THE ROYAL AIR FORCE

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Front cover:
B-2 Spirit. B-bombers can already provide a strategic and tactical effect within hours of an incident, can operate from the continental USA, pack a massive punch per aircraft, minimise the risk of friendly casualties and have the ability to minimise collateral damage in the target vicinity. Are strategic bombers relevant in the 21st century . . . ?
Photo Northrop Grumman

CONTRIBUTIONS TO THE ROYAL AIR FORCE AIR POWER REVIEW

The Royal Air Force *Air Power Review* is published quarterly under the auspices of the Director of Defence Studies (RAF) and has the sponsorship of the Assistant Chief of the Air Staff. It is intended to provide an open forum for study which stimulates discussion and thought on air power in its broadest context. This publication is also intended to support the British armed forces in general and the Royal Air Force in particular with respect to the development and application of air power.

Contributions from both Service and civilian authors are sought which will contribute to existing knowledge and understanding of the subject. Any topic will be considered by the air power Review Management Board and a payment of £200 will be made for each article published.

Articles should be original and preferably not previously published, although those of sufficient merit will not be precluded. Between 2,000 and 10,000 words in length, articles should list bibliographical references as end notes, and state a word count. Lengthy articles may be published in instalments. Contributions from serving military personnel should be in accordance with DCI GEN 313 dated 26 November 1999.

Material should be submitted in Microsoft word, on floppy disk, Zip disk or CD and should be accompanied by numbered page copy plus any photographs and illustrations. Digital pictures should be saved as TIFFs or JPEGs @ 300dpi.

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FOREWORD

The first article in the Spring 2005 edition of *Air Power Review* is by the Commander-in-Chief Strike Command, Air Chief Marshal Sir Brian Burridge, a regular contributor to these pages. The article is taken from his address to the Royal United Services Institute on the occasion of the Trenchard Memorial Lecture in September last year, and describes how Strike Command is developing its ability to undertake effects-based operations, both now and in the future. This is examined in terms of the challenges that are posed in terms of both equipment and personnel, and uses Trenchard's original concept for our Service of concentrating on the foundations first. This piece should be essential reading for all serving RAF officers.

In the second article, Dr Jeremy Stocker has produced a thought-provoking piece that examines why we think about air power, or even aerospace power, as something uniquely different from land and sea power. This is very much a piece that is concerned with the doctrinal and conceptual aspects of air power, and while the conclusion may not be generally accepted, it should at least stimulate both thinking and debate on a subject that is of interest to all airmen.

Sqn Ldr Killey's article is taken from his Defence Research Paper produced while on ACSC 7, having taken as his subject the need for a different approach to the use of air power, and provides an alternate lens for considering how direct and indirect effects may be linked across a number of domains. The translation of higher-level effects-based theory into both a campaign planning tool and associated 'troops to task' methodology is still some way off, and this line of attack may well prove useful as we consider how to develop these necessary elements of the effects-based approach.

Network Centric Warfare (NCW), or on this side of the Atlantic, Network Enabled Capability (NEC) — irrespective of the term used this is a particular area of interest at present, and Wg Cdr Chopra's paper on this subject provides much food for thought in a relatively jargon-free manner. Moreover consideration is given to the critical part that the human in the system will play, and what limitations this may entail, which is certainly worth considering as we move towards greater levels of automation in our C2 systems.

The article by Dr Alfred Price considers the effects of the RAF's rocket-firing Typhoons in Normandy, with reference to two particular actions: Mortain and Falaise. After looking at the technical aspects of attacking armour with this particular weapon, and examining the actual conduct of each operation, an analysis of the results reveals that the indirect consequences of attack were far greater than the direct effects. The parallels regarding the abandonment or destruction of vehicles by the German troops with the efficacy of the B52 attacks against dug-in Iraqi forces in Kuwait and Iraq during the 1990-1991 Gulf War are particularly striking, and remind us of the fundamental importance of the morale element in war.

The article by Sqn Ldr Jones is the second in this edition from ACSC 7, and examines the utility of strategic bombers in the 21st Century, looking particularly at their use in the recent Afghanistan and Iraq campaigns. Whilst the conclusion that a name change is necessary to remove the linkage in the general mindset between large bombers and strategic attack may be questionable, the analysis regarding the usefulness of such platforms in likely future conflicts is undoubtedly sound.

The last piece in this edition is by Mr Thomas Withington, which looks at the experiences of the Soviet Air Force (SAF) during its 10-year deployment in Afghanistan. Although the basic outline of the campaign is probably familiar to many readers, it is interesting to see how many lessons regarding close air support were relearnt by the SAF during their operations, and extremely instructive to compare the ineffectiveness of their

use of platforms such as the Tu-16 and Tu-22 in a strategic bombardment role with the tremendously effective use of B52 and B1 platforms in conjunction with special forces only a decade later.

Finally, as the new Chairman of the Board of *Air Power Review*, I am particularly interested to receive feedback on the publication — both in terms of content and format. We will be specifically seeking opinions in a future edition with regard to possible changes, but in the meantime I would be delighted to hear from you.

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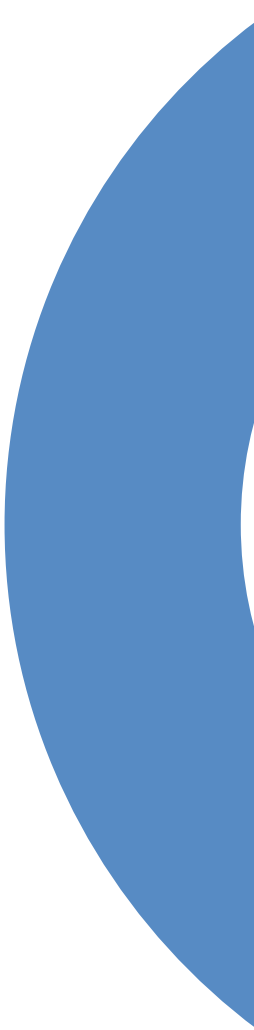

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The Trenchard Memorial Lecture

Delivered by Air Chief Marshal Sir Brian Burridge At RUSI on 17 Sept 2004

Introduction

The scene is the North Sea airspace. The date is 28 July 2004. Nine Swiss F18s took part in Exercise NOMAD as the offensive counter air fighter sweep ahead of an offensive package. The defending team was four Tornado F3s with AMRAAM and ASRAAM, four French Mirage 2000s and four Swiss F18s. The F3s were on a full JTIDS link with the E3D. None of the other defenders had this facility. The offensive F18s were decimated, principally by the F3s and their modern air-to-air weapons that needed to make only three radio calls during the 20-minute engagement. Why was it like that? Because the offensive package had just met Network Enabled Capability for the first time. Marshal of the Royal Air Force Viscount Trenchard would have approved.

We do know that Trenchard did not approve of being termed the 'Father of the Royal Air Force'. This he felt was Lieutenant General Sir David Henderson's honour.[1] Better was Churchill's description of him as the supreme architect.[2] And architect he was. Architecture is, of course, the art or science of building. Much of Trenchard's achievement in terms of building an independent air force was indeed an art and relied on a number of pillars.

The first pillars were the great training institutes such as Cranwell, Halton and the Staff College. The second pillar was the establishment of a reserve through Short Service commissions and the creation of the University Air Squadrons. And the third was the focus on technical knowledge and understanding throughout the new Service. These are fine pillars indeed, requiring the deft touch of a skilled architect.

Not to milk the metaphor to death, Trenchard was a realist, given the difficult economic and geo-strategic conditions that existed in the '20s and early '30s. He pointed out that:

An RAF GR4A on patrol over Iraq

It is a fundamental truth that without control of the air, land forces and maritime forces cannot operate at an acceptable level of risk

"I have laid the foundation for a castle: if nobody builds anything bigger than a cottage on them, it will at least be a very good cottage."[3]

Over the years, it could be argued that the Royal Air Force had gone from castle to cottage and from cottage to castle a number of times. So, in this lecture, I want to look at the way in which Trenchard's legacy of technical thinking (*The Concise Oxford Dictionary* tells me that, like architecture, 'technical' means a particular art, science or handicraft) will take us into the future. I draw a distinction here over technological development, which is merely the hard-edged application of science. Today I wish to focus more on the blend of the equipment, organisation and thinking exemplified by the performance of those F3s on Exercise NOMAD that now allows us to take an effects-based approach to operations.

So, I intend to have a look at Network Enabled Capability from the Air Power perspective. In doing so, I will address the 'technology versus numbers of platforms' debate. I will also cover the capability developments that are needed to run in parallel with the creation of a Network Enabled Capability.

Network Enabled Capability

Let us then begin with Network Enabled Capability or NEC as I shall term it from now on since it has already had an airing.

In achieving 'effect', there is a trade-off that has to be made between platform numbers and capability. For example, take the advances in precision warfare. In the first Gulf War, 15% of the weapons dropped by the RAF were precision-guided. During the Iraq War, the size of the deployed RAF offensive force was smaller than in 1991, but 85% of the weapons dropped were precision-guided. There is no doubt though that the effect achieved in 2003 was greatly in excess of that of 1991. Looking to the future, it is clear that NEC will provide the same leverage.

For air power, NEC provides three enhancements. Firstly, by improving situational awareness and thus speed of response it reduces the risk faced in establishing control of the air. This is not new. The Battle of Britain was fought on just such a basis, with only the technology having changed. The Dowding System was the first example of NEC, and incidentally, time-sensitive targeting, sensors and shooters were linked through a network that included the decision-maker. It is simply that GPO telephone lines and WAAF plotters have now been replaced by secure data-links and plasma screens. It is a fundamental truth that without control of the air, land forces and maritime forces cannot operate at an acceptable level of risk.

Secondly, NEC allows the generation of overwhelming tempo by integrating air power and land manoeuvre. This generation of tempo is key to providing an enemy with problems that he can neither understand nor to which he can react in a timely fashion. More recent conflicts have seen this capability multiplied many times over and was well illustrated by the example of US Special Forces operating on horseback in Afghanistan calling in precision-guided munition strikes from B-52s. Also, the destruction of a large part of the Medina Division of the Iraqi Republican Guard from the air during a sandstorm (which had made action on the ground all but impossible) was a further stark reminder of how far we have come in terms of networked operations. They can offer the means by which our responsiveness is capable of keeping adversaries permanently 'on the back foot'. So air power can shape the battle space and deal with obstacles to progress as they occur. It can only do so if information can be disseminated and understood rapidly and if the resulting analysis and orders can be executed without delay.

Taken further, because air power will become more responsive and can be applied with precision to areas where it will really make a difference, NEC will allow us to maintain momentum using fewer ground forces and less heavy equipment, such as tanks and artillery. Given then the resulting need to deploy less heavy equipment, a nation like the UK can respond more quickly to distant emergencies.

Thirdly, air power enabled by NEC allows us to take advantage of fleeting opportunities in a way that is denied to other forces of lower responsiveness. This aspect is particularly important in dealing with asymmetric enemies. Even the most covert terrorist has, at some stage, to communicate or move location. Such events represent fleeting opportunities because, for a short space of time, they present a tangible symmetric target of a type that air power can address. This was certainly the case recently in Al Amarah where a terrorist mortar team periodically attacked the British CIMIC house from within the cover of the urban area. The combination of a Tactical Air Control Party and an on-station F16 put an end to their activities minutes after they revealed themselves to carry out another attack. We need to be able to do this over and over again. This is the type of persistence required to dominate post-modern battle space, and air power can deliver it.

Whilst in an ideal world, the aim would probably be both to maintain platform numbers and to provide NEC, every indication is that this will be simply unaffordable

Numbers of platforms versus technology

This is not simply about worshipping at the altar of technology and there is frequently a tendency to say, 'Gee, yes!' rather than 'Why, how much?' Rather, it is about applying capability in novel and creative ways to solve the problems that both the recent conflicts such as Iraq and Afghanistan presented. I believe that the time-value of

information will be at its heart. So, in order to take part in such operations safely in future, it will be imperative to be able to function as part of a network-enabled force. Whilst in an ideal world, the aim would probably be both to maintain platform numbers and to provide NEC, every indication is that this will be simply unaffordable. So there is a tough balance of investment decision to make. This was recently manifest in the outcome of the Workstrands, in which the decision was made that we will reduce both Jaguar and F3 numbers with the resulting savings allowing investment in NEC. Clearly there are risks implicit in replacing numbers of platforms with high technology enablers. If the appropriate network enablers are not in place then, in future, we simply

Sopwith Snipes of No 1 Squadron over Iraq, 1923

Suppressing the 1920 Iraq rebellion cost the Army the lives of 2,000 men and the Exchequer £100 million, with a continuing presence costing £32 million a year. Switching to an air approach took just eight squadrons, costing only £100,000 for a six-month operation

will not be able to take part in such operations at all — irrespective of the numbers of platforms that we could bring to the fight.

Future challenges

My vision for Strike Command in 2015 is encapsulated in the phrase, 'Precise Campaign Effects — at Range — in Time'. My interpretation of 'precise' is one of an effects-based approach in that it is implicit that the effect attained should be proportional and, where weapon selection is concerned, precise enough to achieve the desired effect — no more, no less. This is fine where kinetic attack is required but is much less easy to visualise and execute where non- kinetic attack is concerned. In terms of the former, the Royal Air Force has transformed its ability to strike targets with precision over the course of the last decade and to do so at considerable range, both in a strategic and a tactical sense. In order to be able to use our weapons effectively, with the least possible risk of both collateral damage and 'blue on blue' engagements, together with the maximum effectiveness in terms of support for friendly forces, we now need a similar investment in the technology required to ensure that the timely and proportionate element can be achieved. Reducing the time element in the effects-based equation is the key challenge for the immediate future. Doing all this using a non-kinetic approach is vastly more complex and much more thought is required if we are to understand how to achieve a non-kinetic effect that is synchronised with a kinetic scheme of manoeuvre.

The future will call for novel and creative approaches in much the same way as Trenchard had to explain in his era, the role of an independent Air Force and, more particularly, the enormous leverage in 'effect' that air power could bring. The strategic bombing doctrine underpinned much of this but Trenchard needed a novel and creative way of achieving other types of effect. He was well aware that replacing manpower with capability arising out of technical advances would reduce both cost and risk. The success of 'air policing' in the Middle East of the 1920s and '30s shows just what can be achieved by looking at old problems in new ways. Even the limited performance of the relatively basic aircraft then available allowed large areas of territory to be policed using very small numbers of men on the ground. The ability to move men rapidly by air (or to attack rebel forces deep in their homelands) proved to be a significant force-multiplier. This resulting state of Air Control made absolute economic sense. After its debut in 1920 in Somaliland when a single squadron of DH9s defeated the Mad Mullah in just three weeks, the die was cast. Suppressing the 1920 Iraq rebellion cost the Army the lives of 2,000 men and the Exchequer £100 million, with a continuing presence costing £32 million a year. Switching to an air approach took just eight squadrons, costing only £100,000 for a six-month operation. Later, success on the North West frontier in 1925 and settlement of the Aden dispute by a single squadron at a cost of under £6,000, provided further seductive evidence of the ability and cost-effectiveness of Air power:[4] an example of Trenchard's cottage becoming a castle.

As we look to the future where should we build our cottages and what should they look like? Building castles in the air is, of course, a dangerous business!

Firstly, let me consider some of the capabilities that air power needs to generate beneath our umbrella of NEC in order to deliver an effects-based approach to operations. First, let us look at the generation of the information to feed the network. From a national standpoint, our position is improving and improving rapidly. The Nimrod R, the E3D and the Nimrod MR2 together with strategic recce from the Canberra and tactical fast jet recce have long been the backbone of our approach. Recent developments have taken this yet further. The RAPTOR pod yielded outstanding results in Iraq and the Westcam electro-optical (EO) pod on the Nimrod MR2 has been particularly successful. It has seen the MR2 move out of the genre of a maritime patrol aircraft towards that of a multi-mission platform. Having made its debut this way in Afghanistan, the EO sensor has also proved invaluable in counter-drug operations, in controlling smuggling and in curbing illegal immigration. Its real impact though

is being felt in Iraq in patrolling the border with Iran and in identifying and tracking the former Regime Elements and terrorists who are intent on making trouble. For such operations, the aircraft carries a Ground Liaison Officer. Such people only wish we could shorten the sensor-to-shooter time by equipping the aircraft with a precision-guided bomb, and this may, and I stress *may*, become a reality in the Nimrod MRA4. This new aircraft that flew for the first time on 26 August 2004, has the capability to carry most of the offensive weapons in our inventory. This makes it a truly adaptable aircraft with its capability making a big difference to the time element of my 'Precise Campaign Effect — at Range — in Time'.

Equally important in the ISTAR field is ASTOR, which we now call Sentinel. This again is leading-edge technology that brings the UK into the JSTARS-type field for the first time. The airframe

The Nimrod MRA4. This new aircraft that flew for the first time on 26 August 2004, has the capability to carry most of the offensive weapons in our inventory. This makes it a truly adaptable aircraft with its capability making a big difference to the time element of my 'Precise Campaign Effect — at Range — in Time'

Nimrod MRA4

It would be very surprising if UCAVs were not part of our future solution to long-range penetration, although the growth in bandwidth requirement is also an issue

with all its modifications has flown successfully and now we are in the process of proving both the radar and the software. No 5 Squadron is standing-up at Waddington as a Joint unit with a view to reaching Full Operational Capability by April 2008. One area of concern over all of this is the universal provision of secure radios, Bowman is entering service now across land and land-related Force Elements, but by 2008 the US will have equipped *all* their force elements with the Joint Tactical Radio System or JTRS which will give universal connectivity to the network. It will be challenging for us to stay abreast.

Clearly the future of ISTAR will also embrace UAVs. Their inherent efficiency speaks for itself with their applicability to the 3D tasks — Dull, Dirty and Dangerous — is clear. However, they offer more subtle capability advantages such as over the horizon targeting and reachback tailored to a specific requirement. They also offer persistence but they are not as cheap to buy and operate as many imagine, so the degree of their ubiquity in our future force structure remains an open question. Nevertheless, it would be very surprising if UCAVs were not part of our future solution to long-range penetration, although the growth in bandwidth requirement is also an issue.

In delivering kinetic effect, Typhoon will be the backbone of the frontline for sometime to come. It is a stunning aircraft to fly and brings with it great agility and the potential for really elegant weapon system integration. It has proved very reliable so far, not least in two aircraft completing the 16,000-mile return journey to Singapore recently. Incidentally, one of the aircraft had only 12 hours on the clock when it departed. In delivering 'effect' with deployed fast-jet aircraft, we need to consider aspects such as host nation support, overflight and logistic lines of communication. This suggests a variety of approaches, not least Carrier Air. Projecting air power from the sea will make a significant contribution to my 'Precise Campaign Effect — at Range — in Time' equation. Clearly, carriers give us range and reach, always providing warning time is available. Recent history tells us that generally it is. But Carrier Air with its ability to poise in a diplomatically neutral or even coercive way makes a major contribution to the time element. Notice that I talk of carrier air not carriers themselves. For it is the aircraft that achieves the effect. Hence, we attach great importance to JSF, now JCA and to achieving the correct balance in both employing and basing JCA. As our first excursion into stealth, JCA represents a step-change in capability. We should not be seduced into forgetting the information requirements. Attacks against fixed targets in the modern air C2 environment together with closer land-air integration and flexible employment in aspects such as killbox interdiction all call for rapid, accurate and complete data distribution. Thus NEC must be tried, tested and absolutely axiomatic in our way of operating by the JCA era of the next decade.

In a Service focused on expeditionary warfighting, never was the maxim, 'Train for war and adapt for peace' more appropriate

The human dimension

Much of what I have covered in capability terms is perhaps the science within Trenchard's architecture. What then of the art? Clearly, our doctrine needs to develop in both breadth and depth — breadth to account for changes in the context within which wars are fought driven by changes in circumstances. At the time that we were engaged in the Kosovo air campaign, few would have predicted the post 9/11 global war on terrorism and the need to be in Afghanistan. Doctrine needs to be developed in depth as we recognise the opportunities and limitations of platforms and weapons as they enter service — the reality of the rubber meeting the road if you like.

The need for doctrine is self-evident. A greater challenge exists in producing a Royal Air Force that is agile and adaptable. In a Service focused on expeditionary warfighting, never was the maxim, 'Train for war and adapt for peace' more appropriate. This goes to the heart of our structures from Headquarters to Stations and to the people themselves. Our people must adopt an expeditionary mindset; they must not become comfortable on main operating bases in the UK. Clearly, they must be responsive to changes in environment where things don't quite go to plan and where leadership really does mean taking ownership of problems. Strategically, we need to be forward leaning in both accepting and driving change. In the 20 years between 2000 and 2020, virtually our entire front-line will have changed and we will be changing our approach fundamentally to logistic support. There will be novel approaches to delivering capability such as the Future Strategic Tanker Aircraft. We are thus living in an era of huge opportunity that requires real agility from our people if we are to capitalise on the advantages of this outstanding re-equipment programme and deliver 'Precise Campaign Effect — at Range — in Time'. But from a human dimension, the matching maxim must be 'warfighter first — specialist second'.

Lord Trenchard

American airmen regarded him as the patron saint of air power but to us in the Royal Air Force, the nature of his contribution and his legacy is what gave us, and continues to give us, our pride and status

Conclusion

What would I say in conclusion then? First, Trenchard was right to drive the culture of our being a technical service. In no other environment do advances in technology provide such radical changes in capability. It was the technological nature which gave air power its relevance then and does so now. Secondly, the ability of air power to be relevant must rest upon its technological basis. The key elements are of course precision, stealth, the network, plus the ubiquity of air power and its enduring characteristics of speed and range. Particularly, I would emphasise that we have reached a point in the development of technological warfare where we must take an NEC approach to capitalise fully on new capability. Thirdly, Trenchard's legacy represented by that solid pillar of training remains just as important today. That many of our activities are now Joint in approach does not dilute the special nature of air-mindedness possessed by our people. Fourth, and very much a related point, the human dimension remains paramount. Creativity, novel approaches, command in complex environments and adaptability will be what ultimately gives us our winning edge. Our current focus on the effects-based approach is not new but gives a far better articulated framework for the employment of air power that is now more consistent with the language of gurus from Warden back to Trenchard. In taking all this forward, we should remember Trenchard's Memorandum of 11 December 1919 entitled, *Permanent Organisation of the RAF*. He described the existing nature of the Service as being like 'Jonah's Gourd':

"The necessities of war created it in a night, but the economics of peace have to a large extent caused it to whither in a day, we are now faced with the necessity of replacing it with a plant of deeper root"

So, as we renovate our cottage and occasionally construct the odd wall like a castle, we must take care never to dislodge those very deep roots. Roots that go back to the creation of our Service. So, it's hardly surprising then that Harold Macmillan regarded Trenchard as the man to whom the nation owed a debt beyond measure.[5] That American airmen regarded him as the patron saint of air power but to us in the Royal Air Force, the nature of his contribution and his legacy is what gave us, and continues to give us, our pride and status.

Notes

1 Henry Probert, High Commanders of the Royal Air Force, HMSO 1991 p1
2 ibid, p1
3 Architect of the RAF – Obituary of Lord Trenchard, The Aeroplane, 17 Feb 1956
4 Andrew Boyle, Trenchard, Collins p 365-369
5 Henry Probert, High Commanders of the Royal Air Force, HMSO 1991 p4

The city of Dresden was devastated by RAF and US Army Air Force bombing raids in February 1945

There is no such thing as Air Power

By Dr Jeremy Stocker

The concept of air power has been a controversial subject of strategic debate ever since mankind first learned to fly. The addition of a third dimension or environment to warfare, at the same time separate from, yet integral to, both the land and the sea has always engendered fierce controversies over military strategies, resource allocations, cultural differences and institutional interests. Many of these disputes, though now the subject of no more than historical enquiry, continue to generate intellectual and emotional heat in a way that few other military topics can do.[1] Furthermore, a series of western military interventions around the world since the end of the Cold War has given air power a new political and public profile, though generally without it being specified just what is meant by air power.

As Colin Gray points out:
"Notwithstanding ninety years of multinational experience. . .with heavier-than-air flight, disciplined discussion of air power. . .is harassed at every turn by unhelpful definitions, institutional vested interests...and plain incompetence in strategic reasoning." [2]

US Global Hawk UAV (Unmanned Aerial Vehicle)

That today air power must be more than just aircraft is evident, but how much more, remains highly uncertain

This problem continues to worsen, not necessarily through the fault of air power theorists or practising airmen, but because technological and strategic change make discussion of air power ever-more confused and confusing. Indeed, "How useful is it today to focus on 'air power' as a distinct sub-category of military power as a whole?"[3] Some commentators express little doubt about the continuing importance of air power as an idea: ". . . when members of the military profession talk about air power what they are really talking about is one theology with multiple perspectives . . . air power, regardless of the services involved in its application, is still air power."[4] Others take a very different line: "It could even be that the old concept of air power has become an outmoded construct that has outlived its usefulness."[5]

This paper argues that for the first 50 years or so of manned flight, the new medium was sufficiently distinct as to warrant a concept of air power. However, that is no longer the case, and there now can be no definable or useful concept of 'air power'. This is so because the air is at the same time both more and less than both classical air power theorists and contemporary air power doctrines would claim.

The argument presented here is about doctrine and concepts. Just as important, perhaps, is what it is *not* about. It is not about the utility of strategic bombing, or the institutional independence of Air Forces. It is not about operations or organizations, though may have some implications for both.

An examination of how 'air power' or 'airpower' (the two seem largely to be interchangeable) are defined immediately reveals the problem, notwithstanding a recent claim that "air power is, in fact, delightfully simple to understand."[6] Suggestions abound. General Billy Mitchell's view that "Air power is the ability to do something in or through the air . . ."[7] seems more valid than most, but herein lies a fatal flaw in the concept, to which we shall return. British doctrine defines it thus:

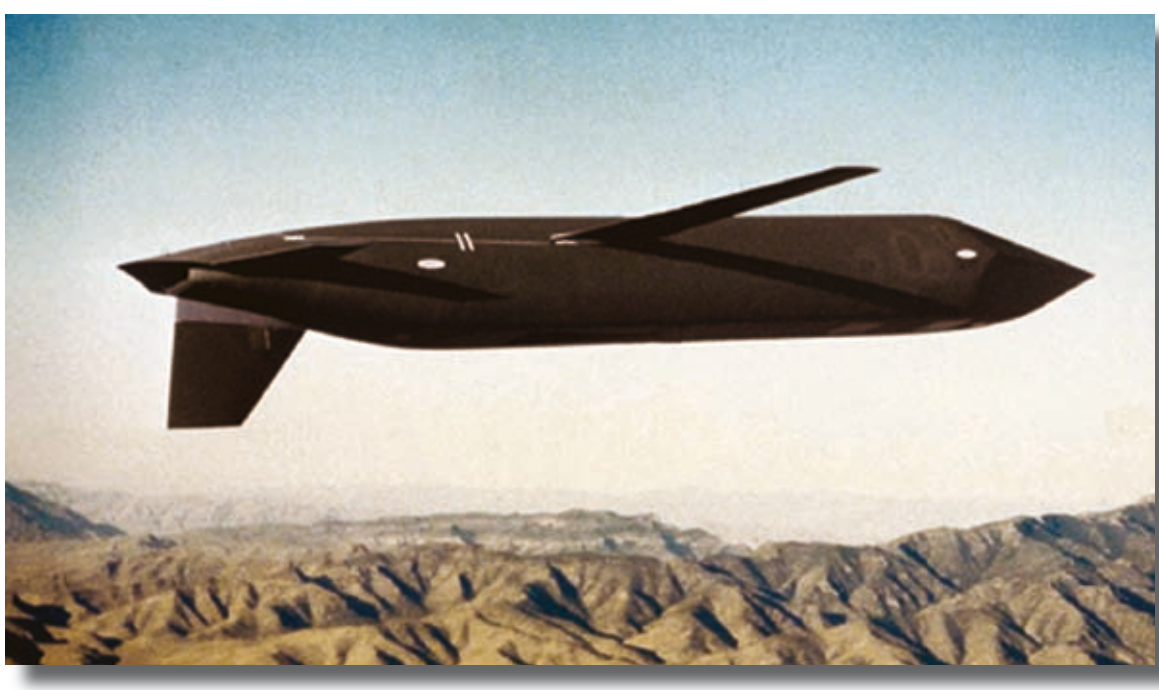
"The ability to project military force in air or space by or from a platform or missile operating above the surface of the earth. Air platforms are defined as any aircraft, helicopter or unmanned air vehicle."[8]

The official American view is much the same, though significantly, with a much greater emphasis on aerospace — the air *and* space (another source of difficulty): "Th[e] third — vertical — dimension is the aerospace environment. The ability to operate in that environment is the source of aerospace power . . . Platforms used to exercise aerospace power include fixed- and rotary-wing aircraft, ballistic and cruise missiles, and satellites."[9] This apparent confusion of platforms and weapons is another source of concern about the validity of the whole concept of air (or aerospace) power.

That today air power must be more than just aircraft is evident,[10] but how much more, remains

Determining just what does, and does not, constitute 'air power' has been a problem ever since, a problem progressively less susceptible to a solution as more and more ways of operating through the air are devised

AGM-129A advanced cruise missile



highly uncertain. Colin Gray again points us in the right direction: "When in doubt it is a good idea to resort to common sense and to remember that definitions are arbitrary and more or less useful. . . "[11] The key question, therefore, is can we define a concept of 'air power' that is not so arbitrary as not to be useful?

Until at least the mid-1940s, man's military exploitation of the air was sufficiently distinctive that one could readily and usefully talk of air power. The manned aircraft extended military operations not just up but also 'out', that is, beyond the immediate reach of surface forces, limited as they were by terrain or the horizon, and the range of surface artillery.[12] Aircraft became progressively more important to, and more integrated with, the surface land and sea battles, but remained a quite distinctive form of military capability. In purely technological terms there was a clear differentiation between bullets and shells passing briefly through the air, and manned aerial vehicles dispensing their own bullets, shells and bombs. Bombardment from the air took war beyond the immediate 'battle space' (to use modern terminology) and direct to targets of 'strategic' importance. The air was now an environment to be fought over for it's own sake, much as the sea had been for centuries.[13]

The extent to which the early prophets of air power such as Douhet, Mitchell, Trenchard and Seversky over-stated their case in arguing for the single-handed war-winning potential of aircraft[14] is, for our purposes here, not the issue. In this context, two particular ironies attend the history of air power. The first is that just as the Second World War seemed finally to have put paid to the more extreme claims of the bombing enthusiasts, so the invention of atomic weapons appeared to provide the means whereby such claims could in fact be validated.[15] Yet no sooner had this occurred than the manned aircraft began to be superseded, at least in part, by new means of projecting military power over long distances through the air. As aircraft became ever more potent themselves, so other ways of exploiting the air environment arose to challenge their monopoly position. This process was begun by the German glider-bombs, V-1 cruise missiles and V-2 ballistic missiles in 1943-45, and came to full fruition with Sputnik and ICBMs in the late-1950s. Determining just what does, and does not, constitute 'air power' has been a problem ever since, a problem progressively less susceptible to a solution as more and more ways of operating through the air are devised.

"If we lose the war in the air, we lose the war and we lose it quickly."[16] Montgomery's oft-quoted remark applies even more today than when he made it. It speaks to the universality, or 'ubiquity'[17] of the air as an operating medium. Airmen are fond of pointing out that though water covers 70% of the earth's surface, the air covers 100% of it. Almost every weapon used by armed forces flies, or is thrown, through the air. The only notable exceptions to this are mines and torpedoes, significant exceptions to be sure, but not so as to seriously challenge the essential universality of the air medium. This is not true, of course, of platforms. However, as two eminent Air Force officers have pointed out: "A change from the past emphasis on platform performance and on to weapon performance...seems not only inevitable but imperative."[18]

To state, as Trenchard did, that "I do not for a moment wish to imply . . . that the Air by itself can finish the war"[19] is in this context beside the point — *all* weapons are 'air weapons' and in that vital sense the air is indeed more than the most ardent proponent of 'air power' has ever argued. When it is asserted, quite correctly, that "Air power, strategic and tactical, simply cannot be isolated from other forms of military power for a comparative assessment of its contribution to the winning of the war",[20] this goes only half-way in identifying the essential truth: Aircraft are intrinsic to almost every form of military operation, but more than that, the *Air is All*. It is *the* operating medium which 'permeates everything'.[21] Mitchell's inclusive idea of air power was at the same time both correct and irrelevant.

This situation has come about because of technological innovation. The appearance of ballistic and cruise missiles, UAVs, rockets, guided shells and lasers has completely eroded

US Navy-launched Tomahawk

It has been suggested that air power includes missiles (from wherever they originate), but excludes shells and bullets. This would imply that a missile fired from a submarine is air power, but a bullet fired from an aircraft is not, which hardly helps

the previously sharp distinction between manned aircraft and surface-based artillery. For example, Fire Support now embraces all manner of means of delivering firepower in support of troops on the ground, and not just traditional Field Artillery.

A workable concept of air power must therefore determine just what is, and what is not, a component or an instrument of air power. If one adopts a weapons-based approach, it has been suggested that air power includes missiles (from wherever they originate), but excludes shells and bullets.[22] This would imply that a missile fired from a submarine is air power, but a bullet fired from an aircraft is not, which hardly helps. Alternatively, only missiles and shells fired from aircraft are expressions of air power, whereas those fired by a soldier on the ground are not, even though the target, and the effect on the target, may be the same. This seems no better. Another suggestion, that only weapons with a range of more than, say, 100 miles be included[23] gets us

A US F/A-18 Hornet patrolling the skies over Bosnia

The physics and logistics of flight . . . require that each individual aircraft [or other aerial vehicle] can be present . . . only relatively briefly . . . it is of the nature of air power to be present . . . only intermittently

no further. Why 100 miles? What if a weapon with a maximum range of 150 miles is launched at a target only 75 miles away? The situation will be further complicated in the next few years by the appearance of guns with extended range guided munitions able to hit targets up to 100 miles away,[24] with greater reach, and in some cases better accuracy, than many existing air- and surface-launched missiles. One's definition of air power therefore becomes either so broad as to be synonymous with *all* military power, and so quite unhelpful, or so arbitrarily restricted as to be equally useless.

If instead the platform, not the weapon, is the key determinant, we are back to the manned, and perhaps unmanned, aircraft. Some weapons find their own way to the target, others are carried part-way by an aircraft. So, for example, a cruise missile fired from an aircraft *is* air power in action, but an almost identical missile fired against the same target but from a submarine is *not*. Or is a submarine, of all things, to be an air power platform? Again, the ubiquity of the air medium mitigates against any worthwhile characterization of air power. Trenchard's idea of the 'indivisibility of the air' contains more truth than he imagined.

Discussion of platforms brings one neatly to the obverse of ubiquity, namely impermanence.[25] In essence, one can operate *through* the air, but not *from* the air. All aerial missions, whether manned or not, 'one-shot', 'one-way' weapons or reusable airborne platforms, originate on the land or at sea, or, conceptually at least, in space. "The physics and logistics of flight. . . require that each individual aircraft [or other aerial vehicle] can be present . . . only relatively briefly . . . it is of the nature of air power to be present . . . only intermittently."[26] A presence can be maintained in the air in a particular locality for some time by rotation of individual aircraft. However, this is an expensive way of operating,[27] and, more to the point, both individual aircraft missions and a cumulative 'air presence' originate on land or sea. "Air bases are the tactical framework within which air forces wage campaigns."[28]

Of course it is true that a presence at sea or in space, ultimately, originates on land. It is also true that a presence on land 'in the field' originates somewhere else (at home), but these presences can be maintained for months, even years and are, for all practical purposes, 'permanent'. This cannot be said of an aerial presence measured in hours, or, in rotation, days and which is therefore 'essentially transitory'.[29] Thus the air is less, as well as more, than has been claimed for it.

This focus on the surface origin of all 'air power missions'[30] is not a thinly veiled argument for the abolition of separate air forces, despite a recurring, but quite unnecessary, Air Force sensitivity on the subject.[31] The mastery of manned flight is a distinct and complex business undertaken by what Mitchell called the 'air-minded people.'[32] 'Airmanship' is a collection of very practical skills somewhat analogous to 'seamanship'. However, given the arguments presented above, whether one can extrapolate from airmanship a worthwhile concept of 'air warfare' that is more than simply the technical operation of military aircraft is less sure. On land at least, the origins of most aircraft missions — airfields — are generally quite removed from other military assets. The institutional separation of air forces from armies is therefore not just desirable (given the special nature of airmanship) but also physically possible. At sea this is obviously not the case and must result either in the division between two services of total aircraft strength, or the operation of one service's aircraft from another's seaborne platforms.

A popular, and somewhat natural, view is that there are three environments — land, sea and air - each addressed by a different Service — Army, Navy and Air Force — even if each does 'stray' into the others' realms to varying degrees.

Space is a unique environment in its own right . . . an environment characterised by the laws of orbital motion, high energy particles and fluctuating magnetic fields and temperatures . . . in other words, quite unlike the air

However, the discussion so far indicates that what we actually have, for perfectly good reasons, are two land-based services and one sea-based, for each of whom, in differing ways, the air is the (almost) universal operating medium.

Mention of space and aerospace has already been made. Space is relevant to this discussion for two reasons: First, the extension of air power doctrine into space, hence Aerospace:

"Of, or pertaining to, Earth's envelope of atmosphere and the space above it; two separate entities considered as a single realm for activity in launching, guidance, and control of vehicles that will travel in both entities."[33]

HMS Lancaster of the UK Royal Navy

The land is quite clearly a two-dimensional 'surface' environment, so far as military operations are concerned. So also, surprisingly, are the sea and space

Second, because the nature of space and its relationship to the other environments tells us a lot about the special nature of the air. Ben Lambeth, a noted theorist of air power, has written of *"the inexorable movement of air warfare into space. Viewing space from an operational rather than an organizational vantage point, it is nothing but an extension of the vertical dimension beyond the confines of the earth's atmosphere . . . exploiting space will be crucial to the continued maturation of air-power. Space is merely a place, not an independent mission or function for air-power . . . There is every reason to expect the gradual withering-away of today's demarcations between 'air' and 'space' . . ."*[34]

This association of space with the air appears to rest on the basis that both are 'up there', while the land and the sea are 'down here'. Air power doctrines, quite validly, refer to the other environments as 'the surface'[35]. However,

"Aerospace is an unfortunate term because it denies the laws of physics . . . the space environment is geophysically and hence technologically, tactically and operationally as distinctive from the air as it is from the land and the sea." [36]

"Space is a unique environment in its own right . . ."[37] "an environment characterised by the laws of orbital motion, high energy particles and fluctuating magnetic fields and temperatures . . ."[38] in other words, quite unlike the air. As a military medium, it actually has more in common with 'the surface' than it has with the air. "Space is not just an extension of the air. Space is an ocean . . ."[39] Space is, like the land and the sea, a basing medium in a way that the air is not. Space is neither 'ubiquitous' nor 'impermanent'. We operate 'from' the land, the sea, and space, and 'through' the air, the medium that connects all the others. That " . . . space power [is] an essential enabler of air power . . ."[40] is not only true, it is also irrelevant. Land- and sea-power are also 'enablers of air power'. Whether Air Forces are best placed to exploit space, as indeed they may be, is another question altogether and one that should not dependent upon a concept of aerospace.

The land is quite clearly a two-dimensional 'surface' environment, so far as military operations are concerned. So also, surprisingly, are the sea and space. The overwhelming bulk of shipping, civil and military, is surface-bound and that which is not, principally submarines, operate mainly close to the surface and with reference to it. The military exploitation of space is an orbital one. Though there is a range of orbital altitudes, this also is essentially a 'surface' operation, albeit one with, like the sea, some depth to it. Earth orbit is the 'surface' of outer space beyond, as viewed from this planet. The air, however, *is* three-dimensional, exploited throughout its vertical range and which connects the environments not just below but also above.

In this sense, it is space, not the air, which is the third dimension or environment. The air's true comparators as impermanent 'connectors' are the electro-magnetic spectrum (which itself uses the air) and, perhaps, 'cyber-space'.[41]

In response to all this one might quite reasonably ask 'So What?'. This argument is about more than just semantics but may well be little more than a matter of theology. But in an era when armed forces are doctrine-led, one surely ought to get one's doctrine right, or at least "prevent the doctrine being too badly wrong".[42] In particular, the existence of an ill-defined but superficially attractive concept of air power may tempt political leaderships to opt for a use of force that holds a false promise of cost-free military effectiveness.

In today's 'joint' world, the operational organization of joint forces remains 'input-based',[43] that is, organized along 'environmental', (single-Service component) lines. If each Service did address its own environment, this might make sense. But a recognition of the existing confusion between basing and operating environments ought to negate this approach. Without a distinct operational concept of air power to match the institutional existence of an air force, operations might more readily be 'output-based', in other words organised according to missions rather than just who supplies the component forces. The UK in particular could make a better distinction between the supply of, and demand for, operational military capabilities.

One must also question the existence, and practical application, of single-Service Air Force air power doctrine, given first, that all the Services operate aircraft and other 'air systems', and second, that, as AP 3000 itself points out, ". . . air power is inherently joint . . ."[44]

Next time we read of 'air power' being used somewhere, it would be as well to remember that what is actually being used is aircraft and missiles, not a doctrinal concept. Gray observes that ". . . the contribution of air power to military operations of all kinds has become so pervasive as to call into question traditionally distinctive notions of land power and sea power."[45] In fact, the reverse is true. The air is so pervasive that it is air power that has ceased to be definable or useable as a distinct concept.

It is a paradox of military exploitation of the air that while claims for specific uses of the air (particularly strategic bombing) may have been over-stated, the significance of the air itself has been under-played. Air Chief Marshal Sir Brian Burridge observed that "The challenge for air power is to maintain its relevance in a changing world."[46] The air's ubiquity is such that its importance cannot be in doubt. It is the *concept* of air power whose relevance we must question.

The air as a military operating environment is at the same time more ubiquitous and less permanent than a distinct and worthwhile concept of air power would require, and so there is indeed, No Such Thing.

Notes

1 For example, the continuing controversy about the military utility and moral righteousness of strategic bombing in the Second World War.
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31 Air Chief Marshal Sir Richard Johns, Chief of the Air Staff, Address to the Royal Aeronautical Society, 21 September 1999
32 Chaliand p. 899
33 US Joint Pub 3-01.1 Aerospace Defense of North America, Washington DC: Joint Chiefs of Staff, 1 November 1996, p. GL-2
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38 AP 3000 p. 2.4.8
39 Commander Sam J. Tangredi USN Space is an Ocean in US Naval Institute Proceedings January 1999 p. 53
40 Benjamin S. Lambeth Air Power, Space Power and Geography in Gray & Sloan Geopolitics pp. 64-5
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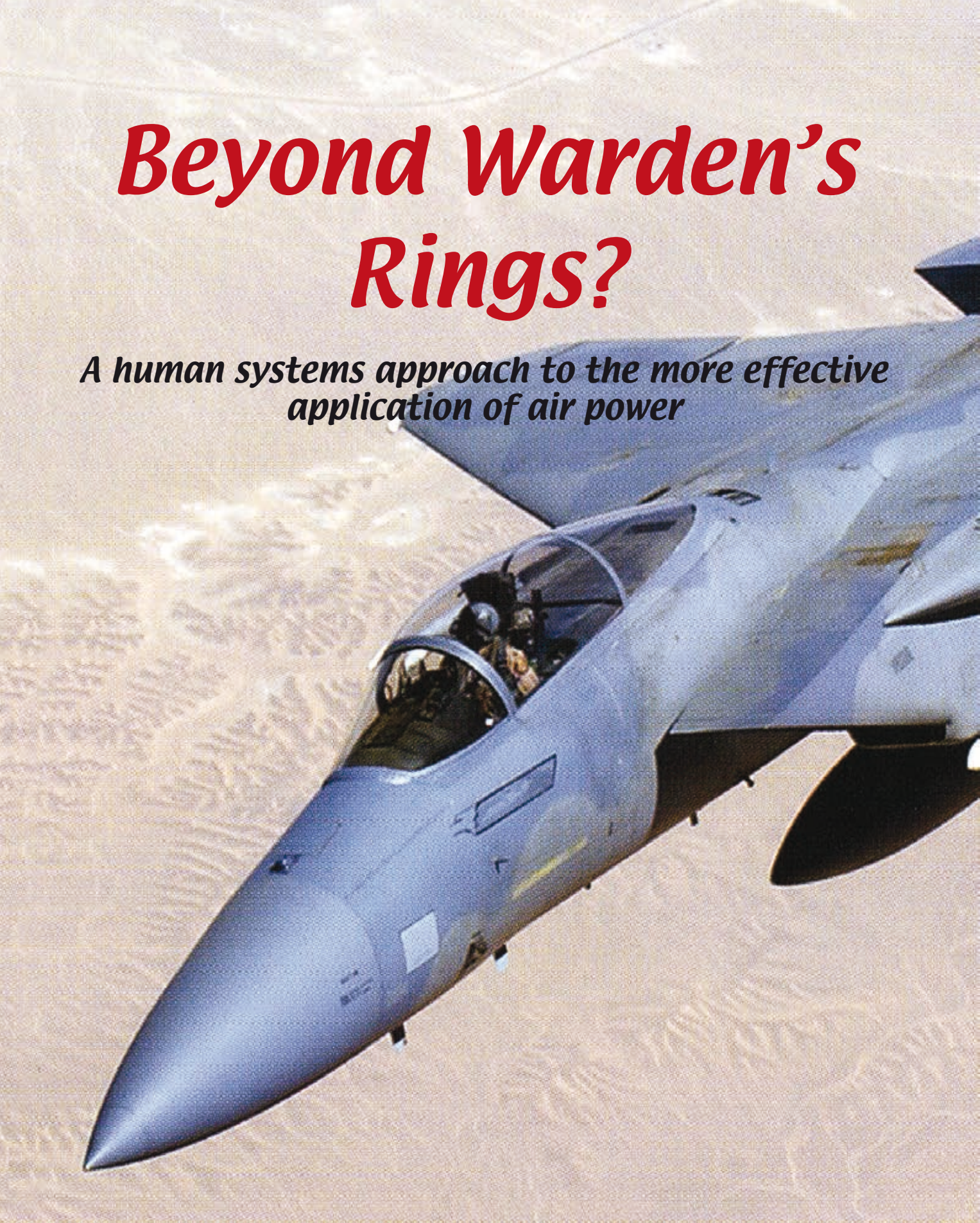
Beyond Warden's Rings?

A human systems approach to the more effective application of air power

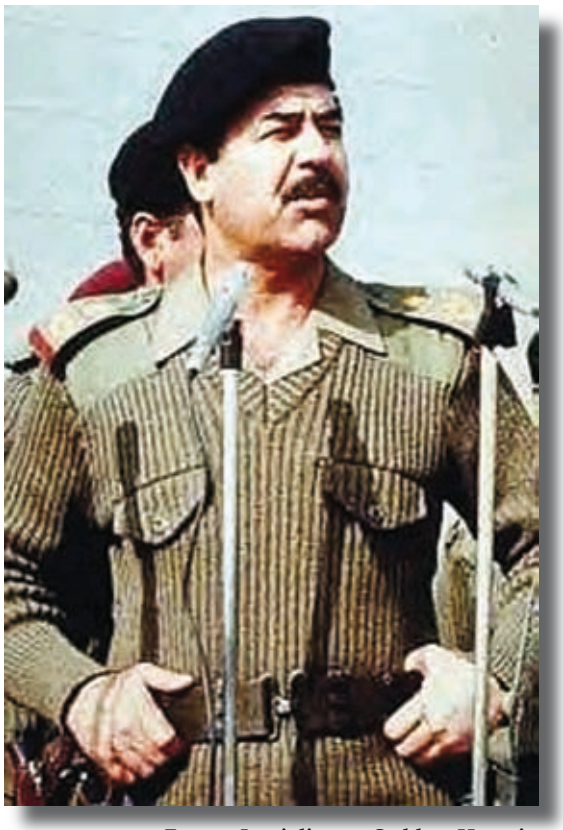


By Sqn Ldr A H Killey

Each age has its own kind of war and has its own theory of war.[1]

The key question for air power theorists must be 'where should air power be focused in order to contribute to effects?' The paper argues that the existing disparate air power theories are part of a continuum that can be integrated using a human systems model to provide a range of option for influencing an adversary's means and will. The model is examined in the light of campaigns in the Gulf War, Bosnia and Kosovo. The paper concludes that the human systems model offers an explicitly holistic view of the adversary as a system, and provides a conceptual framework for understanding the cascade of direct and indirect physical and psychological effects. Air power is most effective when used to influence an adversary's will, rather than his means, but its use must always be tailored to the properties of the adversary and the political objectives.

Air power transformed the conduct of war in the 20th century[2]; the end of the Cold War, the phenomenon of globalisation and now international terrorism is transforming global security in the 21st century. A 'newly volatile security landscape'[3] has emerged, in which the majority of conflicts are within, rather than



Former Iraqi dictator Saddam Hussein

When influencing an adversary's will, should air power aim to paralyse his ability to decide what to do, or to change the gains the adversary hopes to make from choosing a particular course of action?

between, sovereign states and which can have had destructive effects on regional security.[4] This evolving spectrum of security[5] has driven the UK MoD to review and restate the role and utility of the UK Armed Forces[6]:

"to provide security for the people of the UK and the Overseas Territories by defending them, including against terrorism; and to act as a force for good by strengthening international peace and stability . . . through peace-keeping, peace-support, peace-enforcement and humanitarian assistance operations, as well as power projection, focused intervention and deliberate intervention."[7]

The UK is adopting a more integrated and flexible use of the effects that national political, economic and military power can deliver. This implies "significant changes in the way we [UK] plan, prepare and execute operations".[8] In this context the key question for air power theorists must be 'where should air power be focused in order to contribute to joint effects?' Seemingly competing theories have emerged that variously advocate focusing the role of air power to influence the adversary's physical means or moral will. Within these arguments run sub-currents of strategic thought; should air power concentrate on influencing means at the strategic or operational level? When influencing an adversary's will, should air power aim to paralyse his ability to decide what to do, or to change the gains the adversary hopes to make from choosing a particular course of action?

The purpose of this paper is to argue that these theoretical perspectives are part of a continuum that can be integrated to provide a range of options for influencing an adversary to comply with one's will. The decision as to which portion of the continuum to use must be based on an understanding of the adversary, the objectives of both sides, and on what must happen to the adversary to achieve political objectives.[9] First, each theoretical approach is briefly reviewed, highlighting their strengths and weaknesses and employment in recent military operations. Next, a model, based upon the characteristics of human systems, is proposed as an integrating framework for the strands of theory. The integrating utility of the model is examined in the light of campaigns in the Gulf War, Bosnia and Kosovo. The paper concludes that the most effective means of applying air power is to combine these theories in an integrated framework, to provide an air power

theory with the flexibility to achieve the desired political and military objectives in a the world of modern conflict. The data for this paper was researched using secondary sources.

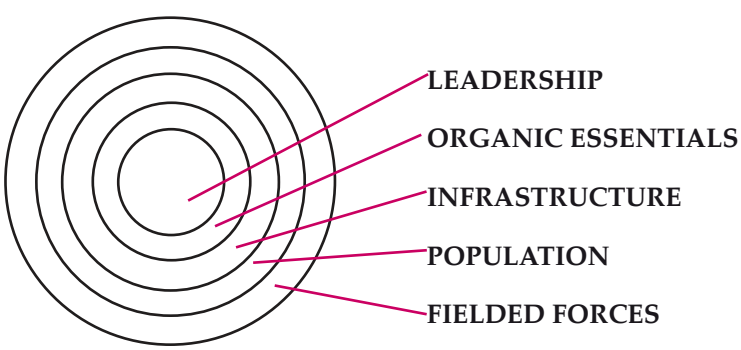
Influencing an adversary
Theoretical approaches to influencing physical means

There is considerable debate about which is the more effective strategy to enforce one's will on an adversary; by influencing his means or his will. Physical means are the personnel, equipment, materiel and organisation required to enact a decision. Moral will is the motive force that attempts to achieve objectives by action.[10] Clausewitz advocated that "Combat is the only effective force in war; its aim is to destroy the enemy's forces as a means to a further end . . . it follows that the destruction of the enemy's force underlies all military actions."[11] He did acknowledge that it was possible to "produce, by means of limited but skillfully applied blows, such paralysis of the enemy's forces and control of will-power as to constitute a significant shortcut to victory,"[12] but maintained that, "direct annihilation of the enemy's forces must always be the dominant consideration."[13] The dominance of influencing means rather than will was furthered by Warden, who contended that an adversary's strength was a multiplicative product of his means and will; driving one side of the equation to near zero made the other irrelevant. Warden argued that an adversary's means could be targeted and destroyed because "the physical side of the enemy is, in theory, perfectly knowable and predictable," but will "is beyond the realm of the predictable". Therefore "war efforts should be directed primarily at the physical side".[14]

While focusing on influencing an adversary's means, a sub-current in the theory of the employment of air power is the level of war at which it is most effective; strategic, operational or tactical. Strategic effect is the use of air power to directly achieve political objectives, and should not be directly equated with bombing targets at range from the homeland.[15] Operational effect is achieving military objectives in a campaign, and tactical effect is the application of air power on the battlefield.[16]

Like Douhet, Mitchell and Seversky,[17] Warden advocates the use of air power for strategic effect, as the best use of its speed, range and flexibility. Warden uses a five-ring model to describe the adversary as a system (see figure 1).[18]

Leadership is the most important system in Warden's model.[19] Warden's strategy strongly advocates blinding, deafening, and muting the adversary's communications and control networks, denying him centralised control of his forces[20] and effectively decapitating the entire organisation.[21] If the leadership ring is not directly vulnerable,



Leadership – most critical ring. Decision-makers and command and control systems.

Organic Essentials – 2nd most critical ring. Those facilities or processes required to survive.

Infrastructure – 3rd most critical ring. The transportation system.

Population – 4th most critical ring. The society.

Fielded Forces – least critical and most hardened by design.

Figure 1. Warden's five-ring model

force must be applied to the other rings, producing unbearable psychological pressure upon the leadership and forcing them to comply with one's will.[22] Each ring is linked to the leadership system in a hierarchical manner, so force applied to the organic essentials ring is more effective than applying force to rings further out. Within each ring is a Centre of Gravity (CofG), defined by Warden as critical to the functioning of the system. Planners must search for vulnerabilities across the system to which influence can be decisively applied. For Warden, the nature of that influence is physical. The most effective course of action to achieve physical destruction is through attacking all of the rings at once, because "parallel attack deprives [the adversary] of the ability to respond".[23]

Air power also has great effect at the operational and tactical levels. Slessor and Pape contend that air power's role was to assist and co-operate with the army in the defeat of the enemy's army"[24] focusing on exploiting the vulnerabilities of the adversary's fielded forces, in support of the ultimate goal in conflict — the occupation of territory by ground forces. This is because air power "weakens [an adversary] to the point where friendly ground forces can seize disputed territories without suffering unacceptable losses".[25]

Within this construct, Pape dismisses the utility of 'strategic effect' by arguing, "the critical element of air power is theatre attack, not strategic bombardment".[26]

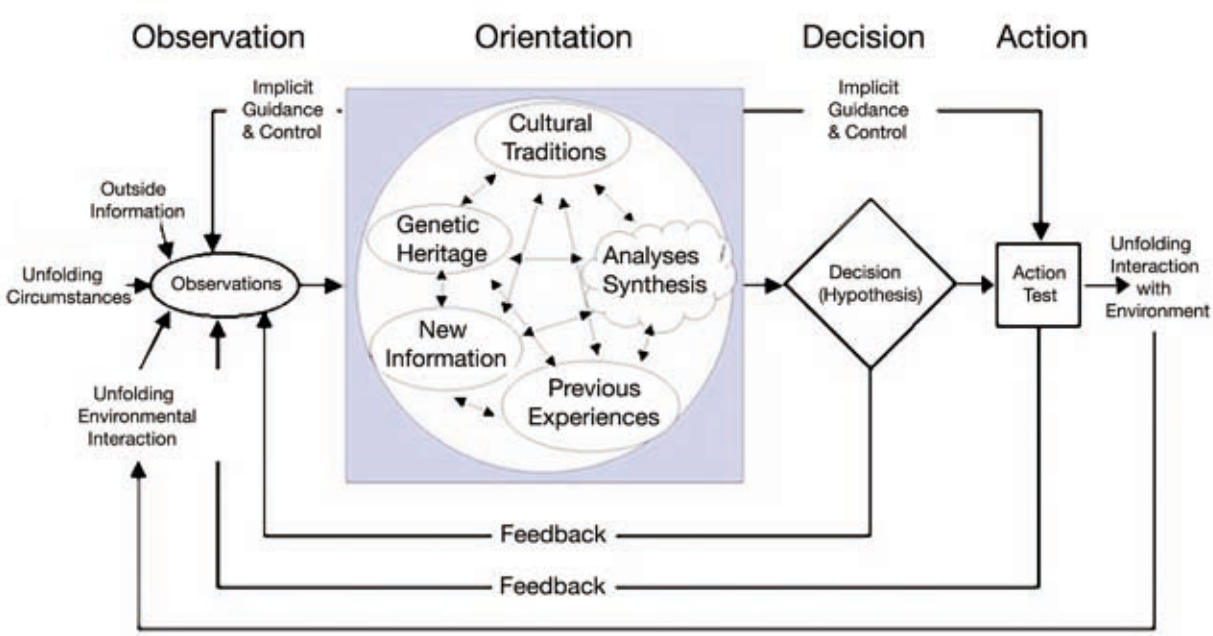
Theoretical approaches to influencing will

Strategy thinkers do not universally accept the focus of influence on physical means. British Military Doctrine states that "the dimension of the mind is of paramount importance in any conflict".[27] This echoes the thoughts of Sun Tzu:

"The supreme excellence in war is to attack the enemy's plans…Those skilled in war subdue the enemy's army without battle. They capture his cities without assaulting them and overthrow his state without protracted operations…For to win one hundred victories in one hundred battles is not the acme of skill. To subdue the enemy without fighting is the acme of skill". [28]

In stark contrast to Clausewitz and Warden, Boyd's theory of conflict advocates a form of warfare that is more psychological and temporal than physical. Boyd contends that all rational human behaviour, individual or organisational, could be depicted as a continual loop through four distinct tasks — Observation, Orientation, Decision, and Action; the 'OODA Loop' (see figure 2). Observations that match up with the decision-maker's particular

Figure 2. Boyd's OODA loop



understanding call for certain decisions and actions. The timeliness and accuracy of decisions are directly related to the ability to correctly orientate to events. Mismatches between the real world and the decision-maker's understanding of that world will generate inaccurate actions. Left uncorrected, inaccurate decisions and actions render the adversary powerless because he is mentally unable to cope with the rapidly unfolding, and naturally uncertain, circumstances of war. Military operations aim to create and perpetuate a highly fluid and menacing state of affairs for the adversary and disrupt or incapacitate his ability to respond by creating surprising and dangerous operational or strategic situations.[29] Unfortunately, Boyd's work was devoid of operational details as to how to accomplish these abstract aims.[30]

While Boyd focuses on the process of decision-making and will to act, other strategies focus on its substance, seeking to manipulate the benefits the adversary expects to gain from a course of action and the costs incurred in undertaking it. When the outcome of this 'cost/benefit calculus' is positive, a rational decision-maker will choose the proposed course of action. A strategy of persuasion seeks to negotiate a voluntary choice of a course of action based upon mutually acceptable costs and maximised benefits, usually using political and economic power in the form of treaties and trade agreements. Military power can be used to influence the cost-benefit calculus by decreasing the adversary's expected benefit or increasing the costs of a course of action. An adversary can be dissuaded from a course of action that upsets the status quo by reducing his expected benefits, but not explicitly raising his costs. Military power can achieve this by preventing the conflict occurring or stabilizing and containing the conflict through peace support, peace-keeping and peace enforcement actions. Military power can also be used to raise the costs of the adversary's cost/benefit calculus sufficiently to coerce the adversary to involuntarily change his course of action. Pape defines three types of coercive strategy: punishment, which targets industry and infrastructure in order to inflict pain and suffering on civilians so as to spur revolt; decapitation, which targets leadership and communication facilities in order to paralyse the adversary; and denial, which targets military forces to prevent their use.[31] Pape argues that the only way to achieve desired political objectives is by 'military coercion'.[32]

Strategic application of theory

All of these theories have been used, individually, or in combination, to underpin the operational art of three air campaigns: Operations Desert Storm, Deliberate Force and Allied Force. Desert Storm was undertaken to prevent the invasion of Saudi Arabia,[33] secure the withdrawal of Iraqi forces from Kuwait,[34] curb the proliferation of Weapons of Mass Destruction (WMD) in the region and enable the UN to work towards peace and stability in the region.[35] The campaign aimed to destroy the Iraqi means of occupying Kuwait and its means of threatening its neighbours in the future by simultaneously destroying the Iraqi leadership and Command and Control (C^2) system, the fielded forces (Iraqi army and the Republican Guard) and supporting infrastructure, and Iraq's WMD. In parallel, organic essentials were disrupted to coerce the population to overthrow the government. Deliberate Force was a coercive air campaign to force the Bosnian Serbs to lift the siege of Sarajevo and negotiate a political settlement to assure freedom of access to the safe haven cities in Bosnia-Herzegovina. Allied Force was also a coercive air campaign, meant to be swift and severe enough to force President Milosevic into discontinuing his ethnic cleansing of the Kosovar Albanians.[36] Initially, the military objective was to coerce Milosevic by disrupting the Serbian ground forces in Kosovo.[37] When this failed, the military objective became the disruption of the infrastructure and C^2 systems that supported to the fielded forces and finally graduated to disruption of organic essentials and destruction of industries owned by Milosevic and his closest supporters, before he conceded.[38]

Despite the apparent differences in each theory in terms of whether they address means or will, it is the contention of this paper that these influential theories are complementary when combined within an integrating framework of a human system model.

The human systems model

Description of human systems

Human organisations adopt a course of action as a result of their means and will to do so. Means and will are the collective outputs of the systems that make up a human organisation, be it nation-state, transnational corporation, or a terrorist group. A system is a collection of elements connected together to achieve a common purpose.[39] Although there are many methods to classify systems, this paper adopts the definition used by Warden's five-rings model[40] as it permits a common frame of reference for analysis.

Human systems, those systems in which humans form an integral element, possess a high level of internal linkage, the ability to self-regulate, adapt and respond unpredictably. All human systems are made up of two components: an activity component that produces goods, services, organisations; and information, overlain by a cognitive component that decides how the activity component behaves (see figure 3).[41]

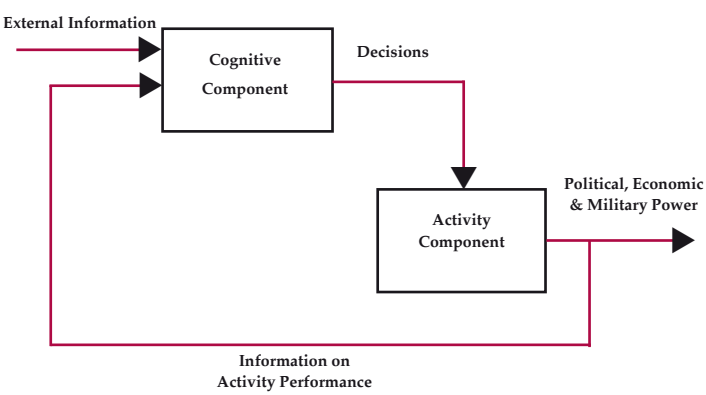
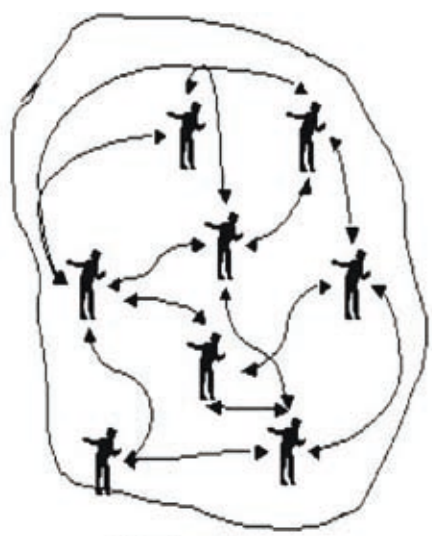


Figure 3.
Relationship between the physical and cognitive components of a human activity system (Source: Adapted from Wilson, 1990, p28)

The cognitive component

The activities in a human system are controlled and coordinated by the cognitive component. This is made up of collections of individuals and groups, connected by interpersonal relationships at both the individual and group level (see figure 4). These individuals and groups make decisions on the basis of what they observe about the output of activities, analyse what they perceive, make judgements about the situation, decide how to respond or act and then control the activities to perform in a required manner. The processes used to observe, perceive, judge and decide are described in Boyd's OODA Loop model (see figure 2). It is the combination of the activity component producing outputs and a cognitive component making decisions that give human systems the properties of self-regulation, adaptation and unpredictable responsiveness.



Relationships are interpersonal

Elements are people doing the activities through particular 'Hows'

Figure 4.
The Elements and links in the cognitive component (Source: Adapted from Wilson, 1996, p 28)

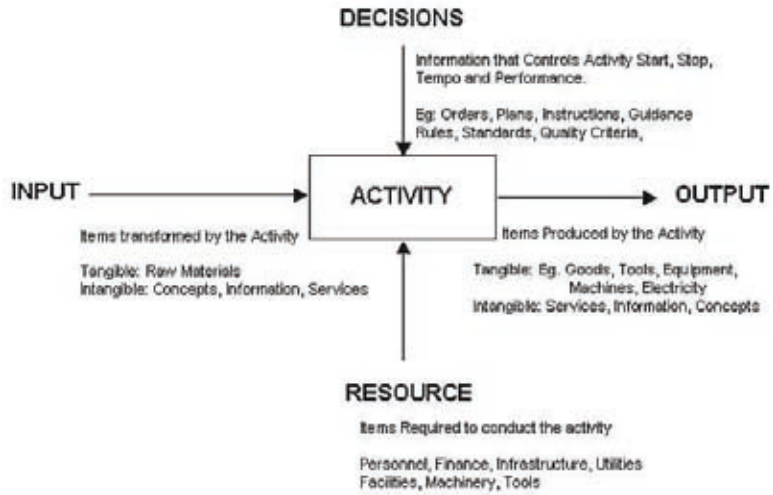


Figure 5. Activity, inputs, outputs, resources and decisions (Source: Adapted from IDEF0[42])

The activity component

The activity component of a human system is made up of a collection of linked physical activities that transform inputs into desired outputs, in accordance with decisions, using resources (See figure 5). One activity's outputs are another activity's inputs or resources. Inputs can be tangible items such as raw materials for a manufacturing process, or intangibles such as information input into a computer system. Outputs can be tangible, such as manufactured products or services, or intangible items such as concepts or information. Resources are required for the activity to take place, but are not transformed into the output; e.g. the people required to carry out procedures; production machinery, infrastructure, i.e. factories and offices in which to conduct work; power, heating and lighting. The information controlling when activities start and stop, the rate at which they transform inputs into outputs, the use of resources, the standards to work to and the targets to reach, are all derived from decisions made by the cognitive component.

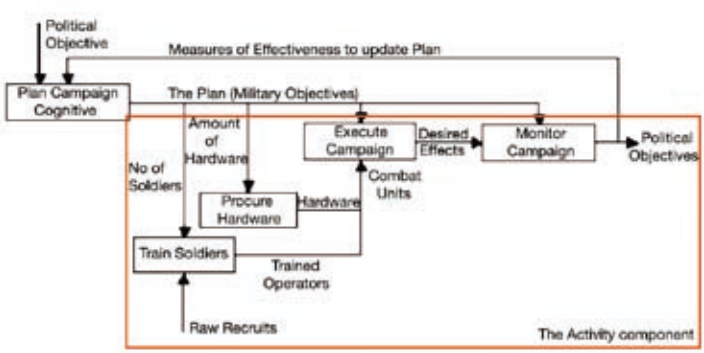


Figure 6. The elements and links in the activity component (Source: Adapted from IDEF0[43])

Activities provide outputs that are used by other activities, whether as inputs or resources, and these link activities together and make them dependant upon each other. For example, an activity that outputs petroleum products is producing an input for a military system, and an activity that outputs electricity is providing a resource for all activities that require electrical power.

This dependency of activities upon outputs is as important as the transformation carried out by the activity itself. It is the combination of individual outputs that defines the system's collective output, and human systems need a minimum degree of connectivity for the output to be produced. [44] For example, national military power is the sum of all the activities that design, manufacture, transport and support combat equipment, and those activities that recruit, train and administer the personnel. As more and more activities stop delivering their outputs, the system reaches a point at which it cannot deliver military power. Human organisations systems are not only dependent upon the connectivity of their internal activities; they are also dependent upon outputs from the internal activities of the other systems, producing a network of interdependence (see figure 7). In this respect the human systems model differs substantially from Warden's hierarchical model. Like Warden's model, each system can be continuously broken down in more and more detail to provide greater definition of the connectivity between activities. The relative dependence between each system is contingent on many factors, including the size, purpose and culture of the organisation.[45] The increasingly

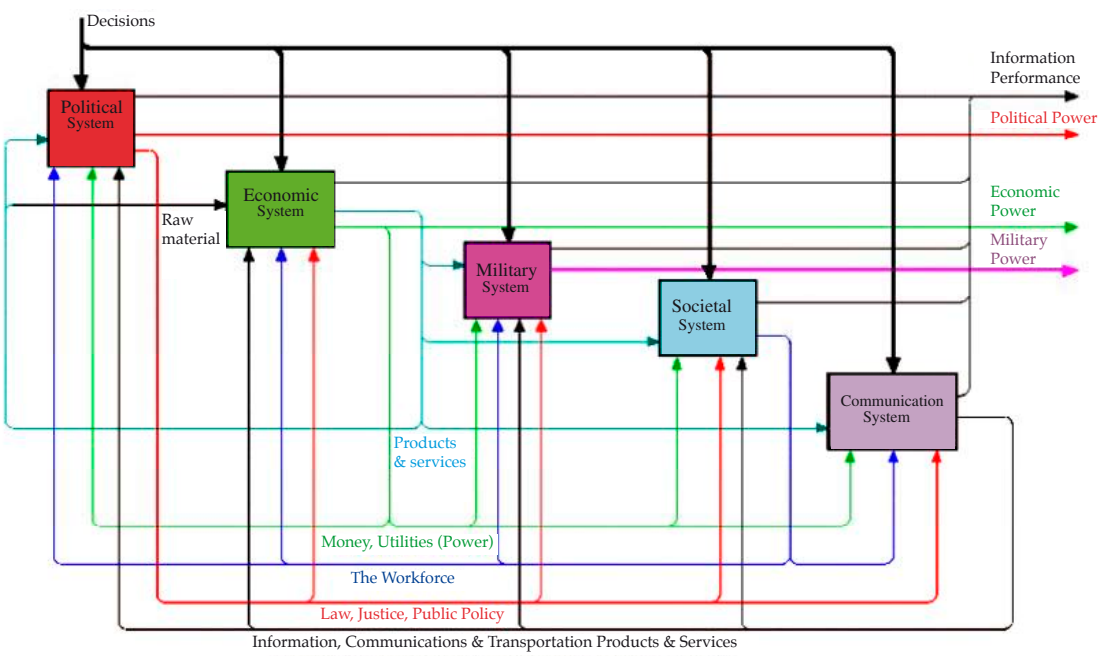


Figure 7.
The Interdependence of systems in the human system. Illustrative only
(Source: Adapted from IDEF0[47])

detailed analysis of the elements and links within systems and sub-systems will lead to a detailed understanding of how the systems deliver outputs, and will identify which activities are critical for the production of a given output.[46]

Centres of gravity (CofG)
Within each system there will be a region where the number of elements and density of links both between the elements within the system and between the cognitive and activity components is relatively high. This is the region of the system that makes the most significant contribution to the system's collective output. An adversary's CofG is a region where sufficient connectivity exists among the elements to enable the system to deliver an output that is critical to providing the adversary with the means and will to undertake a course of action, at a specific time (a critical capability[48]). These critical outputs are not necessarily the adversary's greatest strength or weakness and unless the adversary has sufficient connectivity, he may not necessarily have a CofG.[49] As each system may have a region of high connectivity, the adversary may have more than one CofG, as is the case with Warden's 5-ring model. Where sufficient connectivity does exist, the Human Systems model can be used to identify the elements and links that form the CofG. This concept of a CofG is mirrors Clausewitz's contention that a CofG is the "hub of all movement and power".[50]

System self-regulation and adaptation
Human systems are constantly subjected to influence from their external environment and they possess the ability to respond to it by making decisions that modify the outputs that activities deliver. The rate at which activities produce outputs depends not only on decisions but also on the availability of inputs and resources. Consequently, changes in an activity's performance may propagate along the output links and affect the performance of activities that use that output. The cognitive component coordinates all the changes necessary to respond or adapt to environmental influences. Performance information from activities is used by the cognitive component to decide how to adjust activities in the system. These adjustments may work to minimise the impacts of external influences, or to adapt the system to its new environment if this leads to survival or a more effective method of achieving the common goal.

For example, military systems are able to react to the consumption of assets resupplying itself in order to maintain a relatively constant level of combat potential. Human systems have too many elements and links to exist in a steady state of activity and are inherently dynamically unstable as influences and decisions work their way through the output links in the system. The ability to cope with or adapt to its environment means that the same influence applied to the same point of the system at a different time may result in a very different outcome because the system has adapted. This means that the effects of external influences can be time-sensitive.[51]

However, a human system's ability to cope with or adapt to external environment is constrained in two ways.[52] Firstly, the range of output that an activity can deliver is limited by the quantity of input or resource available. Secondly, the changes brought about by an external influence can exceed the cognitive component's ability to perceive, recognise, control and coordinate changes to performance across many activities. The role of perception and judgment in the cognitive domain and the inherent dynamic instability of human systems mean that they often display non-linear responses to external influences: seemingly powerful influences may have limited effect whilst small ones may have a disproportionately large effect.[53] Furthermore, external influence may have little effect until some 'critical mass' is reached or have no effect unless some other condition is present.[54] For example, a fielded force in combat can continue to fight whilst taking casualties, until a critical level of degradation is reached, at which point the force collapses.

Application of human systems to air warfare
The ability of an organisation to behave in a certain manner is a product of its physical means and moral will to act. Means are the collective output of the activity component and will is the collective output of the cognitive component. Shaping an organisation's behaviour requires

exerting influence on their means, will or both. The application of the human systems model to warfare identifies three strategic approaches for exerting influence on an adversary; destruction of the system's elements, disruption of the system's connectivity and exploitation of the systems control mechanism. These three strategic approaches are assessed in the light of three recent operations, Desert Storm, Deliberate Force and Allied Force.

System destruction strategies

System destruction strategies aim to destroy the elements of an adversary's system with the objective of denying the adversary the means to pursue a course of action. Moral will is an abstract concept and cannot be targetted directly by physical means. Consequently, the focus of system destruction strategies is on the system's physical elements, particularly the fielded forces, although all systems have physical elements that, theoretically, could be destroyed.[55]

In Operation Desert Storm, fielded forces provided Iraq with the means to occupy Kuwait. Up to 12,000 Iraqi troops were killed, the combat effectiveness of many units was reduced by 100% and the Iraqi army in Kuwait collapsed and

System destruction strategies aim to destroy the elements of an adversary's system with the objective of denying the adversary the means to pursue a course of action. Moral will is an abstract concept and cannot be targetted directly by physical means

A destroyed Iraqi tank

An Iraqi Su-22M Fitter in its HAS (Hardened Aircraft Shelter)

Although the Coalition achieved air superiority within 48 hours of the start of the operation, it still sought the physical destruction of the Iraqi air force. Despite destroying runways, taxiways and hardened aircraft shelters, nearly 45 per cent of Iraq's aircraft emerged from the war unscathed

was defeated. However, it took 23,430 sorties, approximately two thirds of the Coalition's air power, to achieve this defeat, and more Iraqi soldiers deserted than were killed.[56] The key political objectives of the complete destruction of the Republican Guard and Iraq's nuclear, biological, and chemical weapons programmes were not achieved despite the Coalition's overwhelming military power. The Republican Guard suffered about 24% attrition, but remained sufficiently capable to withdraw from Iraq and subsequently suppress Kurdish and Shiite rebellions. Only 25% of Iraq's nuclear weapon programme sites were attacked and the efforts to destroy Scud missile systems and chemical and biological weapons were disappointing.[57] Furthermore, although the Coalition achieved air superiority within 48 hours of the start of the operation, it still sought the physical destruction of the Iraqi air force. Despite destroying runways, taxiways and hardened aircraft shelters, nearly 45 per cent of Iraq's aircraft emerged from the war unscathed.[58]

One of the strategies implemented in Desert Storm was the destruction of a small number of political targets in the hope of decapitating the regime, leading to regime change or decision-making paralysis. However, political targets proved difficult to locate and strike effectively. Decapitation may have been unachievable and undesirable as there was no evidence that the death of Saddam Hussein would have resulted in the reins of power being taken up by someone with the ability or desire to unconditionally

withdraw the Iraqi army from Kuwait.[59] Saddam Hussein's regime was not decapitated and remained sufficiently in command of its forces in Kuwait to coordinate the orderly withdrawal of the Republican Guard from Kuwait.[60]

Targeting the adversary's systems for wholesale destruction is a strategy that has not been employed since Rolling Thunder in Vietnam. The destruction of organic essentials and infrastructure to debilitate the fielded forces was a central tenet of the strategic air offensives against Germany and Japan during World War II.[61] However, as this demonstrated, these systems are difficult to destroy entirely, requiring precision bombing, and having considerable capacity to absorb punishment and regenerating or finding alternative sources for inputs and resources and re-routing outputs.[62]

The destruction of the adversary's population, as genocide or ethnic cleansing, involves mass-murder, systematic terrorization and enforced relocation of an ethnic group and has been a feature of recent intra-state conflicts. Up to one million Muslims were expelled from their homes in Serbian-occupied areas in Bosnia between 1992 and 1994.[63] In Kosovo, Serbian security forces killed up to 10,000 and created an estimated quarter of a million refugees.[64] However, as the perpetrators of such crimes against humanity have discovered, not only it is extremely difficult and morally reprehensible to destroy a population entirely, it is illegal under international law.

Despite the perceived relative ease of finding targets for physical destruction as compared to targeting an adversary's will, the level of force and effort required means that physical destruction of a system may not be the cheapest, quickest, or even legal method of achieving political ends. Decapitation may remove the only means of establishing a dialogue with the adversary. Attempts to destroy command and control have not been effective and the destruction of lines of communication, particularly bridges, can impede the movement and resupply of friendly forces. The destruction of organic essential systems and infrastructure systems has some significant disadvantages for the state of the peace afterwards. For the resulting organisation to rebuild itself post conflict, those elements of the system that have been destroyed may need to be rebuilt rapidly. In addition, the mass casualties and extensive collateral damage that such economic warfare produces is increasingly politically unacceptable to modern western liberal democracies.

The horrific loss of life and cost in national treasure that fighting entails, illustrated by two world wars, has always stimulated the search for more effective ways of influencing the adversary's means and will by disrupting the output from these systems rather than to attempt a systems destruction by hard fighting.[65]

System disruption strategies

The connectivity between and within human systems is a vulnerability as well as the source of its collective outputs. An adversary's fielded forces are dependant upon outputs from the leadership, organic essentials, and infrastructure and population systems (see figure 6). System disruption strategies target a system's connectivity with the intention of reducing it below the level of minimum essential connectivity, not its destruction. At this point the functioning of the system is degraded to such an extent it is no longer able to deliver its outputs and the adversary will be denied the use of his fielded forces.

In all the case study operations, the disruption of the connectivity in the military C^2 activities aimed to deny the military system any enhanced combat effectiveness through integration. This is best illustrated by the efforts to deny the air defence output provided by an Integrated Air Defence System (IADS) in order to gain access to the rest of the military and other systems. In all cases, the IADS was disrupted by physical strikes on communication nodes, disruption of electrical power, and destruction of the early warning radar sites, surface to air missiles guidance radars and missile launchers, and sector operations centres. In all cases the IADS were driven into systemic failure in the first 48 hours, successfully forcing the adversary's air defences to operate autonomously, if at all, and permitting access to all the adversary's systems.[66]

In all three case studies, one of the strategies chosen was to target the infrastructure system to disrupt (interdict) resupply to the fielded forces. Military depots, storage facilities, supply infrastructure and transportation systems were attacked.[67] During Desert Storm, the Coalition substantially degraded supply capacities.[68] In Deliberate Force, this disruption strategy so successfully denied the Bosnian Serbs their essential war stocks that they seized UN Protection Force personnel as hostages and chained them to storage buildings in an effort to halt the bombing.[69] However, "anybody that does a campaign against transportation systems [had] better beware! It looks deceivingly easy. It is a tough nut to crack".[70] The Iraqis proved ingenious at using pontoon bridges, ferries, causeways, alternate routes, and underwater bridges to keep sufficient supplies flowing into theatre.[71] After achieving their initial objectives in Kuwait, they adopted a static posture, using stockpiled ammunition and diesel fuel sufficient for weeks or even months of combat.[72] There were some frontline units who experienced extreme shortages of food and water[73] but overall the Iraqi army was not defeated due to lack of supplies.[74]

During Operations Desert Storm and Allied Force, oil refining, distribution and storage facilities, and military production facilities were all struck by air power. The objective in targeting selected organic essentials activities was to cripple specific outputs; military materiel and refined petroleum products.[75] During Desert Storm the Coalition reduced oil refining capability by 93% and 20% of petroleum products held at refineries and major depots were destroyed. During Operation Allied Force, 50% of Serbia's war industries were largely destroyed. Oil refineries were targeted and petroleum reserves dwindled,[76] dual-use vehicle manufacturing plants and chemical industry plants were struck to deny the Serbian military resupply and reinforcements. The effectiveness of disrupting organic essentials is dependant upon the resupply requirements of the fielded forces; for example, the Iraqi army had limited resupply requirements, so disruption of organic essentials did not affect the fielded forces in any significant manner.[77]

An additional purpose of targeting electricity generation plants during Desert Storm and Allied Force was to disrupt power to the communication and information system that linked decision-makers and military commanders. The Iraqi electrical supply was reduced by 88%.[78] As with the attempt to destroy the C^2 system in Desert Storm, the attempt to disrupt C^2 was not effective in Allied Force, as Milosevic had sufficient control to withdraw the Serb forces from Kosovo promptly and in good order.[79]

Disruption strategies can be differentiated by the choice of system to influence, and the depth to which the system is disrupted. Disruption can be achieved without applying the same level of force as system destruction and potentially exposes fewer personnel to risk. Its effectiveness in denying the adversary his means can be decisive, as the disruption of IADS in all three case studies shows. However, the effectiveness of the disruption of C^2 and resupply to the fielded forces is entirely contingent upon the character, posture and intent of the fielded forces. As such, the use of a system disruption strategy needs to be matched to the military context.

System disruption strategies have been described only in terms of achieving purely Clausewitzian physical effects. However, "Physical force does not win a war, mental force does not win a war . . . what does win a war is the highest combination of these forces acting as one force".[80] Every activity in a human system is controlled by a cognitive component and all physical effects will inevitably have a psychological effect on the adversary's cognitive component. Therefore, system disruption strategies can initiate a cascade of physical effects that have psychological effects on the adversary's decision-making. System exploitation strategies seek to exploit the linkage between the activity and cognitive components in one of two ways; either by influencing the cost-benefit calculus of the decision-making process so that the adversary chooses an acceptable course of action, or manipulating the system's limited self-control capability.

System Exploitation Strategies
Cost/Benefit Manipulation

Within the cognitive component decisions are based on the decision-maker's perception and judgment of the costs and benefits of a course of action. A rational actor will adopt a course of action that maximises the benefits and minimises the costs.[81] System exploitation strategies seek to use national power to influence the adversary's cost-benefit calculus, either by dissuasion or coercion. In human system terms, dissuasion strategies involve the use of military power to block an adversary's course of action without actually imposing a cost on the adversary. The NATO operation in Bosnia prior to Deliberate Force was Deny Flight. This operation was intended to dissuade the Bosnian Serbs from attacking the Croats and Muslims simply by the physical presence of NATO forces between both sides of the conflict. Coercion is the employment of a system disruption strategy, but the primary aim is psychological effect, not physical influence. When the decision-makers are not rational, coercion may fail, as decisions are not made on the basis of cost/benefit analysis, but on some other basis. In these cases it may be necessary to adopt a system destruction strategy described earlier.

Both Operations Deliberate Force and Allied Force were primarily aimed at influencing the adversary's cost/benefit calculus by increasing the costs of continued action by the adversary. In the case of Deliberate Force, the coercion was applied almost exclusively by inflicting pain upon the Bosnian Serb Army. In the case of operation Allied Force, the coercion graduated from hurting the fielded force, to inflicting mild pain on the Serbian elite, to punishing Milosevic and his closest supporters.

Operation Deliberate Force aimed to influence the Bosnian Serb leadership's will using both military and political power. NATO specifically permitted sufficient connectivity between the decision-making leadership and the fielded forces so that the leadership had a complete and accurate picture of what was happening to its forces. This strategy was specifically aimed at influencing the adversary's will by exploiting the connectivity between cognitive and activity components, rather than specifically disrupting it. Air power disrupted C^2 sufficiently to ensure that the Bosnian leadership was unable to respond militarily to NATO's action, whilst still remaining in contact with its commanders in the field. Political power, (i.e. diplomacy), was interspersed with the use of military force to spell out the political terms the Bosnian Serbs would have to meet. The interplay between air and political power was at its most powerful when NATO 'paused' the operation on 1 September to permit diplomatic efforts between the Bosnian Serbs and both the UN and Ambassador Holbrook. When it became obvious that the Bosnian Serbs were not meeting the UN-NATO demands, Deliberate Force resumed. Ambassador Holbrooke observed "if the bombing had not resumed that day, the negotiations would have been very adversely affected".[82]

The Bosnian Serb government received a complete and accurate picture of the damage to its fielded forces and the message about the size of NATO's military power and its determination to use it. Initially, the Bosnian Serb Government discounted NATO's threat. NATO's efforts to destroy the Bosnian Serb Army's heavy weapons besieging Sarajevo were frustrated by the practical difficulties of locating, identifying and striking small, well-concealed and dug-in targets.[83] This reduced the credibility of the threat, as did the physical and moral support it received from the Serbian government. However, a decade of sanctions had taken its toll on the Serbians' morale and political cohesion[84] and convinced Milosevic to withdraw his support from the Bosnian Serb government in order to preserve his own political power in Serbia.[85] This loss of alliance cohesion caused the Bosnian Government to reassess its cost/benefit analysis of the situation, and, as the costs of its course of action rose, it was successfully coerced into agreeing to NATO's terms, despite having resisted them for so long.[86]

Operation Allied Force began as an attempt to coerce Milosevic by hurting his security forces in Kosovo. NATO's efforts to destroy the Serbian Army's heavy weapons in Kosovo simply drove them into hiding,[87] making subsequent attacks largely ineffective. Milosevic was not coerced by the disruption of his fielded forces or the systems

providing support to them and the Serbians managed to sustain their ethnic cleansing action.[88] NATO decided to exploit the links between the Serbian political and social systems. A decade of sanctions had caused a significant stagnation in the Serbian economy; per-capita GDP roughly halved to £8,000 year and unemployment was about 50%.[89] The electricity grids were severely damaged, 85% of Serbians had limited electrical power, and the water supply to Belgrade was under threat.[90] The business premises owned by Milosevic and his closest supporters were destroyed and income from smuggling activities was reduced, quite unintentionally, by the destruction of bridges. NATO's actions increasingly threatened to bankrupt the Serbian elite, who, in response, sent their families out of Yugoslavia and put considerable pressure on Milosevic to capitulate.[91]

In Milosevic's cost/benefit calculus, the decision by NATO's leaders to forgo the threat of a ground invasion meant that NATO's threats were not credible.[92] The mounting damage caused by the air campaign, NATO's increasingly convincing statement about a ground invasion and increasing internal political pressure, gradually raised the cost, to Milosevic's position of power, of holding on to Kosovo. Additionally, his failure to destabilise neighbouring countries or split the alliance[93], signalled to Milosevic that the tactical tide was turning against him[94] and his own defeat was inevitable.[95] Milosevic decided that he did not value Serbian control of Kosovo above his own survival.[96] As with operation Deliberate Force, the support of Serbia's Russian ally played a key role in the outcome of Allied Force. Initially, Russia was a strong supporter of Milosevic, but as the conflict progressed, Russia grew increasingly willing to co-operate with the US in the pursuit of a diplomatic solution.[97] Possibly the final straw was Moscow's silence in response to the indictment of Milosevic for war crimes on 25 May 1999. This eliminated any remaining chance that Russia might change course and resume its support for him.[98] Capitulation became his best course, both to minimise further damage to Serbia and its military and secured his position in power while NATO and the UN were still willing to talk with him.[99]

As all the adversary's systems have a cognitive component, they are all liable to psychological influence. During Desert Storm, some Iraqi power plant managers took their plants off-line in a pre-emptive move in order to preclude damage[100] and the Coalition specifically planned to convince the Iraqi population to rid themselves of the Ba'athist regime by disrupting the electrical and telecommunications facilities. This was supposed to demonstrate to the people of Baghdad that the Iraqi president was powerless to counter the US air offensive. Planners wanted to "make [every Iraqi household] feel they were isolated . . . [we] didn't want [the Iraqi people] to know what was going on".[101] There is no hard evidence that using air power to turn out the lights in Baghdad broke the population's will or affected the population's attitude toward Saddam and his regime in any significant manner.[102]

In operations Desert Storm and Allied Force, considerable efforts were made to apply psychological pressure on the decision-making calculus of all individuals in the fielded forces. In addition to heavy bombing of ground formations with substantial numbers of dumb bombs to create fear, more overt psychological pressure was exerted through leaflet deliveries and television and radio broadcasts.[103] During Desert Storm up to 100,000 troops, 30% of Iraqi soldiers, deserted.[104] During Allied Force troop desertion rates reached 300+ per day and an increasing numbers of Yugoslavs evaded reserve call-ups.[105] Post WWI strategists like Douhet and Mitchell advocated bombing centres of population in the belief that the fear that this would cause would make the people force their governments to give in. However, the bombing of major cities in WWI and WWII failed to break the will of the people[106] and the deliberate targeting of non-combatants is illegal under international law, although this is a core strategy of terrorist organisations.[107]

Systemic paralysis

A system paralysis strategy aims to exploit the system's self-regulation capability by overwhelming it.[108] Boyd provides an excellent description of how this effect is achieved in his OODA loop model. In the context of the Human

System model, the 'menacing environment' that Boyd desires is achieved by using air power to disrupt outputs. The disruption of an output will propagate to all downstream activities and indirectly affect the downstream activity through the input and resource dependencies. Indirect physical effects may also cascade upstream as those upstream activities are affected by the changes in the use of their outputs. More importantly, the cognitive component will start to receive performance information about changes in outputs and will try to match the pattern of changes to those learnt or experienced before.[109] Based upon the degree of match, the cognitive component will make a judgement about what is happening and decide how to adjust outputs in response. "Rapid and repeated combinations of ambiguous, but threatening effects and deceptive, but non-threatening ones"[110] will reduce the accuracy of the match and lead to increasingly inappropriate responses. If the speed at which the cognitive component process information falls below the speed at which it receives it, decisions are more and more likely to be out of touch. Inappropriate controls will result in mismatches between inputs, outputs, controls and resources that the adversary must eliminate if decisions are to result in actions that enable him to adapt to such an environment. If the adversary cannot do this, his reactions become totally inappropriate to the situation and paralyse his ability to reorientate to a rapidly changing environment.[111] The inevitable consequence of failure is chaotic behaviour in the activity component, and decision-making paralysis in the cognitive component that will result in defeat.

Model summary

Each case study operation used air power to prosecute one or more of the strategies described. In all cases air power's kinetic effects were used, either just for physical effects, or to initiate a cascade of physical and psychological effects. Peace support operations appear in the conflict continuum, but were not specifically covered in the case studies.

Despite the concentration of air power roles on offensive capability, air power plays a critical, non-combatant role in these operations, where its speed and reach make it ideal for the rapid deployment and projection of national power at the strategic level. Thus, using the human systems model approach, the separate theories for the employment of air power can be viewed as specific zones of a continuum of strategies to influence an adversary through will and means, using high or low levels of national power (See figure 8).

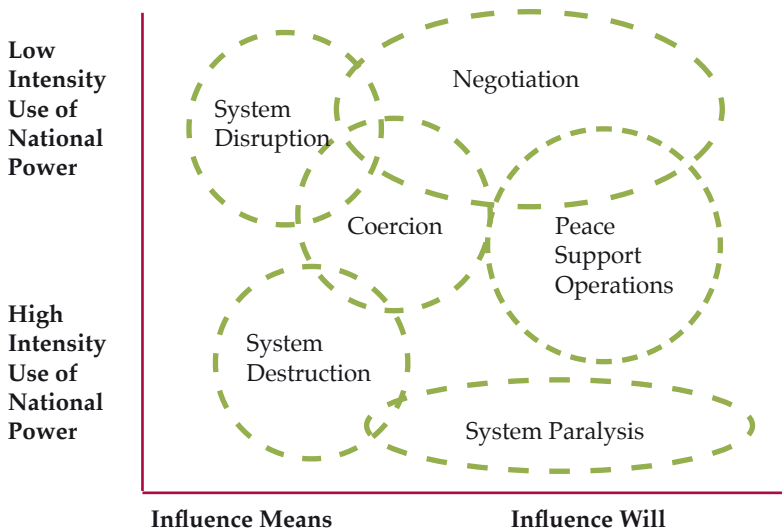


Figure 8.
Spectrum of conflict: The continuum

Effectiveness of focusing air power on an adversary's means

The effectiveness of air power across the range of strategies employed in each of the case studies operations is summarised in Tables 1a and b. Both tables show the same data. In *Table 1a* the data is organised by operation, summarising the effectiveness of combining strategies in an air campaign, and in *Table 1b*, the data is organised by strategy, summarising the effectiveness of air power when employed in each strategy. This summary indicates that air power is effective in system destruction strategies when focused at the operational level, for example, air power successfully destroyed the Iraqi Army in Kuwait

during Desert Storm. Air power was effective because the structure of modern military systems is relatively well understood and air targeting and precision weapon systems are optimised for finding and applying kinetic effects to the military hardware elements of the system. Hardware is capital intensive to replace and destruction has a high degree of effectiveness. During Desert Storm direct physical effects accumulated to have a decisively destructive effect on the function of fielded forces at the operational level. However, this required an enormous military effort. At the strategic level, destruction of military hardware was less effective, for example, the failure to destroy Iraqi WMD and Scud missile systems. This is indicative of the difficulties of using air power in a destruction strategy against systems, or parts of systems, where elements are few, well protected and information about them is extremely limited.

Attempts to use air power to destroy non-military systems also appear to be relatively ineffective. In human system terms, the number of elements in these non-military systems can be vast by comparison to a military system and the links between elements resemble a network, rather than a hierarchy, which means that connectivity is robust. Therefore, significantly more air effort is required to destroy enough elements or links to disrupt the connectivity in non-military systems. Furthermore, the military weapon systems are not optimised for influencing the non-military, the structure of these systems is not well understood and can vary considerably from society to society, and concerns about collateral damage limit the level of force that can be brought to bear on non military systems which significantly limits the potential effectiveness of system destruction strategies. The effectiveness of employing air

Operation	Strategy	Leadership/C2	Organic Essentials	Infrastructure	Population	Fielded Forces
Desert Storm						
	System Destruction	N	N	N		Y/N
	System Disruption	Y/N	N			Y
	Cost/Benefit Exploitation	N	N		N	Y
	System Paralysis	N				
Deliberate Force						
	System Destruction					
	System Disruption	Y	Y	Y		Y
	Cost/Benefit Exploitation	Y		Y		Y
	System Paralysis					
Allied Force						
	System Destruction					
	System Disruption	Y/N	N	N		
	Cost/Benefit Exploitation	Y	Y	Y	Y	
	System Paralysis					

Table 1a.
Summary of effectiveness of system strategies (by operation)

Strategy	Operation	Leadership/C2	Organic Essentials	Infrastructure	Population	Fielded Forces
	Desert Storm	N	N	N		N/Y
	Deliberate Force					N
	Allied Force					
System Disruption						
	Desert Storm	N	N			Y
	Deliberate Force	Y	Y	N		
	Allied Force	N	N	N		
Cost/Benefit Exploitation						
	Desert Storm	N	N		N	Y
	Deliberate Force	Y				Y
	Allied Force	Y	Y	Y	Y	
System Paralysis						
	Desert Storm	N				
	Deliberate Force					
	Allied Force					

Table 1b.
Summary of effectiveness of system strategies (by strategic approach)

Key to both tables
'Y': Strategy attempted & effective
'N': Strategy attempted & not effective
'Y/N': Strategy attempted & effective at one level of war, but not effective at another

power in a system disruption strategy was also variable. At the operational level, air power was very effective when focused upon elements of a military system integrated primarily by information outputs, for example, the successful disruption of IADs in all three operations by targeting early warning and surface to air missile sites and C^2 nodes. However, when applied to organic essentials and infrastructure systems to deny fielded forces resupply, disruption strategies were much less effective, due to the self-sufficiency of the adversary's military system, their ability to repair or regenerate elements of the infrastructure and the impermanence of air power.

Effectiveness of focusing air power on an adversary's will

The analysis indicates that focusing air power on influencing the adversary's will by manipulating his cost/benefit calculus was very effective at the strategic level, for example, the coercive effect of damaging industries owned by Milosevic's closest supporters in Allied Force. However, aerial coercion was not effective when combined with system destruction strategies, for example, the combination of aerial coercion and decapitation strategies was not effective during Desert Storm. In the context of the Human system model, the aerial coercion process uses three stages of effects in a cascade.[112] Direct physical effects are applied to an element of the system. The neutralization, disruption or destruction of this element has an effect on the function of the activity related to the element. In turn, this functional effect may have an indirect physical effect on activities that use the output(s), or provide inputs and resources to the affected activity. These direct and indirect physical and functional effects alter the performance information fed to the cognitive component, where it has a psychological effect

(see figure 9). Contrary to Pape's assertion, both military and non-military coercion appear to be effective. In Deliberate Force, the combination of direct physical effects on the military system with diplomacy resulted in a cascade of effects sufficient to coerce the Bosnian Serb government. In Allied Force, although the same combination was not effective, the cascade process was successful when direct physical effects were applied against those system elements most highly valued by Milosevic. In the context of the human systems model, the cognitive component must have sufficient connectivity with the activity components to receive, understand, and act upon a coercive message, and be sufficiently dependent upon the activity component for its disruption to influence the cost/benefit calculus. Killing political leaders or destroying strategic and operational C^2 systems will not facilitate an aerial coercion campaign because it removes the necessary link between the activity being targeted and the decision-making cognitive component. The same principle applies to the use of air power to achieve system paralysis. Paralysis was a military objective of the Desert Storm campaign, but although air power was employed in a parallel and simultaneous manner,[113] with the intention of employing an effect-based campaign, it became an exercise in servicing a target list as planners did not wait for actions to take effect.

Importance of effects cascade and centres of gravity

On of the advantages of the Human Systems model over Warden's five-rings model and Boyd's OODA loop is that it provides a tool for predicting the route of cascading of physical and psychological effects, as they must travel along the links between activities and the activity and cognitive components. (see figure 9).

Planners can 'shape' the effects of air power by knowing which elements and links need to be preserved for the effects cascade and which need to be disrupted to initiate it. Effects must be shaped to influence the CofG consistent with the desired political objectives. Analysis of elements and links is necessary to identify their relative importance to the CofG, their vulnerability to kinetic and non-kinetic effect, and the permissibility of applying national power against them.

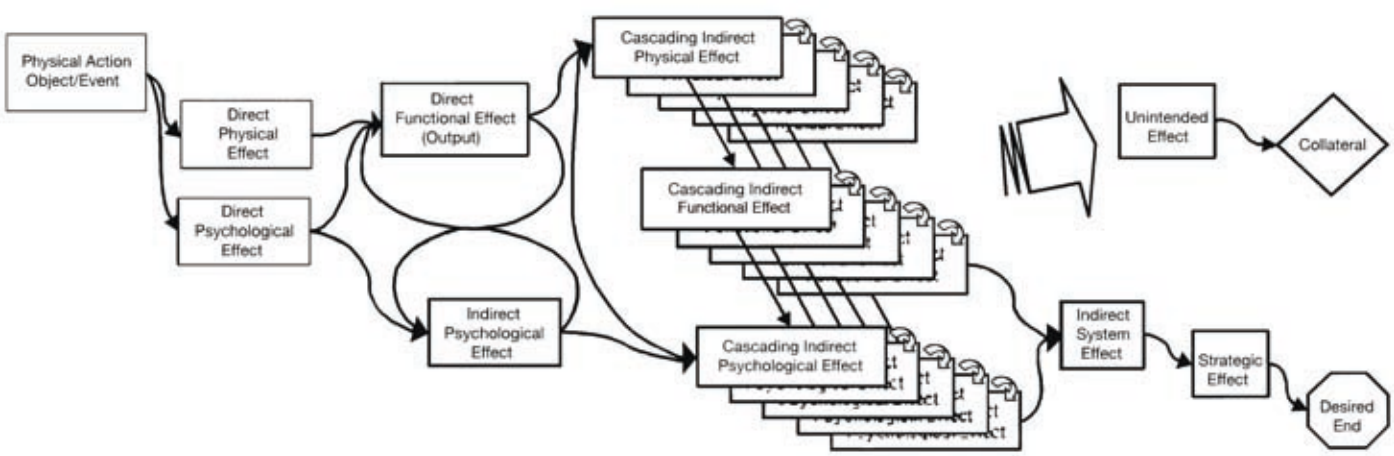


Figure 9.
The effects cascade (Source: Adapted from Smith 2002), p. 317 and Enderby et al 2002, p. 33)

Overall, focusing air power on influencing the adversary's means is a less effective use of air power that influencing the adversary's will, because its effect is primarily constrained to the operational level. Air power was particularly effective when the effects created by its employment were able to cascade through the adversary's systems. However, the complexity and non-linear response capability of human systems mean that it is very difficult to analyse the effects cascade and the adversary's strategic response. This analysis differs slightly from Operational Net Assessment (ONA) in that the primary focus of ONA is on the targeting of physical nodes to achieve effects, whereas the Human Systems approach is focused on understanding system activities and outputs; the selection of physical targets occurs after the desired effect cascade has been selected. Both forms of analysis require a very high level of information about the adversary. Sun Tzu's dictum "know the enemy and know yourself; in a hundred battles you will never be in peril"[114] ring even truer in the modern age. The human system model indicates that the most effective way to employ air power is to approach each adversary as a unique rather than generic opponent, conduct detailed analysis of his systems to identify the inputs, resources and decisions that are critical requirements for the CofG, and tailor a campaign plan aimed at attacking his critical vulnerabilities that enable the application of air power to have decisive effect.[115]

Conclusion

The utility of the human systems model

The human systems approach is an all-encompassing construction offering an explicitly holistic view of the adversary as systems, links and elements. The model also provides a conceptual framework for understanding the cascade of direct and indirect physical and psychological effects through systems. This provides the starting point for detailed campaign planning by helping planners categorise the elements and links of an adversary's system. This enables them to visualize the CofGs that may exist at the strategic, operational, and tactical levels. Campaign planners can then analyse critical capabilities, requirements and vulnerabilities and conceive means to influence them in a way that will achieve political objectives.[116] Political objectives and the properties of the CofG guide the selection of national power needed to induce effects, and the level of force to apply, if any. The range of strategic options identified by the human systems model, and their varying effectiveness, indicates that it is important that the application of force on a critical vulnerability can be directly linked to influence on a CofG. In turn, the disruption, destruction or neutralization of a CofG must be coherently linked to the desired political objectives.[117] A key strength of the human systems model is that the interdependence of the cognitive and activity components overcomes the tendency of Warden's approach to assume that a 'template' campaign can be applied to any adversary. Implicit in Warden's model that an adversary will comprise broadly the same systemic construction as the United States and that the adversary's systems are 'static', unresponsive. The human system model inherently assumes that an adversary's systems are unique and can respond to attempts to influence it. This requires military planners to anticipate the dynamic interaction of friendly and adversary power and likely adversary courses of action. Finally, it overcomes the criticism of Boyd's OODA Loop model that it provides no practical guidance for the implementation of coercive or paralysis strategies. However, the human system model provides guidance on what has to be done, but the how — the operational art — is still the preserve of the commander's judgement.

More effective application of air power

Air power's three more recent tests, the Gulf War, Bosnia and Kosovo, represent different zones of the spectrum of conflict and the analysis indicates that no one air power theory alone exemplifies the panacea of air power. They need to be combined and tailored using the Human Systems framework. Air power can be precisely targeted and its primary emphasis on kinetic weapon seems to make it a useful instrument for influencing an adversary's means. However, strategies that focus air power exclusively on the adversary's means make the assumption that physical means can be completely destroyed. This requires the destruction of all the elements in the system, or the

disruption of all the links in order to be decisive, because the cognitive component will always seek to adapt and overcome. As long as the adversary has the will to resist, he will, with whatever means at his disposal. Disruption or destruction of fielded forces promises a long war of attrition and ignores the inherent flexibility of air power. Deliberate Force and Allied Force highlighted the limits of air power effectiveness in targeting enemy forces, especially in the absence of a supporting ground threat. Air power can effectively disrupt systems that rely upon a very high degree of electronic communications to integrate their outputs because air weapons are optimised for this type of effect. Consequently, air power should only be focused on system destruction strategies after careful assessment of the system against the political objectives to ensure cohesion between ends and means, and that system destruction is a proportional response to the causes of conflict.

Aerial coercion was effective, but only in combination with either diplomatic power, or the presence of ground forces, and aerial coercion air power seems to be a somewhat blunt instrument for influencing the adversary's will.[118] Conversely, air power's inherent capability to deliver parallel and simultaneous effects at the strategic, operational and tactical levels and use precision kinetic and non-kinetic weapons means that it is well suited to the application of military power to influence the adversary's will. Both coercion and paralysis require effects to cascade though the adversary's systems, and are, therefore, likely to be incompatible with system destruction strategies in the same campaign. This incompatibility, and the necessary difference in operational tempo between coercion and paralysis strategies, means that military planners must rigorously address the coherence of political objectives, CofGs and operational means before and throughout a campaign. Using air power to manipulate the adversary's cost/benefit calculus, or paralyse his cognitive and activity components fundamentally assumes that sufficient connectivity can be found to disrupt. It may not, either because although it exists, there is insufficient information to discern its form, or the adversary has specifically minimised internal linkages, such as is the posited model of Al Qaeda organisation.

Where connectivity cannot be found, systemic exploitation cannot be planned, and influencing means is the probably the most viable option until better information reveals the details of the adversary's systems.

The human systems model is a contribution to thought regarding the effective employment of air power. It conceives air power as part of effects-based operation planned in a systems framework exploiting links and elements to influence the adversary's means and will. It considers the full range of direct, indirect, and cascading physical and psychological effects, which may be achieved by the application of political, economic and military power against a CofG's vulnerabilities.[119] The human systems model strives for a better understanding of the contribution that air power makes to war fighting and the means by which that contribution adds value to the military endeavour. It builds upon earlier models, but it is by no means the end.

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1 Clausewitz (1832),p.593
2 Krepinevich (1994)p.36
3 Forster(1995),p.9
4 For examples See Kaplan (1996) and Ignatief (1999),pp.43-61
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6 Strategic Defence Review(SDR),(1998), SDR New Chapter(2002), Defence White Paper(2003)
7 Defence White Paper,(2003),p.4 and Supporting Essay 2
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10 Fuller,(1925),p.96
11 Clausewitz(1832),p.97
12 ibid,p.228
13 ibid,p.228
14 Warden,(1995),p.43
15 For details of the 3 ways in which AP3000 3rd Edition uses the term strategic effect.See Lock-Pullen,(2002)pp59-67
16 See British Military Doctrine,(1996),pp.4-9 to 4-10
17 See Warner,(1943),pp.485-501 for a discussion of theories of air warfare by Douhet, Mitchell and Seversky
18 Warden,(1995),p.49
19 Ibid,p.49.
20 Pollock,(2000),p.448
21 Warden used the human body as an analogy with leadership representing the brain. Hence, by removing or neutralizing leadership, one is "decapitating" the enemy.
22 Fadok,(1997),p.373
23 Warden,(1995),p.46
24 Mielinger(19917)
25 Pape,(1996),p.97
26 Ibid,p.95
27 British Military Doctrine,(1996),p.4-15
28 Sun Tzu(6th Century BC),pp.77 &79
29 Lind,(1979),p.22
30 An operational example of Boyd's ideas is the Russian concept of the 'udar' (operational shock) to be carried out by the 'opertivnaia manevrennaia gruppa' (Operational Manoeuver Group), a soviet combined-arms team of raiders, paratroopers, and diversionary units designed to split enemy formations from within by operating in the enemy's depth. See Naveh,(1997), pp.64-167 & 257-260
31 Ibid,p.97.
32 Pape,(1996),p.4
33 President Bush,(1990)
34 UN Security Council Resolution 660 and 661
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36 Bacon, Kenneth H. DOD news briefing, 23 March 1999. See http://www.defenselink.mil/news/Mar1999/t03231999_t0323asd.html. Accessed 20 Jan 2004.
37 Clarke,(2001),p.245
38 The targets of "unique strategic value" included national command and control facilities; infrastructure such as bridges, POL production, and communications and, later, Serbia's electrical power grid. See Grant,(1999),pp.30–37
39 That is to say that, working together, the elements produce something greater than if the activities worked in isolation See Wilson,(1990),p.24
40 Warden,(1995)

41 Wilson,(1990),pp.24-28
42 FIPS PUB 183,(1993),pp37-42
43 FIPS PUB 183,(1993),pp37-42
44 Wilson,(1990),p29
45 This is in sharp contrast to Warden's 5 ring model, which had a rigid hierarchy between the systems See Warden,(1995),p.47
46 More detailed illustrations are at Appendix 1
47 FIPS PUB 183,(1993),pp37-42
48 Strange,(1996), p43-92, for a detailed analysis of critical capabilities, requirements and vulnerabilities.
49 Echevarria,(2003),p
50 Clausewitz,(1832),p.976
51 Ilachinski,(1996),pp.139-140
52 Rosenau,(1997),p.83
53 Ibid,p.86
54 Wilhelm,(1998),pp,1-3
55 Fuller,(1925),p47
56 Hosmer (1996),pp141–76. &153,
57 Despite claims that Iraq's nuclear, biological, chemical weapons programmes had been destroyed by six weeks of bombing, the United Nations team soon discovered that more than 100 Scud missiles survived, as was as missile production equipment, and at least 19 mobile launchers, and components from new, two-stage missile. In addition, 70 tons of nerve agent and 400 tons of mustard gas also escaped destruction. Atkinson,(1993), p.496
58 However, even after the conflict, Iran did not return many of the Iraqi aircraft that successfully sought refuge across the border. Though the exact number is questionable, these must be counted as physical attrition for the Iraqis even though the actual aircraft were undamaged. GWAPS, vol. 2, pp127-129 & 153–56.
59 Watts et al,(1993),p27
60 Mark.(1994),p224 and Pollack,(1996),pp.548–55.
61 Gorrel,(1978),p.143.
62 Meilinger,(1997),p.60
63 Burg et al,(1999),p.171
64 Daalder et al,(2000),p.193
65 Liddell Hart,(1943),p.21
66 In each operation low level air operations were still prevented by the proliferation of hand held surface to air missiles and anti-aircraft artillery
67 Daalder et al,(2000),p.200
68 GWAPS(1993),vol.II,PtI,p.188,192 and 200. These GWAPS references discuss specific calculations in "tons per day" and how the capacities varied over the course of the conflict
69 Beale,(1997),p.33
70 General Horner, cited in Beagle,(2001),p.62
71 GWAPS,(1993),vol 2,Pt 2,p.201
72 Mark,(1994),p.311
73 Ibid,pp.197–200.
74 GWAPS,(1993),vol.2,pt.1 p.194,p.371.
75 GWAPS,(1993), vol.2,pt.2 p5, vol.2,pt.1,p.40,44
76 Daalder et al,(2000),p.201
77 GWAPS,(1993) vol.2,pt.2,p.201
78 Warheads filled with special carbon-fiber wire detonated over switching stations and high-power lines at Iraqi electrical power plants, causing massive short circuits. By mid-1992 Baghdad's main generator back to 90%. See GWAPS (1993) vol.2,pt.2,p.37
79 Clarke,(2001),p.406
80 Fuller,(1925),p.145
81 Allison et al,(1971),p.16-18,143
82 Owen,(Ed),(2000),p.114
83 Pollock,(2000),p.445 and Beale,(1997),p.37
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89 Daalder et al,(2000),p.201
90 Lambeth,(2001),p.79
91 Daalder et al,(2000),p.4 and Lambeth,(2001),p71
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93 Daalder et al,(2000),p.202,Judah(2000)o.271 and Lambeth,(2001),p-xiv
94 Daalder et al,(2000),p.202
95 Lambeth,(2001),p-xiv
96 Judah,(2000),p.231
97 Daalder et al,(2000),p.5,Judah,(2000).pp.272-279
98 Lambeth,(2001),p.70
99 Daalder et al,(2000),p.5 & p.206, Clarke,(2001),p.326
100 GWAPS,vol.2,Pt.2,p.37
101 Beagle,(2001),p.54
102 GWAPS,(1993),vol.2,Pt.2,p.28
103 AWOS Fact Sheet,(2000),pp.6-8.
104 Hosmer,(1996),p.153
105 DOD news briefings,(1999)
106 Clark2,(2003),p.3
107 Davidson Smith,(1990),pp.11-15
108 Lind,(1979),p.22
109 Robbins,(1993),pp.133-160
110 Fadok,(1995),pp.13-20
111 Lind,(1979),p.56
112 Smith(2002)
113 Deptula(2001),pp.2-6
114 Griffith,(1971),p.84
115 Strange, op cit
116 Pollock,(2000),p.437
117 Pollock,(2000),p.443
118 Lambeth,(2001),p.xxiv
119 Davis,(2001),p.7

F-15 Eagles overfly the tracking station at Kaena Point on the island of Oahu, Hawaii

From simplistic assurances of NEC to optimistic promises of NCW:

More pitfalls than promises?

By Wing Commander A C Chopra

To reduce the costs of conflict, mankind has incessantly pursued means to achieve quick decisive victories. In the past this was achieved by superior firepower. However, proliferation of modern weaponry and asymmetric methods has substantially reduced this differential with the costs of war reaching unacceptable proportions. To regain the decisive edge it is necessary to exploit the capabilities offered by Network Centric Warfare (NCW).

NCW demands information on all battle space entities. In a network centric environment, all platforms will need to communicate with each other. This necessitates the ability of each platform to transmit and receive information and the existence of common communication protocols.

While the prospects offered by it are promising, the path ahead is unlikely to be easy or straightforward. This paper visualises the promises of Network Centric Warfare and explores the hurdles in achieving the capability. In the process this paper reaches the conclusion that while most hurdles imposed by technology may be overcome, the hurdles imposed by humans in the network centric loop will eventually limit our aspirations from Network Centric Warfare.

"Look around. No 'good old-fashioned war' is in sight."
(John Arquilla and David Ronfeldt)[1]

"A vision without the means to execute is just a hallucination."
(Stephen Case, Founder of AOL)[2]

"Predicting the future is an enterprise with a very poor record unless predictions are so broad as to be useless for setting priorities"
(Col John Jogerst)[3]

The aim in all conflicts is to achieve quick decisive victories at minimal cost. In the past, the 'edge' enabling such a victory was usually provided by superior firepower and warfare centred on the niche capabilities of individual weapon platforms. Such form of warfare was 'platform centric'. The proliferation of modern weaponry and asymmetric techniques has reduced the decisive edge offered by platform centric warfare. This edge may be regained if synergy is generated on the battlefield by enhanced cooperation between weapon platforms. The military 'behaviour' that personifies such cooperative behaviour is referred to as Network Centric Warfare (NCW). NCW is characterised by geographically dispersed forces possessing high levels of situational awareness which is generated by linking them to each other and the exploitation of this advantage to generate high tempo on the battlefield.[4]

NCW promises to generate efficiency and synergy between fighting elements, increase tempo of operations, improve time sensitive targeting, reduce possibility of fratricide and increase flexibility in operations

The term NCW is a broad-based concept and may be viewed from different perspectives; therefore it is essential to clarify some issues surrounding the term. United States uses the term NCW, while the United Kingdom uses the term Network Enabled Capability (NEC) to essentially refer to the same basic underlying concept of waging war. However, the difference between the two is that the US is not budget limited, while UK tends to view the concept on a more cautionary note due to its resource limitations.[5] In this paper these terms will be used on a general basis, without the subtleties of either countries approach prejudicing the basic concept. In addition, terms such as Dominant Manoeuvre, Precision Engagement, Full Dimension Protection and Focussed Logistics etc — which have come to vogue and tend to unnecessarily obscure simpler concepts — will be deliberately avoided in this in order to clearly grasp the concepts of NCW.

In simple terms, NCW promises to compress Boyd's Observation-Orientation-Decision-Action (OODA) cycle such that friendly forces sustain high tempo of battlefield operations. It does this by providing force elements with large amounts of correlated information so as to develop high levels of shared situational awareness amongst them (Observation & Orientation). This increase in knowledge levels on the battlefield then permits informed decision making (Decision) and also generates a common understanding of the commander's intent among all fighting elements, so as to achieve effective cooperation between them (Action).[6] In addition to the compression of the OODA loop, NCW promises to garner advantage from enhanced information access to permit 'smarter' behaviour and efficient use of war fighting resources thus allowing faster and more flexible responses to emergent battlefield situations. It is not a new concept and may be broadly viewed as the emerging military response to the information age.[7]

However, the challenge lies in distinguishing the theories behind NCW from how it will actually be practiced, as the practical application of a concept may impact on the concept itself and the result may distort the original intent.[8] This is

As the tools of war increasingly become market-place commodities, who can make war — and how and when — is changing. Proliferation of modern weaponry and information technology has made war like a game of chess

An Iraqi rebel carrying a portable rocket launcher

an important aspect of the issue, because NEC concepts are still in their infancy and likely to evolve further. However, at this stage a few issues are clear. NCW promises to generate efficiency and synergy between fighting elements, increase tempo of operations, improve time sensitive targeting, reduce possibility of fratricide and increase flexibility in operations. It aims to achieve this by generating synergy from cooperation between war fighting elements and exploiting advantages from information superiority. While the intention appears to be clear, there are subtle problems in the path of achieving fully-fledged Network Centric Operations (NCO). Inherent in the path lie problems associated with network security, information overload, command and control structures, interoperability of equipment, bandwidth requirements, lack of appropriate doctrines and increasing erosion of traditional war fighting skills due to over reliance on the promises of nascent technology.

It is easy to fall prey to the promises offered by technology alone. Co-evolution of doctrine must follow; support of legacy systems for their life span needs to be ensured, migration costs need to be carefully apportioned and importantly interoperability within and with external coalitions needs to be maintained. The course of action to possessing a NCW capability must be carefully protracted such that NCW remains a process to achieve an end and not an end in itself. If this is to be realized then it is important to understand what NCW is all about, what it promises to achieve and the problems that may arise in the process of acquiring such a capability. This paper addresses these issues and determines that many technological and human factor hurdles exist on the route to gaining a NCW capability. While the technological hurdles may be eventually overcome human factors in the network will eventually limit our aspirations from NCW. To find out why, we need to determine why NEC is required and how it will affect future operations.

Warfare takes on the characteristics of its age.[9] In the wars of the past, massed armies faced each other over linear battlefields. The Napoleonic model (Corps-Division-Brigade-Regiment-

Battalion-Company-Platoon),[10] a highly institutionalised system, was suited to such warfare. Modern war has changed. The battle space is no longer linear. It has extended by virtue of the increase in number and variety of targets of interest and their dispersion.[11] The presence of weapons of 'effects' capable of reaching across long ranges complicates how battle is viewed and conducted. As the tools of war increasingly become market-place commodities, who can make war — and how and when — is changing.[12] Proliferation of modern weaponry and information technology has made war like a game of chess, where everyone has the same pieces and can see the same battle space. The winner is the one who can make the best use of his pieces.[13] This changing nature of war and its participants needs to be addressed because a stagnant military

While vast amounts of information were collected by the coalition they were unable to effectively analyse it to generate a coherent picture of the battlefield. The inability to do so resulted in fratricide, the second highest cause of coalition casualties

A US Army Bradley fighting vehicle destroyed by friendly fire during the Persian Gulf war

force, inflexibly resisting change in its means and methods of war fighting, is likely to be easily defeated by an innovative adversary.

While it is accepted that wars are inevitable, the increasing costs of war are not acceptable. Wars of attrition and exhaustion are no longer tolerated. Wars may be fought but they have to be fought more efficiently. As the ability to wage war is a function of the available 'means' and 'will'[14] and the differential in 'means' between adversaries diminishes, warfare predictably results in severe attrition on both sides. To avoid the costs of such attritional warfare, smarter techniques such as Effects Based Operations (EBO) constantly explore alternative means of defeating the enemy.[15] As the cause and effect nature of EBO are complex, EBO rely intensively on large amounts of diverse intelligence in an attempt to determine what may be targeted, the existence of accurate success indicators and the chain of cause and effect that reach back to the adversary's ability to wage war. The need to collect, analyse and disseminate intelligence to share knowledge for EBO thus naturally leads the path of evolution of warfare towards 'network-centricity', i.e. the ability to easily share information. This ability to share information by networking will form the essential backbone of NCW. However, this is just the first step and brings up the issue of what more can be offered by NCW. A quick look at some recent conflicts throws light on the subject.

During Op Desert Storm, the Air Tasking Order permitted de-confliction and orderly management of air targeting, but did not permit near real time targeting due to its inflexibility in responding to the changing battlefield. Similarly, while vast amounts of information were collected by the coalition they were unable to effectively analyse it to generate a coherent picture of the battlefield. The inability to do so resulted in fratricide, the second highest cause of coalition casualties.[16] Thus, Op Desert Storm did not witness any sustained information management and exploitation. On the other hand, during Op Enduring Freedom, data services, iridium satellite communications and web-based services such as email were key enablers in the conflict.[17] In the austere environment in Afghanistan the need to network and the advantages of such networking allowed the coalition forces to deal with fleeting targets.[18] The ability to 'see' the battle space allowed the Commander in Chief Central Command to run the war without a Joint Tasking Commander from 7,000 miles away in Tampa.[19] Thus, in sharp contrast to Op Desert Storm, Op Enduring Freedom witnessed the military exploiting the advantages of networking and sharing information between widely dispersed assets. A careful look at the two conflicts clearly brings out the emerging realisation of the value of sharing information. This issue of value is imbued in Metcalfe's Law.

Metcalfe's law observes that although the cost of deploying a network increases linearly with the number of nodes in the network, the potential value of a network increases as a function of the square of the number of nodes that are connected on the network. To understand this concept of value more clearly, take the example of present day communication networks and what they offer. These networks range from traditional mail, telephones, fax machines, email and the multimedia-based World Wide Web. If the services offered by each is scaled on the values of full duplexity, service reach, visual experience, timeliness of information transportation, availability, capability for multi-actor participation, audio experience and search facilities, it may be noted that in the order presented above, each network in sequence presents an increasing value to the user in terms of 'richness' of the interaction and a better understanding of the content of what is communicated. The understanding of this concept of value is fundamental to understanding the power of NCO.[20]

Having understood the relationship between value and networks, it is now pertinent to take a look at how such value from information flow may mitigate the effects of 'fog' and 'friction' in war. It may be recalled that 'fog of battle' is about the uncertainty associated with what is going on, while 'friction of war' is about the difficulty in translating the commander's intent into actions.[21] In one way or another, either one relates to

Even if the intelligence gathered is accurate and relevant but cannot be timely disseminated and received, it has no value in dynamic battle space. Networking will therefore provide the crucial link in insuring an information advantage by providing timely transportation of accurate and relevant knowledge at all levels within battle space

availability of information at all levels in war. For example, the lack of information on an adversary's order of battle (ORBAT), its movements and intentions can lead a Commander to take a wrong decision. Similarly, lack of knowledge on the information upon which a commander's decision is based can lead lower formations to take actions out of line with the commander's intent. Both fog and friction may be alleviated by ensuring the availability of accurate, relevant and timely information with all force elements by interconnecting them. This achievement of information advantage will be one of the first priorities of NCW.

The author believes that accuracy of any piece of information is related to the amount of 'surrounding' information that can be gathered and on the manner in which it can be co-related or fused into knowledge in order to build a more wholesome 'picture'. The larger the amount of information that can be gathered and fused, the greater the accuracy of the final 'picture'. Similarly, relevance of information is important and pertains to determining when a piece of information may be useful. Knowing when a piece of information is relevant depends on knowing the context of the battle space and the knowledge of the context of the battle space is a function of the amount of information available on it. So, firstly, it may be said that to develop an accurate and relevant picture of the battle space there is a need to continuously gather information and fuse it into knowledge. Secondly, relevance of information is related to the ability to retrieve the intelligence from the gathered information when it is required and also relates to the ability to extract intelligence from the knowledge base on the basis of the context of the battle.

However even if the intelligence gathered is accurate and relevant but cannot be timely disseminated and received, it has no value in dynamic battle space. Network Centricity (i.e. the capability of all force elements to communicate with each other) will ensure fast movement of such information. Networking will therefore provide the crucial link in insuring an information advantage by providing timely transportation of accurate and relevant knowledge at all levels within battle space. This information advantage provided by NEC will help reduce the Fog and Friction of War and thus enhance situational awareness amongst all war fighting elements.

To ensure enhanced situational awareness, in addition to possessing knowledge about the adversary's ORBAT and intentions, it is also necessary to possess knowledge of the disposition of friendly forces. Therefore, to supplement the information provided by sensors, friendly force elements will also need to provide information on their status, movements and intentions. This information will then need to be transported over the same network links. Thus, NEC links will provide the information for building a composite picture of all war fighting elements on both sides of the battle space.

While situational awareness of individual elements may increase, the true potential of NEC will be realised when collaborative planning enhances this to 'shared' situational awareness. Networking will provide this ability to plan in

a collaborative manner because it will allow sharing of information between all war fighting elements. Shared situational awareness will then fulfil the two crucial promises of NCW: 'self synchronisation' and 'swarming'. However, before these two concepts are addressed it is necessary to understand the impact of networking and shared situational awareness on existing command and control structures.

Command and Control (C^2) structures serve the purpose of ensuring that the commander's intention is transmitted to his fighting elements (through a plan or concept of operations) and coordination of these elements to ensure their efficient utilisation. Present C^2 structures are pyramidical. These are necessarily so because planning is done at higher echelons, where all relevant intelligence is available. Commanders at each subsequent echelon need to be concerned with only a subset of these operations for three reasons. Firstly, they may not possess enough information on the battle space outside their immediate concern. Secondly, there are limitations to the number of simultaneous engagements that any commander can pay adequate attention to. Thirdly, the available lines of communication dictate the extent of control that each commander may exercise. Similarly military staff functions like intelligence, operations, logistics etc,

While the commander at the highest echelon makes the plan, the middle tier of the C^2 structure ensures that his intentions are understood, plans are developed to coordinate action, performance is monitored and feedback is provided

Soldiers of 3rd Battalion, 187th Infantry Regiment of the 101st Airborne Division, head into urban warfare operations east of the former Saddam International Airport

allow commanders at each level to maintain a coherent grasp of the war.[22] Therefore, while the commander at the highest echelon makes the plan, the middle tier of the C^2 structure ensures that his intentions are understood, plans are developed to coordinate action, performance is monitored and feedback is provided.[23] The command tier between the higher echelons and the force elements therefore exist primarily as facilitators of the commander's intent and as managers of the large resources of personnel and material under the commanders.

However this centralised system of planning and management is a manifestation of the belief in the need for optimising and de-conflicting war fighting elements. This is because in order to maintain cohesion and a grasp on the rapid events on the battlefield, commanders need to restrict the behaviour of its fighting elements short of the chaos that may result. Such optimisation and de-confliction is at the expense of synergy because it generally entails restricting action by one war-fighting element in order to permit freedom of action to another. In addition, it may be said that centralised planning is antithetical to agility because it is slow to recognise and respond to changes, results in ill informed participants and places many constraints on behaviour.[24]

A good example of how optimisation and the need to de-conflict reduce war-fighting capability is exemplified by close air support. At present there exist essentially two methods of avoiding fratricide in the battlefield when the enemy is in close contact. If the target to be attacked is within the Fire Support Coordination Line[25] the attacking aircraft needs to be actively controlled by a Forward Air Controller or the attacking aircraft needs to follow pre-planned procedures to execute his attack. Both methods reduce the flexibility of the pilot to engage emergent targets and impose severe constraints on the employment of aircraft. In addition in most cases, the presence of friendly aircraft in the battlefield restricts the land forces in utilisation of its organic firepower. Thus optimisation and de-confliction necessitated by centralised command and control methods, while reducing chaos, circumvent efficient utilisation of the full potential of war fighting assets.

Such centralised systems of command and planning reside on one end of the spectrum. On the other end of the spectrum is an example of C^2 as exemplified by the famous Battle of Trafalgar in which Lord Nelson commanded and controlled the battle with just two statements. The first was *"England expects that every man will do his duty"* and the second was *"Close Action"*.[26] Between the existing institutionalised hierarchies based C^2 that relies on centralised command (and planning) and completely 'self-synchronised' force elements (as exemplified by Lord Nelson's forces) lies the path that NCW will probably take. As rigidly centralised control and total de-centralisation are equally self-defeating, risks and implications need to be balanced by focused leadership and coherent strategic choices.[27]

The commander's necessity to control force elements in order to coordinate their action towards a centralised plan is also done at the expense of maintaining tempo of operations. On the other hand, if operations were completely decentralised there remains the risk that a subordinate's action could result in unwanted escalation or inappropriate use of force.[28] A good compromise between the two methods of command and control lies in the concept of '*auftragstaktik*', i.e. 'mission command'. The concept of 'mission command' relies upon decentralised execution of the commander's intent (i.e. coherent towards the intent but with high levels of flexibility, permitting exploitation of emergent situations in a dynamic battle space). Forces following 'mission command', would therefore be able to coordinate the execution of a plan while maintaining high tempo of operations. The availability of shared situational awareness among all war fighting elements provided by NEC will ensure that the commander's intentions are understood, thus allowing these subordinate elements greater freedom of action and thus greater tempo of operations. Concurrently, NEC will provide the necessary links to allow commanders at all levels to exercise control over their force elements. NCW will therefore balance between the need to sustain adequate tempo of operations and the need to ensure that the commander's intentions stated or implied are not

violated. NCW will therefore also achieve 'mission command'.

With that in mind, it is time to take a look at an important capability that NCW promises to provide —'self-synchronisation'. This is the ability of all force elements to synchronise their actions to the commander's intentions through shared situational awareness and action, with such speed and agility so as to negate the adversary's initiative.[29] It is a process by which each individual war-fighting element operates such that its actions are coordinated with all others and remains directed towards the commander's intent. Self-synchronisation needs three essential elements, firstly all force elements must have a common understanding of the context of the battle through a common operational picture and secondly they must be aware of the commander's intention and lastly the force elements must possess good training to utilise the knowledge from the first two in order to execute their actions synchronously to the overall campaign objective. Networking of force elements to share their picture of the battle space and easy flow of information between them and the commander will set the stage for such synchronous action. If proper training and doctrine is in place NEC will achieve the goal of providing such self-synchronisation.

To better understand the concept of self-synchronisation let us return to the example of the game of chess. In a networked environment, all friendly pieces will know the position of all other pieces on the board and will also be aware of what the player (commander) wants to achieve. With this knowledge they will then independently execute all necessary steps required to achieve the end state (defeat of the other side), flexibly responding to the adversary's actions and synchronising their actions towards their common objective (the commander's intent). The knowledge of the position and intent of all other pieces allows them to assist each other in a synergistic fashion. In theory, if the pieces are well trained and well knitted together by a sound doctrine, further intervention by the commander (player) would not be necessary till the other side is defeated. This synchronisation in action may only be disturbed when information on the each other's actions and its implications are not available to all war fighting elements. Networking will provide these crucial information links to permit 'self-synchronisation' to take place. Going back to the example of close air support, in a network-centric environment, self-synchronisation between land-based elements and the aircraft would permit the land forces to continue action while the aircraft engages targets more proactively within the same battle space with minimal restraints. The 'common' understanding of the context of the battle and each others 'intent' would permit all elements to behave in what may externally appear as chaos, but subtle coordination not externally visible would tie these actions to make a coherent whole.

If self-synchronisation is to take place, some changes in the existing command structures will be necessary. Self-synchronisation requires 'true' empowerment of the subordinate force elements.[30] Some predict that this need will flatten command and control structures; others argue that this will not be necessary. While it is necessary to understand that some changes will need to take place, their exact nature is however not important at this stage and will be discussed later in this paper.

In addition to promising self-synchronisation, NEC also promises the ability of force elements to 'Swarm'. Swarming behaviour may be explained as the convergence of geographically dispersed decentralised units on a common objective or problem and then re-dispersal for future action — a complex collective behaviour by individuals following simple rules.[31] As opposed to prolonged engagements swarming entails sustained 'pulsing', i.e. sustained 'hit & run' attacks creating running battles of attrition. This ability to flexibly concentrate firepower in time and space could then lead to creation of decisive conditions in multiple situations in battle space. Common examples of swarming behaviour are activities by smart mobs and terrorists. Some examples of swarming in history include the Battle of Arsuf in which Saladin successfully employed swarming techniques

to attack the crusaders, and the behaviour of Somalian militia and civilians in Mogadishu in 1993.[32] An example of accidental swarming action is exemplified by US airborne operations during the landings at Normandy, in which the troops parachuted into Normandy in disarray but accidental formation of ad-hoc groups allowed them to confuse the Germans with their hit and run tactics, till such time that they managed to organise themselves.[33] Similar swarming action, but deliberately executed, will be possible in network centric environments because NEC will provide a high degree of shared awareness amongst all participating force elements through a 'common operational picture'.

Importantly, this ability to swarm as envisaged by NCW also addresses problems with respect to concentration of force in war. The ability to share a common battle space picture and commonly understand the commander's intent will allow widely dispersed forces to pre-emptively initiate swarming behaviour to concentrate their mass (firepower) at any point in the battlefield. Thus, the need to mobilise large forces to cover large areas will not be necessary in network centric environments. The ability to swarm, coupled with standoff weaponry, will therefore change the manner in which concentration of force is generated on the battlefield. It will permit massing of effects rather than massing of forces on the

The need to mobilise large forces to cover large areas will not be necessary in network centric environments

US troops in northern Kuwait

battlefield. Additionally, the ability to generate concentration of force in battle space with widely dispersed forces also generates economy in effort as a lesser density of forces are required in any given size of battle space. Also, present day trends indicate that in order to gain greater mobility for manoeuvre, war-fighting elements are getting more and more dispersed on the battlefield. These will need to communicate through networks in order to maintain coherent action.[34] In fact, it is this trend that reinforces the author's belief that the final goal of NCW is to gain ability to swarm. This aspect will therefore be revisited later in the paper.

Another important capability provided by NEC will be the ability to attack time sensitive targets.[35] While stationary targets, especially high value strategic target systems may be identified by sustained surveillance and successfully attacked, time sensitive targets pose an ongoing dilemma for targeting. NEC will offer the ability to quickly spot, identify and determine the value of a target, thereby permitting it to be timely attacked. This ability will be one of the main value, adding characteristics provided by NCW.

This ability to attack time-sensitive targets exists because collaborative planning (as opposed to centralised planning) permits more agility in operations as well as better utilisation of resources. This is because collaborative planning by widely dispersed forces will allow them to self-assess the best methods for engaging such targets. In addition, flexibility in responses available through the larger subset of opportunities made available by NEC increases the options available to commanders in responding to emergent situations on the battlefield. This ability to operate flexibly in turn enhances the responsiveness of all force elements.

Therefore, NEC will provide the ability to timely share knowledge to enhance the understanding the context of the battle and the commander's intentions. It will permit smaller formations to exhibit unprecedented cooperative behaviour through self-synchronisation and swarming to engage numerically superior forces. It will increase flexibility, agility and responsiveness in action through collaborative planning and enhance the efficiency in utilisation of resources. Lastly, NCW will provide solutions for time sensitive targeting. In short, it will permit efficient operations in a controlled state of chaos.

The author believes that to meet all these promises, NCW will require an infrastructure based upon six critical capabilities:

- A large network with extensive bandwidth to connect all battle space entities
- A large number of sensors to collect information
- Technology to convert collected information to knowledge
- Technology to present the knowledge to all force elements in context of the battle in an easily understood form
- C^2 structures and doctrines to exploit the capabilities of self-synchronisation and swarming
- High training status amongst all force elements to actually execute cooperative behaviour as envisaged by self-synchronisation and swarming.

It may be noticed that out of the six capabilities mentioned above, the first four involve technology and the last two concern human factors. At first glance, it appears that all these requirements could be easily met — at least those concerning technology alone. However, it is easy to be complacent by over relying on the ability of technology to provide all the answers, for even the best of technology has its limitations. Most importantly, advantages provided solely by technology are at best temporary.[36] A closer look at the technological requirements and the human factors is therefore necessary to determine the first hurdles on the path to achieving NCW capabilities.

The first difficulty that comes to mind is the issue of communication between all elements associated with the network. In platform centric warfare, each weapon platform provided a niche capability of its own. The sum total of all the capabilities provided by the platforms determined the overall capability of the forces. There was little interaction between all these platforms.

The need for each weapon platform to transmit and receive poses two problems: firstly, that any transmitting platform can be detected. Therefore while NCW proposes to reduce the battlefield footprint, the presence of a large number of non-stealthy elements in the battlefield will achieve just the opposite. Secondly, the need to transmit and receive information between each force element will require these platforms to carry additional equipment to do so. On fighter aircraft at one end of the spectrum and the foot soldier on the other, the ability to carry such equipment will be at the cost of reducing their effective payload for war fighting. While some platforms may be made larger in size to do so at the expense of increasing their battlefield footprint, others such as the foot soldier cannot.[37] Therefore the core necessity for force elements to communicate in the envisaged ubiquitous networked environment opposes the need for stealth and reduces the effective payload carried by all force elements.

While NCW proposes to reduce the battlefield footprint, the presence of a large number of non-stealthy elements in the battlefield will achieve just the opposite

The next concern regarding the network is the issue of standardisation and interoperability. At present there exists a large number of legacy platforms that communicates on propriety protocols, and a majority that do not communicate with each other at all. In order to be interoperable, all platforms in a network centric environment will need to possess the capability of utilising a single secure communication protocol. Therefore the first step would be the need for all platforms to migrate towards such a protocol. This cannot be easily achieved and would also be expensive. The only viable option would be to accept the inability of older equipment to be interoperable while a contentious effort is made to ensure that all future systems meet the standards set for network centric systems. But, do such standards exist? If set timelines (approximately 2015 for UK)[38] are to be met to achieve a NEC, such standards need to be developed immediately. As the industries providing the weapon platforms are not run by the defence forces, this need to meet future standards must be communicated to them at the earliest. In addition as a large number of the weapon platforms come from different sources within the industry, the industry must agree to the decided standards and must be involved in its development from the start.[39] Such cooperative behaviour within the defence industries is unlikely to be initiated by it, as most industries rely on propriety achievements to develop a competitive edge in the defence market. Therefore, while it may be realised that interoperability is crucial, divergent interests will oppose coherent solutions to the problem.

In addition to the issue of meeting standards, interoperability has extra complications with respect to security of the standardised protocols. For example, in order to permit the industry to develop weapons and weapon platforms that meet the NCW standards, the MoD will need to release the details of such protocols to them. This could create problems on the issue of security of such information. On the other hand, if the protocols were released after weapon systems were chosen, it would unnecessarily delay acquisition of the platforms until such time that they met the set standards. This would in turn increase the cost of the platforms. Lastly, the release of standards to a select few to ensure security would also reduce the purchase options of the MoD.

The issue regarding interoperability does not end here. Even if all force elements are designed to be interoperable within a country, will they be interoperable in a coalition environment? For example, when the US DoD SIPRNet (a military form of the internet) was brought online it excluded its allies, thus forcing the US to develop a 'fix' called the Coalition Wide Area Network

A US Air Force Defence Support Programme (DSP) satellite being launched aboard a Titan IV B rocket in February 2004

In 1999 the US had $100 billion invested in space and in the next decade 1,000 satellites are expected to be launched into space. The costs for launching these was estimated to exceed half a trillion dollars

(CWAN).[40] Sub-optimised networking solutions can hardly be categorised as war wining. The answer to this lies on the ability of coalition partners to determine the need to develop standardised protocols for networking and sharing development processes, such that likely coalition partners meet interoperability standards from the very beginning. This is not likely to be an easy path as every country may prefer to keep certain niche capabilities to itself and may not 'fully trust' other partners.[41] This lack of trust is natural, as security standards for the network will need to meet stringent criteria, which all coalition members cannot afford. Sharing of information may then be restricted to the lowest common denominator defined by security issues. Therefore, coalition interoperability is likely to be a major hurdle in achieving a NCW capability.

In addition, the constant drive by defence industries to maintain a competitive edge has led to failure of interoperability between weapon systems within a country itself. While the development of technology within the military domain two decades ago led to technological advancement in the commercial sector, this process has now been reversed. The realisation of the need for maintaining interoperable standards within the commercial sector has permitted a larger improvement in technology available to it compared with the military domain. Defence industries therefore have no option but to revert to commercial practices on the issue and

will perhaps have no choice but to embrace commercial standards to maintain interoperability. In fact, most of the interoperability existing today has been imposed by the increasing use of commercial off-the-shelf software.[42] The reluctance of the military industry to increasingly rely on commercial hardware and software to maintain interoperability is likely to slow down the process of shifting towards network centricity. Alternatively the use of commercial standards to meet interoperability requirements is likely to pose security problems. This issue will however be dealt with later in the paper.

The next problem with attempting to set up a ubiquitous networked environment is the question of how such a network will physically exist. While short range communications between force elements may be easily achieved, long range communication with major network nodes or intelligence processing sites will need to rely extensively on satellite systems. The need for obtaining access to the information on each and every individually dispersed force element will also require support of the battle space from a large number of satellites.[43] As the transponders that may be fitted on a given satellite are limited, the number of satellites required for this task will be substantial. The problem is additionally complicated by the fact that such satellite systems will have to be geo-synchronous to provide good coverage or the number of satellites required would increase. If the intention is to possess NCW capabilities all over the globe, this number would increase even more. Therefore it is probable that NCW capabilities may only be achieved in geographically limited areas due to limitations imposed by the number of satellite systems available for completing the links required by the network.

The need for satellites also increases the costs of building such networks. In 1999 the US had $100 billion invested in space and in the next decade 1,000 satellites are expected to be launched into space. The costs for launching these was estimated to exceed half a trillion dollars.[44] These satellites are meant for a multitude of tasks from meteorology to relaying TV channels, and by themselves do not constitute the satellites needed for NCW. If the intention is to provide a NEC on a global scale, the estimated bill for providing the satellite coverage envisaged may be extrapolated from these figures to get an idea of the magnitude of costs involved. It may not be possible to meet such budgetary requirements, even for a country like USA. Thus, budget considerations will also constrain NCW capabilities. On the other hand, in a budget limited military force, the costs of continued investment in NEC technology would probably be at the expense of reduction in training, essential force levels or all-round capability. Therefore, while NEC may result in a leaner force with latent capability, it would probably be at the expense of losing traditional fighting skills and realistic training levels or result in restricted niche capabilities. The requirement to avoid these problems would then further increase the costs of building and sustaining a network centric force.

Another 'hidden' area that could increase costs is the need to protect the network. While all other forms of network nodes may be protected in some way or the other on the surface of the earth, protection of satellites is another matter. As the capability to wage a network centric war is heavily reliant on the use of satellites, they will become the 'centre of gravity' of the NEC and a lucrative target of choice. This vulnerability of satellite systems will thus pose an additional problem on sustaining the NEC.

In addition to the problems of long-range connectivity and the over reliance on satellites, there is the need for transporting large amounts of information on the network. This brings up the question of the availability of adequate bandwidth, i.e. the amount of information that can be transmitted at any one time. The increasing ability of sensors to transmit intelligence through video and the increasing demand for information in a visually appealing format whether it is for intelligence or video conferencing will place a heavy demand on bandwidth and a network centric force will therefore always use up whatever bandwidth is available.[45] As the number of force elements increase, this demand would increase exponentially. In fact, the lack of sufficient

bandwidth and its allocation was one of the major problems in communication during Op Enduring Freedom.[46] In the Global 2000 war game the available bandwidth was quickly saturated and caused the technical performance of the network to deteriorate.[47] Similar problems were faced in a NCW simulation exercise 'Millennium Challenge 2002', during which the US Defence Information Systems Agency conducted tests to determine bandwidth requirements and discovered that the small simulation network connecting 30,000 platforms was running at 48 megabits per second. (This is a long call, as present battlefield information systems communicate at only small fractions of this value.) The network therefore had to be adjusted to reduce this need to 10 megabits per second.[48] A medium scale operation could easily involve more than 10 times this amount, giving an idea of the amount of bandwidth that may be needed to satisfy a basic NCW capability. In the high frequency bands this bandwidth may be eventually realised, but achieving this requirement in the presently cluttered V/UHF bands is likely to pose problems. For example, while optical fibre can provide 100 Mbps connections between MoD and PJHQ, and satellite communications can provide 8 Mbps to JTFHQ, the bandwidth down to the lowest sub-unit relying on such V/UHF bands reduces to about 8 Kbps[49] — a figure not likely to provide impressive NCW capabilities.

During Op Enduring Freedom, despite the availability of Hellfire missiles on Predator UAVs (to reduce the sensor to shooter time gap) the problem of target identification still posed sufficient problems to negate the advantages of such systems

In addition, assuming that the physical structure of the network could be set up and that sufficient bandwidth existed to transport the collated intelligence, there would still be a problem with respect to putting the information into context so as to translate it into meaningful knowledge.[50] This will not be an easy task and as vast amounts of information are continuously gathered from the battlefield, the complexity of this task will exponentially increase. Knowledge representation methods will also need to be developed to store the context of the gathered information. Additionally techniques of depicting this information to force elements in forms appropriate to the context of the battle at their level will also need to be done. How will all this be achieved? As the nature of information needed at any given instant in the battlefield will continuously vary, the permutations and combinations of such representation techniques will put an enormous strain on the computing subsystems of the network. The time delays caused by this issue are likely to reduce the real time capability of the network, negating its very purpose.

Coupled to the issue of resolving intelligence to knowledge and presenting it to the network users is the problem of 'understanding' the presented information. It is common knowledge that given the same 'picture' of the situation, different individuals perceive and absorb what they see in a different manner.[51] Therefore the crucial and basic assumption, that it will be possible to develop a 'common operating picture' and 'shared awareness' is not likely to be correct. As NCW proposes to garner synergy from 'shared situational awareness' and 'shared awareness' of the commander's 'intent', the very lack of commonality in what is 'shared' within the minds of people is likely to subvert the intentions of NCW. Worse still, human decision-making alters under stress.[52] How will commonality in thought exist when war itself is stressful? The problem of generating a common understanding is enhanced in coalition environments, where military and civilian personnel of varying cultural, ethnic and religious backgrounds need to work collectively. In a paper written on the Exercise Bridge to Global 99 at the Naval War College USA, one of the lessons

learnt was that global situational awareness was a myth: assuming that such situational awareness exists could be hazardous.[53] At this stage even if it is assumed that the hurdles relating to technology are overcome, it becomes apparent that the real problem areas appear where the network interfaces with humans.

As one of the important objectives of NCW is to provide the capability to attack time sensitive targets, the next foreseeable problem is the question of how such intelligence may be quickly retrieved for action. During Op Enduring Freedom, despite the availability of Hellfire missiles on Predator UAVs (to reduce the sensor to shooter time gap) the problem of target identification still posed sufficient problems to negate the advantages of such systems. Although the rules of engagement in Afghanistan were perhaps more relaxed as may be expected in other conflicts[54] (as the case was in Op Telic), the unavailability of sufficient intelligence feeds to permit real time target identification restricted full exploitation of the available capability for time sensitive targeting. Therefore lack of capability in putting context to the intelligence and representation of the knowledge to the force elements so that they may take informed decisions is likely to reduce what may be expected from NCW.

Alternatively, the human mind is capable of assimilating a limited amount of disjointed information at a time. Therefore, simple representation of information (for example, the JTIDS air picture) will not be sufficient for commanders. As information is available on every force element (friendly or otherwise) the amount of information reaching commanders will be substantially higher than what is available at present. As long as intelligence is translated to knowledge and means exist to present it to commanders in an easily understood format, its sustained availability is likely to assist decision-making in the battlefield. However, as a consequence of slippage in meeting of timeframes for putting context to the information and as information continues to steadily flow in, the next problem that is likely to surface is that of information overload. This would result in commanders being engulfed in large quantities of incoherent information on which they would be expected to take decisions. Additionally, increasing information may reduce uncertainty due to lack of information, but it also increases the decision maker's uncertainty, as alternatives become difficult to single out.[55]

Traditionally, humans confront lack of precise information with heuristic responses and 'rules of thumb' behaviour allows us to handle uncertainty by taking intuitive decisions that reach back into the sub conscious centres of our brains for solutions. Simultaneously the amount of information that the human mind can scan is about seven words per second and process this information at a rate of one every 25 milli-seconds. Therefore, while there are advantages of collecting and organising large amounts of information, constraints on the information 'bandwidth' of the human mind and its traditional way of handling uncertainty impose fundamental limits on a human's ability to guide events in war[56] and lastly, as Macintosh states, "More information does not make for better decisions".[57]

The other end of this problem is that, as more and more information becomes available to commanders they will always want more information before taking a decision.[58] Therefore tools to assist commanders in utilising the vast quantities of information will need to exist before NEC may be gainfully employed. But do such tools exist today? More importantly, the author believes that as commanders increasingly rely on large amounts of information to take decisions their capability to take decisions in uncertain environments will slowly erode. Fast, agile and responsive action by commanders occurs when they rely on their intuition and experience. Over-reliance on information systems for decision-making will reduce this ability and probably be more counter-productive. Similarly if a soldier used to a network centric environment were to lose connectivity, his loss of situational awareness would be a lot higher than that of a soldier not used to it.[59] This could have serious connotations on the battlefield. Therefore, it appears that irrespective of what solutions technology may

US Air Force E-3D AWACS aircraft

Assuming that modern computational power can take on the burden of putting the information together and make a composite 'picture' of the situation, the 'picture' may itself be too complex to understand

offer, the presence of humans in the network centric loop are likely to impose limitations on what may be expected from network centric technology. Alternatively, the persistence of high technology and over reliance on it will eventually corrode the traditional war fighting capability of humans.

In order to exploit opportunities of time-sensitive targeting, self-synchronisation and swarming as offered by NCW, it will be necessary that the decision making process is speeded up. The current hierarchical command and control system is probably not suited to meet this need, because it relies upon a vertical chain consisting of many layers between the commander and the force elements executing his actions on the battlefield. Therefore, while the capabilities to collect, analyse, contextualise and disseminate intelligence exist to help commanders take better decisions, the lack of proper C^2 structures to exploit the capability will negate it. Alternatively, access to information

about every battle space element at higher command echelons may lead them to micro-manage the tactical level battlefield, thereby reducing the flexibility and agility of these war-fighting elements.[60] This problem of C^2 may be resolved only if proper doctrines exist on the subject. But, do such doctrines exist? The lack of doctrines for exploitation of NCW will limit its utility. Therefore, a major challenge will be the adaptation of the decision component to the new requirements of speed and tempo on the battlefield and achieving a balance between extreme centralisation or decentralisation.[61] Once again, the humans in the loop and their interaction with each other appear as the limiting factor.

Similar to the issue of command and control, is the problem of lack of doctrines and training on how self-synchronisation (or swarming for that matter) may take place. At the tactical level, not only is it important that doctrines exist to define the nature of the command relationships vertically and laterally, but it is equally important that all force elements are trained to respond cooperatively. It is important to recall here that self-synchronisation relies upon a common understanding of the commander's intent as well as the disposition and intent of all peer force elements. Pitfalls in sharing a common understanding of the commander's intent have already been mentioned earlier, but even if such an understanding exists, how are these force elements to 'realise' their part in a dynamic battlefield without being commanded to enact their 'subsets' of the plan? This may take place only if these force elements have extensively trained together before with the network centric equipment. Such high levels of training status may not be easily achieved. The inability to synchronise actions and confusion about a commander's intent could then have catastrophic consequences in a network centric environment.[62] To avoid such problems, training standards and operating procedures will need to be in place before attempts are made to use such technology on the battlefield. Therefore, it may be seen that promises made by technology will not bear fruit unless efforts are simultaneously made to address the issues of doctrine and training. Training takes time to catch up and in the meantime new equipment would be a burden to use.[63] Rather than developing the technology and then developing the doctrine, it is be necessary for them to co-evolve. The central issue in training is that of C^2. The fact that C^2 structures have been more or less static for a long time suggests that inherent inertia to transform is likely to be a cause for concern in achieving NCW capabilities. In the Global '98 War Game, existing command structures were identified as the single most difficult obstacle to achieving NCW capabilities.[64] This aspect was noticed again in the Global War Game 2001, when in the absence of extensive indoctrination and training, personnel were unable to make the transition easily to networked environments.[65] These human limitations will therefore need to be addressed along with improvements in technology.

Perhaps over and above all the hurdles mentioned above, as access to data increases, information security challenges will grow exponentially and security of the network will become crucial.[66] As the entire management, control and execution of the battle plan is based on the accessibility of the network, its availability and robustness will need to be of high order. Over reliance on the network would be analogous to 'putting all the eggs in one basket'. As information warfare techniques proliferate, the protection of the network will become increasingly difficult. The magnitude of the security problem may be realised by the fact that 95% of present military communications relies upon commercial communication networks.[67] The loss of any existing terminal with the force elements could pose a significant risk to the security of the entire network or the loss of a network node due to enemy action could result in loss of effective control over a large segment of the war fighting elements.[68] Alternatively, disconnection from the knowledge databanks could have more catastrophic results, with commanders losing situational awareness at a rapid rate.

From this viewpoint of computer network security at present only *SOLARIS 8* from Sun Microsystems is certified to operate at the high level of functionality and assurance specified by US NSA and DoD.[69] In spite of this, a large number of military systems worldwide continue to use Microsoft Windows NT Server, which is commonly known to have serious security holes.

As the number of applications across the network increases, the complexity of the task of providing security to these applications and the data they access will be a difficult time consuming task. In addition to plugging security holes in software, the need to ensure that real time security of network traffic is not compromised could lead to delays within the network. For example, during Ex-Strong Resolve 2002 (a major NATO exercise) security checks on a simple application like instant messaging resulted in delays of six to eight seconds for each message.[70] Such penalties for maintaining security may actually negate the tempo building effects of NEC. Alternatively, instead of becoming the war winning formula to regain the 'edge' in battle space, if improperly protected NEC could become its Achilles Heel.

Probably the biggest hurdle in achieving a NCW capability would be the limitations imposed on its use in the transition period. At one benign end of the segment this could imply that some force elements would not have access to the kind of information that other force elements have.[71] It could also suggest that their lack of 'connectivity' effectively removes them from the chain of force elements with which they could possibly collude or self synchronise (i.e. they would be left out of the 'game'). However, the transition period could also have a darker side. It may be recalled that in a network centric environment all friendly force elements must be aware of each other's disposition and intentions. Lack of connectivity within the network centric environment could then easily result in fratricide as the lack of information on any element would cause it to be classified as the enemy. As connectivity in a network centric environment is 'assumed' the probability of fratricide when connectivity is lost is higher in a network centric environment than otherwise.[72] Thus elite digitised forces such as the US Force XXI would probably have to operate in isolation, negating the very intentions of networking. Thus while experimentation continues, actual operations will need to be conducted on the basis of the least common denominator within the forces.[73]

The ability to wage network centric warfare would depend upon two broadly defined areas: firstly the 'Physical' portion consisting of the physical network connecting all war—fighting elements, its networking protocols, databanks, algorithms to manage knowledge and display systems to interface the knowledge to the force elements; and secondly the 'Behavioural' portion that concerns issues like command and control, dealing with information overload, collaborative decision making, self-synchronisation and swarming etc. The author believes, as explained in the paper above, that at sometime in the future the aspects concerning the availability of the physical portion of network centric capability will not be a problem and that the major obstacles reside in the behavioural portion. Now, some proponents of NCW believe that NCW itself is not about the ability to network, but how networking will alter our behaviour in future combat. In the words of Admiral Cebrowski, NCW is less deterministic and more emergent and has less focused on the physical than on the behavioural.[74] With this premise greater attention will need to be paid towards the behavioural portion of NCW as compared to the technological aspects, i.e. the limitations imposed by the human factor in network centric operations.

The largest subset of the hurdles surrounding the 'behavioural' aspects of NCW revolve around translation of intelligence to knowledge and the assimilation of this knowledge by the force elements so that they can take faster decisions. A look at the investment areas needed for NCW, as stated in the US DoD Report to the Congress on NCW, highlights this concern. In the report, out of the nine major areas needing investment, five revolve around this issue. Some that shed light on the areas of concern are 'sense making processing', 'visualisation', 'estimation and inference engines', 'automated learning' and 'information representation technologies'. [75] It does appear to look as if the technology providing the connectivity will not be a problem area, but the 'human factor' in the network-centricity that will probably need to be the focus of attention.

To understand why, let us take a look at the OODA loop. The process of observation is a continuous process.

As long as information is required, the process continues, the time taken for this process being fixed and decided by the kind of observation platform used (i.e. satellite, radio, humans etc). Similarly, the process of action is more or less a function of the mobility of the force elements and to some extent of their organic firepower. For most battlefield entities, both these values are also more or less invariant. That leaves us with orientation and decision. These may be speeded up but as it may have been noticed, both concern the human in the network centric loop.

Orientation is achieved when all pieces of information translate to an understanding of the situation, i.e. all pieces of information fit together as a jigsaw and sense can be made out of the information as a 'whole'. Assuming that modern computational power can take on the burden of putting the information together and make a composite 'picture' of the situation, the 'picture' may itself be too complex to understand. For example, take the case of fusion of the radar pictures from various ships in a battle group with AWACS to build a composite air picture. While the 'picture' may be complete in all respects the sheer amount of information on the screen could clutter it up to make it useless. Then again the immense amount of information of the screen would make it impossible for a watch officer to coherently answer a simple question as 'Can you tell me what's going on in the air'. Alternatively, even if a complex 'picture' is understood, can a decision that accurately balances the considerations of all aspects of the picture be taken in a timely fashion to exploit the information advantage? The author believes that human limitations of knowledge assimilation and human inability to pay cognizance to a large number of factors before taking a decision will be a serious impediment. Therefore in the aspirations of NCW, there will be an upper limit to the advantages that may be garnered from network centricity and these limitations will be imposed by the presence of humans in the loop.[76]

Having studied the promises and pitfalls of NCW, it is therefore time to review the situation and capabilities existing at present. This is necessary for finding solutions as to how the defence forces should adapt themselves in the near future. As mentioned earlier, the first step could be the development of a concept of what we expect to do with network centric operations before we start creating information architectures.[77] This will pay due cognizance to the behavioural/human factor aspects of NCW in time, lest technology leads us up a blind alley. The process will then chart out the 'art of the possible' to find a middle path between the optimistic promises of NCW and the simplistic assurances of NEC.

To reiterate, there is a need to acknowledge the fact that the drive towards network centricity is an emergent military response to the information age. The process of networking all sources of information is a process that will continue. Demands on information technology to meet the world's knowledge processing requirements will continuously increase and information technology will not fail to provide solutions. However, as determined above in the paper, the limitations imposed by the humans will need closer attention. As a consequence when addressing the question of data fusion and presentation, it will be more important to determine how the human element will interpret presented information than how it needs to be fused to knowledge in the first place. It will be more important to study aspects of training that could improve our ability to develop a 'common' understanding of concepts rather than to study how the capability to chat on computers may be provided to tank crews. Similarly, command and control relationships will need to be addressed to determine how the advantages of network centricity may be exploited. Ultimately, the success of NCW will depend not upon technology but upon how the war fighter will exploit the information advantage it provides.[78]

A careful look at the aspirations of NCW indicate a strong desire for gaining the ability to increase the battle tempo to limits that make it appear as chaotic to the enemy. Perhaps to even operate so fast that the battle is over before the enemy can react and no friendly forces are lost. But technology has its limitations and costs. There is no flaw in the military drive towards embracing

the rewards offered by information technology, but in the exuberance to achieve quick fix solutions the crucial areas may be overlooked until it is too late. When large-scale changes are required to the core techniques of waging war, investment in flawed principles could have drastic consequences. Thus, while many believe that doctrine and training must co-evolve in the drive towards network centricity, perhaps it would be better if endeavours in these areas were actually in the lead.

Finally, in the drive to fight clean and efficient battles, we must not lose sight of the enemy. In the present security environment, it is improbable that any two nations of great military capability will face each other. If NCW is not likely to provide any substantial advantages against enemies who are measurably inferior in capability,[79] then the belief that NCW will make a great difference, which is based upon theorising that our information technology vulnerabilities are mirrored by our enemies, will prove to be false.[80] Therefore it is essential to ensure that NCW remains a natural course of evolution for the military and not an end in itself.

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21 Alberts,Garstka,Stein (2000), p 72
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23 Ibid (2003), p 41
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25 A Fire Support Coordination line is a line drawn on a map, close to the battlefront, depicting the forward edge of the land commander's activity. Any air activity within the boundaries of this line, need to be approved by and coordinated with the land commander.
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27 Peartree (1997), p 121
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54 This is the author's opinion and is based on the fact that media presence was minimal in Afghanistan.
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The rocket-firing Typhoons in Normandy:

Two major actions

By Dr Alfred Price

A film sequence that seems to be almost obligatory for any TV documentary on the 1944 Battle of Normandy is the one that shows a squadron of rocket-firing Typhoons pealing off in succession as they enter their steep attack dives. Cut to the camera gun film taken from a fighter-bomber, showing its rockets streaking away leaving dense trails of smoke. Before the rockets reach the ground the aircraft pulls out of its dive, leaving the watcher to assume they hit their intended target. But is it likely they did so?

As anyone who has studied the subject will know, hitting a small target like a tank from an aircraft is difficult enough even using a modern high-velocity unguided rocket. Could it have been any easier during the Second World War, with the relatively low-velocity weapons that were then available?

A direct hit on a tank with a three-in rocket invariably caused serious and usually irreparable damage. The weapon was too inaccurate to achieve that often, however, and usually a near miss did no more than shower the vehicle with mud

In 1943 the three-inch rocket projectile entered service in RAF. It was a crude weapon. The body consisted of a three-inch diameter cast iron pipe, which housed the cordite rocket motor and carried the four cruciform stabilising fins at the rear end.

The variant of the rocket originally intended for use against armoured vehicles was fitted with a 25 lb armour-piercing solid steel warhead. For use against ships, a quite different 60 lb high explosive semi-armour piercing warhead was also developed, containing 17 pounds of high explosive. Test revealed that the solid shot warhead was not very effective against land targets, though its stable underwater trajectory made it an effective weapon for use against ships and U-boats. Conversely, and perhaps fortuitously, the high explosive semi-armour piercing warhead was found to be the more effective than the solid shot weapon against tanks and other vehicles.[1]

Fitted with the semi-armour piercing warhead the rocket projectile weighed 91 pounds, and during operations over Normandy the Typhoon carried eight of these weapons on external launchers mounted on the outer wing panels. After launch the rocket projectile accelerated to a velocity of about 1,600 feet per second in about 500 yards, in addition to the speed of the aircraft. The motor then burned out and thereafter the weapon coasted towards the target gradually losing speed due to air resistance.[2]

At the time of the invasion of France on 6 June 1944, the 2nd Tactical Air Force possessed fifteen squadrons of Typhoons.[3] These were committed to action on a large scale, and during the actions that followed rocket projectiles achieved great prominence.

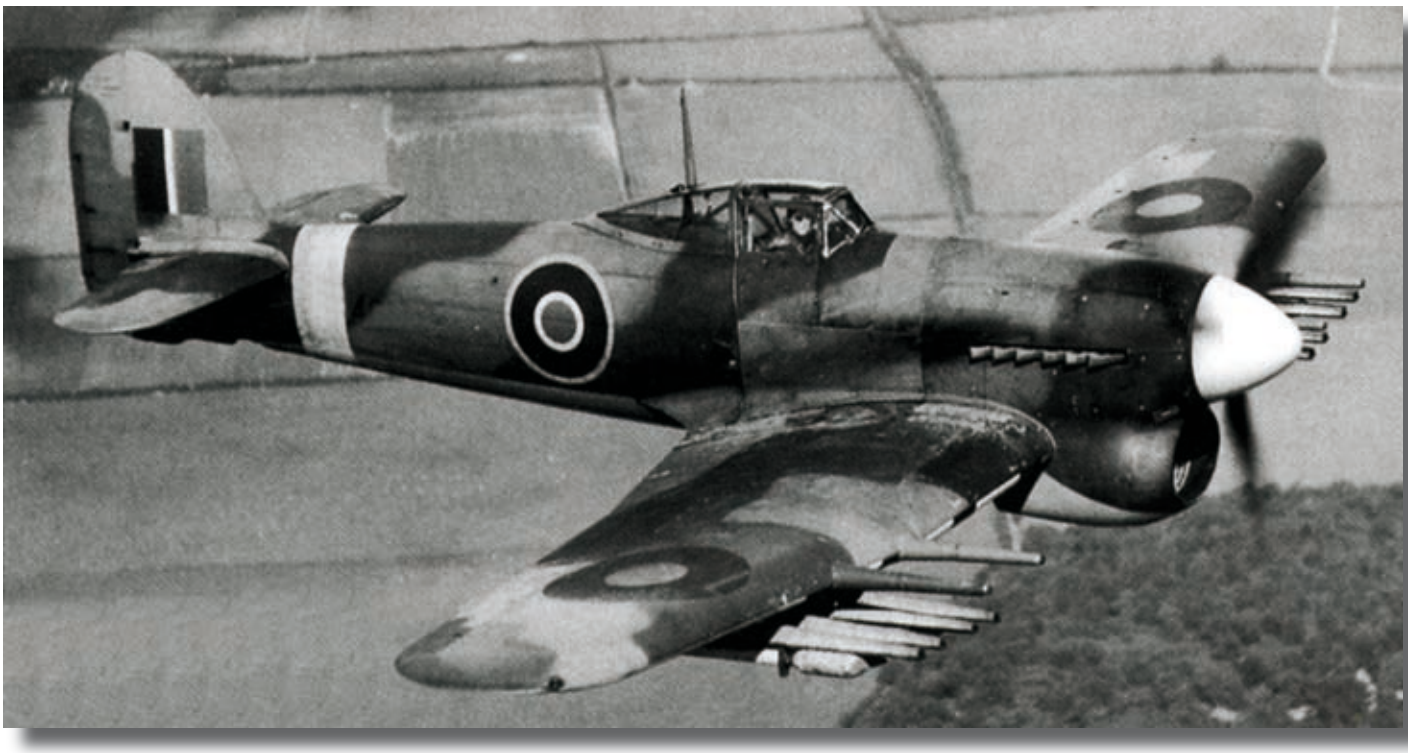
When striking at a defended target, the preferred tactic was to enter a 60° dive at about 8,000 feet (2,440 m). All eight projectiles were fired in a single salvo as the Typhoon passed through 4,000 feet (1220 m), at a slant range of about 1,700 yards (1,550 m).[4] After firing its complement of rockets, the aircraft was to pull into a zoom climb to take it beyond the range of automatic flak weapons as quickly as possible.

Against targets with light defences, the preferred tactic was to enter a 25° shallow dive at 3,500 feet (1060 m). The eight rockets were then ripple fired as the aircraft passed through 1,500 feet (460 m), at a slant range of about 1,000 yards (915 m) from the target.[5]

The shortcomings of the three-inch rocket

A direct hit on a tank with a three-in rocket invariably caused serious and usually irreparable damage. The weapon was too inaccurate to achieve that often, however, and usually a near miss did no more than shower the vehicle with mud.

The three-in rocket could not be considered a 'user-friendly system'. Pilots had to judge their firing range by eye to within quite fine limits. A 150 yards error in firing range caused the rockets to impact 15 yards short of the target or a similar distance past it. Moreover, immediately after launch the fins at the rear caused the projectile to weathercock and align itself with the airflow. Thus if the aircraft had sideslip on at the time of launch,



A report on the results of operational rocket attacks on ground targets during April and May 1944 concluded that under combat conditions the 50 per cent zone for the rockets was 75 yards. That meant that the chances of an eight-rocket salvo securing a single hit on a tank with an area of 200 square feet, was about 0.7 per cent

or was pulling 'G', that caused inaccuracies. Four degrees of sideslip produced a 50-yard sideways error at a firing range of 1,000 yards. If the aircraft was pulling 2 g at the time of firing, the missiles would impact about 30 yards short of the target. Unless allowance was made for it, a 20-mph side wind created an error of 33 yards in line.[6] Any of those errors was sufficient to cause projectiles to miss the target vehicle by a sufficient margin for it to escape serious damage.

If the Typhoon was under fire at the time of the attack, that distraction would compound the projectile's inaccuracies. A report on the results of operational rocket attacks on ground targets during April and May 1944 concluded that under combat conditions the 50 per cent zone for the rockets was 75 yards. That meant that the chances of an eight-rocket salvo securing a single hit on a tank with an area of 200 square feet, was about 0.7 per cent.[7]

The Battle of Mortain

In assessing the overall effectiveness of the rocket projectile, however, it is necessary to consider the effect of the weapon on enemy planning

One problem the German troops did not yet have to face, however, was that of attack from the air. During the late morning the mist cleared, and the Typhoons arrived shortly afterwards

and morale. For two months after the D-day invasion, German armoured units in Normandy never attempted any major offensive action. Undoubtedly the fear of large-scale air attacks by Allied fighter-bombers was a major factor causing this timidity.

Everything changed during the early morning darkness of 7 August 1944, when elements of 1 SS Panzer, 2 SS Panzer, 116 Panzer and 17 SS Panzer Grenadier divisions launched Operation Luettich. This powerful thrust was aimed at the exposed left flank of US troops advancing rapidly southwards after their breakout from the Cherbourg Peninsular. The aim of the German offensive was to reach the sea at Avranches, and thereby sever the US supply line.[8]

Luftwaffe General Alfred Buelowius, the commander of Jagdkorps II controlling all Luftwaffe fighter and fighter-bomber units in northern France, was ordered to make a maximum effort to support the attack with bombing and strafing attacks on the US positions. His fighters were then to provide cover for the advancing German troops and drive away Allied fighter-bombers. Buelowius promised up to three hundred sorties to support the attack.[9] At every point, however, his force had been given a very ambitious commission.

At dawn the Mortain area was shrouded in mist, allowing the attackers to advance slowly despite stubborn resistance from US ground forces. One problem the German troops did not yet have to face, however, was that of attack from the air. During the late morning the mist cleared, and the Typhoons arrived shortly afterwards.

In his post-war despatch Air Marshal Arthur Coningham, AOC 2nd Tactical Air Force wrote[10]:

"It was agreed . . . that the Typhoons, armed with rocket projectiles, of the Second Tactical Air Force, under the local control of AOC 83 Group, should deal exclusively with the enemy armoured columns, while the American fighters and fighter-bombers should operate further afield to prevent enemy aircraft from interfering with our air effort and, in addition, to destroy the transport and communications leading up to the battle area . . ."

That left the 18 Typhoon squadrons now in Normandy a free hand to engage the German columns packing the roads leading into the battle area.

Shortly after noon the commander of No 121 Wing, Wing Commander Charles Green, returned after leading an armed reconnaissance over the battle area by six Typhoons. He reported seeing a concentration of enemy tanks and motor transport at St Barthelemy north of Mortain. Within minutes the first two squadrons from No 121 Wing, loaded with rockets, were airborne and heading for the area. Their pilots found between 50 and 60 tanks and about 200 other vehicles lining the road between St Barthelemy and Cherence. The Typhoons began by knocking out the vehicles at the head and the tail of the column, to bring it to a halt. Then they set about those trapped in between. A shuttle-service was set up, with fresh squadrons of Typhoons arriving at 20-minute intervals.[11]

For the next 8 1/2 hours the German armoured columns came under almost non-stop pounding from relays of Typhoons. That day the Typhoon squadrons flew 69 missions with 458 sorties, of which 294 sorties were against targets in the Mortain area. Total munitions expenditure was 2,088 rockets and 80 tons of bombs.[12]

In the face of the Typhoon attacks, and stubborn resistance from the US 30th Infantry Division, the German advance ground to a halt. On the arrival of the fighter-bombers, the tanks pulled off the roads to hide beneath trees. The enforced halt gave time for US reinforcements to move into blocking positions. The German advance stalled, never to resume.[13]

In the event the Luftwaffe put up somewhat less than the promised 300 fighter sorties to cover for the German thrust. A mission at around 1400 hours involving six Gruppen of fighters, with probably more than a hundred Messerschmitt 109s and Focke Wulf 190s, set out for the battle area from airfields around Paris.[14] The fighters of the US IX Tactical Air Force carried out their blocking role with resolution, however. They intercepted the would-be raiders and, in the series of brisk skirmishes, losses were light on both sides. But the important point was that they scattered the German formation, and not a single plane reached its objective. A further attempt by the Luftwaffe to reach the battle area later in the day, involving fighters drawn from five Gruppen, suffered a similar rebuff.[15]

At 1740 hours that day Luftwaffe Colonel von Scholz was forced to report apologetically to 7th Army Headquarters: "Our fighters were hard pressed by enemy fighters from the moment they took to the air. They could not reach the target area."[16].

Describing the action, the daily report of XLVII Panzer Corps complained that:

"Continuation of the attack during the midday hours was made impossible because of enemy air superiority"[17]. The report continued: *"The attack was bogged down since 1300 hours because of heavy enemy fighter-bomber operations and the failure of our Luftwaffe."*[18]

Finally the Typhoons couldn't find any more Panzers so they bore down on us and chased us mercilessly. Their shells fell with a terrible howl. One fell right next to a comrade of mine, but he did not get hurt. These rockets burst into just a few big pieces of shrapnel, and a man had a chance of not being hit

Werner Josupeit, an NCO with 2nd SS Panzer-Grenadier Regiment, described how it felt to be on the receiving end of the Typhoon attacks:

"The fighter-bombers circled our tanks several times. Then one broke out of the circle, sought its target and fired. As the first pulled back into the circle of about twenty planes, a second pulled out and fired. And so they continued until they had all fired. Then they left the terrible scene. A new swarm appeared in their place and fired all their rockets . . . Black clouds of smoke from burning oil climbed into the sky everywhere we looked. They marked the dead Panzers . . . Finally the Typhoons couldn't find any more Panzers so they bore down on us and chased us mercilessly. Their shells fell with a terrible howl. One fell right next to a comrade of mine, but he did not get hurt. These rockets burst into just a few big pieces of shrapnel, and a man had a chance of not being hit."[19]

A battalion commander who fought with the 2nd SS Panzer Division in Normandy told this writer: "Your fighter bombers simply nailed us to the ground." To emphasise the point he pressed his thumb hard against the top of the table. He then repeated a catch phrase coined by German soldiers to sum up the air situation there: "If the aircraft above us are camouflaged, they are British. If they are silver, they are American. And if they aren't there at all, they are German!"

During the Mortain action the advancing German troops had relatively poor cover from AA weapons. Only three Typhoons were shot down, and one pilot was killed. Typhoon pilots claimed 84 enemy tanks destroyed, 35 probably destroyed and 21 damaged.[20] They also claimed 112 other vehicles destroyed or damaged.

Afterwards Allied investigators made a ground search of the Mortain area, which found the remains of only 43 German tanks. Of those, 19 were assessed as having been destroyed by ground anti-tank weapons, seven by air-launched rockets, two by bombs and four to causes that could not be assessed. Eleven tanks had been abandoned intact, or had been destroyed by their crews to prevent their capture.[21]

What was the reason for the discrepancy between each side's figures? Over the battle area the pall of smoke and dust made accurate damage assessment almost impossible. It was probable that some tanks in conspicuous positions were claimed more than once. While it is possible that the German army recovered some tanks from the battle area, it is unlikely that many of these had been attacked from the air. Usually a direct hit from a bomb or an air-launched rocket damaged a vehicle beyond hope of repair.

A further important factor to consider is that the Typhoons' rockets would almost certainly have destroyed many more tanks, had the latter continued with their advance in the open.

The effect on morale

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By itself, the physical damage inflicted by the Typhoons was insufficient to halt the German advance. More severe than the physical damage was the effect of the attacks on the enemy troops' morale

advance. More severe than the physical damage was the effect of the attacks on the enemy troops' morale. An RAF tactical report on the action, based on reports from prisoners, stated:

"Interrogation of prisoners has shown without question that German tank crews are extremely frightened of attacks by RP [rocket projectiles] . . . Crews are very aware that if an RP does hit a tank, their chance of survival is small. It is admitted that the chances of a direct hit are slight; nevertheless, this would hardly be appreciated by a crew whose first thought would be of the disastrous results if a hit was obtained."[22]

German Army reports attributed most of the tank losses during the Mortain battle to air attack. That was despite the subsequent Allied finding that ground anti-tank weapons inflicted more than twice as many tank losses as those caused by aircraft. Part of the error was due to the inevitable confusion of battle, and the dense smoke columns rising from the many burning vehicles. Another factor was the understandable wish to blame the failure of the offensive on the ferocious Allied air attacks rather than the US ground forces (that meant the onus could safely be shifted to the Luftwaffe, which had made few friends in Normandy). Of course, the erroneous assessment did nothing to weaken the Typhoon's already formidable reputation in the minds of the German soldiers.

To quote once more from Air Marshal Coningham's post-war despatch on the 2 TAF part in the action:

"It was the first occasion in Normandy when the air forces had the opportunity of striking a German armoured concentration. It was a situation which required speed and flexibility of air striking power. A fluid battle was imminent; in it the use of carefully planned concentrations of heavy bombers would not be practical. No fixed positions for planned obliteration

existed; it was a battle of armoured columns striking with speed in which might be a decisive concentration against our ground forces. The fighter-bombers of the Second Tactical Air Force adopted a 'shuttle service' of attacking formations, and as the day developed it was becoming clear that air history was being made. As the tempo of the attacks increased, so did the morale of the tank crews diminish, and at the height of the battle it was observed that the enemy were not waiting to stand our fire. The action of the Typhoons made many of them abandon their tanks and take cover away from them."[23]

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The Battle of the Falaise Gap

The failure of Operation Luettich would leave the German Army units around Mortain in a difficult situation, and one that became progressively worse with each day that passed. Powerful US armoured forces drove south of Mortain, then swung northeast threatening to envelop the entire German force. Yet even as late as 11 August, Hitler was still ordering that his commanders were to resume their westward thrust to the sea as soon as possible[24]. Three days later even he saw that the situation was untenable, and he authorised a large-scale withdrawal. Between 12 and 21 August that withdrawal quickly developed into a rout, as German units sought to fight their way out of the pocket and reach relative safety on the east bank of the River Seine. As the units attempted to move east, they were subject to almost incessant air and artillery attacks. Large numbers of troops escaped from the pocket, but they were forced to leave behind much of their heavy equipment.

After the action the operational research sections of 21st Army Ground searched the area between the Falaise pocket and the German crossing points at the Seine, and recorded details of the tanks and other vehicles that were destroyed and abandoned there. Those results were set down in a detailed analysis of the results of the air attacks during the Falaise Pocket action.[25]

The searchers found 667 German tanks, self-propelled guns and armoured vehicles left behind. They did not claim to have found every enemy vehicle in the area, and it is likely that many were missed in the narrow lanes, orchards, farmyards and woods that occupied much of the area. Of the total found 385 vehicles, or just under 60 per cent, were examined to determine the reason for their having been left behind.[26]

The size of that sample was large enough to give a reasonable pattern of the effectiveness of the various types of weapon used by the Allied air forces: 385 armoured vehicles represented roughly the complement of two full-strength Panzer Divisions. By that stage of the battle some German divisions were down to nearly 60 per cent of their establishment of armoured vehicles, so the 385 came closer to the complement of three divisions rather than two.

The causes of the abandonment of the 385 armoured vehicles, with the causes of their destruction if applicable, were as follows:[27]

Number	Percentage
14	3.6 Rockets
4	1.1 Bombs
21	5.3 Machine gun or Cannon fire from the air
148	39.5 Destroyed by crew to prevent capture
121	31.5 Abandoned undamaged
77	20.0 Other causes

The two largest categories in the above table are significant: those armoured vehicles destroyed by their crews to avoid capture, and those that were abandoned undamaged. Together these amounted to 269 vehicles, or 71 per cent of the total. The great majority of those vehicles had to be left behind

because the Germans troops lacked the fuel to move them. Most of them spent the land battle stationary under camouflage, and when the retreat began they had to be left behind.

The 21 vehicles knocked out by machine gun or cannon fire from the air were lightly armoured scout cars or half-tracks; 87 of these vehicles were examined, of which the 21 represented just over 24 per cent. As was to be expected, no tanks or self-propelled guns were recorded as having been knocked out by machine gun or cannon fire from the air.[28]

The first thing to come out of the above table, once again, is the near-ineffectiveness of the three-inch rocket in direct attacks on armoured vehicles. This weapon accounted for only 14, or 3.6 per cent, of those examined. That was a meagre total, considering the number of Typhoons involved in the action.

From the many German accounts of the land battle, however, there can be no doubt that their troops in Normandy suffered greatly from the Allied tactical air forces. Although the direct air attacks on the German armoured vehicles were not very effective, the indirect effects of the attacks were powerful indeed.

During the 21st Army Group ORS count, a total of 6,656 German lorries and cars were found abandoned. Of these 1,361 were examined and categorised, and the causes of these losses was as follows:[29]

Number	**Percentage**
6	0.4 Rockets
52	3.8 Bombs
377	27.85 Machine gun or Cannon fire from the air
27	2.05 Destroyed by crew
502	37.05 Abandoned undamaged
397	29.0 Other Causes
1,361	100 *Total*

An effective way of preventing a Panzer division from operating was to shoot up the soft-skinned lorries which brought up its vital supplies of fuel and ammunition. The tactical air forces caused considerable mayhem amongst these. There again the rockets were not all that successful. The bombs did slightly better, but even so they accounted for less than 4 per cent of the lorries and cars examined. Machine gun and cannon fire were the most effective of the aerial weapons in this context, though they accounted for only 28 per cent. It was however a commonly used tactic for fighter-bombers to concentrate on the vehicles at each end of the convoy, to box in those in the middle. So it is probable that fighter-bombers were responsible for the loss of somewhat more vehicles than the above figure would suggest. Vehicles stuck in traffic jams would have been listed under the 'abandoned undamaged' or 'destroyed by crew' headings.

To sum up: machine gun bullets and the cannon shells aimed at the soft-skinned supply vehicles played a major part in inhibiting the operations by the Panzer divisions during the Battle of Normandy. When Allied ground forces broke through the German line and forced the German Army into a full-scale retreat, large numbers of armoured vehicles had to be left behind for want of fuel.

Due to its inherent inaccuracies, the three-inch rocket projectile was barely effective against small targets like tanks or individual vehicles. The weapon destroyed relatively few of them. Yet the effect of the rockets on the morale of tank crews, particularly those lacking combat experience, could be devastating. Moreover, throughout the Battle of Normandy, the presence of several squadrons of rocket-firing Typhoons imposed severe constraints on the German strategy for fighting an aggressive defence.

The 7 August 1944 has justly been called 'The Day of the Typhoon', in recognition of the part it played in halting a powerful thrust by elements of five Panzer divisions. Despite its failings, the three-inch rocket projectile also deserves to share of that credit.

Typhoon Operations in Normandy — question of logistics

"The more I see of war, the more I realise how much it all depends on administration and transportation . . . It takes little skill or imagination to see where you would

like your forces to be and when; it takes much knowledge and hard work to know where you can place your forces and whether you can maintain them there."
(Field Marshal Earl Wavell)

It required a robust and effective logistics organisation to support a six-squadron Wing of Typhoons in Normandy. The figures below give the planning requirement for a single day's operations in terms of fuel, oil and munitions.[30]

The planning assumptions:
• Each squadron held 18 aircraft, of which 12 were available for operations
• The daily sortie rate was 24 sorties per squadron
• Aircraft fuel capacity 150 Imp gal, 77 per cent used per sortie
• Oil requirement: 3.3 per cent by volume of the quantity of petrol
• Ammunition expenditure was 25 per cent per sortie
• Bomb expenditure was 100 per cent on 75 per cent of sorties
• Bomb types used: 40 per cent 1,000-pound bombs, 60 per cent 500-pound bombs
• Drop tanks not carried

The logistics requirement
• 6 squadrons flying 24 sorties per squadron per day equalled 144 sorties per day
• Fuel requirement: 144 sorties at 116 gallons of petrol per sortie equalled 16,704 gallons. Allowing an extra 5 per cent for wastage, the total daily fuel requirement was 17,537 gallons, which equaled 76 tons packed
• Oil requirement: 3.3 per cent by volume of the quantity of petrol, 579 gallons which equalled 2.3 tons packed

Ammunition requirement: Typhoon capacity was 576 rounds of 20-mm ammunition. So 144 sorties per day at 25 per cent expenditure per sortie was 20,736 rounds which equalled 9.3 tons

Bomb requirement: 144 sorties per day of which 75 per cent were bombing sorties.
1,000 pounders: 86 – 38 tons
500 pounders: 130 – 28 tons
Total bomb requirement: 66 tons

Total daily fuel, oil and munitions requirement: 153.6 tons

For Typhoons flying the same sortie rate in the rocket firing role on the same planning assumptions, the daily requirement was 135 tons.

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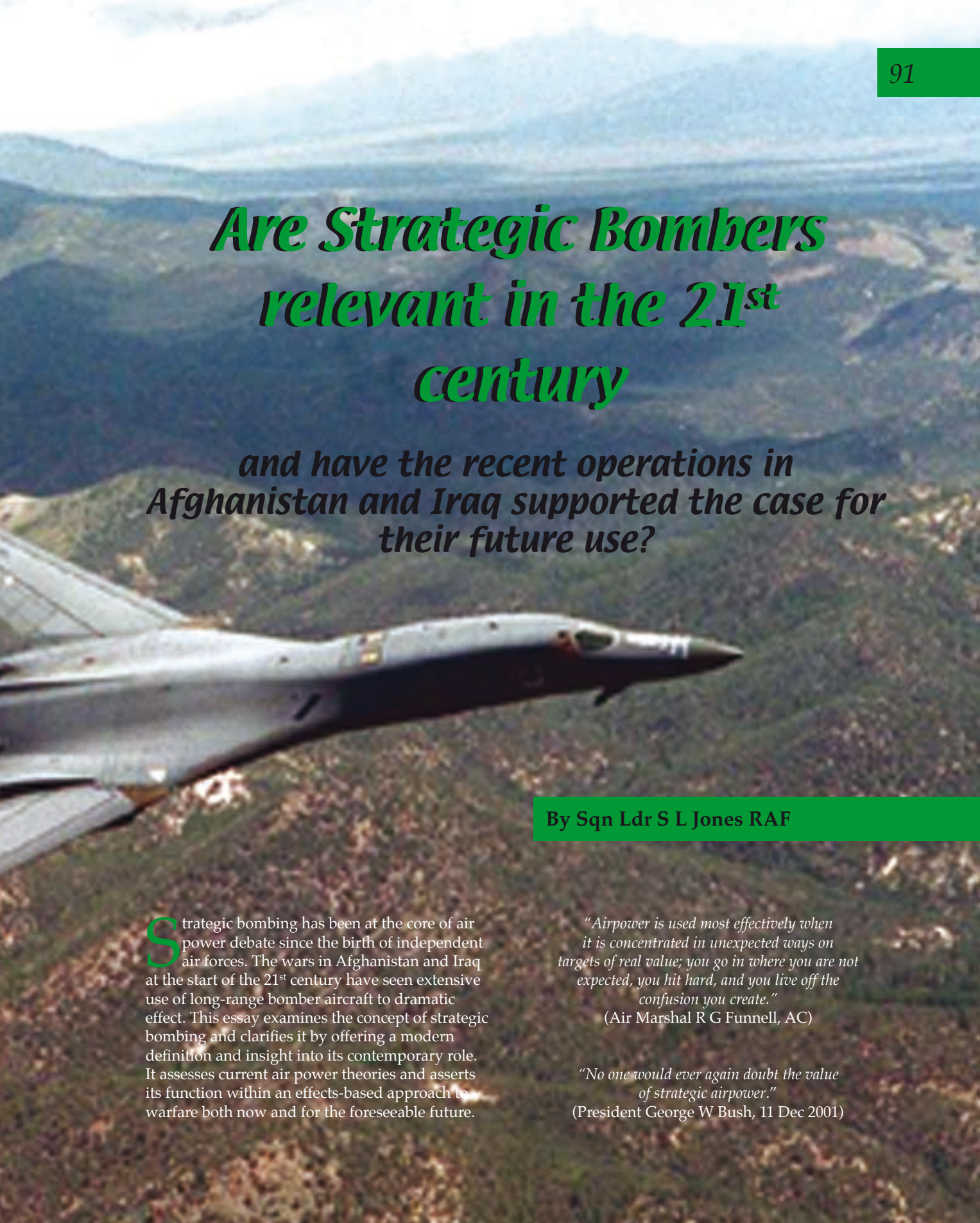

Are Strategic Bombers relevant in the 21st century

and have the recent operations in Afghanistan and Iraq supported the case for their future use?

By Sqn Ldr S L Jones RAF

Strategic bombing has been at the core of air power debate since the birth of independent air forces. The wars in Afghanistan and Iraq at the start of the 21st century have seen extensive use of long-range bomber aircraft to dramatic effect. This essay examines the concept of strategic bombing and clarifies it by offering a modern definition and insight into its contemporary role. It assesses current air power theories and asserts its function within an effects-based approach to warfare both now and for the foreseeable future.

"Airpower is used most effectively when it is concentrated in unexpected ways on targets of real value; you go in where you are not expected, you hit hard, and you live off the confusion you create."
(Air Marshal R G Funnell, AC)

"No one would ever again doubt the value of strategic airpower."
(President George W Bush, 11 Dec 2001)

On 8 April 2003, within 12 minutes of receiving targeting orders, a B-1B Lancer dropped munitions on a restaurant in Mansour, western Baghdad, in an attempt to kill Saddam Hussein and his sons.[1] The accuracy of delivery, coupled with timely intelligence that led to a remarkably brief 'sensor to shooter' gap,[2] provided the military with the opportunity to achieve the desired 'strategic effect' of decapitating the Iraqi regime and thus attempting to hasten the successful conclusion of Operation IRAQI FREEDOM (OIF) — had Saddam been in the building at the time of weapon impact. The activity outlined above represents a relatively new air power capability yet is fundamentally linked to the earliest visions of how to best exploit air power's potential. Driven by doctrinal and tactical development, which have been influenced by changes in global security and political will and enabled by a combination of technological advances and associated equipment upgrades, particularly in the delivery of precision of munitions, 'strategic bombers' have become a highly prized asset in the United States' inventory. The extensive use of these aircraft in Kosovo in 1999 and more recently against Al Qaeda and the Taliban in Afghanistan in 2001-2002 and subsequently Sadam Hussein's Iraqi regime in 2003 establishes their relevance to any study of modern air power.

The imaginations of science fiction writers were vivid, but they perceived that aerial warfare would have a huge effect in shocking the civilian population into despair and defeat by means of air bombardment of enemy cities

Coincidentally, the enduring nature of the strategic bombing debate is well illustrated by its historical foundations in the Royal Air Force's (RAF) use of air power to police Iraq in the 1920s. It was at this time that the RAF was justifying its existence as a separate arm of the military by using the effect of its independent strategic bomber force to contain tribal uprisings. This study, however, must focus on the United States Air Force (USAF) because of its near monopoly on the key air platforms that are associated with strategic bombing, namely the B-52, B-1B and B-2[3] and its significance as the originator of the key contemporary air theories that have developed during the last two decades of the 20th century.

This essay will contribute to the clarification of the debate and generate an alternative classification to replace the term 'strategic bomber'. In the first section, definitions associated with strategic bombing are developed in order to then assess the significance of this role of air power. The themes that fall out of this progressive discussion refer to historical examples and require a brief discussion on broader, classic theories of warfare. The second section demonstrates the direct linkage between strategic bombing and its effect across the levels of warfare, reviews contemporary air power theories and explains why air platforms are becoming increasingly difficult to classify by role. Section three will assess the link between Effects-Based Operations (EBO) theory and the utility of long-range, long-loiter bomber platforms to its application. With the foundations established for an analysis of current employment of these aircraft, their successful utilization in recent operations will be demonstrated and some concerns over their use will be revealed in section four. The enduring difficulty of measuring bomber effectiveness is touched on several times but will be the focus of the penultimate, fifth section. Finally, the introduction of new technologies, the current global security situation and other means of achieving similar effects to current B-bombers are important considerations that will be analysed in section six. The essay will conclude that the ubiquity of conventionally armed, long-range, long-loiter bomber platforms are currently vital military tools at the beginning of the 21st century

RAF Tornado GR4A

Air power proponents have extolled the ability of aircraft in the strategic bomber role to alter the opponent's will, but there has been continued, and as yet, unresolved debate over whether coercion or denial is the best method of utilising air power's characteristics

and will continue to provide, through EBO, a significant means of supporting political objectives across the spectrum of warfare for the foreseeable future. Recent operations in Afghanistan and Iraq have reinforced this argument, although there are limitations that air planners must recognise and work around. While the nuclear capability of strategic bombers is recognised (indeed complicates the debate, as will be shown) this aspect of their role is too broad to be considered within the scope of this essay.

Understanding the strategic bomber concept

The concept of strategic bombardment has been vigorously extolled by air power enthusiasts since the earliest theorising on the military utility of lighter than air vehicles. Indeed, the science fiction of Jules Verne (*Clipper of the Clouds*, 1873) and H G Wells (*War in the Air*, 1908) developed the visions of apocalyptic 'bolt from the blue' airborne attacks against nations.[4] The imaginations of science fiction writers were vivid, but they perceived that aerial warfare would have a huge effect in

shocking the civilian population into despair and defeat by means of air bombardment of enemy cities. The reality of military aviation in the era of World War I and 'total war' spawned theories about the practical use of air power to cause strategic effect, whilst others focussed on the use of air power to directly support land forces in the close battle.

The Italian air power theorist Douhet was an early advocate of the strategic bombardment but was also conscious of the broader context:

Objectives vary considerably in war, and the choice of them depends chiefly upon the aim sought, whether the command of the air, paralysing the enemy's army and navy or shattering the morale of civilians behind the lines. This choice may therefore be guided by a great many considerations — military, political, social and psychological.[5]

Douhet argues that the desired outcome has to be shaped by other influences but, importantly, the application of resources is considered in terms of the effect sought. Whilst these sentiments will be considered later in the contemporary concept of EBO, it is relevant to demonstrate from the outset the linkage between classic and modern theories in order to illustrate the long-term difficulty in settling the 'strategic bomber' paradigm. To build a conceptual and practical framework, a broad understanding of how military force is used to achieve a desired endstate is imperative.

The Prussian military theorist Carl von Clausewitz defined war as: '. . . an act of force to compel our enemy to do our will'.[6] In broad terms air theorists have argued that this may be achieved in one of two ways.[7] The solution may lie in confusing, deceiving, frightening or otherwise influencing the mind of the enemy in the hope of shattering will and thus causing surrender. This is known as the act of coercing the enemy into doing what you want them to do. A more physical and direct route of removing the capability to resist by attacking military forces, military equipment production and industry may lead to surrender. This is known as the strategy of denial. Air power proponents have extolled the ability of aircraft in the strategic bomber role to alter the opponent's will, but there has been continued, and as yet, unresolved debate over whether coercion or denial is the best method of utilising air power's characteristics.

The First World War strategic bombing campaign of the British initially involved attacks on specific German industrial production centres to deny them the means of supporting the war effort. Due to a perception that a more efficient use of their scarce bomber resources was targeting swathes of industrial areas, including workers' housing, they altered their strategy in an attempt to lower morale and thus coerce the Germans into surrender.[8] This policy was left unproven because other factors brought war to an end (issues of measuring the strategic effect of air bombardment are an enduring dilemma for airmen and will be covered later) but was, nevertheless, pursued vigorously by RAF Bomber Command during World War II. Conversely, the Americans retained their targeting policy, developed by the Air Corps Tactical School (ACTS), which aimed to cause German key industries, for example oil production, to fail.[9] Pape argues that coercion rarely works, and when it does it is only by denying the enemy the ability to achieve its goals on the battlefield.[10] Again, problems of measurement are apparent. These act in Pape's favour and obscure the point that the strategy chosen depends on many circumstances, and today on many constraints, such as rules of engagement, collateral damage and various political and media pressures. Meilinger suggests there is actually more of a direct and overlapping link between coercion and denial.[11] It is this school of thought that supports the modern, conventional use of long-range bombers that contribute to EBO. It should also be noted that inflicting massive casualties on civilians in order to break morale and thus force capitulation is not the objective of contemporary military planners — indeed, quite the reverse.[12] The advent of Precision Guided Munitions (PGM) provides two key benefits in this respect. Firstly, they significantly improve efficiency[13] and secondly, they reduce the likelihood of collateral damage.[14] Pape's arguments are critical of modern air power theories, but he stated his case prior to the Afghan and latest Iraq wars. It is therefore necessary to understand why strategic bombing enthusiasts

developed and continue to seek theories that have coercive tendencies. These modern theories continue to have their roots in classic ideas of warfare.

Long before Douhet's thoughts had been expressed and well before aircraft had been conceived, built and flown, Clausewitz considered strategy to be 'the employment of the battle as the means towards the attainment of the object of the war'.[15] He used the analogy of unbalancing the equilibrium of a system to shift the Centre of Gravity (COG).[16] It was the unity and cohesion of the fighting forces, which he regarded to be the hub of all the enemy's power, or COG. By attacking and defeating this hub, through decisive battle, the war would be won. To crudely summarize his ideas, it was the objective of armed forces to defeat the opposition in decisive battle and make the enemy defenceless, or at least disarm him.[17] This is an interesting thought to retain, particularly in light of Afghanistan and Iraq where residual

It was the objective of armed forces to defeat the opposition in decisive battle and make the enemy defenceless, or at least disarm him. This is an interesting thought to retain, particularly in light of Afghanistan and Iraq where residual elements of the regimes have inflicted more casualties after combat operations have officially ended than during them

B-2 Spirit

The USA has a monopoly amongst western powers of ownership of B-bombers but these aircraft do not have a monopoly on achieving strategic effect

elements of the regimes have inflicted more casualties after combat operations have officially ended than during them. The highly publicized success of strategic bombers' contributions in these two wars may be undermined by the lack of long-term effect, or denial, of key elements of the opposing forces.

More recently than Clausewitz, Sir Michael Howard, the British historian, argued that:

"Wars are not tactical exercises writ large. They are . . . conflicts of societies, and they can be fully understood only if one understands the nature of the society fighting them. The roots of victory or defeat often have to be sought far from the battlefield, in political, social, and economic factors."[18]

Although the above argument explains why military success in battle often fails to contribute to overall campaign victory, it also expresses the need to delve deeper into what will affect the enemy most and bring about its defeat. An example of this is the United States' overwhelming tactical wins in the Vietnam War, but overall failure to achieve their long-term aim.[19] Pape[20] considers that the American bombing strategy in Vietnam failed for three main reasons: an imbalance in the level of damage the opponent was willing to absorb to that which the assailant could inflict; mobile, guerrilla forces are not susceptible to air attack in the same way as mass conventional forces; and, even if these two problems can be understood, accurately assessing vulnerabilities and applying a coercive strategy will not work if the opponent's level of commitment and morale are very high.

Again, parallels to the recent wars against factions such as Al Qaeda that operate outside societal structures should be noted. Linking Pape's and Howard's arguments suggests a need to comprehend issues beyond the battle space in order to know the weaknesses of an opponent and thus the vulnerabilities that will allow the COG to be unbalanced. These points will be relevant when assessing the effectiveness of 'strategic bombing' in the recent air campaigns.

Contemporary air power theories

Appreciating the link between classic theories on warfare and contemporary air power doctrine provides the basis for understanding the concept of creating strategic effect. Current RAF doctrine[21] advocates the employment of air power to achieve strategic effect via an identified target set. It considers air operations for strategic effect to be:

". . . aimed to destroy or disrupt the defined strategic centre of gravity of an opponent. The effect sought by airpower could be destructive, non-destructive or a combination of both, against target sets which undermine an opponent's ability, will and means to continue his aggression. Air operations for strategic effect are not limited to bombing or solely the domain of attack aircraft. All combat aircraft and associated weapon systems are capable of action for strategic effect." [22]

In criticizing the RAF's use of the word 'strategic', its association with target set[s] and its adoption of the COG concept, Lock-Pullan[23] argues that the RAF has constructed a somewhat contradictory explanation that fails to sever the link between strategic effect and strategic bombing. He argues that the legacy of early air power definitions that justified the independence of the RAF, a hangover from Cold War 'deep strike' policy and the need to justify a single Service capability have moulded a 'bomber-centric' description of the concept. This analysis neatly illustrates that the effect air power can create is not directly linked to a specific air platform. Thus, any consideration of the resurgent utility of strategic bombers must acknowledge that they too are being used for an effect that crosses the boundaries of perceived aircraft roles. The RAF will perhaps state this more clearly in the next version of its air power doctrine.[24] By dealing with similar conceptual and platform related employment issues, the USAF has forced through changes in its thinking and structure that has facilitated the contemporary use of their B-bombers in roles that they were not originally designed for.

In 1998, General John T Chain, Commander in Chief of the USAF's Strategic Air Command (SAC) recognised that SAC would have to offer more than merely contributing to the USA's nuclear deterrent.[25] He identified three pillars of conventional wisdom that would have to be knocked down in order for the bomber force to have wider defence utility. The first pillar was that bombers were for nuclear use only; the second that strategic meant nuclear and that SAC bombers were tied to the nuclear mission; and third, that theatre warfare was solely for tactical or fighter aircraft.[26] The need to reshape the USAF to the threat at the end of the Cold War, combined with experience in Gulf War I and the ability to carry a variety of weapon systems, including unguided bombs, PGMs and CALCMs[27] subsequently highlighted the potential for a wider use of these aircraft. SAC was amalgamated with Tactical Air Command in June 1992 to create Air Combat Command.[28] Importantly, the linkage between 'strategic' and 'nuclear' in the context of bombers had been broken. The Department of the Air Force's 1990 White Paper '*Global Reach-Global Power*' was an indicator of the changes that were to follow. The recent resurgence in 'strategic bombers' must therefore acknowledge that the foundations for any recent success were laid in the late 1980s and early 1990s. The concurrent developments in technology and doctrine during this period reinforce the need to isolate 'strategic' from 'bomber' in order to understand what the B-bombers are employed to do. The essay will therefore build a case to argue that the term 'long range/loiter effects platform' (LRLEP) is a more relevant description of what has historically been referred to as the 'strategic bomber'.

The United States (US) has invested in the largest and most capable air forces in the world. The combined USAF, USN, US Army, USMC inventory

(all types) is in excess of 16,000 military aircraft.[29] In contrast, China and Russia have approximately 9,000 military aircraft each and all other nations hold below 2,000. The USA has a monopoly amongst western powers of ownership of B-bombers but, as will be discussed, these aircraft do not have a monopoly on achieving strategic effect. The following foreword to the USAF Strategic Attack Doctrine Document[30] by Major General Ronald Keys, Commander, Air Force Doctrine Centre clearly establishes the priority that the USAF places on air operations that lead directly to the achievement of strategic campaign goals:

"Strategic attack is not defined by the weapons or delivery systems used — their type, range, speed, or destructiveness — but by their effective contribution to directly achieving national or theatre strategic objectives. Air and space forces, with their responsiveness, range, and unique ability to exploit the third dimension, can transcend normal operating limitations imposed on land and maritime forces in attaining strategic objectives [Strategic attack] is the Air Forces' most decisive combat mission and function."

Importantly, he distinguishes between the effect desired and the means, or platform, used to attain it. The term 'bomber' is not included; the adoption of 'attack' also provides a broader context to the concept. The USAF doctrine builds on this premise by stating that 'strategic application of aerospace power has had a decisive impact on war'[31] and supports this proposition by declaring that experience in conflicts as diverse as World War II, Operation DESERT STORM (Gulf War I, Iraq, 1991) and Operation ALLIED FORCE (Kosovo, 1999) prove this argument.[32]

The current formal USAF definition of strategic attack is as follows:

". . . those operations intended to directly achieve strategic effects by striking directly at the enemy's Centres of Gravity (COGs). These operations are designed to achieve their objectives without first having to directly engage the adversary's fielded military forces in extended operations at the operational and tactical levels of war."[33]

A modern interpretation of the concept of COGs is: "those characteristics, capabilities, or localities from which a force derives its freedom of action, physical strength, or will to fight".[34] These are targeted to meet the overall objectives that are set by senior political and military leaders. Interestingly, the important relationship between COGs and identifying means to undermine or defeat them is not articulated.[35] This issue will be raised later in terms of measurement of effect. The definition also refers to the levels of war, which are particularly relevant to the discussion because they help to define 'strategic attack' by exposing its relationship to the spectrum of conflict, military planning and the direct achievement of the political objective by attacking the COGs.

Bucknam[36] considers the levels of war to be the conceptual tools that usefully facilitate thinking about and planning for military activities. The relationship between the levels of war[37] is considered in the planning process that guides staff at various levels through a framework for understanding the grand strategic objectives of the civilian leadership, through the various commanders' intent, down to the tactical application of force.[38] Importantly, the process allows courses of action to be developed and evaluated. The air commander's analysis should provide a link between strategy and the task so that each sortie flown contributes to the overall strategic effect. The process recognises a hierarchical connection as each level of command undertakes its own analysis from a top down perspective. This is particularly relevant to understanding the modern role of the bomber platform, as these aircraft are capable of creating effects across the spectrum of warfare.

Peach presents a deeper analysis of the importance of levels of war to the military, and particularly to air forces.[39] The application of air power with its innate characteristics of speed, reach and ubiquity blurs the boundary between these levels. Furthermore, it is difficult to compare the strategic context of air operations during a limited war such as the UK's Op BLACK BUCK attack by Vulcan bomber aircraft on the Falkland Islands against the mass bomber raids on Germany during

World War II.[40] Peach's comment that coalition air power in Gulf War I was successful due to the mass effect of tactical air effort rather than systematic target selection indicates that even in a geographically contained conflict, there is a greying of the boundaries and varying degrees of what constitutes strategic, operational and tactical employment of air power.[41]

In a small-scale war, a tactical move is more likely to have a strategic impact, or effect than in a large conflict. Bucknam[42] states that the defining characteristic of things strategic is that they are linked directly to the ultimate or political objectives involved; things tactical are actions and events relative to an engagement and, importantly, are not mutually exclusive. Some strategic objectives can be pursued directly with each engagement, obviating the need for the intermediate operational level objectives. Again, the unique attributes of air power activities, particularly long-range and long-loiter bombing can have an impact at all levels of war. Bucknam[43] cites the example of allied bombing of German oil targets in the summer of 1945 to illustrate this point. As already discussed, these activities can have both coercive and denial effects. Applying the term 'strategic' to 'bomber' often obscures the role of certain air platforms and reinforces the case for adopting the term LRLEP rather than 'strategic bomber'. Rounding off the conceptual overview, it is essential to link EBO to the themes covered in order to provide firm foundations for an assessment of B-bombers in recent air operations.

It is therefore apparent that the term 'strategic bomber' is outdated. This further reinforces the case for describing these assets as LRLEP

Creating the desired effect

The development of EBO is generally attributed to Lieutenant General Deptula.[44] It provides a contemporary war-fighting thesis that incorporates the idea of parallel warfare.[45] It is important to note that the exploitation of the technological advances in air power, particularly stealth, PGMs, intelligence gathering capability and networked communications and data is central to the theory. Critics, particularly United States land forces, believe that the concept is flawed because of this very heavy reliance on perfect information, advanced technology and precision attack.[46] It is nevertheless at the forefront of Western military thinking and, as will later be discussed, the operations in Afghanistan and Iraq were designed along its principle tenets. In a study on behalf of the US Joint Forces Command, the US Rand organisation defined EBO as:

"Effects-based operations conceived and planned in a systems framework that considers the full range of direct, indirect, and cascading effects, which may – with different degrees of probability – be achieved by the application of military, diplomatic, psychological and economic instruments."[47]

The theory has grand aspirations to overcome attrition warfare, achieve success with limited resources and lack of forward basing, reduce casualties and limit the duration of conflict. It draws on the 'systems framework', which refers to the work of Colonel John Warden[48] and promotes 'rapid decisive operations' which in turn link to Boyd's 'Observe-Orientate-Decide-Action' (OODA) model.[49] These theories are empowered by aerospace and information gathering and analysis capability and, if fully understood, provide a framework for analysing and subsequently conducting war as effectively as modern capabilities and policies allow. It is the precise, synergistic targeting of nodal elements of the opposition's systems, by the most appropriate means that EBO advocates believe will generate the desired strategic effect. Thus Deptula argues that EBO can achieve the ultimate aim of war, compelling an opponent to act according to one's own strategic interests.[50]

The discussion has shown that there has frequently been a direct correlation between the use of air power, particularly 'strategic bombing' and the desire to achieve strategic effect and hence the

The B-1 reportedly dropped more bombs on Afghanistan than any other aircraft, and was critically acclaimed as the workhorse of the conflict

US B-1B Lancer

fulfilment of strategic or political objectives. This explanation provides strategic bombing with an identifiable role that separates it from operations to gain control of the air, or those operations that involve air support to surface forces, whether directly or indirectly. The strategic use of air power, however, has been shown to have an impact at sub-levels of warfare and is not reliant on specific types of aircraft. Similarly, with the introduction of EBO theory, the achievement of the desired effect does not rely on a specific type of platform. It is therefore apparent that the term 'strategic bomber' is outdated. This further reinforces the case for describing these assets as LRLEP. The central issue of compellence that EBO aims to pursue, facilitated by the use of aerospace technology, will be considered in the following case studies. In doing so, the longstanding problem of measuring the effectiveness of air operations and whether or not there is an enduring role for LRLEP in the 21st century will then be assessed.

Afghanistan and Iraq case studies

Following the 11 September 2001 attacks in the United States, President Bush laid down the gauntlet 'to rout terror wherever it exists'.[51] Having identified the relationship between the Taliban and the perpetrators of the terrorist attack led by bin Laden, the United States set on a path to destroy Al Qaeda and its infrastructure within Afghanistan. The official Op ENDURING FREEDOM (OEF) combat air operations lasted 78

days and demonstrated a number of firsts for the US bomber fleet. Articles published immediately after the recent operations in Afghanistan and Iraq express the view that the USAF B-bombers were the signature weapons used during the wars:

● *USAF's heavy bombers dominated events in Afghanistan . . .*[52]

● *The abiding image from the war in Afghanistan was a US Special Forces soldier astride a horse using his laptop to send a digital burst of co-ordinates to a circling B-52 bomber.*[53]

● *The Return of the Strategic Bomber.* [54]

What the statistics fail to explain, however, is what effect each of the platforms was used to achieve, or indeed, how effective they were. Moseley, for example illustrated this by stating that a B-2 delivered 80, 500-pound bombs during one single sortie that involved a round trip from Whiteman Air Force Base in the USA

War in Afghanistan was unique in many ways but broadly involved a combination of standoff, precision air strikes and ground manoeuvre warfare. By the 76th day of operations, 57 per cent of the 17,500 munitions that were expended on over 120 fixed target complexes and over 400 artillery and guns were precision guided. B-1 and B-52 bombers flew 10 per cent of the strike missions yet delivered 11,500 of the weapons. The B-1 reportedly dropped more bombs on Afghanistan than any other aircraft, and was critically acclaimed as the workhorse of the conflict.[55] US strategists had exploited their first opportunity since Kosovo to employ the developing EBO philosophy and LRLEP. The headlines suggest that it worked. Biddle,[56] however, raises concerns that the lessons learned from the war would be the wrong ones and the war neither justified a radical restructuring of US military nor US foreign policy that the EBO advocates propose. He believes the argument that technology, particularly the use of PGMs, has introduced a new type of warfare model is inaccurate and that Afghanistan did not provide a template for success in other situations. The US attempted to use pinpoint air attacks against bin Laden's Arab-led fighters who, it could be argued, were the enemy COG that influenced the Taliban leadership. Initially these attacks were not decisive because the Northern Alliance could not see the results of precision attacks against infrastructure and leadership. The coercive effect was initially minimal on both the well-protected Al Qaeda and Taliban forces in cave complexes and the pro-coalition Afghan alliance. It required a shift in strategy to more dense and visible aerial attack, co-ordinated with American-supported land forces, to provide impetus to the Northern Alliance.[57] When the ground war gained momentum, air-ground manoeuvre, combined with the Afghans switching sides, led to a relatively quick Allied victory. Biddle's argument that the air-ground synergy and ultimately land battle were the decisive factors has merit. By implication, however, the utility of LRLEPs was critical to success; the effect they generated was valid, albeit in his view, only after the strategy had been adjusted. Importantly, within the EBO framework, the massive weapon loads and long loiter time of B-1B and B-52 bombers (because of being based relatively close to the region) was exploited to provide a CAS role supporting SOF-led alliance forces. While this was a tactical use of the bombers, it ultimately had strategic effect once the targeting policy had been adjusted. This reinforces the point that to be effective, EBO planning requires clear understanding of how both enemy and own forces will react to it.

Despite air power enthusiasts' rhetoric, the war also indicated that the advantages of PGMs could be outweighed when the enemy is not susceptible to their effects, as earlier lessons from Vietnam have indicated. EBO certainly contributed to US-led success in taking control of Afghanistan but many of the Al Qaeda and fundamentalist fighters

may have slipped away to continue their fight in other ways.[58] A similar residual problem linked to EBO strategy that occurred in Iraq will be revisited later. The result of the OEF air campaign was, however, viewed very positively by the coalition Air Commander, Lieutenant General Moseley who claimed success and was able to apply his experience in OIF.

General Moseley was responsible for employing air power to neutralise the Iraqi government's ability to command its forces; to establish control of Iraqi airspace; to provide air support for Special Operations Forces and Army and Marine units advancing on Baghdad and Basra; and to neutralise Iraq's force of surface-to-surface missiles and suspected cashes of biological and chemical weapons.[59] His 'By the Numbers' assessment[60] highlights that virtually all types of combat aircraft in the United States' inventory were used. Fifty-one B-bomber aircraft contributed 505 sorties out of a total of 41,404 [61] flown during the period 19 March to 18 April 2003. The combined use of PGMs was approximately 65 per cent of all munitions expended — a massive leap from the seven per cent in Gulf War I. What the statistics fail to explain, however, is what effect each of the platforms was used to achieve, or indeed, how effective they were. Moseley, for example illustrated this by stating that a B-2 delivered 80, 500-pound bombs during one single sortie that involved a round trip from Whiteman Air Force Base in the USA.[62] It is therefore necessary to refer to other reports, which incorporate interviews with the air commanders and the crews that flew the missions, to provide more substantial analysis.

Of the bomber sorties, the B-1B Lancer was a constant presence over western Iraq, ready to strike emerging targets.[63] To achieve this, one aircraft would be airborne on a specified orbit, one returning to base and one transiting to the theatre of operations. Over two-thirds of all Lancer operations contributed to the Time Sensitive Targeting (TST) process that had been developed by the Combined Joint Air Component Commander's staff.[64] There were three types of targets defined as TSTs: Leadership, which accounted for 50 missions; Weapons of Mass Destruction, which accounted for 102; and terrorists, four. These missions were tightly managed, and would typically have been supported by a variety of fighter sweep, suppression of enemy air defences, electronic warfare, ISTAR[65] and tanker aircraft. B-52 bombers were also used to provide precision strikes against a small number of key targets and then to attack the Iraqi Republican Guard with both unguided 'iron' bombs and precision weapons.[66] During the war, the coalition's methods were explained as a fighting synergy using intelligence, surveillance and reconnaissance assets to identify enemy locations and then use air and long-range shooters, and artillery systems to attrit enemy forces to ensure that when ground combat occurred it was not an even fight.[67] LRLEPs were instrumental in this and were particularly effective in terms of both denial and coercive effects on Iraqi forces during a period of adverse weather and sandstorms when they, more or less alone, maintained campaign momentum.[68]

Ultimately, the combined effect was that the Iraqi regime collapsed in 21 days. Grant goes as far as suggesting that "air and space power made the conduct of OIF nothing less than a new style of warfare".[69] In highlighting a renewed focus since losing during the Cold War the USAF's expeditionary competency forged in WW I and WWII, General Jumper, USAF Chief of Staff, provided more balanced views on the war: "joint warfare is imperative" and the war in Iraq demonstrated that "(the) USAF is thinking about things in 'new ways' — delivering close air support from B-52s aided by Global Hawk sensor (equipped) unmanned aerial vehicles and forging tight links between satellite, pilots in the air, special forces on the ground, and land force commanders to rapidly plough a path through enemy defences", and ". . . the days are over when any service assumes it can win a war by itself". Similarly, his comment that the war "showcased the Air Force's push to go back to its roots as an expeditionary force and its continuing rapid evolution as it applies new thinking to old hardware and doctrine"[70] is important. It recognises that intellectual application is essential but also implies

a longer term utility for platforms including the B-bombers. Hence the development and integration of new and old technology and evolving doctrine, tactics, training and procedures are at the core of how the USAF intends to contribute to resolution of any future conflict. It is nevertheless important to acknowledge that Iraqi and other insurgents have inflicted more casualties on the US coalition since the declaration of the end of hostilities than during official combat operations. This highlights the need to apply a strategy that has understood all aspects of the enemy. While outside the scope of this essay, further study of these residual effects of EBO is required. This should focus on the long-term results of EBO, particularly where rapid military victory, often by avoiding direct contact with ground forces, may not provide the desired longer-term strategic victory.

B-52 Stratofortress

The employment of LRLEP in the Psychological Operations role, supporting Commando Solo airborne TV broadcasts with leaflet drops (34 B-52 leaflet missions over Iraq out of a total of 158 contributing to over 31 million leaflets dropped) is another example of considering the employment of means to achieve the desired ends

Notwithstanding residual issues, recent conflicts have demonstrated that LRLEP has been pivotal to providing 24-hour effect, at a specific place and

time and thus provided the air commander with unmatched flexibility. There is no need to constrain B-bombers by the legacy of strategic bombing; they are equally capable of performing other roles. General Jumper stated "the USAF's emphasis on EBO as opposed to fighting a war of attrition allowed it to employ the B-1B strategic bomber in non-traditional ways to provide CAS".[71] The employment of LRLEP in the Psychological Operations role, supporting Commando Solo airborne TV broadcasts with leaflet drops (34 B-52 leaflet missions over Iraq out of a total of 158 contributing to over 31 million leaflets dropped) is another example of considering the employment of means to achieve the desired ends.[72] Conversely, following EBO and its technology and doctrine-based concepts, other platforms that are considered tactical were used to conduct strategic missions. Two such examples of tactical aircraft used in the strategic role are the American F-15 and the British GR4. Carrying PGMs and CALCM they operated both deep in enemy territory and at standoff range to achieve strategic effect in Iraq.[73] When supported by tanker aircraft and the typical Composite Air Operations packages of fighter and EW aircraft they can significantly add to the air planner's options and are likely to be available in more numbers than LRLEP. These aircraft do, nevertheless, require far more ground support, more tankers and put more crews at risk to achieve effects similar to LRLEPs. They are not as capable of short-notice, long-range power projection, but they may prove preferable in certain environments or where power projection from an aircraft carrier is appropriate.

It is accepted that, at present, only USAF B2 aircraft can penetrate enemy defences with impunity, the B1-B may operate in a low-medium threat and the B-52 at standoff ranges or in a low threat environment only

Similarly, the precision and ubiquity of cruise missiles, which were used 985 times in Op IRAQI FREEDOM, provide commanders with an effect controlled at the high operational and strategic levels. Expertise in selecting the right weapon against the right target to achieve the right effect is essential. Weapons such as TLAM may provide competing capability to LRLEP, but in terms of EBO they are more likely to provide a complementary effect. Issues, including, but not limited to cost, stock availability and politics contribute to the decision on weapon selection but ultimately, the decision taken must be justifiable in terms of contributing to the strategic objective.

Whatever weapon platform is employed, the air commander will almost certainly be required to establish appropriate control of the air, not only within a classic sequential campaign, but also within any parallel EBO. Although having to contend with the so-called 'Super-MEZ'[74] around Baghdad, in OIF (and OEF) the US-led air forces enjoyed near air supremacy that allowed offensive operations to proceed unhindered. This is possibly, but not absolutely, typical of the situation US-led coalition forces will operate within in the future. However, even if conflicts are only limited to small or medium scale regional affairs, future adversaries may have access to Russian S-400 Surface- to-Air Missile (SAM) systems, high speed, highly agile, long-range air-to-air weapons or a variety of other weapon technologies that are currently emerging. It is accepted that, at present, only USAF B2 aircraft can penetrate enemy defences with impunity, the B1-B may operate in a low-medium threat and the B-52 at standoff ranges or in a low threat environment only. While these factors cannot be allowed to detract from the successful employment of LRLEP in recent conflicts, they are relevant to the analysis. Contrasting LRLEP effectiveness in a relatively benign environment to one against a more

formidable threat raises broader issues regarding measuring the effectiveness of modern air power platforms and the doctrine, tactics and procedures employed. From the earliest days of air power, and equally evident in recent operations, the short, medium and long-term, or tactical, operational and strategic effects that each bomb and offensive mission has had on the opposition have been difficult to accurately gauge.

The measurement of effects dilemma

For several months prior to operations, as part of the assessment of the Iraqi regime's strengths and weaknesses, the US had been preparing the intelligence picture in order to generate a detailed understanding of Iraq.[75] It should be added that 12 years of policing the two 'no-fly zones' after the first Gulf War also provided substantial insight into Iraqi military capability and tactics. Once military action commences, however, an effects-based concept is difficult to conduct if the effect cannot be measured, particularly in the fog and noise of war. Even detailed post-war analysis of the results of bombing campaigns is difficult and often influenced by various agendas.[76]

Secretary of the Air Force, James G Roche recognised after the Afghanistan and Iraq conflicts that measurement, particularly Battle Damage Assessment (BDA) was a problem.[77] He stated that the BDA process must be "dynamic and responsive to our ability to strike". He added "anything less undermines the inherent deterrence and compelling effects air power brings to (our) war fighting team". It follows that the success of EBO relies not only on a detailed knowledge of the opposition, their systems and courses of action, but also how effectively each tasked mission contributes to the overall objective. Once an assessment of the damage is achieved, expertise is required to understand how the effect impacts on one's own objectives, and importantly, enemy strategic objectives. This must avoid 'mirror imaging' one's own considerations and get into the mind of the enemy. It is challenging, but necessary, to define and construct measures of effectiveness that are meaningful to a campaign strategy. The right choice of measurement will affect how resources are allocated and how the campaign develops. Williams's argument that both predicted and unpredicted and desired and undesired effects must be accounted for and correctly analysed is particularly valid.[78] The correct analysis of imagery and the timely transfer of information up and, importantly, back down the command chain in order to successfully conduct activity at all levels of warfare is essential. This is key not only to the observation and orientation phases of the OODA cycle, but critically, to the decision and action phases. Thus, EBO not only demands knowledge of the enemy, but also ability to transition quickly from one effects-based activity to another. There is therefore a balance to be struck between perfect knowledge and sufficient knowledge to take decisive action. Overall, the relatively quick victories in Afghanistan and Iraq substantiate the claims for EBO success and the ability of the US leadership to deal with the measurement of effect dilemma in terms of gaining territory. The shift in bombing strategy in Afghanistan, for example, certainly supports this view.

It has been shown that LRLEPs were a major factor in the military successes and sufficient evidence has been given to illustrate the potent capability that the B-bombers provided. Whether or not the same effects and end result could have been better achieved with the improved BDA that Roche seeks will require much deeper analysis of classified information. One way that these measurement problems are being addressed is through the expansion of operational analysis in the Combined Air Operations Centres (CAOCs). Expertise in these areas contributes to intelligence-led and intelligent EBO targeting, but to achieve the desired strategic outcome it must be capable of understanding the enemy and his ways of thinking.[79] Thus BDA and the ability to think like the enemy are aspects of EBO that are always likely to need continuous effort. Recent LRLEP use, across the levels of warfare, illustrates the contemporary problems. In the CAS role, visual assessment of target damage is often simple to measure by the Forward Air Controller (FAC), for example, the enemy stops shooting. Conversely, destruction of a vehicle as part of TST may be witnessed by the FAC but exact knowledge of who was in the vehicle and the longer-term strategic effect may take significantly more time to assess and understand. Similarly, the coercive effect of a

parallel EBO approach on the civilian population in Afghanistan, particularly via warlords and tribes, was different to those in Iraq, where an uprising did not overtly occur. Pape argues that the bombing that knocked out power generation in North Korea (90 per cent), North Vietnam (85-90 per cent) and Iraq in 1991 (more than 90 per cent) did not cause civilians to rise up against their respective regimes.[80] He goes on to suggest that the increased clinical use of PGM's, (only seven per cent in 1991) while politically sound for US-led coalitions, is not likely to increase the chances of a civilian uprising against a regime. This PGM argument was to some extent justified by the initial lack of success in prompting the Afghan Northern Alliance to attack the Taliban, but this was quickly addressed after analysis of the situation. Significantly, however, the transformation in doctrine and technology since his assessment appears to partially invalidate his findings in terms of the broader use of coercive bombing.

While lacking the detailed operational analysis of these wars,[81] the coercive effect of air power through the high use of LRLEP, nevertheless, appears to have been effective. The lack of Iraqi Air Force activity (including the burial of aircraft) implies that the enemy's will was broken by

The lack of Iraqi Air Force activity (including the burial of aircraft) implies that the enemy's will was broken by threat alone

A MiG-25 Foxbat is recovered after being buried in the sand by the Iraqis

threat alone. Similarly, the shaping operations and rapid, overwhelming defeat of large ground forces without direct contact[82] implies that coercion was a factor. When more information is available it might be possible to measure how strategies targeting leadership, organic essentials (including electricity) and infrastructure, compared to the effect of bombing fielded forces. As already outlined, the residual difficulties facing coalition forces in both countries indicate that decapitating key leadership has not yet created a stable security environment in either country — although presumably a key strategic aim of each war. It is on this point that Pape's argument may prove to be valid. However, in terms of modern air power, there must be a distinction between the outdated concept of a 'strategic bomber' that he refers to and the broader use of aircraft that contribute to EBO.

On balance, and despite measurement difficulties, LRLEP has provided a significant contribution across the levels of warfare to both the coercive and denial elements of EBO in recent limited wars. However, the longer-term validity of the B-bombers that have so far defined LRLEP in this essay may be questioned if the pace of technological change continues. Therefore, it is appropriate to look at what tools air power can provide to successfully conduct EBO in the 21st Century.

LRLEP in the 21st century

The USAF leadership's comments 'post-Afghanistan and Iraq' underscore their enthusiasm for both EBO and the aircraft technologies that facilitate it. The current world security situation 'post-Cold War' is such that the US and many Western nations consider policies involving effective rapid reaction expeditionary forces to be necessary for the foreseeable future. A capability to create early and decisive effects, where and when necessary, whether opposed or not, and without the time to build up to an event will be an increasingly critical element in the ability to face down, and ultimately remove, acute threats.[83] B-bombers can already provide a strategic and tactical effect within hours of an incident, can operate from continental USA, pack a massive punch per aircraft, minimise the risk of friendly casualties and have the ability to minimise collateral damage in the target vicinity. Thus, the USAF has assets that can quickly carry out western global strategy and are capable of coercive options that avoid the political ramifications associated with overseas basing. General Jon Loh, USAF, stated that:

"Bombers fit perfectly in the new way of waging war in the network centric real-time targeting system of systems, because bombers provide the engage link in the FFTTEA kill chain. The Air Force has not fully appreciated the long endurance characteristic of the bomber. It does recognise the long-range capacity. By exchanging range for loiter time with huge bomb loads it is able to respond rapidly to reduce the time lines for Find-to-Engage significantly." [84]

Coupling these comments with the conclusion of the 1990 White Paper, aptly summarised in the its title *Global Reach — Global Power*,[85] and the 1999 USAF White Paper on Long Range Bombers,[86] there is a clear determination in the USAF to sustain long-range bombers up to the second half of the 21st century. In terms of Aerospace Expeditionary Force (AEF) tasking, bombers can "demonstrate their global power capability" and "integrate to form a synergistic force that is at the core of a lean, lethal, tailored, and rapidly responsive AEF".[87] Future weapon upgrades, largely comprising smaller and standoff PGMs, avionics and countermeasures upgrades are being integrated and there are no signs that intentions to further develop them will diminish. With self-targeting PGM capability on these platforms, and under political and media pressure, air planners are expected to call on these assets as the air platform of first use, if not first choice. The inherent flexibility and utility they provide is a potent instrument of deterrence, coercion and denial.

As technology advances alternatives to B-bombers may fulfil the LRLEP role. At present, variants of cruise missiles are vastly more expensive and thus limited in stock compared to PGMs. They are not as flexible for TST, are less effective against hardened targets and the platforms that deliver them are limited in the number they can carry. Also, they lack utility in circumstances when Rules of Engagement are tight or positive identification

Predator UAV armed with laser-guided Hellfire missiles

UAVs capable of deploying munitions have demonstrated their worth in the find-to-engage process in recent conflicts

of targets is necessary. Nevertheless, they already complement PGM-carrying bombers and cannot be discounted as a means of delivering cross-spectrum warfare effects, particularly if technology develops and costs reduce. Other pilot-less air vehicles — Unmanned Combat Air Vehicles (UCAV) and Unmanned Air Vehicles (UAV) — are highly likely to play a part in how effect is delivered. UAVs capable of deploying munitions have demonstrated their worth in the find-to-engage process in recent conflicts. A cost versus capability analysis would be valuable at this point, but requires comparative data on weapons effect, loss rates, risk and so on, that are currently unavailable.

The next generation of fighter-bombers will add to the air power tool bag, but the current USAF bomber fleet will continue to provide a capability for at least 30 years.[88] The only impact that future aircraft procurement may have is deflecting resources from the USAF bomber fleet or vice versa. General Loh stated "the Air Force fears that if it pushes for greater number of bombers, it will be at the expense of the F/A-22".[89] Current manned platforms can provide similar effects, particularly when deploying PGM, CALCM and, from the surface, TLAM but are less flexible, or more costly both financially and in personnel, to deploy quickly to achieve the same effect. Ultimately, the number of LRLEPs in use will be limited and only the USA is currently willing and able to maintain the capability in its inventory.[90] One spin-off from the latest PGM technology is that it could be fitted to variants of other large aircraft that have potential for medium-level, long-range/loiter. Examples include the RAF's planned MRA4 or any number of current and future airlift platforms. Indeed, the MoD Deep Target Attack Equipment Capability Directorate's vision is, by 2020, to field 10 times the effect of (current) long-range strike weapon systems, with one-tenth the deployed logistical tail, 50 per cent of the manpower and at half the cost of ownership compared to 2002.[91] The RAF's Future Offensive Air System (FOAS) will be developed to meet these requirements. This hints at the prospect of a variety of other nations gaining LRLEP capability

Other nations may soon be capable of deploying LRLEP to meet their own global aspirations with, without or against the USA

at a fraction of the cost of the B-bombers. Nevertheless, the current enthusiasm for these platforms, coupled with neo-conservative lobbying in the USA, could potentially see a drive to acquire a new supersonic/hypersonic stealth bomber sooner than 2030.[92] From senior USAF commander's comments on joint solutions to success in conflict, there seems little validity to the argument that: "To many senior leaders in the US Army, the concept of EBO is another attempt by strategic bombing advocates to line Air Force coffers at the expense of land forces".[93] Whatever academics, cynics and detractors argue, current USAF doctrine and its recent application appear to be shaping how the US, and in coalition its partners, will fight future wars. All evidence suggests that the B-bombers will remain a significant LRLEP in support of EBO for at least 25 years; other platforms and burgeoning technologies will complement rather than replace them during this period.

Conclusion

Strategic bombers have proved to be an important, if not decisive, tool in the development and employment of air power. Equally, they have been at the centre of the most long-running and contentious debate on how air power should best be exploited and measured. Understanding the strategic bomber concept has, therefore, always been an important but multifaceted issue. Advances in technology, specifically in PGMs, and the commensurate evolution of air power doctrine, particularly towards EBO, have further obscured the role of aircraft that fly fast, far, and with large payloads. At present, only USAF B-bombers are characterised by their long-range projection, enduring presence over an area of interest and effect across the spectrum of warfare. In order to better place these interlinking capabilities and conceptual issues in the air power lexicon, the term LRLEP should replace 'strategic bomber'. Other technologies will be developed that initially complement B-bombers and, if cost and capability allow, will eventually replace them, quite possibly in a completely different, and potentially unmanned form. In these circumstances, many other nations may soon be capable of deploying LRLEP to meet their own global aspirations with, without or against the USA.

EBO and the 'new warfare model' have still to fully develop, particularly in terms of the timely understanding and measurement of effect and the longer-term implications of warfare that avoids destruction of the opponent's future fighting capability. However, while recent wars have not provided a credible air force and air defence challenge to the conduct of air operations, LRLEP operating within an EBO framework were decisive in pure air power projection terms and equally instrumental in the success and tempo of ground force's activity. The recent Afghanistan and Iraq wars appear to be typical of modern conflicts and have supported the case for the employment of aircraft with such powerful coercive and denial capabilities well into the 21st century. The combination of technological advances, international security crises and the development of doctrine and subsequently, tactics, training and procedures that support joint and combined campaign objectives have created a niche capability for B-bomber LRLEPs. Under these circumstances, LRLEP has never been more relevant in fulfilling air power's role as expressed by Air Marshall Funnell in the opening quote.

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Notes

1 Withington (2003)

2 The period between finding and engaging a target

3 To be referred to in the essay as B-bombers

4 Knight (1989), p.2

5 Westenhoff (1990), p.31

6 Howard and Paret (1976), p.75

7 Meilinger (2003), p.180

8 Biddle,T (1995), p. 92. Biddle's comprehensive study of early British and American air strategies through the First and Second World Wars argues that strategic bombing was shaped by the availability of aircraft and their capability, the military organization, politics and bureaucracy and the influences of dominant theories on warfare, particularly the impact that aerial bombardment could have on civilian morale.

9 See Biddle (1995) and Gentile (2001) for detailed analysis of why these strategies were pursued and case studies on the effectiveness of strategic bombing.

10 Pape (1996), p. 314. His book gives an extensive assessment of the success of coercion and denial in various bombing campaigns. He argues that coercion strategies, aimed at attacking civilians (Germany, Japan, Korea and Vietnam and to a lesser extent Iraq (1991) did not provide concessions to any part of the coercer's demands. He argues that in the same cases conventional denial strategies (against the fighting forces) that were pursued had some success (but not in Vietnam).

11 Meilinger (2003), p. 180

12 US Secretary of Defence Donald Rumsfeld stated at the outset that Operation IRAQI FREEDOM strikes would be carried out with breathtaking precision. The air commanders were required to obtain his approval for any planned air strikes that might result in more than 30 civilian deaths.

13 A frequently repeated statistic, purported to originate from Col John Warden, is that the number of allied aircraft required to succeed against one German target in 1944 during WWII, even in a benign environment, was 1000. In comparison, a single aircraft and one PGM during Gulf War I could achieve the same effect. Satellite navigation, PGM technology and availability of stealthy bombers (B-2) have improved this capability significantly since 1991.

14 To be considered a precision weapon, munitions must be capable of hitting within 9.9 feet of the aim point. If outside the circle, but within 66 feet munitions are called near precision weapons.

15 Knight (1989), p. 1

16 Lock-Pullan (2002), p. 63

17 Howard and Paret (1976), p. 77

18 Howard (1981), p. 14

19 Accepting that the US failure was partially because of their lack of a clearly articulated strategic aim.

20 Pape (1996), p. 209

21 AP3000 (1999), p. 2.6.2

22 ibid, p. 2.6.1

23 Lock-Pullan (2002), p. 60

24 Finn (2003), p. 2

25 Lambeth (2000), p. 164

26 Chain, (1988), p. 23, quoted in Lambeth, B (2000), p. 164

27 Conventional Air Launched Cruise Missile

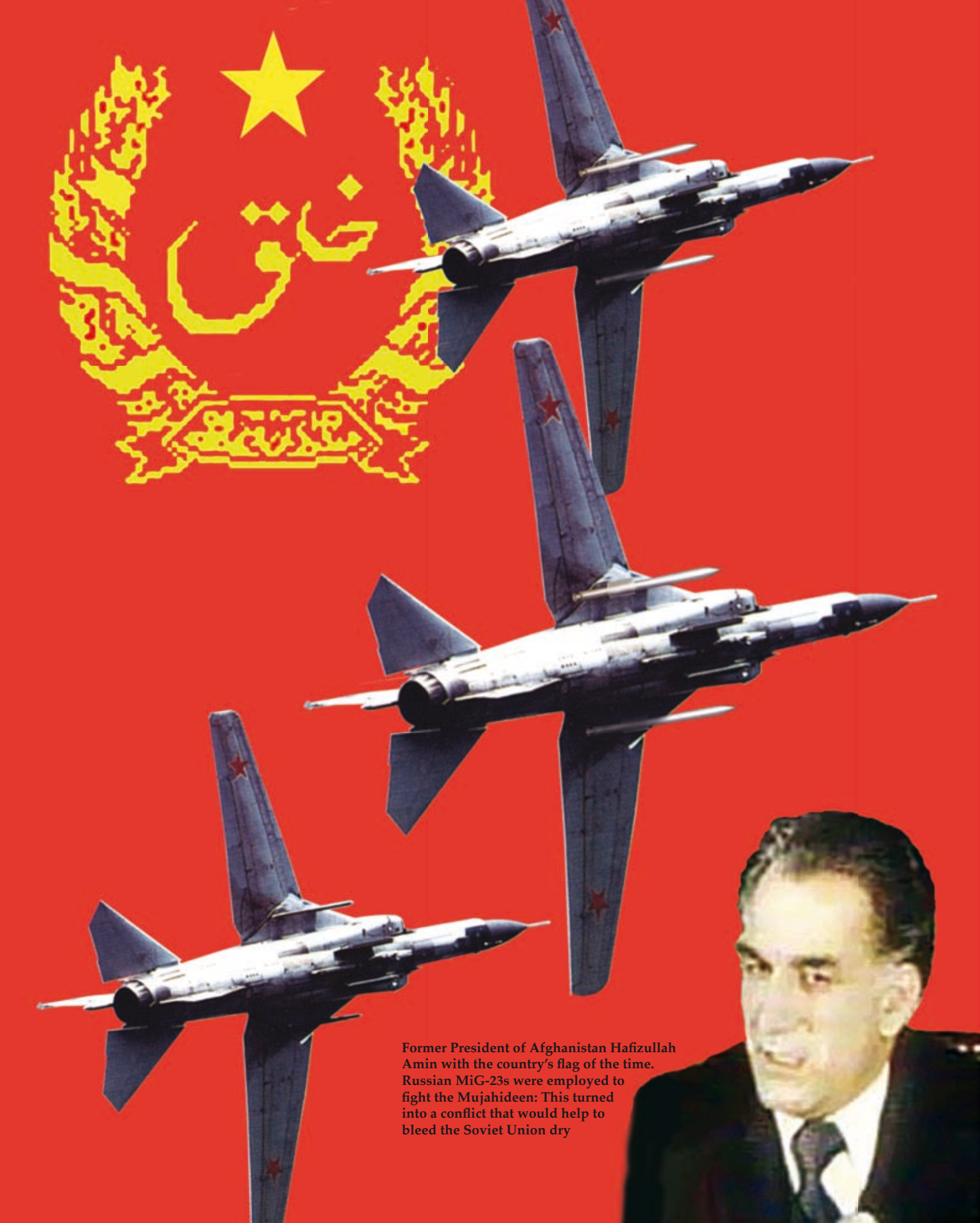
28 Lambeth (2000), p. 166

29 Meillinger. Statistics provided during a brief to the Advanced Command and Staff Course Number 7, 14 Oct 2003

30 Air Force Doctrine Document 2-1.2 (1998)

31 ibid, p. 1
32 ibid, pp. 4-11
33 ibid, p. 1
34 id
35 Strange (1996). In his study of COGs, Dr Strange links the modern concept of COGs to critical capabilities, critical requirements and then, importantly, critical vulnerabilities. It is the critical vulnerability, or opponent's weaknesses that are most susceptible to attack that must be identified and exploited with an appropriate focus of effort.
36 Bucknam (1998), pp. 315-318
37 British Defence Doctrine (2001), p. 1-2 defines levels of war. Grand strategy refers to the co-ordinated use of economic, diplomatic and military power. Military strategic is the art of developing and employing military forces consistent with grand strategic objectives. The operational level is the level at which campaigns are planned by establishing operational objectives. The tactical level is the level at which warfighting actually takes place.
38 For example see JWP 0-10 or JWP 3-00 for two versions of the UK estimate format.
39 Peach (2003), pp. 57-63
40 See Knight (1989), p. 46 for an assessment of the value of these raids.
41 Peach (2003), p. 59. Peach contends that, notwithstanding Warden's Five Rings systems construct (discussed later), General Horner, the Air Commander, employed a classic NATO Cold War style air campaign. This involved sequentially suppressing Iraqi integrated air defences, establishment of a degree of control of the air and then attacks on other targets including Iraqi leadership. He suggests that it was actually the ability to manage over one thousand sorties per day during the first Gulf War that allowed concentration of force to achieve a strategic effect on Iraqi defences.
42 Bucknam (1998), p. 316
43 Bucknam (1998), p. 317. At the Tactical level, the bombers were used as bait to draw Luftwaffe fighters into combat with allied fighters. At the Operational level, loss of oil hindered German ground mobility and enabled Allied land advances to meet their objectives. At the strategic level, oil shortages undermined the overall war effort, forced changes in training and operational policies and affected munitions production.
44 Deptula (2001). His essay explaining the use of an effects-based approach during Gulf War I provides an influential argument for how American forces should be structured to fight in the future. It appears to have the backing of Joint Force Command and, significantly, Donald Rumsfeld, US Secretary of State for Defence.
45 Deptula (2001) argues that in air campaigns prior to the first Gulf War, force was applied sequentially to roll back the enemy defences prior to attacking high value targets. The analogy of the electrical circuit, where electrons flow in a line through light bulbs sequentially to complete a series circuit illustrates the concept. In warfare this requires assets to be tied up suppressing enemy defences before reaching the objective thus giving rise to high attrition, limiting the overall surprise and dispersing the mass of main effort. In a parallel circuit, electricity reaches the light bulbs almost simultaneously. In parallel warfare the simultaneity of attack against high priority targets enables surprise at the tactical level, a larger span of influence, fewer casualties, paralyzing effects and shorter time to impose effective control over the enemy.
46 Williams, (2002), p. 133
47 Davis (2002), p. 7
48 Warden, (1996), pp. 364-374. His highly influential 'Five Rings' concept is acknowledged as the basis of coalition air operations planning for the 1991 Gulf War. The theory uses the analogy of a target board with leadership at the centre. Wrapped around the core are the organic essentials (for example electrical power). The next layer out is the infrastructure, then the population, then finally the outer layer, the fielded military. Simultaneous (non-linear) attacks on these sub-systems of a 'system' provide an inside-out approach to warfare, as opposed to the classic outside in method where the fielded forces are peeled away to expose the opponent's infrastructure. Importantly, it provides a framework for analysing COG in order to achieve the desired effects.
49 Boyd focussed on creating a time advantage over the enemy by rapid transition of activities based on better intelligence, effective assessment of it, fast decision making (using intuition) and decisive action. By accelerating the O-O-D-A loop cycle, the enemy is increasingly confused and ultimately defeated.
50 Deptula (2001), p. 26
51 Quoted in Friedman (2003), p. 88
52 Tirpak (Feb 2002), p. 32
53 Brookes (Apr 2002), p. 26
54 Withington (2003), p. 86
55 Website: globalsecurity.org
56 Biddle,T (2002), p. 50
57 Friedman (2003), p. 184
58 Prof Rodgers, Bradford University, presentation on International Terrorism to ACSC 7, 8 Mar 2004.
59 Brookes (2004), p. 40
60 USCENTAF (2003)
61 Excludes Special Operations Forces, Army helicopter and coalition sovereignty flights.
62 Quoted in Hebert (Nov 2003), p. 27
63 Hebert (Jul 2003), p. 49
64 TST was designed to Find, Fix, Track, Target, Engage and Assess (FFTTEA) important targets that were available for only a fleeting time.
65 Intelligence Surveillance Target Acquisition and Reconnaissance. These may include E-3 AWACS and JSTARS for example.
66 Newman (2003), p. 52
67 General McCrystal, quoted in Finn (2003), p. 6
68 See General Jumper's comments regarding the utility of airpower in poor conditions in Hebert (2003), p. 27
69 Grant (2003), p. 83
70 Jumper quoted in Tirpak and Hebert (2003), p. 81
71 Jumper quoted in Finn (2003), p. 15

72 USCENTAF OIF – By the Numbers (2003), p. 8
73 Tirpak (2002), p. 38
74 Missile Engagement Zone
75 Newman (2003), p. 52
76 See Gentile (2001) for a detailed study of the US bombing surveys from WWII and Gulf War I.
77 Tirpak and Hebert (2004), p. 80
78 Williams (2002), p. 144
79 Peach (2003), p. 4A-8
80 Pape (1996), p. 320
81 Due to classification of material
82 Significant numbers of Iraqi soldiers dispersed or surrendered
83 Anderson (2003), p. 43
84 Loh quoted in Boyne (2003), p. 176
85 Air Force & National Security White Paper (1990), p. 15
86 USAF White Paper (1999) outlines the USAF's long-term requirement for B-bombers
87 ibid, p. 15
88 ibid, p. 24.
89 Quoted in Boyne (2003), p. 177
90 The Russian Federation does retain Blackjack aircraft but these are far less capable than the USAF B-force
91 Anderson (2003), p. 45
92 Boyne (2003), p175. NASA proved hypersonic capability on 27 Mar 2004 with the launch (from a B-52) of X-34, its SCRAM-jet platform that is surely destined for military application.
93 Cheek (2002), p. 73



Former President of Afghanistan Hafizullah Amin with the country's flag of the time. Russian MiG-23s were employed to fight the Mujahideen: This turned into a conflict that would help to bleed the Soviet Union dry

The Experiences of the Soviet Air Force in Afghanistan 1979-1989

By Thomas Withington

The Soviets did not want any upsets in their soft, southern underbelly, but the political situation in Afghanistan was unravelling in the dark days of the late 1970s. The grip on power that President Hafizullah Amin and his Socialist People's Democratic Party of Afghanistan (PDPA) had wielded from the capital Kabul was loosening, and despite signing a Treaty of Friendship and Co-operation with the USSR in 1978, the socialist agricultural and social 'reforms' which Amin was attempting to institute in Afghanistan was infuriating major sections of the Afghan population. Fiercely traditional rural communities grew highly sceptical of plans to abolish the feudal power of the countryside landlords, while the urban population was increasingly frustrated at the non-existent, yet promised, social reforms such as equal rights for women and ethnic minorities, and freedom of religion.

Amin, a prominent member of the Marxist 'Khalq' (*People's*) faction of the PDPA, began his grab for power in Afghanistan upon the assassination of Mohammed Daoud Khan during a coup led by the PDPA. Amin became a deputy Prime Minister of Afghanistan along with Babrak Karmal, leader of the rival and more moderate PDPA 'Parcham' ('Banner') faction. Meanwhile, Noor Mohammed Taraki became the President of the Democratic Republic of Afghanistan (DRA). Upon

gaining power, Amin began to flex the muscles of the Khalq faction over the Parcham grouping, eventually sending Karmal into exile in Europe, thus making Amin the sole Prime Minister. On 14 September 1979, in his final act of consolidation Amin and his supporters moved against Taraki, killing him in a palace coup and paving the way for the erstwhile Prime Minister to now declare himself President of the DRA.

General Secretary of the Communist Party and President of the Soviet Union Leonid Ilich Brezhnev looked on in astonishment from Moscow at the turmoil in the Soviet Union's mountainous neighbour. Afghanistan was supposed to be a trusted and loyal Soviet ally, but Amin was not following the script. His radical agenda was provoking widespread protest and subsequent armed revolt across much of the country. To make matters worse, the loyalty of the DRA's armed forces ebbed and flowed according to whether it supported the government or the opposition, and soon showed itself to be unwilling and unable to quell the rebellion that was gripping large swathes of Afghanistan. Amin responded in characteristic fashion to the disintegration with a harsh crackdown on political opponents with thousands being jailed, tortured and executed. As the situation unravelled, Amin appealed to Moscow for Soviet troops to help him crush the rebellion. As the demands became more frequent and more desperate, Brezhnev and his Politburo comrades pondered the issue, fully aware of the international outrage that an open invasion of Afghanistan would bring.

President of the Soviet Union Leonid Ilich Brezhnev looked on in astonishment from Moscow at the turmoil in the Soviet Union's mountainous neighbour

On Christmas Day, 1979, they replied to Amin's demands. In the dead of night, his official residence in Kabul was stormed by Soviet troops from the 105th Guards Airborne Division. In the bitter battle for the Royal Palace, where Amin had moved believing it to be more secure than his official residence, he was killed, along with his bodyguards and the members of the Afghan National Army (ANA) who had remained loyal; 1800 of whom were killed. By the morning, Afghanistan had a new President, as Karmal was bought out of retirement and installed as Moscow's puppet. As the 105th Guards Airborne Division were finishing the job, other Soviet units were pouring into Afghanistan to assist what was left of the ANA in crushing the rebellion by the Mujahideen ('Holy Warriors') who were leading the rural uprising against the Kabul regime which they perceived as avowedly secular and intent on wrecking rural traditions. Moscow's intervention was supposed to be short: to help the ANA and Karmal to regain control of the country and then to leave. Yet it would develop into a conflict which would help to bleed the Soviet Union dry.

Air power would be vital to the Soviet Union before the invasion got underway and until the very end, as the USSR fought its 'hit and run' war against the Mujahideen on the undulating and unforgiving Afghan landscape. Prior to the invasion, the Soviets had performed aerial reconnaissance of border regions and Afghanistan itself using Voenno-Vozdushnie Sili (VVS)[1] aircraft. However, so as to keep Soviet actions under wraps, these aircraft were festooned with insignias from the DRA Air Force (DRAAF). They were flown by Soviet ethnic Tajik and Uzbek crews so as to not to arouse any suspicions among the Afghan population lest they crash.[2] Tajiks and Uzbeks comprise 25% and 8% of Afghanistan's contemporary population respectively.[3] In November 1979 Soviet transport aircraft from the Voenno-Transportnaya Aviatsiya (VTA)[4] such as Il-76 jet heavy-lift jet freighters (NATO

Il-76 Candid

In November 1979 Soviet transport aircraft from the Voenno-Transportnaya Aviatsiya (VTA) such as Il-76 jet heavy-lift jet freighters (NATO code name 'Candid') along with An-22 (NATO codename 'Cock') and An-12 (NATO codename 'Cub') heavy-lift and tactical turboprop freighters airlifted the first Soviet troops and their equipment into Afghanistan

code name 'Candid') along with An-22 (NATO codename 'Cock') and An-12 (NATO codename 'Cub') heavy-lift and tactical turboprop freighters airlifted the first Soviet troops and their equipment into Afghanistan: an operation which would use no less than 38% of the VTA fleet.[5] In executing the invasion, the Soviet military emulated their invasion of Czechoslovakia in 1968; attempting to shock Amin's regime by airlifting the 105th Guards Airborne Division of the Sukhoputnyee Voyska (SV)[6] which were tasked with rapidly seizing strategic targets around Kabul as well as Amin's residence.[7]

At the start of the invasion, the profusion of transport aircraft greatly outnumbered the quantity of offensive aircraft which the VVS deployed. It is thought that in the days immediately after the invasion, perhaps only 20 attack helicopters, presumably Mi-24 (NATO codename 'Hind') from Armeiskaya Aviatsiya (AA)[8] were sent south, plus an undisclosed number of VVS fighters and fixed-wing attack aircraft. No sooner had the Soviets arrived in Afghanistan than the Mujahideen, known as the dukhi[9] to Soviet personnel, began to inflict serious damage on troops and equipment. The 40th Army, the SV unit tasked with conducting

Su-24 Fencer

The Fishbed and Fitter would soon make way for the more capable MiG-23 (NATO codename 'Flogger') and Su-24 (NATO codename 'Fencer') which appeared in the Afghan skies from 1980 and 1982 respectively. Their performance and accuracy was a major improvement on their predecessors

invasion and helping the ANA crush the insurrection, would soon realise that this small number of offensive aircraft would be inadequate for the task in hand.[10] It is all but impossible to give an exact order of battle for the total number of Soviet aircraft which were deployed to Afghanistan throughout the intervention. Estimates vary widely between 450 rotary and fixed-wing aircraft to 1250 aircraft of all types.[11]

This mass of air power was placed under the command of the 40th Army headquarters in Kabul with a senior VVS officer and staff section attached to help direct air operations and to coordinate them with the SV. However, the overall VVS Headquarters, logistics facility and maintenance base for operations in Afghanistan was located at Termez in present-day Uzbekistan.[12] This made sense given the situation on the ground in Afghanistan where air bases were favourite targets of the Mujahideen who would conduct regular attacks on aircraft and personnel, exacting serious damage. Therefore, the Soviets found it prudent to perform the 'deep' maintenance of their aircraft serving in Afghanistan across the Soviet-Afghan border, well beyond the range of the marauding dukhi and their rocket-propelled grenades.[13] Despite this, the Soviets did invest in Afghanistan's airfields, making them more suitable for their aircraft. Local labour was often utilised to expand runways and extend facilities, with airfields at Bagram, Kabul, Shindand, Kandahar, Farah, Jalalabad and Mazir-i-Sharif all benefiting.[14]

For military operations, the Soviets had parcelled Afghanistan into four sections. The northern region included the cities and towns of Kunduz, Khanabad, Faizabad, Puli-Kumri, Tashkurgan and Mazir-i-Sharif; the eastern region included the Khost, Asadabad, Jalalabad, Gardez, Kabul and Bagram conurbations; the southern region included Munarai, Kandahar and Lashkargah while the western region comprised the cities of Farah, Shindand and Herat.[15]

One of the biggest challenges experienced by Soviet combat aircrews was in planning their sorties. Afghanistan's rugged and elevated terrain tested a navigator's skills to the limit. Aircrews did often try to meticulously plan their missions; however, time pressures often meant the crews having to 'make it up as they went along', planning their missions on the way to their targets.[16] This would often affect the so-called desant missions where a package of cargo helicopters carrying SV troops and their equipment and protected by a phalanx of helicopter gunships, were ferried to an area of Mujahideen activity for an assault.[17]

Soviet training had a reputation for rigidity, discouraging aircrews from showing initiative and deviating from prescribed tactics and methods for a particular mission. However, to a very limited extent, this thinking was abandoned in Afghanistan and helicopter pilots in particular would often work in a 'freelance' capacity. For example: a pair of Mi-24 gunships could be joined by a Mi-8 (NATO codename 'Hip') aircraft. The Hip would act as a decoy to draw Mujahideen fire. As soon as the rebels opened fire they would expose their position, allowing them to be engaged by the gunships.[18]

Another favourite tactic of the helicopter pilots was to fake an approach to a landing zone. This was to goad the Mujahideen into believing that a

The high degree of accuracy and the 8,818 lb (4,000 kg) payload of the Su-25 terrified the Mujahideen

Having entered service in 1954 the Tu-16 was one of the Soviet's oldest bombers. From 1987 onwards the more modern, variable-geometry wing Tu-22M (NATO codename 'Backfire') was unleashed on Afghanistan

desant was on its way and to open fire. Once the rebels began firing they would reveal their position to the fighter-bombers following the faux desant which would then offload their ordnance on the guerrillas.[19]

Fighter-bomber pilots had a fondness for confusing the Mujahideen with the so-called 'star' formation in which with attack aircraft repeatedly hit the same target while flying from different points in order to surprise the dukhi. Another tactic would see two pairs of aircraft attacking the same target on a parallel course, but from opposite directions. This would help to confuse the Mujahideen as to which direction the attack was coming from.[20]

Such 'freelance' operations were important for Soviet crews and their survival could be greatly enhanced by learning from experience. Pilots would describe the training for operations in Afghanistan as woefully inadequate and being selected for service in this difficult theatre would not entitle a pilot to any special instruction before their departure.[21] One common complaint was that a premium was placed on training the aircrews to avoid accidents while the development of initiative and independence was neglected.[22] One Soviet pilot even commented that: "in normal training we are used to acting shablomo (by textbook) . . . when the situation becomes complicated as in battle, we are not able to cope with the task before us. That is the cost of oversimplification and the lack of initiative".[23] A confidential poll of Soviet aircrew conducted between 1987 and 1989 gave some clues as to the levels of 'job satisfaction' amongst the pilots. Training was a major complaint: 87 per cent of fighter pilots, 98 per cent of fighter-bomber pilots and 50 per cent of bomber pilots said that they were dissatisfied with the training which they had received before their service in Afghanistan.[24]

However, there were parts of the air war where the Soviets excelled. For example, they made widespread use of avianovodchiki[25] who would often accompany ground units in vehicles or would be positioned in helicopters during a desant where they would direct the landing operations and attacks by helicopters and fixed-wing aircraft.[26] The Soviets compartmentalised their aircraft according to the missions that they were tasked for. For example, fighter-bombers were supposed to assist the prevailing counter-insurgency war against the Mujahideen. They would attack areas thought to be rebel strongholds prior to the arrival of a desant force. The weapons of choice for such missions were originally aircraft such as the MiG-21 (NATO codename 'Fishbed') and the Su-17 (NATO codename 'Fitter'). However, these aircraft were betrayed by their poor accuracy and performance which were unsuitable for the mountainous Afghan terrain. For example, the MiG-21 was ostensibly designed as a high-performance air-to-air fighter with a maximum speed of 1,160 knots (1,336mph/2,150 km/h)[27] This did not lend it to the twisting canyons, hidden ravines and caves, which were a favourite redoubt of the Mujahideen.[28] The Fishbed and Fitter would soon make way for the more capable MiG-23 (NATO codename 'Flogger') and Su-24 (NATO codename 'Fencer') which appeared in the Afghan skies from 1980 and 1982 respectively. Their performance and accuracy was a major improvement on their predecessors.[29]

The aircraft which really scared the Mujahideen was the Su-25 (NATO codename 'Frogfoot'). Echoing back to the legendary Il-2 anti-tank aircraft of the Great Patriotic War, the Frogfoot built upon the Shturmovik's illustrious reputation.[30] Using a more attractive nickname than its NATO moniker, Soviet troops called the Su-25 the 'Gatch'.[31] The aircraft made its combat debut in Afghanistan in 1980 when two aircraft were sent for testing. Another six aircraft arrived in 1981, and by the following year two squadrons were based at Shindand and Bagram. The high degree of accuracy and the 8,818 lb (4,000 kg)[32] payload of the Su-25 terrified the Mujahideen.[33]

Throughout the Cold War, the VVS maintained a formidable long- and medium-range heavy bomber force and aircraft from Bombardirovch'nyi Aviatsion'nyi Polk (BAP)[34] flew missions during the Afghan war. One of the workhorses was the Tu-16 (NATO codename 'Badger'). Its main role was to attack areas where Mujahideen sympathy was thought to run high, and also to conduct area attacks of regions thought to be harbouring Mujahideen before ground and air offences began.[35] The former role was especially important to the Soviet political leadership. In an effort to terrorise the Afghan rural population into not giving support to the Mujahideen, heavy bombers would attack villages, towns and farming communities in areas where there had been dukhi attacks on Soviet troops. According to Lester Grau; a Military Analyst at the Foreign Military Studies Office at Fort Leavenworth, Kansas, and an expert on the Soviet Afghan war; "the Soviets believed in Mao's assertion that the guerrilla is the fish that swims in the sea of the population. The Soviets intended to drain the ocean".[36]

The net effect of the area bombing performed by the VVS was not the degradation of popular support for the Mujahideen, but the creation of huge numbers of civilian casualties

In one notable instance, Tu-16s were used against the Panjshir valley in north-eastern Afghanistan, a stronghold of the late Ahmed Shah Massoud: arguably the finest Mujahideen commander and one of the finest military leaders of all time. On 21 April 1984, they attacked Mujahideen villages and bases in the valley. The raid was one of the largest of its kind for the Soviet bomber force with 36 aircraft flying between 30 and 40 sorties per day. But the Soviets had to be careful. Just over the southern border from the Panjshir valley lurked the Pakistan Air Force (PAF). The VVS and the DRAAF had already lost aircraft to the PAF after sneaking over the border to attack Mujahideen bases and infiltration

Having a similar psychological effect to the Su-25, and the Soviet's signature weapon of the conflict, the insect-like Mi-24 looked as fearsome as it was ugly

routes close to the border in Pakistan. Loosing a bomber would be a major embarrassment for the VVS and it went to great pains to ensure that these large aircraft were not placed in undue danger.[37]

Having entered service in 1954 the Tu-16 was one of the Soviet's oldest bombers. From 1987 onwards the more modern, variable-geometry wing Tu-22M (NATO codename 'Backfire') was unleashed on Afghanistan. In one incidence, these aircraft were tasked with bombing Mujahideen positions to help to relieve the siege of Khost, a city in south-eastern Afghanistan. Tu-22M3 aircraft from the 185 BAP were deployed to the Mary-2 air base in present-day Turkmenistan. Their great advantage over the Badgers was that they could fly faster and higher than their predecessors, which the VVS hoped would put them out of range of PAF air defences, a vital consideration given that this raid would take them close to the Afghan-Pakistan border. As an additional defence, the bombers were escorted by Tu-22PD (NATO codename 'Blinder-E') aircraft, which were outfitted with powerful electronic warfare equipment. However, the PAF stayed on the ground and the force was able to drop its 6,613 lb (3,000 kg) FAB-3000 bombs undisturbed.[38]

The net effect of the area bombing performed by the VVS was not the degradation of popular support for the Mujahideen, but the creation of huge numbers of civilian casualties. Meanwhile, the use of incendiary bombs and fuel-air explosives ensured that Afghanistan's once lush farmland and orchards became charred moonscapes. Allegations that the VVS fighter-bombers dropped chemical weapons[39] have proved to be notoriously difficult to substantiate. However, the VVS did drop anti-personnel mines from aircraft[40] in the belief that

Between 1981 and 1984, the VVS, along with the DRAAF, were reported to be conducting up to 200 violations of Pakistani airspace per year

as the weapons were designed to injure rather than kill, they would drain Mujahideen morale. Instead, these weapons have not discriminated between combatant and civilian leaving a grim legacy across the Afghan landscape with reports of up to 40 to 100 casualties being caused by landmines per week.[41]

One tactic of the fighter-bomber force was to engage the rural population in so-called 'Air Strike Diplomacy'. If, for example, Soviet Prisoners of War (PoWs) were being held by in a village, the VVS would conduct an impressive display of bombardment within sight of the village. This would be followed by a leaflet drop which would inform the villagers that they would be subjected to similar treatment unless the PoWs were released .[42]

For most of the time, however, fighter-bombers would be used for close air support during ground or desant attacks. In the early years of the war, Soviet fighter-bomber pilots were cautious, dropping their bombs from altitudes of 5,000 ft (1,524 m) often causing their weapons to drift widely off target. Yet soon the advent of more innovative techniques such as those described above would embolden the Soviet pilots to 'get down into the weeds' and press their attacks directly to the enemy.[43] During major operations, fighter-bombers would perform the opening air strikes against Mujahideen positions; they would then be followed by either Mi-24 aircraft, or the Mi-8TB (NATO codename 'Hip-E') gunship variant of the utility helicopter.[44]

At the start of the Soviet intervention, the tactics used by helicopter gunship crews were the opposite of those adopted by the fighter-bomber pilots. While their fixed-wing cousins were flying high and often missing their targets, the Hind pilots were hugging the ground with 'nap of earth' flying which displayed scant concern for the Mujahideen.[45] But Afghanistan was not the environment for helicopters. Heliports could be positioned up to 5,605 ft (1,800 m) above sea level, while summer temperatures could soar to 125° Fahrenheit (52° Celsius) – such 'hot and high' conditions can be a nightmare for helicopters, reducing engine power and lessening the load that the aircraft can carry.[46] Helicopters were not restricted to fighting the dukhi; they also played a vital role as a 'beast of burden', re-supplying isolated garrisons in inaccessible regions or those which had become surrounded by Mujahideen. Incidents such as these occurred in 1983 and in 1987 when the Soviet garrison near the city of Khost was besieged by rebels on two separate occasions. Rotary aviation was used to airlift supplies and reinforcements to the garrison, allowing it to break out of its base from the inside.[47]

Moreover, helicopters were also tasked with airlifting casualties, conducting reconnaissance, carrying avianovodchiki and performing general utility flights.[48] Reconnaissance missions were especially important. Helicopters would drop illumination flares for night operations or target identification. They would also patrol Afghanistan's various international borders to check for Mujahideen infiltrations, along with surveying rebel targets to be attacked. Other roles included route reconnaissance and path-finding for advancing troop convoys, a role often performed by Mi-8 aircraft.[49]

Having a similar psychological effect to the Su-25, and the Soviet's signature weapon of the conflict, the insect-like Mi-24 looked as fearsome as it was ugly. Well-defended with armour plating, this aircraft was highly resilient to small arms fire. Yet the aircraft had its weak points. Its engine air intakes were exposed, along with its tail rotor and oil tank, which for the Mujahideen was conveniently located behind the large red star on either side of the aircraft's fuselage, giving something highly conspicuous for the dukhi to aim for. Once again, the helicopter crews showed their initiative. According to Dr Mark Galeotti, an expert on the Afghan war at Keele University, they would "move the position of the red star or simply paint over it during combat operations. The stars would then be replaced before official inspections".[50]

However, Hinds were especially vulnerable to the licence-built Egyptian and Chinese versions of the SA-7 (NATO codename 'Grail') Man Portable Surface to Air Missile System (MANPADS) which was based upon the Soviet 9K32M/SA-7 MANPADS, and which were covertly supplied to the Mujahideen by the United States. The

administration of President Ronald Reagan had decided to arm the rebels to fight a proxy war against the Soviets soon after the invasion. The missiles could be outfoxed with low-altitude flying, although this heightened the strain on the Mi-24's airframe and increased losses.[51] Furthermore, when performing sharp manoeuvres, the Hind's main rotor could strike the tail boom with catastrophic results. Also, given the hot, thin mountainous air of Afghanistan, the Mi-24 would sometimes have to make a rolling take-off to get airborne when fully laden with fuel and weapons.[52]

Although the Hind can carry troops, contrary to popular belief, it was not used in this role by the Soviets during the Afghan war, in order to save weight.[53] The crews preferred to fly their machines relatively light, because of the peculiar environmental conditions in Afghanistan and because of the need for the Mi-24s to be relatively agile. In some cases, machine guns were installed on either side of the aircraft to allow a technician to fire on Mujahideen rebels when the aircraft was exiting an attack, as the helicopter was vulnerable from the rear.[54] The Soviets did perform experiments to see if a machine gun, which could be reached by the technician via a small gangway, could be fitted in the rear of the fuselage.[55] However, the location of the weapon in an area of the fuselage awash with exhaust fumes was unbearable. The idea was eventually abandoned when during one demonstration an overweight Soviet General got stuck in the gangway.[56]

The SV troops were fond of the Hind and its ability to provide them with devastating aerial firepower. The Mujahideen, on the receiving end of the Mi-24, were less enamoured christening it Shaitan-Arba.[57] This was an apt nickname given that the weapons payload of the 'Krocodil' - as it was called by the Russians - could consist of ten 220 lb (100 kg) bombs for well-defended targets, while more robust installations could be hit using either four 551 lb (250 kg) or two 1,102 lb (500 kg) iron bomb.[58] Other weapons included 3.14 in (80 mm), 4.8 in (122 mm) and 9.8 in (250 mm) rockets. The helicopter was also outfitted with either a 0.5 in (12.7 mm) Gatling gun, two 0.3 in (7.62 mm) Gatling guns or a 1.18 in (30 mm) grenade launcher. Twin-barrelled 0.9 in (23 mm) cannons could also be mounted on hardpoints of the aircraft's wings.[59]

The Hind crews soon earned the same hard-bitten reputation as their mounts. AKS-47 Kalashnikov assault rifles with a collapsible stock to save space were the self-defence weapon of choice for the Hind crews. Food and water rations were often left back at base to make way for extra 0.3-in ammunition and grenades for self-protection. Starvation was considered a small concern compared to fending off vengeful dukhi in the event of being found after a crash landing. The life of the Hind flyers gave them a certain caché within the Soviet Army with their commanding officers nicknaming them the 'flying hooligans' .[60] One particularly nerve-racking mission for the Mi-24 crews would be the so-called 'Mandatory Matsurov'. Named after a hero of the Great Patriotic War who flung himself across a German machine gun to allow his comrades to advance, the helicopters would be tasked to escort jet transport aircraft as they arrived and departed from Kabul International Airport. The Hinds would dispense flares to confuse the heat-seeking MANPADS of the dukhi. If a missile was launched, then the helicopter was to fly into its path and absorb its impact, the Krocodil sacrificing itself for the jet.[61]

The Mandatory Matsurovs were no doubt appreciated by the VTA given that the transport fleet had to fly an 'air bridge' from airfields such as Termez, Kushka and Mary in Soviet Central Asia to Afghanistan, ferrying troops and materiél.[62] Fixed-wing transport aircraft would also supply isolated garrisons by airdrop such as those at Khost and Gardez in south east Afghanistan.[63]
One of the most important roles performed by the VTA was the evacuation to the Motherland of personnel who had been wounded in action. This was greatly appreciated by the troops. Dr. Galeotti notes that "most Soviet soldiers would point to casualty evacuation as being the most important element in the air operations. It had a major effect on morale".[64] Operations to rescue downed aircrews and wounded soldiers could last for days. Sometimes, the Soviets would even

negotiate with the Mujahideen for the return of their fallen comrades. The rebels were known to mutilate the bodies of Soviet soldiers.[65] They would also strongly resist any attempts to rescue captured Soviet PoWs. To increase their chances of survival, Soviet troops were given radio homing beacons and survival kits in case they were shot down, however the dukhi were known to use captured homing beacons to lure Soviet troops into an ambush.[66]

VTA assets were also used as airborne observation posts to watch Mujahideen movements , yet the use of such aircraft could be counterproductive, giving the rebels prior warning that an assault was imminent[67]. There were reports that the Airborne Warning and Control Systems (AWACS) variant of the Il-76 freighter, the A-50 (NATO codename 'Mainstay'), was used along the Afghan-Pakistan border to monitor the movements of the PAF.[68]

The VVS did not always restrict its role to attacking the Mujahideen in Afghanistan, it would occasionally perform lightening raids into Pakistani air space to attack Mujahideen supply caravan routes from Pakistan. To this end, between 1981 and 1984, the VVS, along with the DRAAF, were reported to be conducting up to 200 violations of Pakistani airspace per year. Invariably the PAF were in the skies to meet the intruders, and both the Afghan government and the Soviets may have lost up to ten aircraft to the PAF between 1986 and 1989.[70] A smaller number of sorties were conducted against Mujahideen bases on the Iranian side of the Afghan-Iranian border but it is unknown how many aircraft were lost to the Islamic Republic of Iran Air Force during such missions.[71]

Although the Mujahideen were able to use their SA-7 MANPADS against the VVS and DRAAF, at the beginning of the conflict they were equipped with a lacklustre collection of simple air defences. These consisted of various heavy machine-guns either captured from the Soviets or Afghan government forces or supplied from China. To make matters worse, the jets tended to fly too fast to be hit by machine-gun fire, while the Hinds tended to be fairly resistant to such weapons.[72] The Mujahideen began to receive the SA-7 from 1982. In October 1984, a Grail missile hit an An-22 transport with the loss of up to 200 Soviet troops and aircrew.[73] But this was no 'wonder-weapon' and the Grail had its foibles which lessened its effectiveness. According to the author James Adams, the missile could "be easily distracted by reflections hitting snow or heading for the sun instead of the aircraft's engine".[74] Despite this, the Grail did enjoy some success. It forced Soviet pilots to fly higher and more defensively than before to avoid the missile. Yet every weapon has a counter and the Soviets soon fitted their aircraft with countermeasures or flew very low: the missile would not work properly if fired downwards from a mountainside into a valley where an aircraft was hugging the ground.

While the VVS were learning to adapt to Afghanistan's peculiarities, their enemy was also developing innovative air defence tactics. One fairly standard practice was to set up an ambush near a major airbase in order to attack aircraft as they flew into and out of the airfield. Rebels would rapidly move, with their MANPADS, to and from airfield perimeters on motorcycles and trucks. Another favourite tactic saw the dukhi mounting a ground ambush. Once Soviet aircraft appeared to give their comrades close air support, a second, hidden Mujahideen team armed with a MANPADS would then attack the VVS aircraft.[75] A third technique was to hide several anti-aircraft positions over a wide area. When an aircraft approached, a single anti-aircraft gun would open fire. If the target was a helicopter it would usually move out of range of the gun, but unbeknownst to the pilot, into the range of another hidden weapon which would begin firing. The more weapons were hidden the more difficult it would be for the helicopter to escape hostile fire.[76]

From 1986 onwards the Mujahideen received increasing sophisticated air defence weaponry as the covert US-led arms supply increased. One of the first Western air defence weapons to arrive was the 0.8 in (20 mm) Oerlikon cannon, along with the British-made 'Blowpipe' MANPADS. Blowpipe was a qualitative improvement upon the SA-7 except its

In Afghanistan, air power could not win on its own; it was supporting a largely conscript army which did not want to be fighting a ruthless, determined enemy in this unforgiving land

sophistication resulted in the operator requiring a high level of training as the missile had to be remotely steered towards its target with a joystick. However, the missile could not be outfoxed by the flares which the Soviets had fitted to their aircraft for self-defence.[77]

While the Hind was the signature Soviet weapon of the conflict, then for the Americans it must be the FIM-92A 'Stinger' MANPADS which achieved iconic status. Stingers began to arrive in Afghanistan from September 1986 and were supplied to the Mujahideen by the United States. Guided by infrared, the missile was immune to basic flare countermeasures and evasive action. Jet pilots responded by flying higher, while their rotary counterparts flew closer to the ground, meanwhile some close support operations were increasingly undertaken by ground-based rockets and artillery. The Soviets also increased their efforts to equip their aircraft with electronic countermeasures to jam the missile. On the ground, extra effort was taken to increase the interception of Stingers being smuggled over the Afghan border from Pakistan. Any area where the Stingers were used could also be subjected to high-altitude retaliatory bombing.[78]
The role of the Stinger has reached almost legendary proportions with claims that the missiles exacted such a high toll on Soviet aircraft that it became almost impossible to provide the SV with close air support. Was the missile that good? It is impossible to say for certain. The difficult nature of Afghan terrain and the hazards of war hardly made it feasible to conduct a field study of the missile's effectiveness. We will probably never know exactly how many Soviet and DRAAF aircraft the missile was responsible for destroying. However, what the Stinger did do, according to Dr. Galeotti, was to confirm "to the Soviets that this was a counterproductive war".[79]

In terms of the complete Soviet losses for the war, exact figures are almost impossible to find. Prior to 1986, it was reported that the Soviets lost 600 aircraft of all types to all causes including hostile action and accidents. Total losses for the Soviets and for the DRA Air Force have been quoted as 2,675 aircraft, yet this contradicts widely with the sporadic air power orders of battle which are available. Other estimates are comparatively lower with 451 Soviet aircraft being lost throughout the entire conflict. After 1986, following the introduction of Blowpipe and Stinger, reports circulated that the Soviets may have lost an average of 450 aircraft per year to the weapons.[80] In reality we probably will never know the true figure given that it may not have been known by the Soviets and is therefore unknown to the Russians.

The Afghan war was a harsh teacher for Soviet air power. Lessons were learnt; one of the most important being that the Soviets were able to project power beyond their borders in a short space of time by using airlift, which may have rung some alarm bells in the countries bordering the Soviet Union and also in NATO headquarters.[81]

The AA helicopter force came of age earning its spurs in a baptism of fire comparable to that endured by their slick American counterparts in their UH-1 'Huey' utility helicopters in the US Army and Marine Corps during the Vietnam War. The Soviets learnt how to operate rotary aviation in hot, high and rugged environments. Furthermore, they successfully integrated the fire support available from the gunships with the ground forces thanks to the use of Forward Air Controllers. One official US Army document noted that: "(t)he most significant development in air support for Soviet ground operations in Afghanistan was their use of armed helicopters".[82]

The same cannot be said of offensive VVS fixed-wing aircraft. High altitude bombing from Tu-16 aircraft was often wildly inaccurate. While this may have been of little concern to the Soviet top brass, given that they were trying to bludgeon rural support for the Mujahideen into submission, it was woefully ineffective and civilian loyalty to the rebels could not simply be bombed into smithereens. Fighter-bombers were not used in an imaginative fashion. There is little evidence that such aircraft were organised into a 'cab rank' system - loitering near the area of operations to provide rapid on-call air support when required. Fighter-bombers and their heavier counterparts

were instead restricted to softening up areas prior to an assault on the dukhi, following the familiar Soviet practice of a highly choreographed offensive adhering to a textbook formula.

Training, where it was available, failed to both learn lessons from the war and pass them down to the pilots and crews earmarked for the Afghan theatre. Pilots who did show initiative were not rewarded for their efforts. Dr. Galeotti says that "groups of pilots which did show initiative were dispersed across the VVS infrastructure" upon their return from Afghanistan rather than being ensconced in the Staff Colleges and Academies to disseminate their wisdom. The military became prisoners of their own doctrine, Dr. Galeotti believed that they followed a "chess mentality, where the last thing you wanted was your pawns doing their own thinking".[83]

The break-up of the Soviet Union two years after the Soviet withdrawal from Afghanistan saw Russia inheriting much of the VVS infrastructure, manpower and materiél, however many of the pilots who flew combat missions over Afghanistan left the service, preventing the lessons learnt being passed to a new generation of pilots who are now fighting a similar enemy on the ground in the breakaway Russian province of Chechnya. The net effect, according to Dr. Galeotti, is that in some ways the present-day Russian Air Force "is in an even worse position" to fight these kind of guerrilla wars than it was in the Soviet days.[84] In his seminal study *Soviet Air Power: Tactics and Weapons used in Afghanistan* (Air University Review, 1985), Lieutenant Colonel Denny R Nelson argues that the VVS learned "the same hard lessons (the United States) learned in Vietnam. Fighting guerrilla forces with conventional forces is a long, arduous affair".[85]

It was not the VVS pilots and aircrews who were at fault. They did the best they could with inadequate training and textbook tactics. But that was not enough; the VVS adopted the ostrich position as far as the experiences of its pilots was concerned. In Afghanistan, air power could not win on its own; it was supporting a largely conscript army which did not want to be fighting a ruthless, determined enemy in this unforgiving land. At home, initial enthusiasm for the war within political circles and the general population began to ebb once the coffins on the 'Black Tulips'[86] began to trickle home, eventually becoming a deluge as the casualties returned en masse.

It is over 15 years since the last Soviet soldier returned home across the Friendship Bridge spanning the historic Amu Darya River which demarcated the border between the USSR and its restive neighbour. Today Afghanistan's skies once again reverberate with the thump of rotor blades and the screams of jet engines as the US-led coalition battles Al-Qaeda and Taliban remnants in the graveyard of the Soviet military machine. Instead, the West have ultra-advanced technology and highly professional troops, aircrews and innovative tactics which form and mould to the situation. They have also, we hope, learned their lessons from history.

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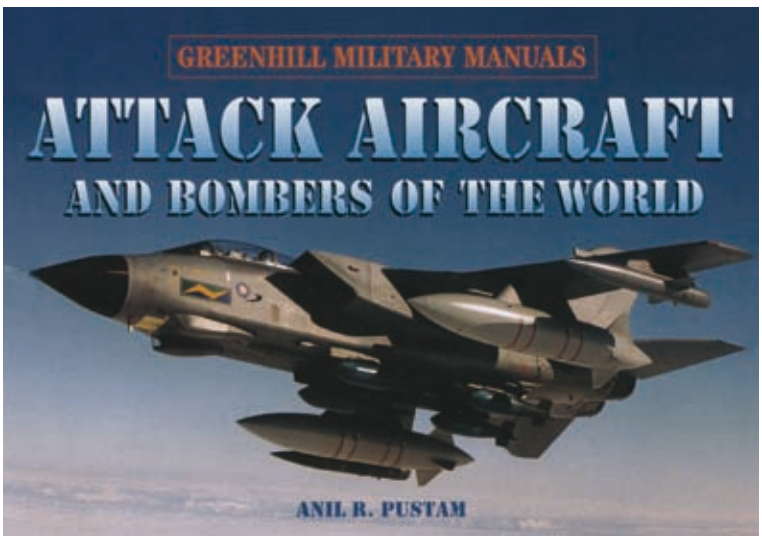


Attack Aircraft and Bombers of the World

By Anil R Pustam

Price: £14.99
ISBN: 1-85367-581-4
Format: Hardback, 128pp
Publisher: Greenhill Books, London

Reviewed by Wg Cdr Gerry Doyle

Any summary of current attack aircraft that includes types as small as the armed variant of the SF-260 piston-engined trainer, as large as the B-52, as old as the MiG 17 and as modern as JSF is trying to cover a lot of ground. A reader seeking a brief summary of the current status of 43 types, fitting the (ground) attack definition of the title may have found what they want. The book has good coverage of both western and eastern bloc types, and includes the various Chinese 'clones' of former Warsaw Pact types still in service.

The format of each entry is roughly standard. A brief description of the history of a type, its derivation from earlier aircraft or other models of a common design is followed by a short summary of key design features. Subsequent upgrades, and avionic, propulsion and weapons characteristics are then covered, along with a list of original and subsequent operators. A brief combat history, where appropriate, is then followed by leading particulars. Photographic coverage (in black and white) is included with at least one and up to three photographs per type.

The text is clear and the quality of the photography, which comes from a variety of sources, good. Specifications of each type follow a common format, although not all information is included for each type. The units chosen, however, although they should appeal to an international readership and are at least consistent, may not be to UK taste. Ranges are in km, speeds in kph and ceilings in metres, for instance.

My main reservation about the book is the gaps in its coverage. Omission of the Typhoon, Rafale and Gripen are justified in the foreword on the grounds that those types 'are fighters first'. Equally, there is no mention of the F-4 or the F-16, though both types remain in service in several countries, (surely in greater numbers than the A-7 Corsair, which is included, for example) carrying a variety of air to surface weapons. Also if the Aermacchi family and the Alpha Jet merit a mention, the omission of the Hawk seems strange.

If these gaps are acceptable to a prospective reader, then this may be a useful reference. However, in my eyes, the gaps mar the book. Additionally, anyone seeking a book to support recce training should note that although there are photographs of each type, there are no three-view drawings.

Books

Russian Security and Air Power 1992 – 2002

The development of Russian security thinking under Yeltsin and Putin and its consequences for the air forces

By Marcel de Haas

Price: £65.00
ISBN: 0-714-65608-9
Format: Hardback, 264pp
12 line drawings and 17 tables
Publisher: Frank Cass Publishers 2004
[Also available in paperback, price £19,99, 272pp]

Reviewed by Gp Capt C J Finn

The headline title *Russian Security and Air Power 1992 — 2002*, would seem to indicate that this is a book primarily about air power, perhaps in the Chechen conflicts. However, the sub-title shows that the book is aimed in a somewhat different direction. The book is an abridged version of the author's PhD thesis completed under the sponsorship of the Royal Netherlands Military Academy and the Royal Netherlands Air Force while he was an instructor at the Academy. The author clearly sets out his intent in his introduction (page 2) where he states that "The ultimate aim is to assess the effect of political-strategic decision making on the use of air power in irregular warfare".

In Chapter 1 the author describes the structure of Russian security policy, leading in Chapter 2 to an analysis of the decision-making process and its effects with a useful summary of the arguments so far. Chapter 2 also has the particular merit of analysing Russian policy from a Russian viewpoint whereby NATO is seen as a threat and the UN Security Council as the only legitimate international decision-making body. Chapter 3 describes both the physical and the doctrinal structure of Russian air power and particularly how it developed over the period and why. The move from the Cold War posture of specialist air defence forces and tactical air forces under the command of the ground force commander to a Western model of unified and centralized command and control is explained, as is the use of 'lessons learned' in the bureaucratic battle for resources. In Chapter 4 the author discriminates between the 'implementation of air power' in terms of strategy and doctrine, and the use of air power itself in the Chechnya and Dagestan conflicts. At the strategic and operational levels the author gives a very good explanation of the blend between the political and military imperatives. In his consideration of the employment of air power the author discusses the role of combat support air operations and the failure of the Russians to provide 'joined up' intelligence support. However, his conclusions that the effectiveness of the kinetic mechanisms was greatly reduced by the lack of funding, and hence the lack of PGMs, NVGs etc (irregular warfare, p164) seems to ignore the vital role of ISTAR in enabling the effective use of PGMs in any conflict. In Chapter 5 the author argues how the preceding chapters have met the original aim stated above. The key point is perhaps contained on page188 where he states that "Russian military doctrines are geared mainly to the military-political level", thus returning to the traditional Clausewitzian argument.

The strengths of this book are equally its weaknesses. As the author states, it is an abridged PhD thesis, not a book derived from one: thus it is pedagogically structured. Those specifically interested in the application of air power in irregular conflicts should concentrate on Chapter 4, with reference to the concluding elements of the other chapters. On the other hand it meets the author's ultimate aim in providing a very well researched analysis of, and reference to, the development of Russian political and military thought in the immediate post-Cold War era.

14 SQUADRON 90TH ANNIVERSARY CELEBRATIONS

No 14 Squadron will be holding a celebratory weekend, 8-10 April 2005 at RAF Lossiemouth, to mark the 90th anniversary of its formation.
A number of activities are planned, and all present and former members of the squadron, whether serving or retired, are invited to attend.

Further details can be obtained from the Project Officer, Flt Lt David Tucker, at 14 Sqn. RAF LOSSIEMOUTH, Morayshire, IV31 1SD, Tel Lossie Mil Extn 7972, or 01343 817972, Fax

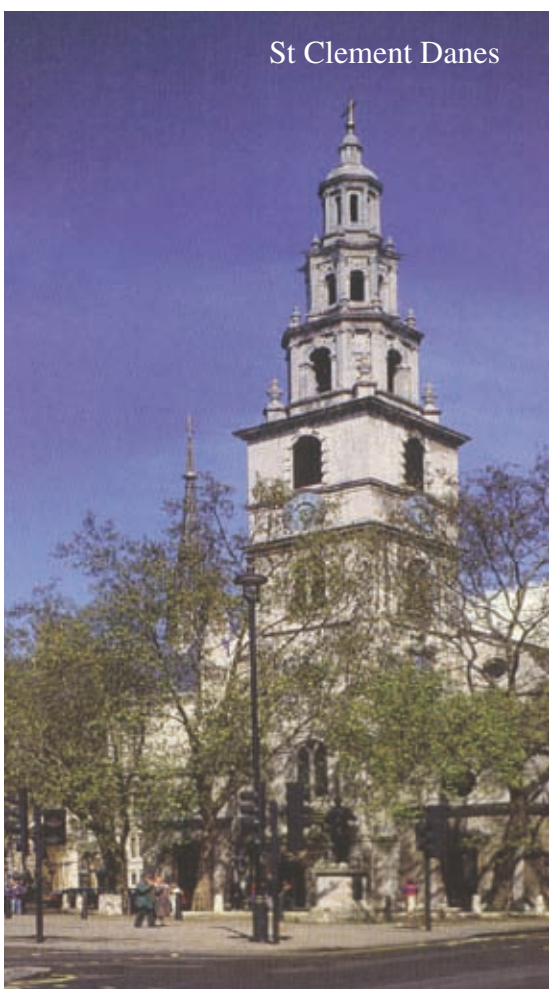
ROYAL AIR FORCE HISTORICAL SOCIETY

Formed in July 1986 to study the history of air power, the RAF Historical Society examines such topics as the Strategic Bomber Offensive of World War ll, the V-Force, various air campaigns, and further aspects of modern air power. The Society holds lectures, seminars and discussions, bringing together those involved in RAF activities past and present, at a membership fee of £15 a year.

Please contact:
Dr Jack Dunham, Silverhill House, Coombe, Wotton under Edge, Glos, GL 12 7ND.
Tel: 01453 843362.

ST. CLEMENT DANES, STRAND, LONDON CENTRAL CHURCH OF THE ROYAL AIR FORCE

This beautiful Wren Church, which is also the Royal Air Force Central Church, has a world-wide following and is open daily from 09.00 am – 4.00 pm. There is Choral Eucharist or Matins every Sunday at 11.00 am, sung by the famous choir. Civilians and all members of the Armed Forces are welcome to visit the church and attend the services.



St Clement Danes