted in which a Predator fired a AGN-114 Hellfire missile at a ground target and this capability proved effective in Afghanistan in 2002. UAVs may also seem attractive platforms to carry directed energy weapons. However, all aspirations to increase the use of UAVs depend on considerable further work on airworthiness, certification and its C2 requirements.

The distinctions between what is a sighting system, what is a UAV and what is a munition will become harder to determine. Shells will be developed which on being fired from a gun will be able to fly to 100km and beyond, loitering for some hours to acquire a target and attack it.⁴⁰ UAVs with imaging sensors will also be fired from tank barrels.⁴¹

Progress has also been made in other forms of target acquisition. Interest in acoustic systems is growing. The UK fielded the Advanced Sound-Ranging Programme (ASP) in 2002 to detect artillery fire out to about 20km. The USA is developing an advanced seismic and acoustic system to provide networked information, delivering situational awareness on the future battlefield as part of its Future Combat System (FCS). Acoustic systems have the advantage of being passive, and they are well-suited to cueing active systems such as radar, a variety of which continues to be developed in many countries.⁴²

Munitions

Greater accuracy offers the greater likelihood that the precise effect can be delivered at the correct location in battlespace. In the case of a simple HE munition, doubling its accuracy means that its explosive mass can be reduced by a factor of eight to achieve the same effect, yielding major logistic advantages. By the same token, if air-delivered munitions become so accurate that one weighing 250lbs is as effective as a less sophisticated one weighing 1,000lbs, an aircraft could conduct four times the number of attacks with the same pay-load. The technology to make munitions more accurate will increasingly lie in the munitions themselves, rather than the platform that fires them, or in better target data. Munitions will 'know' more about where they are, where their target is, and its characteristics. Some will make decisions based on detailed attack criteria, giving greater assurance of avoiding fratricide and collateral damage, and some will make their own BDA. In time, some may also make decisions about what effect they need to create in a

given circumstance. To achieve all this they may need more time, and so some will be given the ability to manoeuvre, and to loiter to search for targets.

Such discrimination and precision will require major advances in the technology of propellants, warheads⁴³ and software. Precision does not mean only the ability to hit a point in battlespace accurately, it means the creation of measured effects in time and space, over an area as much as at a point.

The disadvantage of rockets remains their long minimum range and that, when fired at long range, their time of flight makes them relatively unresponsive to tactical targets. It seems probable, however, that there will be an increasing shift of resources from guns to rockets given the latter's inherent advantage in range; and that guns will often fire RAP. Rockets are well-suited to the delivery of heavy loads of submunitions, but these have sometimes been controversial due to their high dud-rate. They can have significant implications for manoeuvre in general war, and moral and legal implications in Peace operations.⁴⁴ The bomblet munition of the 1980s is an area weapon which was developed to compensate for lack of terminal accuracy against complex targets; but its successors need to be much more accurate and reliable. As ranges extend, there will be powerful arguments for giving new munitions positive terminal-guidance with a human in the decision loop, perhaps through fibre optic control.

MLRS is the mainstay of Western battlefield rocketry, and it will receive a series of major upgrades that will give it longer-ranged and more precise and reliable munitions.⁴⁵ The longest-ranged of these is currently the US Army's ATACMS series, but its capability will be significantly improved.⁴⁶ Extended Range-MLRS (ER-MLRS) will also be introduced into many armies. It is a free-flight area-attack system, providing a lower sub-munition dud-rate at a range of up to 45km. Guided MLRS (GMLRS) is an evolution of ER-MLRS with a range of 60km which can be guided and controlled.⁴⁷ The MLRS Smart Tactical Rocket (MSTAR) will be the first MLRS rocket to carry smart munitions and could enter service in the US Army as early as 2004, if funded.⁴⁸ Research is also being conducted into hypersonic missiles.⁴⁹ These might have a range of 50-500km and cover 150km in two minutes.

The US Army's FCS is a system of systems, which includes the robotic NetFires or 'rocket in a box', formerly known as the Advanced Fire Support System (AFSS).⁵⁰ This combines the platform with the munition. TBM are already prolific and seem likely to spread still further.⁵¹ They are also relatively inaccurate, but the means to remedy this will become much cheaper and easier to develop.

155mm has become the standard calibre for tubed artillery, and its effectiveness will be greatly enhance by the various smart munitions due in service in the early years of the 21st Century. A cannon-launched projectile needs a guidance system that can survive accelerations of 10,000-12,000G, so the demands on technology are formidable. It is harder to build such technology into the smaller 105mm shell; but progress has been rapid,

and new 105mm rounds with RAP and DPICM are coming onto the market, and smart 105mm munitions will follow.⁵²

The 155mm Copperhead was the pioneer of precision shells but it had serious disadvantages. It required the target to be illuminated for thirteen seconds and demanded high skills in training. Nevertheless, exercises at the US Army's NTC, showed that it could yield high returns against high-value targets. Shells with more modern technology will clearly yield even greater benefits.

The US Army will seek to increase the commonality of its advanced 155mm munitions with the XM982 Excalibur.⁵³ The British Army and many others will introduce similar munitions systems.⁵⁴ One remarkable aspect of the post-Cold War defence industry is its multi-nationality, as many nations find the need for common capabilities, yet wish to maintain some industrial capacity at a time of generally falling defence budgets.⁵⁵ Some have created 'niche' capabilities in a global market.⁵⁶

Shells will take on increasingly unconventional forms and roles. They will be used as target acquisition devices in an effort to enhance 'first-round effects on target'.⁵⁷ Field artillery could also assume an indirect fire air defence role.⁵⁸

Projectiles are increasingly likely to be built with modular, inter-changeable parts, some with a higher percentage of warhead and others with more propellant or fuel. They will be fitted with a variety of wing formations, depending on the length of their flight path and the agility required to manoeuvre.

The distinction between which arms fire directly and indirectly is blurring. Tanks were often used in the indirect role in the Second World War; but they will soon be armed with 'fire-and-forget' top-attack rounds. Examples of such 105mm rounds already exist. The US Army has a requirement for a 120mm tank round with extended-range for the Abrams tank, with an indirect fire capability out to 8km.

As guns achieve ever greater ranges, there has been concern that the supported manoeuvre arms might lack the responsive close support that they need. This has led once again to greater interest in mortars, which have also been given extended range⁵⁹ and greater and more varied effects, including non-lethal 'frangible' bombs of non-traditional materials to limit collateral damage.

Greater range normally requires more or better propellant or on-board fuel supply. Progress is rapid, but some novel technologies have proved disappointing.⁶⁰ During the 1980s, liquid propellant was seen as the next major leap in technology which would yield great benefits in terms of reliability and logistics.⁶¹ The US Army's Crusader was originally intended to use liquid propellant, but plans were abandoned when the difficulties proved too severe. For now, the role of conventional propellant seems secure, and there are many improvements, both chemical and in modular packaging to enhance its performance.⁶²

Terminal-guidance gives munitions the ability to hit unseen targets accurately at long range, mirroring the technical-tactical developments resulting from the mastery of predicted, indirect fire did during the First World War. Some munitions are externally guided, requiring gun-based processing for course correction. Others require an off-board sensor for trajectory measurement, and do not require line-of-sight from the fuse to the gun throughout the flight. This allows the gun to 'shoot and scoot' and has advantages in difficult terrain. Others are self-directing or initially guided. In the latter, the munition compares its desired point of impact with its anticipated actual point of impact, and corrects its flight accordingly with canards.

The growing 'intelligence' of munitions incorporates these navigation devices, target sensors⁶³ and fuses that initiate and control the effect of the warhead. Much of this technology is located in the 'fuse' and is often referred to as such, even though strictly speaking the fuse merely initiates the detonation at the required time.

So-called 'smart fuses' combine the detonating function with a course-correction capability, although course-correction can be applied through the fuse or through the body of the projectile. Range-correcting fuses⁶⁴ do not adjust for line, as this would require power and batteries. They can be used on 'dumb munitions', which makes them economically attractive. Multi-option fuses mean that pre-fused rounds are likely to become the norm, and an important requirement for automated guns/howitzers, with the fuses being set electronically in the barrel.⁶⁵

Micro-electromechanical systems (MEMS) offer numerous potential advantages in fuse design. For example, a single point of initiation may not give optimum lethality; and it should be possible to remote the detonator from the fuse. Base initiation could be useful because it would canalize the explosion forward not back. MEMS may also help in creating better delay and self-destruct mechanisms which will become more common in munition design.⁶⁶ They will also prove useful in the guidance, navigation and control systems of future munitions. As fuses become more dependent on electronics so will electronic counter-measures, and counter-counter-measures.⁶⁷

Platforms

Although munitions rather than the platforms that fire them are the focus of the most intense research incorporating 'Information Age' technologies, much is being done to transform platform design. The new imperative is to build lighter, more rapidly deployable pieces; but many heavier automated ones are also entering service, firing faster and further.

Rockets are likely to become more common, but guns will continue to have a valued role, thanks in part to their short minimum range. In that sense, rockets have the same disadvantages as direct firing guns in the early 20th Century. Guns will become lighter and more deployable, but may seem to lack the range and utility of light rocket systems. Those

requiring close support will continue to develop heavy mortars, but the new generation of heavy SP guns will remain an essential capability in most armies for many decades. In the longer term, the US Army will seek lighter yet more effective systems for its 'Objective Force'; but in the meantime the US Army is looking for an Interim solution to provide greater mobility for its field artillery.

In the Quadrilateral Ballistics Agreement, major NATO armies agreed to make 155mm their standard calibre, and to transition from the 39-calibres barrel to the 52-calibres barrel, giving shells a 'softer' ride and greater range. Despite that, the 105mm calibre is becoming more popular again with longer ranges and advanced munitions.⁶⁸ A reduction in calibre from 155mm to 105mm implies a reduction in HE charge of three quarters, with clear logistic advantages. A typical 105mm gun has the advantage of being portable inside a helicopter, rather than underslung, thus allowing tactical flying. 105mm pieces are also being designed to travel on trucks, or as wheeled SP pieces. Devices are also being produced to give light guns the same supporting technology as heavier SP pieces.⁶⁹

The area of greatest research is in light 155mm pieces, using aluminium and titanium alloys and novel recoil systems.⁷⁰ The USMC's M198 weighs 15,600lbs and has to be lifted by the CH-53E helicopter. With its ammunition, this presents a formidable logistic challenge. The US Army and the USMC are to replace the M198 with the BAE Systems XM777 lightweight howitzer, redesign Ted the M777 in 2002.⁷¹ If the ability to deploy by helicopter is not an imperative, greater tactical mobility might be achieved by matching it with a truck. There are numerous wheeled SP 155mm pieces on the market, such as the French Giat Caesar⁷² and the Chinese WA021. The Russians experimented with light pieces such as the 2A61, but appear not to have achieved the same weight and range advantages of Western models.

Light-weight systems have inherent problems achieving the same ranges, rates of fire and protection as more capable, heavier SP pieces.⁷³ The US Army's M109A6 Paladin was introduced in the early 1990s and was the first digitized combat vehicle in the US Army's inventory. The final conversion of M109s to Paladin was completed in June 1999.⁷⁴ Although SP systems may lack strategic deployability, there are many advanced SP systems coming into service to replace the venerable M109. What they have in common are greater capabilities to operate autonomously, fire automatically and to produce high rates of burst-fire.

The French Army's basic AUF1⁷⁵ was first produced in 1977 and is due to be replaced by the 52-calibres AUF2 between 2002-2008.⁷⁶ The British Army's semi-automatic AS90 entered service in the mid-1990s and is likely to be replaced by an improved model with a 52-calibres barrel.⁷⁷ The Bundeswehr's PzH2000 began to enter service in 1997 and has in effect become the predominant European SP gun/howitzer, being procured by the Netherlands, Greek and Italian armies.⁷⁸ The Russian 152mm 47-calibres 2S19 SP gun entered service with the Soviet Army in 1989-90, but has since been upgraded to the 2S19M.⁷⁹ The Chinese have developed the SP GCL45, reported to be based on the designs of Dr Gerald Bull from the 1980s.

The US Army's Crusader (XM2001)⁸⁰ was to have been the most advanced SP piece in the world. The need for field artillery to keep up with the armoured vehicles of manoeuvre arms was revealed during the Gulf War of 1990-91. General Shinseki maintained that, "Crusader is the answer to the long-standing (artillery) problem that we have not fixed."⁸¹ It was due to replace all M109A6 Paladins and M992A2 FAASVs in the active US Army. It had long been a controversial design at a time when the emphasis was on 'Transformation', improving deployability as well as effectiveness. It also faced challenges from those who preferred naval vessels and aircraft as sources of fire.

Under 'Transformation', heavy systems such as the XM2001 were required to make drastic weight reductions. The total weight of each of the two Crusader vehicles had to be reduced from fifty-five tons to no more than thirty-eight tons, or forty-two with add-on armour, to make them deployable simultaneously by C-17 or C-5B aircraft.⁸² In 2001, the US Army planned to buy 480 of the original intended purchase of 1,138 XM2001s. Half of the supply vehicles (RSV XM2002) were to be tracked, and the remainder wheeled. Crusader was due to enter service in 2008, but was cancelled in 2002.

There was heated debate in the US defence community over the cancellation of Crusader. This saw a great clash of view and interest, reminiscent of those in 17th and 18th Century Europe over artillery ballistics, the need or otherwise for a light gun, and the merits of a 'grande batterie'. In the 19th Century, similar partisan views were found in the arguments over breech- and muzzle-loading, and the merits of smoothbore versus rifled pieces.

The case for Crusader was made by retired general officers such as Generals B.R. McCaffrey and G. Sullivan.⁸³ In essence they argued that UAVs and precision munitions do not constitute some 'silver bullet' that will make the close support of armoured forces obsolete; and that without Crusader, US forces will be at a significant disadvantage in future conflicts. Others argued that war remains an essentially human endeavour, and an over-reliance on technology might have serious consequences come the 'knife fight'. Its supporters cited the much greater capabilities of Crusader compared to Paladin, which was already a poor complement to the Abrams tank in 1991. It would be wrong, they argued, to see Crusader solely as an element of the Objective Force. It should also be seen as the long-overdue complement of the heavy force; and not so much behind-the-times, as indispensable and already late. They pointed out that Crusader is lighter than the tanks it would support, and no less deployable or necessary than those 'legacy' armoured forces which will be the mainstay of US land capability for many decades.

Crusader's advocates maintained that airpower cannot be an adequately responsive substitute for close support, in all conditions, as evidenced by its relative ineffectiveness against field units in the Balkans. They believed that artillery, not aircraft, will be the dominant fire system within 50km of ground forces; and that the Crusader was an efficient system given its unit cost, the investment already sunk in it and its low manning requirements. Equally they noted the reductions in the US Army's field artillery and

elsewhere, made in the expectation that the superior capabilities of Crusader would compensate for these cuts.

Others argued that wars in which the USA fights will increasingly be won from space and the air, with a much reduced need for ground forces. They maintained that Crusader would still be too heavy to be a readily deployable part of the Objective Force; and that the termination of Crusader will enable the US Army to skip a generation of technology, moving directly to the FCS incorporating 20-ton pieces, NetFires and the Excalibur ammunition system. R. McDaniel maintained that the cancellation of Crusader marked the end of the dominance of the battlefield by cannon artillery after one hundred years,⁸⁴ and that all indirect fire tasks should in future be conducted by missiles and mortars. He maintained that the balance of advantage of the missile over the gun has become decisive, with greater deployability, longer range and payload with greater precision, all contained in a more flexible and cost-effective system. Most of these factors have explained why, at various times over the last two hundred years, rockets have been preferred to guns. The significant difference today is that what was always held to be the inherent disadvantage of the rocket, its inaccuracy, has been overcome.

With the cancellation of Crusader, it now seems likely that Paladin will have to 'soldier on', or a short-term replacement be found; and that funds will switch to systems such as HIMARS, variants of the M777, GMLRS, Excalibur and NetFires in the FCS.⁸⁵

The US Army's future 'Objective Force' will be based on the FCS, a networked combined-arms team of manned and robotic ground systems, and a type of UAV known as the Organic Air Vehicle (OAV).⁸⁶ The FCS's indirect fire capability will be vehicular not towed, and probably of 105mm calibre. The FCS seems likely to use a common chassis, and the family of vehicles must be lighter than twenty tons, and fifty percent smaller than the Abrams tank, to fit in a C-130 aircraft. The FCS will have a multi-role electrothermal-chemical indirect and direct firing gun, with a rate of fire of between twenty and thirty rounds per minute.⁸⁷

The continuing importance of the SP mortar as a source close support is reflected in numerous international developments. The Germans, Russians, Chinese and Finns are among those who have produced new models.⁸⁸ The USMC continues to develop Dragonfire, a mortar capable of 'ship to objective manoeuvre', which can be airlifted and towed.

The greatest progress in rocketry is in the munition rather than the platform, but important advances continue to be made nonetheless. The fielding of the improved MLRS M270A1 with a higher rate of fire will take place between 2000 and 2011.⁸⁹ It has improved stowage, displacement, elevation and slew, which should reduce exposure by seventy-five percent.

The need for light rockets for early entry forces and rapid effects was identified and widely discussed in the late 1980s. It will be met in US forces by HIMARS, a wheeled rocket

platform, deployable by C-130 aircraft and capable of firing within minutes of landing. HIMARS could re-embark on the aircraft immediately and fly off in what would amount to a new type of artillery raid.⁹⁰ The US Army's FCS will incorporate a missile system, NetFires or 'missile in a box', which will fire precision and loitering munitions.⁹¹

The proportion of Joint fires delivered by aircraft has grown steadily and air forces will buy more stand-off, air-to-surface missiles such as the USAF's Joint Air-to-Surface Stand-off Missile (JASSM) which has a range of 370km. It is essentially a stealthy cruise missile with a variety of possible pay-loads.⁹² Such weapons/munitions are designed to hunt and attack targets such as high-value missiles which would otherwise require an aircraft to find and attack them. Depending upon whether they are air- or surface-launched, combat UAVs should probably be seen either as a form of artillery munition or as an aircraft; but increasingly such issues of categorization and ownership will seem less useful in understanding Joint three-dimensional warfare.⁹³

As surface-to-surface systems reach out further, it seems likely that manned aircraft could become an inefficient method of delivering fire in areas within range of these systems. Low-level CAS, on the traditional model, has become increasingly less attractive in recent years⁹⁴, while interdiction and strategic attacks have become more so; and this trend will probably continue as the battlespace expands.

On the other hand, new precise air-delivered munitions enhance accuracy, and thus the survivability of aircraft⁹⁵ and friendly forces on the ground.⁹⁶ The accuracy of bombs has risen from about 1,000m for a 2,000lb bomb of the Second World War, to 3m today.⁹⁷ Accuracy is no longer necessarily a function of altitude, just as the accuracy of precise artillery munitions is no longer necessarily a function of range.

The delivery of precise munitions by high-flying aircraft is likely to make the distinction between CAS and air interdiction less distinct; and CAS delivered from medium and high altitudes seems certain to become a prevalent operation, at least in the case of US forces.⁹⁸ Some airmen now refer to CAS as 'precision off-board targeting'.

The Joint C2 arrangements for such missions will remain complex; but there will be a growing role for Forward Air Controllers (FAC), both airborne and on the ground.⁹⁹ Ironically this is partly due to the deficiencies inherent in precision weapons. Over-reliance on precision-guided bombs without direction by an FAC "means that at least ten percent of air-dropped ordnance will go out of control and could kill our troops. As was tragically relearned in Afghanistan (in 2002)...CAS from above 15,000 feet can be as hazardous to friendly troops as to the enemy...The current media euphoria over near-precision munitions as a battlefield panacea hasn't factored in the many friendly deaths these bombs have inflicted on our soldiers...JDAMS...use GPS¹⁰⁰...thus they can go astray...if misused as CAS weapons".¹⁰¹

Timeliness is another problem. The US Rear Admiral M.G. Moffit noted that "Satellite-guided weapons – like the JDAM- don't require a picture of the target, just its

coordinates. But they are not ideally suited for time-critical strikes. The process of getting the GPS-guided bombs ready for firing takes longer than it would for an aviator to spot a target with its sensor pod, beam a laser and release a laser-guided bomb...For time-critical targets, we needed a weapon that we could actively place on the target in real time."¹⁰²

These problems can be solved. Major General R. Scales described the developing relationship between air forces and ground forces as, "A tectonic shift in the nature and character of how ground forces fight."¹⁰³ Ground forces reveal the enemy's position, or force him into the open so that he may be acquired and attacked from the air. Others, however, see this model as a flawed one, akin to the Maginot Line, whose effectiveness was based on the belief in the dominance of observers linked to fire, albeit artillery observers not aircraft.¹⁰⁴ They regard it as a model that may be too easily 'outflanked' by other methods of warfare. Equally, it is criticized by those who believe that airpower can no more 'occupy ground with fire' than can artillery.

When artillery has disappointed, it has often been when it has been party to the misleading prospectus that it has achieved the ability to so cover the ground by fire that the manoeuvre arms have merely to advance and occupy the ground of a defeated enemy. Inadequate target data and lack of responsiveness have often led to inadequate effects in the face of such excessive expectations. Analogous arguments today in support of airpower should be treated with similar caution for similar reasons – the imperfections of target information, discrimination and responsiveness. It is unlikely that an enemy can be defeated by airpower alone, although there will be such cases, as there have been for artillery. Ground manoeuvre forces will require their own resources, including organic indirect fire support, working in conjunction with all Joint fires.

5.5 FUTURE ROLES AND STRUCTURES

Structures ought to reflect technology and missions, and this is indeed how most structures originate; but over time their relevance fades and they can sometimes constitute an inappropriate yet resilient legacy. In the long-run, the shifting 'tectonic plates' of fire and manoeuvre overcome this inertia.

There are therefore likely to be significant changes in the manner in which armies organize themselves at all levels to deliver the effects of fire. There will be an increasing trend to deploy Joint forces in task forces tailored precisely to the mission, and to command them with an appropriately shaped headquarters. There will be less likelihood of deploying an all-purpose division or corps headquarters, just because it exists, rather one to fit the force commanded.¹⁰⁵ NATO's force generation process ensures that that has already become the norm with most national contributions to Peace operations, and the multi-national forces that result from it. On the other hand, some Joint and Combined packages will be 'hard-wired' in peacetime, as many amphibious and air-mechanized forces are already, creating new types of permanent structure.¹⁰⁶

Historically, issues such as C2 and survey have been the chief determinants of artillery structures. Battery size has depended upon the number of guns that can be commanded by one or more command posts, given the dispersion possible with the type of platforms and their communications available at any one time. This will become less significant as the autonomy of individual platforms increases.

The future of the forward observer is much debated in the British Army. The need for a 'Man-In-The-Loop' will probably remain, especially in Peace operations, but also in warfighting as ROE become more complex. The artillery observer is currently almost the only combatant with access to the necessary target acquisition devices and means of communication that enable timely calls for indirect battlefield engagement. This will change as technology develops, particularly in the areas of ISTAR and C4I.

Remote sensors, communicating directly to strike platforms, will increasingly conduct target acquisition, allocate resources and even control fire. Anybody with an appropriate communications link could call for fire from indirect systems with confidence that the target would be accurately engaged. Even though the forward observer might often be able to relinquish the basic roles of target acquisition and engagement, he will become even more important in the complex business of planning the coordination and delivery of Joint effects for his commander. His judgement in assessing a target's characteristics may be crucial in making legal judgements and decisions regarding ROE.

Battlespace will become an increasingly complex and 'dense' environment, filled by many more aerial and electromagnetic systems than hitherto. Many of these will have an offensive support task, and management and exploitation of the battlespace will be crucial to the successful conduct of operations. The role of the forward observer as the offensive support advisor could also naturally evolve to deal with the tactical management and exploitation of battlespace, informed by, and as a part of a broader three-dimensional picture which has previously been the preserve of higher-level airspace managers – something rather different.

As land warfare moves from operations in the area of the two dimensional plane, with fire and manoeuvre through the third dimension, it will increasingly involve fire and manoeuvre in the third dimension itself. The challenge of how to manage and exploit the high-density, three-dimensional battlespace of the future, incorporating fire and manoeuvre on land and in the air, with low-level control but high-level command, has yet to be convincingly explained.

5.6 OVER THE HORIZON

The perceived importance of field artillery has varied greatly over 650 years. It has been least valued when the firepower of the supported arm grew relative to its own, as it did in the period 1860-1914, or when inadequate technology or techniques rendered its own effects inadequate against the primary threat, as was the case against armour in the second half of the 20th Century.

The balance of advantage in the provision of indirect fire has also varied. The importance of the gun versus the rocket at any particular time has depended upon technological developments in each; and the mortar has often proved more useful than the field gun or rocket in certain situations. Naval fire has for centuries often been vital to success in land operations, and since 1914, airpower has played an increasingly important role in the provision of fire across the battlefield.

Some wonder whether the days of the cannon are numbered as mortars, rockets and above all aircraft, manned and unmanned, take over its combat tasks. Certainly the provision of indirect fire by mortars, whether regarded as artillery or infantry systems, seems likely to increase in proportion to the greater use of rockets, because they complement them so well, compensating for the latter's long minimum range and lack of tactical responsiveness. Rockets offer exceptional efficiency in delivering precise effects at long range, both with accuracy at a point and with massive, shocking weights of fire over large areas. They will undoubtedly become more prevalent in the artillery's inventory. They will also become more important as surface-to-surface, strategic, offensive systems for many countries. Other forms of surface-to-surface fire may also emerge in asymmetric forms to disrupt the traditional equations. Guns may become fewer in number relative to these other systems, but given their flexibility in terms of effect, responsiveness, range and protection, they seem unlikely to disappear.¹⁰⁷

A more contentious issue is the possible replacement of surface-to-surface fire systems by airpower. The suggestion that complete reliance might be placed on aircraft to carry out tasks in which artillery was previously dominant is one that makes sense only in a limited 'cultural' context, and even then is highly dubious. The 'cultural' factor is that the issue is effectively relevant only to the USA, and those nations whose forces conceive of no operations outside a USAF 'umbrella'.

Few believe that wars can be won or conflicts resolved solely by airpower. At some stage ground troops become essential. For those without air superiority, there can be no guarantee of air support to ground operations, and so they must have their own organic fire system. It has also yet to be demonstrated that airpower can be organized, and its effects sequenced, to deal with rapidly changing and highly complex tactical situations over sustained periods against large numbers of targets. It would be advantageous if airpower could guarantee to achieve this, and in time the USAF might be able to do so; but in the meantime there is ample evidence that this is what artillery has been crafted to achieve by the process of combat evolution over 650 years.

It seems likely that the proportion of fire delivered by the USAF will inevitably grow and be delivered in a different combination and style to former times. In practice the purpose and sequencing of this fire would be much the same as that once mandated for field artillery. This increasing role of airpower is scarcely surprising, given the conspicuous trends of the last hundred years, but it does not invalidate the need for organic fire support for manoeuvre forces once committed.

For the remainder of the world's armies, there can be no guarantee of air superiority which might allow the use of airpower to support them. On the contrary, because of the very dominance of American airpower, forces which might face those of the US can have no realistic expectation of any significant fire support from their own air forces, and will become ever more dependent on surface-to-surface artillery of all sorts to support their manoeuvre forces. It is also likely that most conflicts around the world will not involve US forces at all, and nations engaged in them may be expected to deploy the full range of air forces and field artillery assets.

Since the mid-1970s, US air operations have become more effective and at a rapidly decreasing cost in casualties. The growing gap between this air capability and the counter-air capability may continue to grow; but on the other hand, historical trends might encourage the belief that it will eventually shrink again. The technologies of air defence may undergo a resurgence in novel forms, reducing the advantage, or methods might be adopted to make that airpower unusable.

In the longer term, should a military 'peer competitor' to the USA emerge, assumptions of comprehensive air superiority over deployed forces would appear to be erroneous. In this case, the 'long term' could be only a thirty to fifty years, which in the cycle of equipment procurement is not very long at all.

It may also be asserted by some that wars, as they have been fought in the past, will not be fought again. Certainly some nations may be fortunate enough to make such an assumption for now, but for many nations around the world the utility of war still has its appeal, and the instruments of choice for waging it include field artillery. Equally, terrorism and guerrilla operations may well be conducted using artillery systems of both the most primitive and sophisticated types, and in such a way that artillery is not the best response. Such 'pre-emptive suppression' is in itself a most skilful use of the artillery system.

Artillery will be used in many future conflicts in a manner that has scarcely changed for a hundred years. Yet, those who can afford it will expand the boundaries of technology and doctrine to suit their changing circumstances and strategic challenges; and for them, significant and fundamental change seems inevitable.

In the early 21st Century, field artillery must provide precise effects against high-payoff targets, as part of a responsive Joint system of fires, twenty-four hours per day and in all weathers, abiding by the ROE, and often with a 'man-in-the-loop'. New technologies will allow the detection, accurate location and identification of more targets than hitherto, and provide the delivery means and munitions to attack them precisely. This must be carried out with the minimum of expense, casualties and collateral damage, while reducing the logistic burden. However, major changes in the underlying assumptions about how all this will be achieved seem likely, yet these fit readily into the prevailing historical pattern.

The distinction between direct and indirect fire has been one of the most critical in the development and understanding of 20th Century warfare. From 1880, all the fundamentals of indirect fire were understood, but they were technologically undeveloped and often ignored; and prior to 1914, warfare was essentially a battle of two-dimensional linear encounter. The advantages of indirect fire were fully recognized in 1914. Thereafter, the Indirect Fire Revolution, using the third dimension, ensured that non-linear operations by fire could be conducted simultaneously, throughout the whole area of two-dimensional battlespace, close, deep and rear. Battlespace expanded as a consequence; but by the end of the 20th Century, longer ranges generally diminished terminal accuracy, and reduced the effectiveness of indirect fire against the highest-value targets which tended to shelter out of its reach.

A new phenomenon is, however, emerging that will reshape battlespace geometry and the style of warfare, probably as radically as it was by indirect fire at the beginning of the 20th Century. The technologies at the heart of the US Army's 'Transformation' and the so-called Revolution in Military Affairs (RMA), are primarily those which will deliver precision almost irrespective of range.¹⁰⁸ They will restore the underlying 'logic' and 'geometry' of fire relative to the battlespace that obtained in the first half of the 20th Century, even though the appearance of combat and military organizations might appear radically different in future. The new technologies of precision will also expand the Land component's battlespace still further into the third-dimension, making the 'above' as vital as 'close', 'deep' and 'rear'. High-payoff moving targets will increasingly be located in three dimensions and require precise engagement by responsive fire systems. As the fourth dimension, time, contracts; and as the fifth dimension, cyber-space, expands in unquantifiable directions, these actions will be assessed through the distorting lens of disparate perceptions.

Arms and Services have evolved in step with major technological advances, and are to a large extent expressions of the different characteristics of direct and indirect fire and weapon-range - legacies of specific technologies at specific moments in history. The current distinctions between them may need revision as a result of imminent change.¹⁰⁹ There is nothing alarming in this, rather it should be seen as an opportunity. Disruptive revolutions are best avoided by measured incremental evolutions, reflecting external and internal pressures, before they become essential at inopportune moments, but that is easier said than done. Arguments in favour of the status quo can often only be justified on 'cultural' grounds and in the interests of stability. Whether the opportunity is seized or not is another matter; but those who identify the opportunities and act are likely to enjoy benefits denied to those who do not.

Until now, artillery has generally provided the bulk of indirect fire, and direct fire has usually been the primary mode of armour, infantry, AH and GBAD. The concept of indirect fire as a separate entity is still useful in the short- to medium-term. In the longer term, the previously fundamental difference between direct and indirect fire may be unhelpful in understanding effects and how best to apply them in battlespace.

This change will be caused largely by a blurring of the capabilities of direct and indirect fire weapon systems; and the purpose of the effects generated by both will become increasingly similar. For instance, it is currently possible for a tank to fire a round with a top-attack capability directly from its barrel or vertically from a pod. This could and probably will be developed to give such combat vehicles a long-range, indirect fire role. What is the difference between a non-returning, air- or ground-launched attack UAV and a loitering, one-off rocket, or shell with RAP, in terms of combat effect? What is the significant difference between a loitering UAV that fires directly at a ground target, and an indirectly fired munition which itself loiters and locates its target before attacking it directly with its own sub-munitions? These different methods of attack cannot usefully be segregated and categorized as direct or indirect. In the same way, meaningful distinctions between platforms and munitions will be harder to discern.

The distinctions between the effects of organic land and organic air systems may also be harder to distinguish, making the use of the term 'component' itself unhelpful, or even misleading. Operations between these two components will become increasingly integrated and Joint, except perhaps in strategic operations and space, which will probably remain predominantly the domain of the Air component.

Until now, targets in the air have generally consisted of manned aircraft and have been the concern of direct-firing GBAD, or of friendly manned aircraft. In future, there will be many more objects throughout the three physical dimensions of battlespace, and most of them will be unmanned. The air will be populated, not merely by 'dumb' projectiles, but also by sophisticated munitions, that are themselves high-payoff targets, and various UAVs either loitering or heading for their targets. If an armoured ground force comes under attack from a large number of missiles carrying terminally-guided sub-munitions, which are dispensed at a distance and spiral down to attack it precisely, is it under air or artillery attack? Is that attack a direct or indirect one?

In such a situation, the ground commander will require a means to engage in three dimensions and not just in two; and not merely with systems designed to match the primary threat of a previous period – a relatively few manned aircraft. Would he wish to engage directly at short range, or would he prefer to do so indirectly at a greater distance? In either case, would he be conducting a CB/CF or a GBAD mission?¹¹⁰ New technology will make it possible to intercept and destroy munitions in flight, using novel methods of attack.¹¹¹

It is somewhat surprising that GBAD has doggedly retained a direct fire *modus operandi* for so long, given that the air defender must usually place himself at a location within the range of the target's own weapon systems. Perhaps this has been caused by the assumption that friendly, manned aircraft would deal with aerial targets at greater ranges, and that GBAD was merely the means of last resort.

The development of indirect fire GBAD weapons is now underway. Future ground manoeuvre platforms will probably carry vertically-launched, indirect fire missiles to shoot

down helicopters, and other flying objects, in a top-attack GBAD role. Equally, field artillery guns and launchers could fire indirectly on long-range GBAD missions, given adequate C4I, ISTAR and terminal-guidance. Combat UAVs will have a direct SEAD role, and future combat UAVs will also have an air-to-air air defence role. They may, for example, be used to create flank guards for air manoeuvre. Screens of combat UAVs could be used against expensive AH in highly cost-effective engagements, or to force fixed-wing aircraft to operate at a greater distance than the range of the new generations of stand-off munitions with which they will be armed. These forms of fire can also not usefully be categorised as direct or indirect, and such a distinction will become less relevant.

It seems unlikely that the current structures of the components and their 'theology' can remain immutable in the face of such developments. The prime responsibility is to build a capability which will necessarily be Joint and capable of operating effectively in a Combined environment. That capability should be divided up to make the span of command manageable, and to make the connections between parts of critical functions as seamless as possible. The important issue is to identify where the 'joins' in a Joint capability should best lie. It is increasingly unlikely that the 'legacy structures' of the components and the 'seams' between them will automatically coincide with the required spans of command and capabilities of the future, rather the frictions at the 'seams' may indicate the need for them to be redrawn, not merely assuaged.

Air forces became separate Services from armies largely because of their determination and capacity to carry out strategic missions. Air operations seem likely to move up and out¹¹² as both the Land and the Air components become more capable. Targets within range of surface systems are likely to be inefficient targets for air forces, unless there are other constraints in force.¹¹³

Indirect fire was introduced at the beginning of the 20th Century as a tactical method of self defence. Through further technical developments and unexpected applications, it led to the expansion of the battlefield and it transformed the way wars were fought and the relationships between elements of the armed forces. Airpower emerged as a complementary source of fire often at longer ranges, but it was a direct fire system with its inherent problems. By the end of the 20th Century airpower had many of the qualities of an indirect system and could deliver effects with precision. Land forces were slow to introduce precise capabilities, those which apply the desired effect at the exact time and location; but such capabilities will soon be fielded.

The adoption of such precise systems both on land and in the air promises to transform warfare as profoundly as indirect fire did one hundred years ago. Precision matched with other emerging technologies such as information networks and robotics will expand the battlespace and the relationship between the arms and Services. Joint activities will become ever more integrated in the coming decades, to the extent that the term 'joint', which entails cooperation between separate entities, may come to seem an underestimation of the fundamental new relationships. The focus must be on how to optimize these new

relationships and the effects that they generate. This dynamic is not surprising, it is the historical norm.

The introduction of indirect fire changed much, but not the principles of war or the human dimension which lies at its heart. The challenge is to exploit today's technical opportunities to change the face of war without forgetting the more enduring characteristics of conflict, mindful of the options open to those who seek to circumvent the logic that others would to impose on them.

¹ For a British view of emerging strategic trends and the manner in which British forces expect to develop and operate is given in *Strategic Trends* and *The UK Joint Vision*, both produced by the Joint Doctrine and Concepts Centre at Shrivenham.

² Military action will be more closely influenced by the rulings, and even the very existence of the International Criminal Court, and all will be subject to close external assessment of the proportionality of their actions. Military action in or near industrial areas may also arouse concern at its environmental costs; and some weapons themselves may come to be seen primarily in a moral and environmental context rather than a military one. This has already happened in the case of anti-personnel landmines, and could happen in the cases of submunitions, depleted uranium rounds, fuel-air explosives and weapons using 'rays'. The use of cluster bombs in the bombing of Afghanistan in 2001 was criticized by some on these grounds.

³ Quoted in Goure (2001), p.25.

⁴ Sir Michael Howard has pointed out that strictly speaking 'terrorism' is merely a means of waging war, not the 'enemy' itself. It is the weapon of the otherwise weak, who hope by 'propaganda of the deed' and a 'strategy of provocation', to lead the stronger into self-destructive acts. Howard (2001).

⁵ Bloch (1899).

⁶ This idea is explored in Bellamy (1992).

⁷ Colonels Qiao Liang and Wang Xiangsui. Quoted in Gertz (2002), p.16.

⁸ See Howard (2001).

⁹ In some operations of very low intensity, such as that of the United Nations Force in Cyprus, it has proved possible to sustain missions for decades.

¹⁰ There have been many cases in history where undemocratic states at war can, over time, harness powerful forces of patriotism or religious fervour to support wars which might otherwise have become unpopular. The Soviet regime was probably strengthened by the Second World War; and the Governments of Iran and Iraq may well have been bolstered by the emotions unleashed by their war of 1980-88. On the other hand, the military regime in Argentina was undermined by the Falklands War of 1982.

¹¹ The speech by President G.W. Bush to Congress on 20th September 2001 reflected the need to prepare his electorate for a long campaign against those who attacked the World Trade Centre and the Pentagon on 11th September 2001. It was rich in allusions to the need to seize the 'temporal initiative', in both the current and historical senses. He warned Americans that they should, "...not expect one battle, but a lengthy campaign, unlike any other we have seen." He asserted that, "this country will define our times, not be defined by them", in "a task that does not end"; and that they should be assured of "patient justice."

¹² The tension between 'continental' warfighting and 'imperial/global policing' is not new. In 1815, 1918 and 1945 after long continental wars, the British Army was forced by events to concentrate on imperial policing operations. The maintenance of a full warfighting capability seemed by comparison to be wasteful; and merely an unimaginative hankering to refight the last war. This imperial bias left the British Army ill-placed to fight in 'continental' wars in 1914 and 1939. The necessity to mount expeditionary campaigns and to conduct internal security duties in Northern Ireland during the Cold War led some to suggest that the British Army really only came to terms with 'continental' armoured warfare in the late 1980s, as the Cold War was ending. At the beginning of the 21st Century, the 'North West Frontier' once again has a strategic immediacy, along with the need to confront unconventional attacks.

The British Army's experience in the latter part of the 20th Century suggests that it is desirable and possible to maintain competence in a broad spectrum of capabilities.

¹³ The issue is analysed in Gompert, Kugler and Libicki (1999).

¹⁴ The US has a Joint Munitions Effects Manual, the directory of what munition is required to have what effect on a given target. Some have suggested that it should be replaced by a Joint Weapons Effects Manual, including the effects of electronic warfare, lasers, microwaves and directed energy weapons. Public discussions at, 'Thinking out of the Box and into the Future', The Potomac Institute, Washington DC, on 26th June 2000.

¹⁵ These issues and 'asymmetric operations' are analysed in Metz and Johnson (2001).

¹⁶ Fuel-air explosives were not widely discussed during the Cold War despite their development in many countries. One of the first articles explaining their significance to a wider public was Geisenheyner (1987), pp.280-282. They were first used by US forces during the Vietnam War, packaged as the CBU-55, primarily to clear landing zones. The development of computers in the 1970s permitted better modelling of their effects and spurred further development. Such munitions were then used for mine-clearing. Only since the 1980s has their potential in urban operations been widely appreciated. Their effects were demonstrated by the Russians in their Chechen Wars. The Russian Smerch BM 9A52 multiple rocket system is reported to have a fuel-air munition, the 9M55S, with a 100kg warhead and a range of 70km.

¹⁷ In the First World War commanders frequently attacked with fire from 'below', in the form of large mines. The British success at Messines (7th June 1917) was due largely to the detonation of mines containing one million pounds of high explosive under the critical sector of the German front. There was also a reciprocal need to engage targets 'below' to counter such mines. The only foreseeable need to attack 'below' on land will be fire against enemy assets sheltering deep underground, or, as in the first attack on the WTC in February 1993, as a means of asymmetric attack.

¹⁸ In the British Army these terms are increasingly seen in conceptual terms. Thus, deep operations are those which expand the battlespace in time and space, help to shape close operations, prevent the enemy from concentrating his combat power and diminish his coherence and tempo. Rear operations help to establish and maintain the freedom of action of friendly forces to conduct close and deep operations.

¹⁹ Brig Gen D.L. Grange called for the US Army to create an air mechanized capability. Grange (2001), pp.46-7

²⁰ Sweetman (2002) p.45 In the Gulf War, 600,000 people deployed in theatre shared 80Mb/s of communications bandwidth. For Operation ALLIED STORM, 100,000 personnel used twice that, and in 2001-2002 in Afghanistan, 10,000 US troops used 500Mb/s.

²¹ The role of space in the delivery of future fires is described by LTG E.G. Anderson, commanding general of the US Army Space and Missile Defense Command, in Anderson (1998), pp.9-12.

²² 'Transformation' requires one brigade to be ready to fight within ninety-six hours, one division within 120 hours and five divisions within thirty days. Before the Future Combat System (FCS) is fielded, the Initial Brigade Combat Team brings the lethal capabilities of a heavier force, while being transportable by C-130 aircraft.

²³ This enduring need for balance between fire and manoeuvre in new circumstances is described in Scales (1999) and Scales (1999a).

²⁴ Baxter (1998), pp.1-6.

²⁵ See, for example, Lambeth (2000), pp.42-50.

²⁶ The dispute is typified by the exchanges in the *Armed Forces Journal International* of October 2000 and March 2001 between Brig Gen H. Wass de Czege, and Dr B.M. Blechman and Z. Lum.

²⁷ The contrasting views of the air and land forces is explained in Woods (1998), pp.8-13.

²⁸ Quoted in Strawson (1985), p.44.

²⁹ Gray (2002), p.25.

³⁰ See Gray (2002), pp.25-27.

³¹ Overkill on damaged targets, or failure to continue firing at those that survive, may be avoided if BDA is accurate. Making such assessments is an inherent part of the targeting process, but the physical means to observe damage may be limited. Armies often employ statistical models to predict damage for want of

other evidence. This modelling is described in Hodgkins (1997), pp.11-13. BDA will increasingly be assisted by technology inside the attacking munition itself, or munitions fired subsequently.

³² ASCA seeks to achieve a common interface between the artillery systems of the USA, UK, Germany, France and Italy. The aim is to link AFATDS, BATES, ADLER, ATLAS and SIR, accommodating the different C2 procedures, hardware and software of each nation, securely.

³³ The British Army also has a battery consisting wholly of amphibious observers to support NFS, and a battery of specialist STA patrols to direct fire onto high-value targets in depth. These are in addition to special forces who can also undertake these tasks.

³⁴ C. Dunlap, 'Technology and the 21st Century Battlefield: Recomplicating Moral Life for the Statesman and the Soldier', Strategic Studies Institute, US Army War College (Carlisle, 15th January 1999), p.28.

³⁵ A survey of international locating equipment is given in Gander (2001), pp.8-18.

³⁶ The debate about the uses of UAVs and unmanned land vehicles, and a record of technical programmes is contained in the journal, *UV*, published by Shephards of London.

³⁷ The US Army is procuring the Shadow 200 tactical UAV (TUAV) and a number of other models will enter US service. The UK will acquire a new family of TUAVs collectively named Watchkeeper. Most other nations have or aspire to similar programmes.

³⁸ Some of the munition loads currently under consideration in the USA are described in *Unmanned Aerial Vehicles Roadmap 2000-2025*, Office of the Secretary of Defense (Washington DC, April 2001), p.31. The first combat UAV was probably the US Army's Kettering Aerial Torpedo or 'Bug' of 1915. It had a range of forty miles, flew on a pre-set course at 55mph and carried a warhead of 180lbs. A radio-controlled, bomb-carrying UAV was developed in the USA in 1928 but abandoned in 1932. The first reusable, returnable UAV was probably the British 'Queen Bee' of 1933. In 1938 a GB-1 glide bomb, was developed in the USA, and 108 were dropped in 1943 during a raid on Cologne by fifty-four B-17 bombers. The AZON surface-to-surface 'Bat' was also developed in the 1930s. Cairns (1987). The German V1 was an early attack UAV, as are the cruise missiles which are derived from it. More than 3,000 UAV missions were flown in Vietnam by the US Firebee.

³⁹ The British Army's Phoenix UAV was operated in the Balkans in 1999 along with the Franco-German CL289, the French Army's Crecerelle and the US Hunter and Predator UAVs, which were used primarily to identify targets for aircraft to attack.

⁴⁰ The Gun-Launched Aerial UAV (GLUAV) could be produced with a 155mm calibre to carry out reconnaissance, target acquisition and BDA. It would be expendable and cheap. It could carry a variety of sensors, including chemical and biological agent detectors and conduct EW tasks. It could be controlled in flight by direct link or satellite. 'Gun-launched Expendable UAV has Multiple Applications', *Jane's International Defense Review*, February 2002, p.15.

⁴¹ The early Compact Aerial Vehicle – Shooter Linker (CAV-SL) illustrates the potential of this concept. It has a range of 5km to match the range of direct firing armoured vehicles.

⁴² The US Army's divisional artillery Firefinder Block II Q-37 radar increases range and accuracy to 60km, and can acquire Theatre Ballistic Missiles (TBM) at 250km. It can cover zones not covered by the Q-36 Version 8. The AN/TPQ radar should start to replace the AN/TPQ-37 in 2004. It will double detection range to 60km for cannon projectiles, 100km for rockets and 300km for short-range ballistic missiles.

The UK hopes to have the ASTOR airborne ground surveillance radar in service by 2005 with a range of about 300km. 'ASTOR Programme Enters the Home Straight', *Jane's International Defense Review*, 9/1998, p.5. It is a 'sensor to decision-maker to shooter' capability. It can be used to locate targets providing near real-time data for artillery systems. It can also cue other sensors such as UAVs and the COBRA radar, whose range of about 40km will greatly enhance the CB/CF capability of British and other European artillery.

⁴³ These will include a wider range of non-lethal warheads such as stunning and EW devices.

⁴⁴ As many as 15,000 unexploded bomblets may have been left in Kosovo at the end of NATO's bombing operation in 1999. Such a high dud-rate restricts the likelihood of a future artillery weapon system being permitted to fire bomblets or other submunitions, particularly if it is inaccurate and might scatter them away from the intended target area.

⁴⁵ The MLRS launcher is too heavy to match the deployment requirements of many nations, and lighter launchers such as HIMARS are being developed to fill this gap in capability. HIMARS can fire the MLRS family of munitions. Some other light rocket munitions such as TRIFOM, which has a range of up to 60km, will be guided by fibre optics and be able to conduct their own BDA.

⁴⁶ The ATACMS Blocks I and IA are fired by the M270 MLRS. The Block I reaches 165km and the Block IA with GPS enhancement fielded in 1998 reaches 300km, but with a lesser load of anti-personnel and anti-material (APAM) submunitions. Block II carries thirteen fire-and-forget Brilliant Anti-Tank (BAT) anti-armour submunitions 140km, and Block IIA has six BAT submunitions, ranging out to 300km, depending upon the warhead. BAT uses acoustic sensors to detect moving vehicles. Other ATACMS variants with unitary warheads and penetrating capability will also be available.

⁴⁷ It is due to be fielded by the USA, UK, France, Italy and Germany. GMLRS munitions can be air-burst, point-detonated or delay-detonated to penetrate buildings and bunkers. The unitary warhead will give GMLRS a precision-strike capability, reducing the risk of collateral damage.

⁴⁸ It carries 'fire-and-forget' munitions to 60km, and its anti-armour sub-munitions have a search area of 4km. It would use the basic GMLRS rocket, but not the DPICM grenade-dispensing warhead.

⁴⁹ See Brown, Cook and Sirak (2001), pp.23-27.

⁵⁰ NetFires is intended to deliver five to ten times the 'kill per ton' capability of other artillery systems, reducing personnel and vehicles by fifty percent. It consists of fifteen vertical-launch missile tubes with a computer and communication system, providing power, and data on location and orientation. It weighs less than 1,600kg fully loaded, and comes in a shipping container of eight Container/Launcher Units (C/LUs). The Loitering Attack Munition (LAM) fired from the C/LU would be able to loiter for fifteen minutes at a range of more than 100km. It would engage targets located by the A160 rotor unmanned aircraft, and Internetted Unattended Ground Sensors (IUGS), using seismic and acoustic technology. The system would distinguish between friendly and enemy vehicles by passive, electronic tags. Such systems are likely to be in service with the US forces before 2010.

⁵¹ In 2000, countries such as Iran were reported to have ballistic missiles with ranges of up to 1,500km. E. Blanche, *Janes Defence Weekly*, 12th July 2000, p.16. In May 2002, it was reported that Iran had test-fired the Shahab 3 medium-range ballistic missile (MRBM) to a range of about 1,000km and that Pakistan had test-fired a series of similar missiles.

⁵² See Pangelley (2002).

⁵³ The XM982 will be the first extended-range guided projectile in US service, replacing the M864 extended-range projectile, increasing the range of the M109A6, M198 and M777 from 28km to 37km, and the XM2001 from 40km to about 47km. It has on-board GPS and an inertial measurement unit that acts as a back-up in the event of GPS being jammed. The DPICM version has sixty-four XM85 grenades and the SADARM model has two submunitions. The unitary HE variant would be capable of penetrating 200mm of reinforced concrete. The Silent Eyes 155mm RAP may also be produced. This carries an imaging sensor to send video data for BDA. The XM982 is expected into service between 2005-2010.

⁵⁴ The French Army is considering the Pelican family of long-range, guided cargo-rounds which contain either four Bonus submunitions, or ninety Ogre bomblets, with a range of 65km. A Bonus shell ejects two anti-armour submunitions descending on wings. It detects targets which have already been destroyed and it has a self-destruct mechanism. Other French 155mm shells incorporate the SAMPRASS and SPACIDO systems to increase accuracy.

⁵⁵ Russia's KBP and France's Giat have cooperated in developing the KBP Krasnopol 152mm laser-homing precision shell. Krasnopol is claimed to have a range of 22km and can be fitted with a larger driving band to fire from 155mm pieces. Krasnopol laser seekers can be programmed to suit NATO codes. The round was demonstrated successfully in India in 1999, fired by a Swedish FH-77B. KBP are also reported to be working with Germany's Diehl on a RAP laser-beam-riding round. The Ukraine has produced Kvitnyk to compete with Krasnopol. As at 2002, Krasnopol was reported to have been sold to twelve countries, with many more likely customers. See Williams and Holthus (2002), pp.31-32.

⁵⁶ South Africa continues to be a significant producer of new artillery munitions, such as the 'Assegai' family, building on its reputation for innovation from the days of its cooperation with Dr Gerald Bull. For example, Denel makes long-range 155mm PRO-RAM projectiles which can reach 70km. It is engaged in

numerous collaborative international projects, for example with Diehl of Germany, and has been particularly successful in marketing its charge systems in NATO countries.

⁵⁷ For example, QuickLook is a US 155mm munition with tail-control, wings and a propeller, equipped with GPS. Data from its imagery would be integrated with other material by AFATDS. Numerous others are under development. See 'US Forces Study Sensor-Equipped Munitions', *Jane's International Defense Review* (September 2001), p.10.

⁵⁸ The 120mm Bofors 'Abraham', which delivers a 10kg warhead 10km, is said to cost one tenth that of a missile with the same function.

⁵⁹ The US XM935 120mm Precision Guided Mortar Munition (PGMM) has a range of 12-15km. It glides at about twenty degrees below the horizontal until it reaches a 500m x 500m 'footprint' when it locks onto a laser marker spot. Equally, it could fly to a pre-determined point using GPS. It could be used by the USMC with the Dragonfire mortar system, which could also be used by other US 'early entry' forces. Catto (2002), pp.38-43. It is thought that automation could achieve a rate of fire 500 percent greater than that of a conventional 105mm gun. An extended-range mortar round, the XM984, could enter service by 2009 carrying a payload of fifty-four M80 grenades out to a range of 12km. 'US Pursues Comprehensive Mortar Improvements', *Jane's International Defense Review*, 9/1998, p.22. Other developments include a range of 'smart' mortar bombs, such as the Israeli Military Industries (IMI) 120mm M971 with bomblet, HEAT and various 'top-attack' warheads. Russia's KBP has produced the 120mm Gran and 240mm Smelchak laser-homing mortar bombs.

⁶⁰ Rail guns were also seen as a revolutionary alternative to conventional propellant charge systems but have come to little, at least in the short-term. It is, however, quite likely that such systems with ranges of hundreds of kilometres will be in service by 2025, but on warships, given the weight of the power source. A gun is a thermo-dynamic engine, whose muzzle velocity is limited by the Second Law, in effect to 1-1.5km per second. A rail gun has no limits to its potential velocity, and hence range and penetrating power. A kinetic projectile hitting armour at a speed of 3kms per second is devastating. An Abrams tank gun produces eighteen to twenty megajoules. The power source to produce a similar capability would probably have to deliver forty megajoules and be extremely heavy. Current experimental rail guns are typically of 90mm, powered by thirteen megajoules. The rails suffer severely and survive only a few firings. The US Navy employs coil guns as catapults for carrier aircraft, but these weigh tons. Public briefing at, 'Thinking out of the Box and into the Future', The Potomac Institute, Washington DC, 26th June 2000.

⁶¹ The packaging for solid propellant is heavy and bulky. For comparison, the equivalent of thirty-four charges for an M109 SP gun could be carried in a single fifty-five gallon drum of liquid propellant. It has been estimated that during the Yom Kippur War of 1973 most vehicles that were destroyed were destroyed by the secondary explosions of their own ammunition. The components of liquid propellant could probably be transported separately, improving vehicle survivability. One method tested involved injecting a specified quantity of propellant into the gun chamber and igniting it. The problem was that chamber pressures and the MVs of projectiles varied because of hydrodynamic instability. Another technique tried was 'regenerative injection', whereby a piston forced a jet or spray into the chamber during the combustion. It was hoped that this would improve control and achieve exact metering and consistent MVs. This also proved unsuccessful.

⁶² Laser ignition is also likely to be used in future systems. Its advantage is that it has no expendable components, allows a simpler breech design, sustaining greater chamber pressures; and it generates potentially higher rates of fire.

⁶³ The target-locating SADARM, uses three different locating systems: active Millimetre Wave (MMW), passive MMW and Infra-Red (IR). The sensors search an area of 150m diameter.

⁶⁴ Range-correcting fuses use 'drag-brakes', plates pushed out from the side of the fuse. This solution to a ballistic problem was tried unsuccessfully by the French Army prior to 1914 to make the otherwise flat trajectory of its '75' gun dip and hit German guns behind cover.

⁶⁵ Fuses for the US Army's defunct Crusader must be set inductively in 1.5 seconds. During the Second World War, the British Royal Navy experimented with setting fuses electrically after a round had been loaded in the chamber. The fuses were, however, mechanical; and it was difficult to achieve physical movement with an electrical impulse.

⁶⁶ For example, in urban operations a delay fuse must survive the 'burster' effect of roofs, and hit targets in basements or on the ground floor. This requires a reliable post-impact delay function.

⁶⁷ During the Gulf War of 1991, the Iraqis deployed an SPR-1 fuse-jamming system capable of protecting a 750m oval area. A survey of fuses is given in Pengelley (2001), pp.39-45.

⁶⁸ Denel have produced the LEO 105mm 52-calibres piece weighing 3,800.kg, with a range of 24km, and 30km with BB shells. The characteristics of modern 105mm pieces are described in Pengelley (2002a).

⁶⁹ GPS has transformed the problem of knowing where launchers and observers are located, but it cannot be guaranteed to survive during hostilities. Back-ups to GPS are increasingly being built into systems. The most important is the ring-lased giro. Such giros are found in the British Army's Laser Inertial Automatic Pointing System (LINAPS or APS), fitted to its 105mm L118 light guns. Combining data about the location of the platform with that for orientating and elevating the barrel achieves much of the autonomy that artillery requires. C. Foss, 'UK is First to Deploy Pointing System', *Jane's Defence Weekly*, 3rd March 1999, p.35.

⁷⁰ The BAE Systems M777 has a trunnion-height of just 650mm. Future barrels will contain steel liners bound in carbon fibres. By reducing the thickness of a barrel wall by sixty percent, the net weight saving could be as much as forty percent. Pengelley (2000), p.38.

⁷¹ The M777 weighs about 9,000lbs and has a range of 30km. It has an emplacement time of less than three minutes and a displacement time of less than two minutes. It will use the Towed Artillery Digitisation (TAD) package with inertial navigation, ballistic computer and MV measuring device. The Gun Laying and Positioning System (GLPS) provides orientation and survey data. BAE Systems are likely to produce similar models with barrels ranging from 26-calibres to 52-calibres, with a range of 40km.

⁷² Caesar has a range of 40km. It weighs 17.7 tons and can be deployed in a C-130. Wheeled SP 155mm pieces are also made by companies in Sweden, South Africa, Singapore, Slovakia and Spain.

⁷³ Long-range guns with high rates of fire are susceptible to extreme barrel heating. This can only be alleviated by active cooling. It is harder to incorporate this in a light gun.

⁷⁴ In 2001 it was estimated that there were still 6,000 M109s in service around the world. The M109A4 with improved NBC protection, and the M109A5 with a new cannon, were introduced in the mid 1990s. A 52-calibres version of the M109A6, the M109-2000, is likely to be the last major upgrade. It offers autonomous operation and a range of 40km.

⁷⁵ The AUF1 has a crew of four, automatic loading and a magazine of forty-two rounds. It can fire four rounds in twenty-five seconds, and six rounds in forty seconds to a maximum range of 23.5km. Delivery of the 1988 T model delivery was complete by 1996. It had on-board navigation and a rate of fire of three rounds in fifteen seconds, and seventy-two in sixty minutes.

⁷⁶ The AUF2 has a range of 42km. It has a temperature measuring device embedded in the barrel to inform the on-board computation system. It has the same rate of fire as the AUF1 T, but can fire ten rounds in sixty seconds. It has a multiple-round simultaneous-impact (MRSI) capability of eight to ten, in fourteen seconds at 10-25km.

⁷⁷ One AS90 variant of this stows thirty-two projectiles in four powered magazine modules which position themselves for loading. The highest rate of firing during a US Army trial was three rounds in eight seconds and eighteen rounds in two minutes. 120 rounds in sixty minutes was demonstrated during a trial in Saudi Arabia. Forty-eight rounds can be stowed in 6.5 minutes. It has on-board navigation and pointing. It can come into action in under thirty seconds, and out of action in under fifteen seconds. It has no azimuth firing restrictions. It has a device for measuring barrel erosion in microns, in the grooves as well as the rifling lands.

⁷⁸ The Bundeswehr has ordered 185 PzH2000, of which 120 had been delivered by 2001. It will be the first army to deploy a 155mm 52-calibres system. It can achieve more than 40km, firing the South African Naschem M2000BB Assegai projectile, using the Rheinmetall DM72 modular charge system. It can fire 34km with a standard L15 round.

PzH 2000 carries sixty rounds on-board, a large number compared to the lightened Crusader; but it faces formidable constraints on deployment at its weight of 55,300kg. There have been thoughts of producing a lightweight version at forty-one tonnes to allow it to fly in a C-5A Galaxy. It has on-board navigation, and a pointing system, plus muzzle velocity measurement. It has a semi-automatic loading system. The

fuse on the projectile is normally set by an inductive setter, programmed by the on-board fire control system. The magazine can be reloaded by two men in about eleven minutes. It has a laser range-finder for direct fire. It can use 'shoot and scoot' tactics, and fire eight rounds per minute, but can achieve ten in less than that. It can fire 120 rounds in under fifty-two minutes. It can come into action in less than thirty seconds, fire ten rounds and come out of action in less than twenty seconds. At Meppen in 1997 it fired five rounds at 17km with MRSI, but could achieve more. It has a five-man detachment.

⁷⁹ The 2S19M has a range of 29km, an on-board ballistic computer and navigation. It can come into action in three minutes and fire after thirty seconds. The 2S19M1 has a NATO standard 155mm 52-calibres barrel firing 30km, and 40km with BB projectiles.

⁸⁰ The XM2001 has a 56-calibres barrel and a range of 40km, 50km with RAP; and it can fire up to eight rounds with MRSI. It has a first-round response of between fifteen and twenty seconds, and can fire ten to twelve rounds per minute, sustainable for five minutes. On 4th November 2000, at Yuma it fired fifteen rounds in 10.4 minutes. The supply vehicle (XM2002) has an automatic ammunition handling system which can transfer sixty rounds of ammunition and fuel in twelve minutes. It has a modular charge system known as MACS, although originally it was hoped that it would use the regenerative liquid propellant system. The XM2001 incorporates many novel features. It has active, mid-wall barrel-cooling, integrated electronics and automated armament and ammunition handling. It is manned by just three soldiers in a cockpit, with 'drive by wire' technology and flat-panel, touch-screen displays. For the first time in an SP piece there are no personnel in the turret firing compartment or in direct contact with the ammunition. This represents a major improvement in ergonomics and crew fatigue when working in difficult climates or a hazardous NBC environment. The crew have continuous tactical situational awareness provided through AFATDS, which will be integrated with on-board navigation and pointing systems.

⁸¹ Quoted in *Defense News* 9th-15th July 2001, p.18.

⁸² Although the XM2001's weight was reduced, it had the same engine designed for the heavier version. The result was an extraordinary power-to-weight ratio of 36hp/t, about twice the average for an SP gun, and much greater than that for main battle tanks, enabling Crusader to out-run the Abrams tanks that it was to support.

⁸³ See Sullivan (2002) and McCaffery (2002). The cancellation of Crusader has to be seen in the context of a wider debate about the Transformation of the US Army. Many of the issues are outlined in Boyer (2002). Operation ANACONDA in Afghanistan in February 2002 became part of the 'Crusader debate'. It was reported that at the Senate Armed Services hearing on 16th May 2002, General E. Shinseki testified that, "In the first two days of ANACONDA, twenty-eight of our forty-six casualties were due to indirect fire from mortars. And it would have been in our interests to put together the capabilities to have turned those guns off, turn those mortars off, found them and be able to lift the burden of fire falling on our troops. We could have used and would have used cannon artillery at ANACONDA...Crusader would have been capable of doing all of these." General T. Franks was reported to have disagreed, saying that Crusader would have been too heavy for such operations. See Novak (2002).

⁸⁴ McDaniel (2002). McDaniel favoured containerized missile platforms, with similarities to the 'rocket in a box' concept. Some believed that the same logic that led to the demise of Crusader might well be applied to other systems such as submarines and the F22.

⁸⁵ Sherman (2002), p.4

⁸⁶ The OAV will create situational awareness over a wide area. It will be fully autonomous and require little operator intervention. It will take off and land vertically. The USAF has a concept of persistent area denial in which loitering robotic systems provide continuous coverage over a battlefield for extended periods.

⁸⁷ It is hoped that new propellant will increase the energy of such a gun by thirteen percent, with a fifty percent decrease in volume. A new recoil system will be needed, and may involve active movement forward by the gun prior to firing. The FCS's cargo round could have a range of 50km. The intent is to get 155mm lethality from a 105mm munition, and greater range without RAP. The objective is to achieve sixty to seventy percent of the round as payload, compared to the present fifty percent of a typical 155mm cargo round today. Smart structures will be used to enhance volume and improve aerodynamic performance. It may be possible to achieve greater ranges by making the flight of the shell more efficient

and at a higher maximum altitude. This might involve changing the body-shape of the shell in flight. More efficient surfaces will help, as may so-called 'unsteady aerodynamics'. These technologies are discussed in *Jane's Defense Review*, July 2001, p.10.

⁸⁸ The German 120mm Wiesel 2 is a light SP mortar which has high strategic deployability. It weighs 4,100kg, has a crew of three and can fire sixty seconds after arriving in its firing position. The Russians have produced the 120mm 2S31 SP mortar. It is capable of autonomous operation and can fire directly and indirectly to a maximum range of 13km. The Chinese have developed a wheeled SP mortar, the 120mm WZ 551.

⁸⁹ The Russians have also upgraded their 122mm BM-21 and heavier rocket systems; and the Chinese have produced the 300m A100 rocket system, comparable to the Russian Smerch.

⁹⁰ HIMARS can fire all MLRS munitions, but carries just one pod rather than two. Prototypes were delivered to the US Army in 1998. Production is due to begin in 2004, and the system could be operational with the USMC by 2008. It would weigh 13,170kg.

⁹¹ NetFires is described in Durham and Cunningham (2002), pp.5-9.

⁹² It will be harder to distinguish between such air-launched weapons, combat UAVs and loitering surface-launched munitions. For example, the AIM-120 AMRAAM is essentially a small robotic kamikaze fighter, or air-launched combat UAV, with an air-to-air role.

⁹³ Boeing's developmental UCAV, the X-45, could be in service by 2010 and seems likely to carry a 1,000-3,000lb payload for SEAD and other missions. It can be lifted into theatre, with six per C-17, or twelve per C-5. The Low-Cost Autonomous Attack System (LOCASS) is a small, loitering robot aircraft with a decision-making capability about which targets to attack. UAVs such as the General Atomics RQ-1A can fire ground-attack missiles and, like many others, could fire air-to-air missiles, transforming air defence and the equations upon which AH missions are based. Combat UAVs could also carry directed energy weapons.

⁹⁴ The USAF A/OA-10 Thunderbolt ground-attack aircraft is nevertheless likely to remain in US service until 2028, primarily in the interdiction role, although it will remain capable of CAS when required. It has also been suggested that the A-10 be made robotic. Sherman (2000), pp.14-16.

⁹⁵ Aircraft are achieving greater survivability. During the Battle of Cambrai in November 1917, British Royal Flying Corps losses on ground attack missions never fell below thirty percent per sortie. In the Second World War, the US Army Air Forces lost 10.3 aircraft per 1,000 sorties. Over North Vietnam, US losses were 2.04 per 1,000 sorties. In Operation DESERT STORM 1990-91, they were 0.37 per 1,000 sorties, and in Operation ALLIED FORCE in 1999 they were 0.18 per 1,000 sorties. In Operation ENDURING FREEDOM in 2001-02, the USAF lost no aircraft. Stealth, EW and SEAD work.

⁹⁶ In air operations prior to Operation DESERT STORM, nine percent of munitions dropped by aircraft were precision munitions; on Operation ALLIED FORCE, precision munitions represented sixty percent of the total; and in Operation ENDURING FREEDOM, that figure rose to seventy percent. Observations made at the conference 'Future Offensive Air Capability', held at the Royal United Services Institute, London, 29th May 2002. Despite the increasing importance of precision munitions, it was reported that French studies showed that only fourteen Yugoslav military vehicles were hit during NATO's air operation of 14,000 sorties over Kosovo. Pengelley (2002), p.58. Precision without precise intelligence has little value.

⁹⁷ B-2 bombers dropped 656 JDAMs during Operation ALLIED FORCE in 1999, putting ninety percent of them within twelve metres of their target. A B-2 can deploy up to sixteen 2,000lb JDAMs, targeting sixteen different aim points. Goodman (2000b), p.26. Precision increases effect, and for that reason munitions can become smaller. The lighter the bomb, the more that can be carried per sortie. For example, a B-2 might be able to carry 300 250lb bombs, potentially attacking 300 targets in one sortie, whereas in 1945, it might have taken 1,700 sorties to attack one bridge. The Airpower Conference at the Royal United Services Institute, London, 29th May 2002.

⁹⁸ The B-52, built as a strategic bomber for the Cold War, played a major role flying CAS missions at 35,000 feet against the Taliban, in support of US special forces and the Northern Alliance during Operation ENDURING FREEDOM in 2001-02. Goodman (2002), pp.54-57.

⁹⁹ More attention will have to be paid to Joint training if the potential of CAS is to be fully exploited for, in most armies, training and procedures remain similar to those of the Second World War. The

deficiencies are described in Brown (2002), pp.20-22. There was criticism in 2002 that CAS was not being used well at the NTC. For example, commanders were not used to tasking CAS, airspace coordination was insufficiently developed, SEAD planning was inadequate, combined-arms fire coordination did not rehearse CAS adequately, too much time was taken to brief aircrew and CAS sometimes conflicted with indirect fires. Pengelley (2002), p. 59.

¹⁰⁰ GPS-guided bombs can go astray if the guidance system is defective or damaged, if the GPS coordinates are incorrect, if the incorrect coordinates are entered into the bomb, if there is interference to the GPS signal, perhaps by mountainous terrain, buildings, flares or deliberate signal jamming.

¹⁰¹ Grange et al (2002), p.14.

¹⁰² Grange et al (2002), p.15.

¹⁰³ Quoted in Pengelley (2002), p.58.

¹⁰⁴ Fallows (2002).

¹⁰⁵ For example, in the case of the USA, Task Force HAWK in Albania in 1999 was comprised of Apache AH, MLRS, ATACMS, infantry to defend them and a small headquarters; but it was commanded by the US V Corps Commander.

¹⁰⁶ There was a debate in the USA over whether standing, Joint task forces at high readiness would be more efficient and effective than ones tailored specifically for particular missions. See, Burger and Koch (2001), p.19.

¹⁰⁷ Many armies around the world continue to build large forces of field guns. For example, the Indian Army was reported to require a future force of between 3,000 and 4,000 155mm field guns. Bedi (2002), p.4

¹⁰⁸ If the US Army's Objective Force achieves the massing of precise effects without entailing the massing of equipment, 'fire manoeuvre', it will have attained the conceptually orthodox aspiration of artillerymen, achieved by the Prussians in 1870 by increased range, but more substantially at the beginning of the 20th Century with the introduction of indirect fire.

¹⁰⁹ In the British Army, 'legacy nomenclature' masks the actual functions of the arms. For example the Royal Artillery has proponentcy on behalf of the Land component for: The coordination of Joint effects, GBAD, remote surveillance and target acquisition, and battlespace management.

¹¹⁰ CB/CF does not merely involve attacking the weapon platform, but the whole system, which should be taken to include the munition in flight.

¹¹¹ 'Laser Testbed Shoots Down Artillery Shells in Demonstration', *Janes International Defense Review*, February 2003, p.3.

¹¹² Dr R. Hallion argues that long-range Joint strike will increasingly be mounted from space-based systems, interconnected via systems such as JSTARS and UAVs. The USAF refers in its *Vision 2020* to the 'aerospace continuum'. The role of a Space Force or Space Corps will receive close attention. Hallion (2001). Lieutenant General J. Costello, commanding the US Army's Space and Missile Defence Command, observed in August 2000 that Directed-Energy Weapons (DEW) are, "A potentially revolutionary addition to the battlefield of the future". The synergy between space and fires is described in Costello (1999), pp.12-15. Such weapons may, however, be located anywhere in battlespace, from a truck to space. See M. Hewish, 'Beam Weapons Revolution', *Janes International Defense Review*, 8/2000, pp.34-41.

¹¹³ For example, during the air operation against Yugoslavia in 1999, Macedonia consented to KFOR's presence on its territory provided no hostile actions were mounted from it. Surface fire from Albania was not undertaken for a variety of reasons, among them the dangers of collateral damage that might have been caused by imprecise, long-range artillery munitions.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS FOR FURTHER RESEARCH

6.1 CONCLUSIONS

From earliest times the 'geometry' of warfare was essentially one of two dimensional linear encounter. Bodies of men fought each other along the line where two forces met, in the field or in a siege. This was a consequence of the short range of weapons and the need to see the target. That line could be irregular, for there might be penetrations or envelopments, but it was along that line that combat occurred.

The critical issues pertaining to the application of artillery have remained remarkably constant throughout its history, although the outcomes have been very different as circumstances have changed. The advent of field artillery potentially permitted the enemy to be engaged at longer ranges, but the need to see the target remained and the particular characteristics of the most effective munition, solid shot, ensured that this model of warfare did not change, rather it was assured.

A cannonball could be effective throughout the length of its trajectory, provided targets lay in its path. Even a small increase in elevation would cause a greater proportion of its trajectory to be above head-height and harmless. When a ball fired at higher elevation hit the ground, its angle of descent would be such that few of the enemy were in danger of being hit by it, and its effect was probably limited to that of a single terminal strike. Too low an elevation would also reduce the effectiveness of a ball, causing it to plough into the ground at a relatively short range.

The optimal elevation in terms of range and effect was found to be one that achieved fire parallel to the ground, a flat trajectory, for although this might appear to reduce the potential range, the ball could be made to ricochet off the ground and, most important, it remained below head-height and lethal throughout the course of its trajectory. This may have been the most effective trajectory, but it limited the range at which effects could theoretically be achieved. Since it was frequently hard to identify an enemy at a greater range than that which could be achieved with flat trajectory fire, and smoke compounded the problem of target acquisition, this did not seem too severe a handicap. Fire was therefore habitually direct, that is against targets which could be seen from the gun itself. The essence of the tactical system, sensor, commander and gun were combined and controlled in a single location – the gun platform itself. Communications within this system were readily achieved.

The effectiveness of field artillery depended not merely upon the physical characteristics of the gun and munition, but also upon how it was deployed; and such decisions had generally to be made prior to battle, often by the overall commander himself. The potential lethality of a platform was greatest when the greatest number of high-payoff targets lay within the 'tunnel of destruction' through which balls would fly. Firing in enfilade along the ranks of an opponent, rather than at right-angles to those ranks,

increased effectiveness. Achieving this required astute decisions by a high-level commander who had anticipated events and shaped his battle accordingly. The artillery system was more than merely the firing platform. A successful deployment of necessity entailed the strategic ability to move artillery to the battlefield and to sustain it. Poor communications between a commander and his artillery once battle commenced was a general and serious deficiency and it ensured that command usually devolved to the lowest level after the initial deployment. Without effective links to the overall commander, there was no meaningful artillery network.

There were times when artillery did fire munitions in a higher trajectory and achieve greater ranges. Shells are generally designed to explode at or near the terminal point of their trajectory. It is unlikely that a shell will be lethal along its flight-path, but it is able to achieve effects at or around the terminal point, at whatever range can be attained and with whatever accuracy can be achieved, given the problems of target acquisition at longer ranges. It proved difficult to make shells explode at the desired point on their trajectory, and they were generally judged to be less effective and flexible as a munition than ball, which remained the most common projectile.

For these reasons, warfare remained a matter of two-dimensional linear encounter for the first 650 years of field gunnery. Artillery was typically deployed in the front line and engaged targets that could be acquired from the firing platform itself. As a consequence fire could only be concentrated by concentrating guns themselves close to the target, and there were limits to the numbers that could be positioned in one place, let alone have their fire coordinated effectively given the noise, smoke and vagaries of combat. The difficulty in deploying large numbers of guns close to the most lucrative targets before and during a fast-moving battle severely limited the potential impact of field artillery on the outcome of battles. Yet, when by luck or judgement guns were well deployed the effectiveness of artillery could be devastating.

Large concentrations of guns, the 'grande batterie', while a primitive network of sensors, commanders and guns designed to increase decisive effects, failed for the most part because the capabilities of none of these three elements was significantly improved by their physical propinquity, and the communications and fire control within that grouping remained problematic. Until these were improved, such concentrations were unlikely to deliver synergy, and the whole was often significantly less flexible than a dispersed deployment, or a more mobile force of guns, which offered a greater spread of fire against a variety of unpredictable targets in an uncertain battle.

Yet the notion that artillery's untapped potential lay in developing an integrated system capable of concentrating fire was widely recognized to have merit. The means of realizing it, however, proved elusive. There was little incentive to make field guns with a longer range than the available means of target acquisition; and the demonstrable advantages of firing in a flat trajectory militated against aspirations for greater range until a munition was developed which was effective when fired at higher elevations. Such a development would also permit the possibility of concentrating fire on targets from a number of

dispersed guns, using fire mobility instead of platform mobility. It would create a wide network of fire obviating the disadvantages of forming a concentrated 'grande batterie', while realizing the latter's object. See Section 2.1.

Innovations such as rifling, breech-loading and recoil mechanisms showed that technology could be developed to achieve longer ranges; but the shortcomings of merely firing at longer range were revealed in the American Civil War. By 1870 it was clear that an improved shell could indeed make fire mobility a substitute for equipment mobility; but the system still lacked adequate means to acquire targets at longer range, let alone with the required accuracy. Artillery remained very much a lesser arm.

By the end of the 19th Century, the principles of indirect fire were widely accepted in theory and demonstrated in practice. Indirect fire entails separation between the gun and the observer who orders the fire. The problem was that communications between the two relied on semaphore, voice or telephone line and so in practice the distance of their separation could not be great. By the beginning of the 20th Century indirect fire was regarded as a useful means of tactical protection for guns, enabling them to shelter in covered terrain from lethal new infantry weapons, not so much a method of improving the fire that resulted per se. See Section 2.2.

Soon after the outbreak of the First World War, it became clear not only that indirect fire was essential if guns were to survive, but also that the technology and techniques to enable indirect fire could be readily improved. As a result, new revolutionary possibilities rapidly became apparent. Concentrations of fire could be switched across the front from guns dispersed to the rear. Improvements in target acquisition, primarily by aircraft, but also using other devices, meant that these concentrations could be created at any range that a gun could achieve. This transformed warfare.

Warfare was no longer a matter of two dimensional linear encounter, but one of combat across and throughout the two dimensional plane of the battlefield, by firing in higher elevations through the third dimension. Artillery anywhere in the area of operations of one side could now engage any target anywhere in the area of operations of its opponent – if it was within range. These targets could be of higher value than front-line troops and could include the enemy commander, artillery, logistics and reserves; and all could be engaged simultaneously or in some subtle sequence in conjunction with the scheme of manoeuvre. The static nature of much of the combat in the First World War enabled a network of sensors, commanders and guns to be constructed, in which the identity and affiliation of particular assets was of little relevance compared to their availability and ability to engage. The role of the commander lay increasingly not merely in marshalling artillery resources for a given battle; but in constructing the network of fire to support his plan. It was artillery that came to determine the scale of the battle that he could countenance. In that sense, artillery was not so much supporting manoeuvre as enabling it, and manoeuvre was seen to be the means of exploiting fire superiority. Artillery was recognized to be the arm whose characteristics now determined the 'geometry' of battle and regulated the scope and pace of manoeuvre.

The system, however, still had limitations. The advantages of commanding artillery at the highest level were evident, but how to control fire at the lowest, where it needed to be most responsive to unforeseen developments, was not clear. Equally, while guns could indeed in theory engage any target within range, that advantage was moderated by the inaccuracy inherent in any ballistic system, and that inaccuracy increases with range.

This sophisticated network of artillery did not merely fire through the third dimension, it was soon meshed with other airborne capabilities. Besides target acquisition and battle damage assessment, aircraft increasingly delivered fire in conjunction with ground manoeuvre. See Section 2.3.

The development of radio between the World Wars meant that an artillery network could be created in which the distance between sensors, guns and commanders could be greatly increased and the responsiveness of fire to low-level control by observers could be achieved, integrating that fire with the scheme of manoeuvre and reacting to the unexpected. Radio also improved the linkages between guns themselves, making their deployment more flexible and cohesive. Above all, these improvements could be achieved in mobile operations; but the problem remained as to how to achieve accuracy at long range. See Section 2.4. Aircraft were seen to provide an answer, and during the Second World War the Germans tended to use them as a substitute for precise artillery support. The Allies increasingly used aircraft in place of heavy artillery for deep attack, either in fighter ground attack or as a 'grande batterie' of bombers, making up for their imprecision with a massive weight of fire at ranges that artillery could not reach. Both sides created radio networks to enhance the responsiveness of this air-land system.

By the end of the Second World War the network of fire was a truly three-dimensional one. It was commanded at high level and control enabled at low level. There was a wide variety of ground and airborne sensors linked to aircraft firing directly, and a complex web of artillery equipments firing indirectly, although many of these were also used to fire directly at airborne platforms, and in extremis at close armoured targets. See Section 2.5.

Artillery theory and practice evolved in different ways on either side of the Iron Curtain during the forty-five years of the Cold War with profound implications for operations in the strategic environment that emerged after 1990. By the end of the Second World War the Soviets were convinced that overwhelming firepower was the decisive factor in warfare and that this was generated primarily by artillery. Their method of achieving this was the deployment of masses of guns, rockets and ammunition. Their C3 was relatively primitive yet highly effective. The US Army and the British Army had tended to rely more on an increasingly sophisticated C3 system to maximize the firepower generated from fewer resources. They were eager to reduce the size of their forces after 1945 and were reassured by the massive firepower of nuclear weapons which was deemed to insure against any conventional deficiency.

The use of nuclear weapons to avert conventional defeat grew less plausible during the 1970s and while NATO sought ways to make its conventional forces more capable, so too the WP sought ways to win more quickly, without resort to its own nuclear weapons and before NATO could use its own. Throughout the 1970s and 1980s the WP deployed more mobile systems and ever greater numbers of heavier and longer range artillery pieces, far outnumbering those of NATO. Soviet artillery retained its importance in all-arms planning for offensive operations; but in NATO the relative value of field artillery waned as airpower grew and new infantry guided anti-armour weapons were introduced.

In some respects the 'geometry' of operations in North West Europe had again become linear, and artillery was unable to attack targets throughout the depth of the WP area of operations. The deep echeloning of WP forces meant that the most important targets, other than those on the front line, were often at too great a range to be reached or to be engaged accurately. At the same time accuracy had become even more important because the highest pay-off targets were now armoured and mobile. NATO lacked the means of acquiring these precisely enough for them to be attacked effectively by guns with a slow rate of fire and simple high explosive shells. Rockets were designed to attack area targets, but were still wanting in range, accuracy and terminal effect.

In the meantime, airpower seemed the best answer to NATO's problem and along with ground manoeuvre was the key to the concept, AirLand Battle. The viability of CAS close to the front-line became dubious given the density of WP air defences, but air interdiction of WP echelons beyond the range of artillery became a vital element in NATO's planning. The difficulty in carrying out effective CAS marked out artillery's primary area of operations even more clearly, but artillery still lacked effect against moving armoured targets, even at relatively close range. Artillery was consigned primarily to fighting the close battle, which on an extended battlefield now stretched out to 30km, and it was airpower which took on the role which artillery had played, relative to overall battlefield 'geometry', when indirect fire was first introduced seventy years earlier. The importance of airpower was further enhanced by the introduction of ever more sophisticated precise munitions although, ironically, aircraft still delivered these directly and therefore often at great risk.

If artillery was to regain its importance on the battlefield it would need to be a part of a system that could achieve better target acquisition, greater accuracy and improved terminal effects against the most demanding targets. In the final years of the Cold War these improved capabilities were close to being fielded by NATO nations. New radars, UAVs and stand-off aerial sensors like JSTARS were developed for the acquisition of deep targets for Joint attack. Longer-range missiles such as ATACMS were to be introduced and a series of new field guns capable of firing smart munitions were due into service. The end of the Cold War caused the cost and relevance of many of these artillery systems to be questioned, given that the massive armoured threat had apparently diminished. Plans for many smart munitions for guns and rockets were abandoned, even though many of the new target acquisition systems were not. See Chapter 3.

After the Cold War artillery still lacked effect against targets which could now be acquired at long range. These targets were increasingly allocated to aircraft for attack. Their success in doing so led to a virtuous spiral of technical and tactical development which came to include stand-off munitions, allowing aircraft, at last, to engage targets indirectly and therefore at less risk. Equally, they could also now attack from the safety of a higher altitude, the equivalent on land to out-ranging their opponents.

The environment in which artillery was applied after the Cold War was shaped not only by the Cold War itself, but also by the other operations which had been running concurrently with it. The value of massive firepower was appreciated and applied in the Korean War even more than it had been in the Second World War. In America's war in Vietnam, the same preference for firepower was evident, but so too was its price. It was seen to be too indiscriminate against an elusive enemy who did not present a target for which the artillery arm developed during the World Wars had been designed. The political costs of massive firepower, whether from the air or artillery, came to seem excessive. See Sections 4.3 and 4.4.

The importance of applying artillery in limited, precise ways against clearly identified targets avoiding unnecessary collateral damage became evident in a series of small wars around the world. See Sections 4.2, 4.5, 4.6 and 4.7. These lessons were learned in the West, but the Soviets and their Russian successors seemed not to acknowledge them in Afghanistan and Chechnya. See Sections 4.8 and 4.13. Meanwhile in the Middle East new insights into how artillery might be applied were emerging. See Sections 4.10 and 4.11. Artillery was used by Arab armies in the manner in which they had been taught by the USSR, but with increasing guile; and Israel learned the difficulties of applying artillery fire in operations against irregular forces in the Lebanon and against her own Palestinian Intafada, in a complex and sensitive political environment.

The American and British Armies which were designed to fight the WP on the North German Plain were well equipped in 1991 to fight an Iraqi Army that in many respects, other than ability, replicated that of the USSR. See Section 4.12. The value of artillery in close battle, even without smart munitions was clear, but it was increasingly evident that airpower using precise munitions now played the role once undertaken by field artillery in deeper operations; and there was little prospect of artillery being equipped with precise munitions of its own in the near future.

There had been numerous examples of light artillery demonstrating strategic deployability, for example to retake the Falklands Islands in 1982, see Section 4.9; but the Gulf War also caused some to suggest that the majority of field artillery might be too heavy to deploy in the timeframes required to meet anticipated crises. Tracked and armoured pieces were heavy, consumed large quantities of fuel and potentially huge quantities of ammunition. It was doubted by many that they were light enough to deploy fast enough, and whether they could generate sufficient combat power when they did arrive in theatre. These considerations caused a revival in the design and acquisition of lighter pieces which has continued to the present.

Even though the value of ordinary munitions was repeatedly demonstrated, albeit at relatively short range in a greatly expanded battlespace, the need for precision became increasingly evident as the dynamics of the strategic environment evolved in the 1990s. It also became clear that the manner in which fire should best be applied would, in many cases, have to be very much more sophisticated than in many previous conflicts.

The disadvantages of massive firepower in complex political situations had been apparent since the Vietnam War and in Israel's attempts to deal with insurgency. These became even more obvious in a series of Peace Support Operations especially in the Balkans in the 1990s. See Sections 4.14 and 4.15. The moral authority, legality and thus even the viability of an operation could be threatened by the careless application of fire, whether by air or artillery. The presence of the media made matters even more sensitive. Precise target acquisition, compliance with ROE and accuracy within the system of fire became crucial in many complex operations. The need to deploy rapidly, see Section 5.1, also determined that the focus for artillery development would be on light guns and rockets with as small a logistic footprint as possible, using fewer more expensive precision munitions. Effect rather than firepower per se became the measure used by the military to assess its performance. See Section 5.2. This employment of artillery would therefore be very different to that envisaged in Cold War Europe, even though much of this new technology had its origins in the Cold War. See Section 5.3.

Precision technology became the critical element in the new munitions and had the potential to solve the problem that hobbled firepower, especially given the increasing sensitivities to its misapplication. Accuracy had always been a function of range; and while indirect fire had enabled effects to be concentrated from dispersed firing points at any theoretical range, it was the correlation between range and accuracy in a ballistic system that prevented that being a practical proposition. Precision, whether achieved by designating a target remotely for the munition, or by the munition's own on-board sensor meant that accuracy need no longer be a function of range. In both theory and practice a target could be attacked accurately at any achievable range throughout the area of operations. This promises to be as revolutionary in its consequences as was the introduction of indirect fire at the beginning of the 20th Century, for given the ranges attainable at that time and the nature of the targets, that was also what was achieved, but subsequently lost. Yet by 2003, precision munitions were still not available for use by artillery, although they were the mainstay of operations by aircraft.

Despite the lack of precise munitions, the artillery system developed rapidly after the Cold War and it will be substantially upgraded in coming years in most Western forces but especially those of the USA. The intention is to create a network linking sensors, 'deciders' and 'shooters' seamlessly, so that the prescribed effect may be achieved at the precise time and place using the optimal assets available. See Sections 5.4 and 5.5.

Precision therefore offers the possibility of perpetuating a one hundred year old model of warfare which was eroding as accuracy failed to keep pace with the increases in range

inherent in an expanding battlespace. This model of warfare, whereby effects can be created using the third dimension anywhere in the two-dimensional area of land operations from any range, simultaneously or sequentially according to the tactical or Operational plan, can be rejuvenated by the technology of precision linked to the method of indirect fire which gave birth to it. This model will also incorporate a shrinking fourth dimension as time 'contracts' and the need for effects to be applied more rapidly grows commensurately. Meanwhile the fifth dimension of cyber-space grows in a manner and within boundaries which are uncharted. All these dimensions will be seen and assessed through the distorting lens of perceptions. See Section 5.5.

This model will also lead to another more complex paradigm so far as the three physical dimensions are concerned. Airspace has long been used for airforces to fight each other, to support operations on the ground; and by forces on the ground attacking airforces. The third dimension will, however, become an increasingly vital dimension of operations, and the terms 'land' and 'air' will become less useful in describing the nature and totality of operations conducted in the volume of battlespace. Forces will manoeuvre in it, and fire at other objects in it and many of these will be unmanned, and the differences between platforms and munitions will themselves become less distinct. Whether those forces or their targets are on the ground or airborne will be of lesser significance as also will be their Service affiliation. In that sense the pattern of warfare will move on again. One hundred years after the indirect fire revolution created today's familiar model, warfare will become fully three dimensional and may require organizational change to match. This is not surprising it is the historical norm.

6.2 RECOMMENDATIONS FOR FURTHER RESEARCH

Historical Themes

There is much work to be done before we understand early artillery practice adequately, especially outside Europe, even though many Asian armies employed large quantities of guns. We still do not know who invented the gun or gunpowder. Convincing evidence has yet to be found of any gun from Asia that pre-dates those that exist in Europe. We do not know how knowledge of these inventions and their use travelled around the world. The technology survives in the guns themselves, but little trace remains of the doctrine. We know something of the use of artillery in siege operations, but far less about field artillery. We know little of how the hundreds of guns in the inventory of Calicut in the 15th Century would have been used, or of the artillery practice of the Sultan of Aceh in the early 17th Century. What of Chinese field artillery doctrine, and that of the Sikhs?

Technology

Many of the old debates about guns versus mortars and rockets, and tracks versus wheels remain unresolved and take on new meaning with every technological advance. Where are these debates heading?

If 'reach' is the sum of platform mobility and munition range, more work is required on how both might be increased and the effects of reach be achieved more rapidly. What strategic lift is required for what force packages; and what new materials will lighten the system sufficiently to achieve growing aspirations for rapid deployment? Research is required into new materials and ideas which might offer artillery greater protection and survivability. Equally, investigation would be valuable into new propulsion, projection or other forms of attack which might substitute for traditional methods.

Further research is required before we can judge whether rail-guns and liquid propellant were 'dead-ends' of 1990's thinking and technology, or whether other approaches will enable them to realize their once obvious appeal. The potential of Directed Energy Weapons (DEW) is unquantified; and if their primary disadvantage is that they are direct fire weapons, can they be mounted effectively on indirectly fired platforms? More work is required on thermobaric weapons to see whether they can be made more precise in their effect and acceptable in ethical and legal perceptions. What new munitions might be developed to tackle new forms of armour? The future of non-lethal artillery systems and even 'virtual fire' in cyberspace have received relatively little attention; and there has been little rigorous thinking on how their planning and application differ conceptually from current practice.

Robotics have great potential to be incorporated in fire systems; and little has been done to assess the scope for 'intelligent' techniques to alter and optimize the aerodynamics of munitions in flight, either by modifying their shape or the qualities of their surfaces.

Effects

The effects of conventional indirect fire have always been difficult to assess. Work needs to be done on how better to measure and assess the effects of fire, not just the physical damage but also the psychological effects of shock. Shock has generally been regarded as the most important effect of artillery, more so even than destruction, if only because it is easier to achieve at less cost. In the early years of artillery, the relative lack of physical effect made shock even more important. As we enter the age of precise artillery munitions, it may be that very limited but precise destruction will fail to create the shock effects which have been more potent in the past. How should we approach this problem, let alone solve it?

Precision is not merely a matter of accuracy at a point. Area attack and suppressive effects must be made more precise. Techniques of achieving all the desired effects in complex terrain such as mountains, jungles, but especially urban areas, should be analysed.

The relative cost-effectiveness of various types of effect deserve detailed measurement. For example, how can we know whether, in a given situation, assuming all systems are or could be moved into range in the critical time, an effect is best achieved by strategic air, maritime air, maritime surface-to-surface attack, field artillery rockets, guns, mortars or

helicopters? What are the real costs and opportunity-costs of achieving effects, and how should this guide procurement policy?

Tactics

Work is required on how best to identify and attack targets in an increasingly complex and crowded battlespace, where non-combatants are becoming an increasingly controversial part of that complexity. The means to avoid fratricide, and improved situational awareness can accelerate our decision-action cycle to exploit manoeuvre and our capacity to create effects with fire throughout the many dimensions of battlespace. This 'knowledge superiority' and tempo remain mere aspirations without greater thought and competence.

C3

Field artillery introduced the first electronic sensor-decider-shooter network during the First World War. What should be the characteristics of the future network of fires, given that it will be increasingly joint and part of a broader and deeper network? How will command of resources and the formulation of intent be matched with technology to enhance the responsive control of the application of effects? Will a change in command philosophy be required? Space will play an increasingly important part in the architecture of C3. The extent to which space will be militarized, and the legal and ethical issues arising from this debate, deserve closer scrutiny.

Structures

As direct and indirect fire become harder to differentiate, as platforms and munitions become increasingly indistinct, as the definitions of, for example, counter-fire and GBAD merge, and as operations are conducted increasingly in three rather than two dimensions, what will, or should be, the consequences for the structures that deliver capability? Will the structures of Arms have to be adjusted? The better integration of ground fires with those of other components needs further study, and one consequence of that might be the fundamental reassessment of current inter-Service boundaries and distinctions.

Training

Further work is required on how the ever more diverse effects of indirect fire, lethal and non-lethal, may be better simulated in the full range of novel training environments.

International Developments

Globalization and the end of the Cold War make it increasingly easy to track international developments in artillery in open sources. There remain, however, some areas where little is known. The Korean peninsula is a likely location for major conflict in the future; and field artillery, could be the most potent conventional element in it. The equipment and

doctrine of the North Koreans, and the threat that these constitute relative to other capabilities, deserves much greater attention than has been afforded in this thesis.

The emerging capabilities of the Chinese Army and its possible adoption of novel approaches to warfare also deserve greater public investigation.

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