RAF AIR POWER REVIEW Vol 7 No 1 2004

THE ROYAL AIR FORCE

AIR POWER Review

Volume Seven Number One Spring 2004

SEE THE ROYAL AIR FORCE
AIR POWER REVIEW ON-LINE
VISIT: www.raf.mod.uk

Published quarterly, *Air Power Review*
is the professional flagship publication
of the Royal Air Force

Cover picture: Lockheed Martin artist's concept of the Atlas V 'Evolved Expendable Launch vehicle' (EELV) that will launch most USAF and NASA intermediate and heavy satellites

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.

Final design format for article presentation on the printed page will be at the discretion of the Editor.

Send articles to:

Director of Defence Studies (RAF)
Joint Doctrine and Concepts Centre
Shrivenham
Swindon,
Wiltshire
SN6 8RF
Email: defs-raf@netcomuk.co.uk

FOREWORD

The importance of space in modern combat was highlighted by the appointment for Operation IRAQI FREEDOM of General Moseley, the Combined Forces Air Component Commander as the Space Co-ordinator, in addition to his other responsibilities. With modern armed forces now reliant upon space-based systems for communications, ISR, navigation and weapon aiming, environmental data and missile launch warning, it is inevitable that a debate is emerging about the weaponisation of space. While the 1967 *Treaty on Principles Governing the Activities of States in the Exploration and use of Outer Space, including the Moon and other Celestial bodies*, was clear in its prohibition on the placement of nuclear weapons or other weapons of mass destruction in space, the legality or otherwise of placing other weapons systems in space is by no means clear. In his article Dr Karl Mueller gives a clear explanation of the potential different types of space-based weapons and their targets, and their potential utility. He then goes on to explain the key positions of the proponents and opponents of space weaponisation. Finally, Dr Mueller addresses the question "is space weaponisation inevitable" and concludes that there are no distinct winners in the for and against debate, but that the arguments deployed are either too simplistic or too emotional to be rationalised.

Looking back over the last six years of *Air Power Review*, it is clear that historical articles have predominated in three areas: that of the Second World War, the post-Cold War conflicts and, to a lesser extent, the First World War. The article by Mr Sebastian Cox, Head of the Air Historical Branch (RAF), on the Berlin airlift, marks the start of a series of articles that are planned over the next two years to address the less well-known conflicts and other aspects of the Cold War. The article, which was first published by the Air Historical Branch in 1998, examines specifically the British contribution, Operation PLAINFARE. In all, British aircraft carried slightly over 23% of the total tonnage into Berlin. Furthermore, 6% of that was by British civilian aircraft, which carried the majority of liquid fuel into Berlin. In terms of the Cold War, the Berlin airlift was the first time that the Allies confronted the Russians, the ultimate goal being to prevent the reunification of Germany on a Soviet model. Thus the Berlin airlift was not only a tactical success but a strategic one as well: what we would now describe as an Effects-Based Operation.

The next article, by Flight Lieutenant Dave Tucker, was originally written as an essay as part of the MLitt course in Strategic Studies which he undertook at Aberdeen University in 2002-03. The article outlines the arguments for increased co-operation in European air power, and then makes the point that in the NATO context air forces have been interoperable for decades. Tucker concludes that the real challenge for European air forces is to improve co-operation at both the operational and political levels and that rhetoric from European political leaders in support of ESDP is not matched by resourcing.

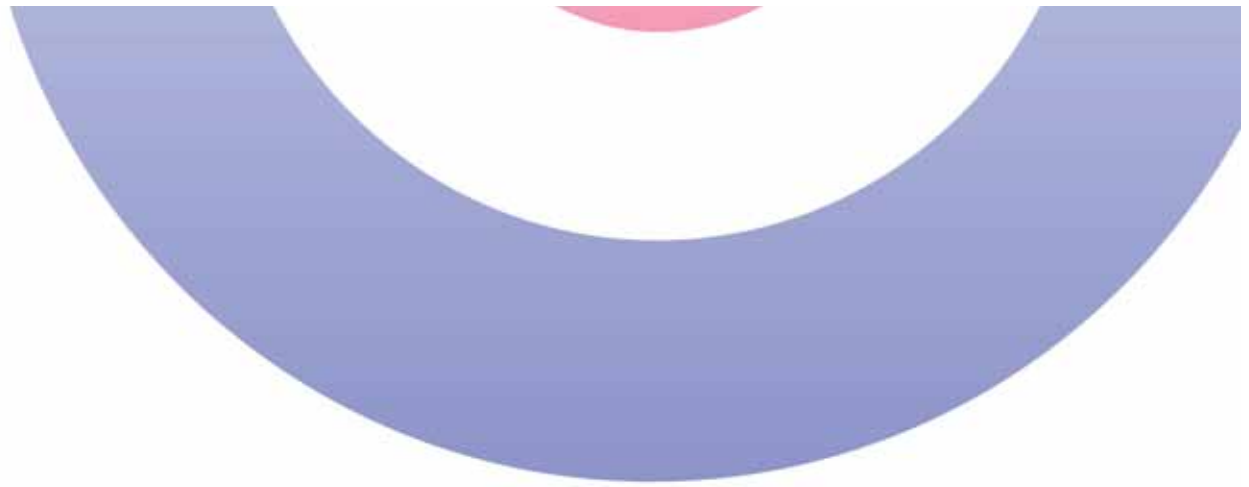
The vast majority of the readership of *Air Power Review* is undoubtedly well aware of the basic story of 617 Squadron's raid on the Ruhr Valley dams on the night of 16-17 May 1943. However, the early books on the raid, epitomised by Wing Commander Guy Gibson's *Enemy Coast Ahead*, told neither the full story of the raid nor particularly analysed its aftermath. Wing Commander Tim Webster's article, which is taken from his Defence Research Paper completed while on No 6 Advanced Command and Staff Course, uses both the early and the more modern sources to provide an overview of the raid. Webster exposes the lesser-known aspects of the background to the raid, the lead-in and the raid itself, particularly in terms of the other targets which were attacked. Wing Commander Webster's analysis of the "effects" of the raid, in particular the consequential and unintended ones, also provides a good example of the utility of an effects-based approach in moving beyond the first order analysis of weapons effects.

At one level Lieutenant Colonel Thomas McCabe's article on the Chinese Air Force and air and space power is an interesting analysis into how the People's Liberation Army Air Force's doctrine has changed. He concludes that while they appear to be espousing a Western approach in which air power, using precision weapons in a manoeuvrist style campaign, is now the primary means of conducting warfare, they have neither the number nor quality of aircraft and weapons to do so. At a different level, the article is more a discussion of the true nature of the threat that China poses to Taiwan. However, the article also makes some very good points concerning how a potential "enemy" can have a very different thought process to one's own. But what also comes out from the article is that, however differently the fundamental tenets of modern air power doctrine may be expressed, they are still often the same.

Squadron Leader Tony Seabright's article, which is also taken from a Joint Services Command and Staff College Defence Research Paper, is a timely one in view of the emphasis that the RAF is now placing on the linked aspects of ethos, history and heritage; some of the reasons for which are identified in the article. Squadron Leader Seabright finds the challenge to the RAF as being how to define its fighting ethos in a post-manned combat aircraft era. His underlying point is summarised in his quotation from General Shinseki, "If you don't like change you are going to like irrelevance a lot less". However, readers may conclude the solution to the problem posed, the reduction in the current distinction between aircrew and non-aircrew, war fighters and non-war fighters, has already been *de facto* achieved in the post-Cold War expeditionary Royal Air Force we find ourselves in today.

The final article, by Alexis Tregenza, also fits into the Cold War theme with an examination of the military capability of the RAF's V-bomber force in the late 1950s and 1960s. Taken from Alexis's dissertation towards an MA in War Studies at King's College London, it provides an interesting account of the problems facing the V-Force in its early years, not least in terms of the volatility of Britain's early nuclear weapons. The article then charts the development of tactics and equipment within the V-Force as the Soviet surface-to-air missile and fighter capabilities also increased. Alexis Tregenza then concludes that despite all the problems towards the end of the V-Force's time in that role, in particular the high anticipated losses, the V-Force as part of a wider NATO force still made a creditable contribution to the West's deterrent posture during the Cold War.

D Def S (RAF)



AIR POWER Review

Editor
Jay Myers

Production Editor
Harvey Grainger

Studio
John Griffiths
Dave Mitchinson

RAF MAGAZINES
Floor 1, Zone A
St George's Court
2–12 Bloomsbury Way
London WC1A 2SH
Tel: 0207 305 2166
Tel: Mil: 96305 2166
Fax: 0207 305 4145
E-mail: jay.myers420@mod.uk

Those wishing to be placed on the distribution list should write direct to the Defence Storage and Distribution Centre (DSDC) Llangennech with their UIN stating the number of copies required per edition together with the address to which material should be sent.

Recurring Publications Desk
DSDC(L) 3a
Mwrwg Road
Llangennech
Llanelli
Wales
SA14 8YP
Tel: 01554 822 399
Fax: 01554 822 515

Other general enquiries on magazine distribution may be made to the London address.

The views expressed are those of the authors concerned, not necessarily the MoD.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form without prior permission in writing from the editor. Unless by prior arrangement, articles and photographs will not normally be returned.

Contents

1 Totem and Taboo
Karl Mueller

25 Britain and the Berlin Airlift
Sebastian Cox, Air Historical Branch (RAF)

45 Preparing the Way for Cooperation in European Air Power
Flt Lt David Tucker

59 The Dam Busters – Success or Sideshow?
Wg Cdr Tim Webster

77 The Chinese Air Force and Air and Space Power
Lt Col Thomas R McCabe

91 RAF Ethos and Culture in the 21st Century – Aircrew or Air Power?
Sqn Ldr Anthony J Seabright

113 How Capable Was the V-Bomber Force Militarily of Delivering Britain's Nuclear Deterrent in the Late 1950s and 1960s?
Ms Alexis Tregenza

136 Book Reviews

138 Notices/Reunions

Editorial Board:
Gp Capt C J Finn, D Def S (RAF), Chairman
Mr J Myers, Editor, Head of RAF Information Media Training and Technical Publications;
Gp Capt M Wiles, MoD; Gp Capt M Doel DRAFJD, JSCSC Watchfield;
Wg Cdr J Spencer, Dep D Def S (RAF); Mr S Cox, Head of AHB (RAF);
Dr C J M Goulter, JSCSC Watchfield; Mr C Hobson, Chief Librarian;
Sqn Ldr P Morris, SO2 D Def S (RAF), Secretary;

Artist's impression of how a space laser-equipped satellite might fire at a ballistic missile from long range

Totem and Taboo:

Depolarizing the Space Weaponization Debate

By Karl P Mueller

This article was reprinted from *Astropolitics: The International Journal of Space Power and Policy*, Frank Cass Publishers Ltd, with the kind permission of the author, editors and publisher.

The debate over space weaponization is typically cast in simplistic, unidimensional terms, while many participants caricature their opponents as naive pacifists or rabid warmongers. This article redraws the subject more realistically. First, it surveys the question of what systems are truly space weapons and what developments would constitute weaponization. Second, it describes six distinct schools of thought regarding weaponization: idealist, internationalist and nationalist sanctuary theories, and preemptive, utilitarian and hegemonist pro-weaponization perspectives. Third, it analyzes and largely debunks the leading arguments which hold that space weaponization is inevitable. Finally, it suggests reforms to make the debate more sensible and productive.

2

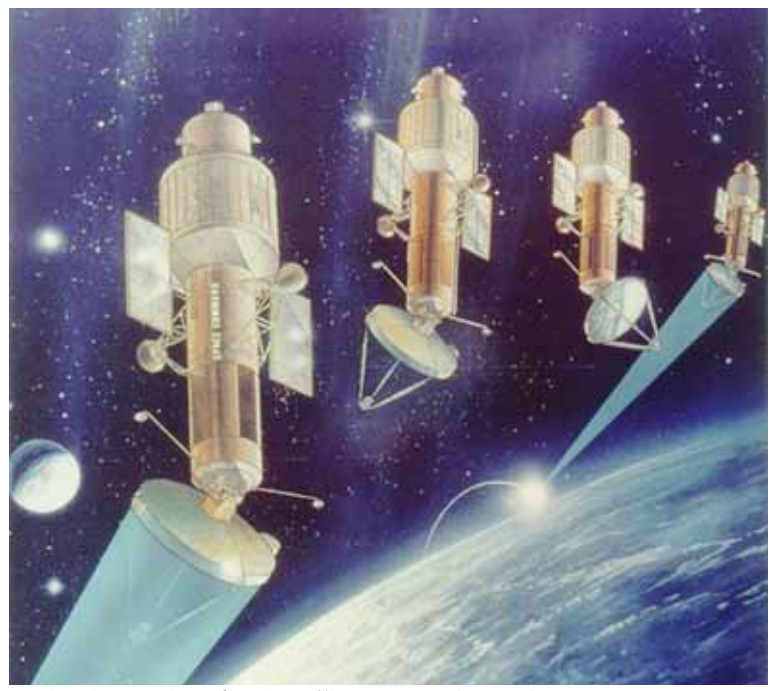
Space militarization is not a simple linear path along which a phase change occurs at some fixed point and space suddenly becomes weaponized

Should the United States place weapons in space? This question, long neglected in most discussions about US defense policy except where it touched upon arguments about ballistic missile defenses and Cold War nuclear stability, is now at last becoming the subject of active and serious debate in the United States and abroad. Many factors are contributing to this trend, including the growing economic and military importance of satellites, renewed US interest in national missile defense, and the work of the Space Commission chaired by Donald Rumsfeld prior to his appointment as Secretary of Defense.[1]

The US policy debate about space weaponization is often portrayed as a fight pitting idealistic arms control enthusiasts who oppose all weapons against warmongering militarists who never saw a weapon they did not like. Although there are people who do fit one or the other of these stereotypes,[2] most serious opponents and advocates of space weaponization do not. Moreover, positions on this question do not always fall along a simple left-to-right or liberal-to-realist continuum, so these caricatures fail to capture the key elements of the debate even when treated as polar extremes between which more moderate opinions are possible.

This article seeks to describe the principal schools of thought regarding space weapons (this term will be used in its widest possible sense for the sake of simplicity) in a way that better corresponds to reality, suggesting a way forward to distinguish amongst six different positions regarding the question of whether and when the United States ought to build space weapons. In order to do this, the preliminary problems of defining and characterizing space weapons and space weaponization are first addressed. Following the subsequent discussion of weaponization perspectives, the questions of whether space weaponization is inevitable, and whether this matters, is examined; the article then returns to the subject of how all participants in the weaponization debate might move beyond their current polarization to make greater progress towards developing sound policy in this increasingly important arena.

What is space weaponization?
Space weaponization is a subset of space militarization. If one envisions a natural sequence ranging from space systems not being used for any militarily useful purposes at all, to satellites providing services to support terrestrial military operations (from the late 1950s for the United States), to satellites being integral parts of terrestrial weapon systems (from the 1990s), and finally to weapons themselves being deployed in



Artist's impression of anti-satellite weapons (ASATS)

Both the United States and the Soviet Union developed and tested rudimentary ASAT systems during the Cold War. Some insist that this means space has already been weaponized, rendering the subject of this discussion irrelevant

space, weaponization occurs when the upper range of this sequence is reached. At its most extreme, space weaponization would include the deployment in quantity of a full range of space weapons, including satellite-based systems for ballistic missile defense (BMD), ground- and space-based anti-satellite weapons (ASATs), and a variety of space-to-Earth weapons (STEW), and these would play a central role in any type of military operations conducted by their owners.

However, space militarization is not a simple linear path along which a phase change occurs at some fixed point and space suddenly becomes weaponized. Instead, there are a number of intermediate steps along the way, and how politically significant each will be is not only unclear, but must necessarily be unclear prior to the event because it is a matter of social construction. For example, both the United States and the Soviet Union developed and tested rudimentary ASAT systems during the Cold War.[3] Some insist that this means space has already been weaponized, rendering the subject of this discussion irrelevant, but this is clearly a fallacious argument: we have not yet crossed the principal space weaponization threshold precisely because almost everyone believes that we have not.

GPS navigation satellite

In some respects a satellite-guided bomb or cruise missile is thus very much a space weapon, although policy makers and the public clearly do not consider the deployment of such weapons to constitute space weaponization

Thus, there is no single definition of 'space weapons' that is appropriate in every context.[4] Instead, there are a number of dimensions of weaponization along which a given development may resemble more or less closely an idealized version of space weaponization. For each it is possible to identify a number of steps on the ladder ranging from qualities that do not look very much like those of a 'space weapon' to ones that seem quite extreme. However, in exactly what order the steps should be placed is not always apparent, as will be discussed below. At least six of these dimensions are worth considering in some detail (see *Table 1*), although others could certainly be identified as well.

Basing

The most basic dimensions are where the weapon is based and what sort of targets it can attack. The basing dimension ranges from purely terrestrial weapons, such as land-based ASAT lasers or terrestrial weapons for attacking space launch and support facilities, to true space-based weapons, satellite weapons platforms placed in orbit for the long term well before a crisis or conflict.

Table 1: Dimensions of space weapon-ness

- Basing (terrestrial, direct ascent, suborbital, launch-on-demand, long-term orbital)
- Potential targets (location and type)
- Attack mechanism (non-weapon, electronic, KE, conventional, DE, nuclear, etc.)
- Weapon effects (nature, severity, duration)
- Discrimination (including collateral damage and orbital debris)
- Potential utility (especially in offensive and defensive scenarios)

4 *Weapon effects are an obvious and a relatively simple matter: does the weapon destroy, damage or merely disrupt the activities of the target?*

Intermediate steps along this continuum include direct ascent ASATs (which are launched into space but not into orbit), suborbital weapons including ballistic missiles (which travel through space en route to their targets but do not linger there), and launch-on-demand orbital weapons (which are deployed into space only when needed, thus perhaps avoiding crossing the weaponization threshold during peacetime). Somewhere along the way, fall weapons such as today's global positioning system (GPS)-guided munitions, in which a terrestrial weapon depends upon space systems in order to operate; in some respects a satellite-guided bomb or cruise missile is thus very much a space weapon, although policy makers and the public clearly do not consider the deployment of such weapons to constitute space weaponization.

Potential targets

Two features about the targets that candidate space weapons could attack are important: their location and their nature. Target locations include the land and sea surface, objects aloft in the atmosphere, and objects (satellites and suborbital projectiles) in orbital space, where it is important also to distinguish among different orbital altitudes, especially low, medium and geosynchronous Earth orbit (LEO, MEO and GEO respectively).[5] Among space-based weapons, the ability to attack terrestrial targets ('space force application' in US military doctrine) is usually taken to be a more extreme form of weaponization than being able to attack other space vehicles, although a case can be made that the former actually represents far less of a departure from current military capabilities than does the latter, and therefore this conventional intuition should be reversed. The types of targets that can be attacked is a fairly straightforward matter, relating to how hard, small, fast, agile, distant and stealthy a target the weapon is capable of striking. To this list could be added the question of how many targets could be attacked, either in total or during a specific opportunity, particularly for the rare weapon system that cannot simply be scaled up to increase the number of targets it can strike.

Together, the basing and target location variables, along with the attack mechanisms discussed below, define the major categories of space (or not-quite-space) weapons.[6] The hierarchy of 'space weapon-ness' among them can be ambiguous – for example, is deploying a direct ascent ASAT a more limited or more extreme step towards weaponization than deploying a space-based laser for ballistic missile defense? In general, it can be said that space-to-space and space-to-Earth weapons are generally considered to be space weapons, that terrestrial ASATs sometimes (but not always) are,[7] and that terrestrial and purely suborbital systems (including ICBMs) for striking terrestrial targets usually are not.

Muddled as this picture can be, it is further complicated by the fact that some weapons have the ability (often termed 'residual capabilities') to attack secondary targets. For example, nuclear-tipped anti-ballistic missiles and even short-range ballistic missiles can potentially be employed as powerful ASAT weapons. This does not make a Scud missile a space weapon for most political purposes, but it would certainly have to be taken into account in any arms control effort to prohibit the possession of anti-satellite weapons. Much the same is true of the limited but potentially significant anti-satellite capabilities of the US Space Shuttle and many other space systems designed to perform purely non-violent functions.

Attack mechanism

Space weapons can employ a wide range of mechanisms to affect their targets. The most obvious are conventional explosive, kinetic energy and directed energy (e.g. laser and radio frequency) weapons, which together occupy the middle range of this chain, and clearly qualify as weapons. Above these are nuclear weapons (and perhaps biological and chemical weapons, though the latter are especially unlikely for space weapons employment), the only category of weapon whose deployment in space is proscribed by international law or treaty.[8]

More interesting in political terms is the other end of the spectrum: devices or techniques that could have weapon-like effects but whose status as weapons is ambiguous. These include such things as electronic jamming of communications and telemetry, barriers with which to shade satellite solar panels or obstruct the view of space-based

sensors, and space 'special forces' capabilities, including direct human or mechanical interference with or sabotage of satellites in orbit.[9]

The remaining dimensions are less significant with respect to defining whether a system is a space weapon, and thus whether deploying it would constitute space weaponization. However, they might potentially be very important in determining the political significance of the deployment of such a weapon.

Weapon effects
Weapon effects are an obvious and a relatively simple matter: does the weapon destroy, damage or merely disrupt the activities of the target,[10] and to what degree of severity? If less than destruction, how long lasting are the effects, will they abate on their own, and/or how easily can they be repaired or circumvented? Finally, will the effects cost lives, either directly or indirectly, or only damage property or cause other economic harm?

Discrimination
The extent to which the effects of a weapon can be confined to its intended target is also likely to play an important part in shaping perceptions of the system, with more discriminate weapons appearing on the whole to be less objectionable if not necessarily less weapon-like.[11] This is most obvious, perhaps, with respect to the creation of orbital debris by kinetic energy ASATs and the widespread damage that would be produced by using exoatmospheric nuclear detonations for anti-satellite purposes or to inflict electromagnetic pulse damage against terrestrial targets. At the lower end of the damage scale, a device to deny GPS signals to a narrow area or certain categories of receivers would be more discriminate than one which produced a similarly disruptive effects over a broad region. For space-to-Earth weapons, of course, traditional concerns about discrimination and collateral damage concerning the effects of such-weapons would apply.

Potential utility
Finally, the scenarios in which a weapon would or would not be effective or useful would be likely to affect the political implications of developing it. A weapon which would be powerful if used in a first strike but highly vulnerable to pre-emption by an enemy who struck first would probably create more furor or discontent than one that would work well on the strategic defensive. Because of the relative visibility of satellites and the predictability of their orbits, many space-based weapons would tend toward the offensive end of the scale rather than the defensive, but a variety of factors would enter in to this equation. Similarly, weapons that could be deployed or employed without detection (or anonymously) would likely offer more to an aggressor than ones whose use and ownership would be obvious. Clearly, if a weapon is effective only against a certain class of targets, say long-range ballistic missiles, this would have a considerable effect on how it was perceived, depending in large part upon which states expected to possess such targets. Similarly, whether a system would be capable of attacking many targets or only a few (a major consideration for missile defense systems in particular[12]) would likely have considerable importance in determining the events in which it would or would not be valuable.

Together, all of these factors would shape the political impact of any particular decision to develop or deploy space weapons, potentially including, but not limited to, whether the action in question would or would not be considered to constitute the profound violation of the current space sanctuary norm with which many space weaponization discussions are primarily concerned.

Six perspectives on space weaponization
As the introduction to this article suggested, the space weaponization debate often appears at first glance to be as a classical confrontation between hawks and doves.[13] The former, now apparently in the ascendancy within the US government under the George W. Bush administration, are said to believe that space weapons should and will be deployed more or less as soon as they can be, and that the United States must lead the way down this path lest another state do so in our place. The other side of the debate is typically portrayed, at least by their opponents, as starry-eyed arms control enthusiasts who believe space should be preserved as a sanctuary free of weapons: in fact, this was the preferred policy of the US

So the absence of space weapons prevents space warfare, while their presence would not only make war in and from space possible, but would in fact encourage it

government during most of the space age, albeit usually for reasons that had little to do with idealism, although the Clinton administration was more conspicuous in its reluctance to develop space weapons than its predecessors.

Like any good cartoon, this image contains a considerable amount of truth. However, it is too simple a picture on which to base serious analysis of what is actually a far more complicated debate. There are in fact a variety of positions on both sides of the weaponization question, which the following discussion groups into a taxonomy of six basic perspectives, three of which favor a space sanctuary and three of which envision and advocate US-led space weaponization, at least under certain circumstances (summarized in *Table 2*).[14] Each of these schools of thought is at least internally consistent, although they are not all of equal intellectual merit. However, it is important to note that these categories are ideal types, and are not mutually exclusive: it is entirely possible, and even common, for individuals in the real world to hold beliefs that fall into more than one of these camps, which the reader should bear in mind throughout the discussion that follows.[15]

Table 2. Policy perspectives on US space weaponization

Pro-sanctuary perspectives

- *Idealists*: Oppose all space (and typically other new) weapons, for reasons transcending defense policy considerations.
- *Internationalists*: Oppose space weapons because they would cause or contribute to general, arms race, and crisis instability.
- *Nationalists*: Seek to avoid space weaponization because it would reduce US power and/or security relative to potential adversaries.

Pro-weaponization perspectives

- *Space racers*: Seek to avoid rivals gaining military or political advantage by the United States developing space weapons before they do.
- *Space controllers*: Favor development of space weapons when and insofar as they would usefully enhance US military capabilities.
- *Space hegemonists*: Favor intense development of US space weapons in order to make US military and political preponderance unassailable.

Sanctuary idealists

The perspective most categorically opposed to space weaponization can aptly be labeled *sanctuary idealism*.[16] Perhaps the most widely held of all the perspectives, especially outside of the United States, sanctuary idealism opposes the spread of weapons or warfare into any new realm (with outer space being the most prominent one not yet weaponized), and the deployment of new types of weapons; typically, sanctuary idealists also at least nominally favor the elimination of some or all of the types of weapons that already exist, though this is of limited relevance to the space weaponization debate.

The reasons for this policy preference vary among the idealists, but may range from aesthetic, moral or philosophical distaste for contaminating unpolluted territory with engines of war, to more instrumental fears that opening new arenas to military competition will drain scarce resources from peaceful uses or will increase the level of animosity and distrust among nations. Most typically, sanctuary idealism is based on two central political premises. The first is that weapons are necessary for — and tend, through arms races, to be a cause of — war, so the absence of space weapons prevents space warfare, while their presence would not only make war in and from space possible, but would in fact encourage it. The second principle is that minimizing the amount and the extent of warfare is intrinsically desirable. Similar themes have underlain some earlier arms control advocacy, such as the effort before and after the First World War to prohibit the use of aircraft as instruments of war.

Thus, unlike the strands of space sanctuary theory discussed below, sanctuary idealist arguments are not for the most part related to the specific characteristics of space weapons, either individually or in general, or to the physical nature of orbital space. The logic of the idealist approach applies more or less similarly to other types of weapons that might be banned (such as chemical weapons or landmines) and to other places from which weapons might be prohibited (such as Antarctica, the deep seabed or regional nuclear-free zones). However, space weapons are a natural focus for such arms limitation advocacy, since averting the

development of new weapons appears far easier than does reversing the status quo after new weapons have been deployed and integrated into military operations.

Sanctuary idealists generally advocate some variation on the same policy theme as other sanctuary proponents: the United States should work to keep orbital space free of weapons. This might be pursued through negotiating an international agreement to ban space weapons, as China and Russia have occasionally proposed in the past. Even without such an agreement, most sanctuary idealists would argue that the United States should continue to exercise unilateral restraint in the development, or at least the deployment, of space weapons, in order to reduce the incentives for other states to build their own; some sanctuary idealists also contend that the example the United States would set by unilaterally eschewing space weaponization would give significant political and moral encouragement for other states to do the same. However, although space sanctuary proponents believe that the potential costs and risks of actually weaponizing space would be high, even sanctuary idealism is compatible with 'space control' measures such as improving US space tracking capabilities or hardening US satellites to make them less vulnerable. None of the major schools of thought sees merit in American vulnerability to attack in space, though they may differ widely with regard to choosing the best ways to avert it.

Sanctuary internationalists

Where the idealists oppose new weapons, and weapons in new places, in general, *sanctuary internationalists* oppose space weapons in particular because of their potentially harmful effects on international stability. Drawing in part upon theories about the effects of offensive advantage and the security dilemma,[17] this perspective argues that the nature of space weapons makes them far better suited to offensive than to defensive warfare: weapons in orbit can strike quickly and with little warning, but are themselves vulnerable to attack because they move predictably, cannot remain over friendly territory, and are difficult to conceal. Thus, both the owners of space weapons and their enemies would have incentives to strike first in a crisis.[18] These theories predict that in addition to encouraging pre-emptive attacks and preventive wars, if states were to shift their military investments from terrestrial to space weapons the growing advantage of the offense would tend to produce other pathological political effects, heightening international tensions and further reducing stability.[19]

Sanctuary internationalism also warns of potential coupling between space weaponization and nuclear instability, on several levels. First, and perhaps least seriously in the current global environment, opponents of space-based ballistic missile defense, like generations of BMD critics before them, fear that such systems would weaken the deterrent potency of major powers' second-strike nuclear forces. Second, sanctuary advocates are concerned that anti-satellite warfare could contribute to nuclear instability by disabling space-based ballistic missile launch detection systems, reducing strategic warning and potentially allowing states to launch missile attacks anonymously, and thus with hope of avoiding retaliation. Third, they note that conventional space weapons, such as kinetic energy projectiles launched from orbit, might have considerable utility in their own right as part of a first strike against an enemy's nuclear capabilities. Finally, they argue that space weaponization might encourage nuclear proliferation, since states facing threats from space weapons but lacking the ability to respond in kind or to neutralize the danger would be likely to seek asymmetric means to shore up their security, among which the acquisition of nuclear weapons might be attractive.

For the sanctuary internationalist, the undesirability of space weaponization would depend on the particular shape it took. Some space weapons would tend to be more destabilizing than others: the more a specific set of technologies and deployment choices creates a situation in which space weapons are valuable to an aggressor but vulnerable to pre-emption, the more malignant the stability implications of space weaponization would be, and some space weapons might even enhance stability. However, since most possible space weapons would combine a high degree of first strike utility and

Artist's impression of an anti-satellite (ASAT) weapon

If satellites were subjected to substantial threat of attack or interference it would be a greater hardship for the United States than for any other major country

vulnerability relative to most terrestrial weapons, and because space weapons without destabilizing characteristics might help pave the way for space weapons with them, sanctuary internationalists are inclined to oppose space weaponization in general, although they would tend strongly to embrace other, stabilizing means of reducing vulnerability to attack in or from space. Finally, they would not necessarily favor the United States responding to another state's deployment of space weapons by doing the same: depending on the scenario, an American response in kind might either enhance or reduce overall stability.

Sanctuary nationalists

The third sanctuary perspective is grounded in the tradition of classical realism. *Sanctuary nationalists* oppose space weaponization not because it would weaken global stability, but because they believe that although space weaponization might enhance American military capabilities in absolute terms, it would weaken the power and security of the United States relative to the rest of the world. Many of their arguments cluster around the theme that it is the United States, as both the dominant world power and the pre-eminent spacefaring state, which has the most to lose from space weaponization.[20]

First, and most visibly, the United States derives the greatest advantage from the space sanctuary status quo. The US military, government and commercial sectors have led the world in exploiting the potential of satellites and space technology for a host of vital functions, with satellites being particularly indispensable for US military operations. If satellites were subjected to substantial threat of attack or interference it would be a greater hardship for the United States than for any other major country.

Second, the United States enjoys an unrivaled ability to project military power around the world. Although space weapons would further increase its expeditionary military capabilities, their benefits would be only marginal in the vast majority of scenarios. On the other hand, effective space weapons might greatly enhance the military capabilities of other states, which currently have little capability to attack the United States and whose military inferiority is due in no small part to the US advantage in space capabilities. Moreover, while the United States would enjoy a large initial lead over its rivals in a space weapons competition, it already has a huge advantage in the other dimensions of military power, and there is little reason to believe that rivals would find it harder to challenge US pre-eminence in space power than in sea or airpower.

Third, sanctuary nationalists argue that the dynamics of alliance formation and maintenance

A Titan IV-B rocket carrying a Milstar II communications satellite lifts off from Cape Canaveral, Florida

If weaponization is inevitable and if leading the way is imperative, any political costs associated with being the first state to violate the sanctuary of space will have to be paid sooner or later, and delaying it will not avert having to pay the price

imply that if the US leads the way in space weaponization it would not only antagonize rivals and enemies, but would also tend to weaken the system of security ties between the United States and its large and powerful bloc of allies. The potentially oppressive proximity and omnipresence of American weapons in orbit might not actually encourage other states to align against an apparent assertion of US hegemony, but would at least make them less comfortable and cooperative with American dominance in international politics.[21] Even in the absence of such balancing behavior, a shift in US military strategy toward greater autonomy from allies and coalition partners, which is one of the principal selling points of Space-to-Earth weapons, would tend to weaken existing security relationships and increase the burden of defense on US national resources.

Some sanctuary nationalists also contend that a shift to space weapons as the key currency of

military power would weaken the global military dominance of the United States by making its currently overwhelming advantage in power projection through air and naval power obsolescent. Much as Britain's naval superiority was undermined when steam replaced sail, and again when pre-Dreadnought battleships were replaced by their steam turbine-driven, all-big-gun successors, the slate would be wiped clean and states that had previously lagged behind in the old technology would be able to compete in the new one from something closer to a neutral start.[22]

Thus, sanctuary nationalists do not think that US space weapons would be intrinsically bad, but instead that their eventual costs would greatly outweigh their benefits, particularly insofar as US space weaponization would lead to other states building their own space weapons. Although sanctuary nationalists are likely to doubt that US restraint in space weaponization would set a compelling moral example for other states to follow, or that arms control agreements would be a powerful barrier to weaponization, they maintain that other states would be more likely to embark on space weaponization if the United States does so first, for two reasons. The more obvious of these is that US space weapons would give other countries more valuable and threatening targets to attack in and from space, creating greater incentives for ASAT and even STEW development.

The other reason is more subtle: a belief that by leading the way in space weaponization, the United States would not only encourage other states to follow suit, and shield them from any political stigma that might be associated with being the first state to weaponize space, but would actually make it easier for them to do so. By serving as the technological innovator, and paying the costs of developing new technologies, the United States would reduce the technological and cost barriers for the states that followed. Such 'advantages of backwardness', well-recognized in economists' studies of the product cycle, are consistently visible in the development of military technologies, including aircraft, missiles and nuclear weapons.[23]

The prescription that emerges from nationalist sanctuary theory is that the United States should avoid taking actions that will motivate or facilitate adversaries' development of space weapons, or cause other effects that would tend to reduce US military advantages over other states. In general, this would point towards avoiding space weaponization, whether through multilateral regimes or unilateral restraint – either one conditional on the actions of other countries – or other means. However, as for the internationalists, the specific features of potential space weapons would affect whether and to what extent the development in question would endanger US security. To take one example, some but not all of the effects that nationalists seek to avoid would probably be less serious if the US built suborbital rather than long-term orbital space weapons.

Space racers

Of the three pro-weaponization perspectives, the one that generally appears least extreme, though it is not necessarily the one that shares the most common ground with space sanctuary theory, is that of the *space racers*. These are more or less reluctant space weaponization advocates, and may accept that sanctuary is desirable in the abstract, but who believe that space weaponization is inevitable, and that this makes it imperative for the United States to lead the way in the development and deployment of space weapons.[24] The space racer perspective is shared by many, including academic theorists who are attracted to restraint in armament but pessimistic about its prospects, and military leaders who are reluctant to see defense resources diverted from other areas into space weapons, but who are similarly skeptical about the chances of avoiding this.[25] Because the thesis that space weaponization is inevitable is tied to many of the pro-weaponization perspectives, the next section of this article will examine it in some detail, and the present discussion will focus simply on its implications.

For space racers, the most important consideration with respect to space weapons is that the United States should not allow other countries to surpass, or even to rival it in this sector of military competition. Being the leading space power may offer significant military advantage, or it could simply

If space weapons will enhance the nation's power, the United States should not squander the opportunity to develop them while waiting for a challenger to appear on the horizon

be an important source of national prestige and international political influence.[26] In either case, the United States must be at the forefront — and in the end — be the first state to weaponize space, for even if that is unpleasant, it will surely be better than being the second state to do so. Moreover, if weaponization is inevitable and if leading the way is imperative, any political costs associated with being the first state to violate the sanctuary of space will have to be paid sooner or later, and delaying it will not avert having to pay the price.

According to this perspective, the correct time for the United States to weaponize space will depend at least in part on the behavior, capabilities and intentions of other countries. If the threat of a rival state weaponizing space were remote, the United States would have the option of moving relatively slowly down this path, as long as it carried out sufficient research and development efforts to remain squarely in the forefront of this dormant arms competition. Many space racers are far from sanguine about the prospect of space weaponization by other states, especially in light of China's rapidly advancing space program, and anticipate that it will not be very long before the United States is compelled to deploy weapons in space. Others see the threat of space weapons rivals as less imminent, but in either case the space racer perspective is essentially threat based.

Although it can be described as the most 'middle of the road' approach to space weaponization policy – or perhaps because of this – the space racer perspective is arguably also the least intellectually satisfying. Its central weakness, though it is not necessarily a fatal one, is the contention that space weapons will be so irresistible that states will not be able to refrain from building them, and so powerful that it would be catastrophic for another state to build them before we do, yet not so attractive that the United States should build them as fast as possible in the absence of a military space challenger. Most sanctuary theories reject the first or the second (or both) of these propositions; the other two pro-weaponization perspectives accept these but reject the third.

Space controllers

Within the US military space community, the dominant attitude regarding weaponization is probably what has become known as the *space control* perspective. Space controllers believe that space will necessarily be an important arena of future conflict due to the great military benefits that space systems will provide to states that operate them. Some military missions, such as boost-phase intercontinental ballistic missile defense against large adversaries, can feasibly be conducted only from space, while the ever-increasing importance of satellites for communications, targeting and other essential military functions will make both attacking enemy satellites and defending one's own satellites (for which space controllers believe that space weapons will be required) a matter of leading strategic priority. In addition, as the relevant technologies improve, space-to-Earth weapons will become a potent military instrument.

Space controllers may accept the proposition that weaponizing space will be politically costly – though many in this camp tend to ignore such political variables in their enthusiasm for the development of American spacepower,[27] not all do – but in addition to agreeing with the space racers that any such costs will have to borne sooner or later, they believe that these will be outweighed by the benefits of any space weapons that are militarily worth deploying. Moreover, they are highly skeptical of the suggestion that US restraint in space weapons development would significantly reduce the inclination of other states to weaponize space as soon as doing so appears to be militarily advantageous to them, and of the prospects for negotiating feasible limitations on space weapons.

For space controllers, the right time for the United States to weaponize space will be as soon as doing so appears to be useful, whether or not other states are moving in the direction of doing the same. The key criterion for such a decision will not be a comparison of potential US space weapon capabilities with those of rival states, but a comparison of future US military capabilities with and without the potential space weapons. From the space controllers' perspective, space racers

If space weapons are too powerful not to build, they must also be too powerful to allow our potential enemies to possess

seem to lack the courage of their own convictions: if space weapons will enhance the nation's power, the United States should not squander the opportunity to develop them while waiting for a challenger to appear on the horizon.

Space hegemonists
Finally, at the most pro-weaponization end of the spectrum, are the *space hegemonists*. Where space controllers believe that space will be an important arena of conflict in the future, space hegemonists argue that space will be *the* critical battlefield, the 'ultimate high ground'. In the tradition of Mahan and Douhet, space hegemonists believe that he who controls space will control the world.[28] In the words of then-Senator Bob Smith, the most prominent if not the most persuasive spokesman for this perspective, concerted American development of space weapons

"will buy generations of security that all the ships, tanks, and airplanes in the world will not provide . . . With credible offensive and defensive space control, we will deter and dissuade our adversaries, reassure our allies, and guard our nation's growing reliance on global commerce. Without it, we will become vulnerable

With respect to the development of space weapons themselves, space hegemonists differ from space controllers only in matters of degree. Where the controllers favor deployment of weapons as soon as it is militarily advantageous, the hegemonists tend to advocate an even more aggressive weaponization program, with little consideration of the possibility that space weapons might not prove to be the optimal solution to most military problems. Space controllers tend to envision space weapons complementing terrestrial weapons, as well as offering unique capabilities that would be impossible or difficult to provide without them; space hegemonists are more inclined to envision space weapons as supplanting most terrestrial weapons, and dominating the traditional battlefields as well as the new ones in space, in a genuinely transformational revolution in military affairs.[30]

Where the space hegemonists stand out most fundamentally from other weaponization advocates is on the political dimension, where controlling space becomes controlling the world. One explanation for how this is to occur, as Smith has suggested, is that overwhelming US spacepower will be unassailable, so that the rest of the world will not challenge American hegemony. Either they will perceive it to be benign, or they will be so intimidated by it that defiance of the United States will appear pointless. The weakness of this argument lies in the tension between believing that there are rival states strong enough to become the space hegemon if the United States fails to do so, and believing that these same rivals are too weak or too meek to develop dangerous space capabilities in the face of US spacepower.

The other scenario, couched in less optimistic *realpolitik* terms, is that space weapons will be so powerful that the United States must exploit its current lead in space technology to seize control of the high ground and actively deny its use by unfriendly states.[31] According to this point of view, rival powers will indeed have incentives to challenge US dominance in space, and since the United States will not be able to afford to have its control of space contested, it will need to quash any such challenges before military space races develop, including pre-emptively destroying any space vehicles launching without US authorization and any terrestrial ASAT weapons that unfriendly states might build. This vision of the future represents the core elements of the other pro-weaponization perspectives being carried to their logical extreme: if space weapons are too powerful not to build, they must also be too powerful to allow our potential enemies to possess[29].

Is space weaponization inevitable?
As the preceding discussion described, the belief that space weaponization is, or is not, inevitable looms large for several of the major perspectives. It is most central for the space racers, for it is the expectation of inevitable weaponization that drives them into the pro-weaponization camp. The other pro-weaponization perspectives are not based on such an inevitability belief, but their adherents routinely invoke it as an argument against a sanctuary approach. For their part, all three of the sanctuary perspectives presume that weaponization is avoidable, or at least that

Whatever threats may be posed by enemy space systems, invasion is very low on the list. In short, satellites have more in common with lighthouses than with oceangoing ships, and space commerce resembles telegraphy or terrestrial radio more than it does maritime trade

American actions can affect how soon and in what form it occurs. Therefore the following discussion will briefly examine the four principal arguments for the thesis that space weaponization is inevitable.[32]

Specifically, the question here is whether there is good reason to believe with certainty that space weapons will be built and deployed to a substantial degree in the near-to-medium term, say the next 50 years, regardless of the behavior of the United States.[33] There are four prominent arguments which hold that this is true: that human nature predestines weaponization, that historical analogies with the sea and air prophesy it, that the growing economic importance of satellites mandates it, and that the military utility of space weapons will make not building them strategically irrational. This section will consider each of these propositions in turn, arguing that the first three are thought provoking but ultimately weak, while the last is more powerful but less than conclusive.

Human nature

The simplest inevitability argument is that warfare and armaments are intrinsically uncontrollable because people are warlike: weapons and warfare abhor a vacuum, and will spread wherever humanity goes.[34] This assertion is often accompanied by arguments that arms control never works, although it is possible to argue more narrowly that only space arms control is infeasible.[35]

This generalization is not far from the truth, yet it is far enough from truth that it can and should be considered invalid. For example, although the longstanding success of the 1957 Antarctic Treaty's proscription of military bases in Antarctica, often cited as an example of an effective sanctuary regime, would be far more impressive if the signatory powers actually had strong incentives to establish bases on that continent, it still flies in the face of the idea that weaponization must always follow wherever people go (the argument that space weapons in particular will have military utility too great to resist is a different proposition from the contention that weapons always spread everywhere). Similarly, some types of weapons have fallen into disrepute over the last century. While they have not yet disappeared, it could be argued that chemical and biological weapons have been shunned by all but renegade states and terrorists, and anti-personnel land mines are following in their wake. Many states that could easily have developed nuclear weapons have opted not to do so, in some cases in spite of apparently very good military reasons to go nuclear.[36] Perhaps most strikingly of all, even among space weapons advocates one does not find voices arguing that the placement of nuclear weapons in orbit is inevitable based on the rule that weapons always spread. The fact that this has not happened is due to many factors other than the 1967 Outer Space Treaty's prohibition on such weaponization, but if some weapons do not necessarily follow wherever people go, the idea that a law of human nature requires that others will do so should not be seriously embraced as a basis for national policy.

Historical analogies

The second argument that space must inevitably be weaponized is that the evolution of sea and airpower reveal a striking historical pattern leading inexorably in this direction, which the exploitation of space is also following. According to an influential recent commander of US Space Command, for example:

"If we examine the evolutionary development of the aircraft, we see uncanny parallels to the current evolution of spacecraft . . . The potential of aircraft was not recognized immediately. Their initial use was confined to observation . . . Until one day the full advantage of applying force from the air was realized and the rest is history. So too with the business of space . . . [Military] space operations, like the land, sea, and air operations that evolved before them, will expand [into] the budding new missions already included in the charter of U.S. Space Command of space control and force application as they become more and more critical to our national security interests".[37]

The parallels between the early days of space flight and, especially, the early development of

It was the value of being able to destroy enemy surveillance satellites that drove the ASAT programs in both the Unites States and the Soviet Union

aerial flight are indeed striking, at least at first glance. Yet upon closer examination, it is clear that the spread of weapons into the three previous environments into which human activity has so expanded – the seas, the air, and the undersea world – has been far from identical, raising serious doubts about the soundness of drawing such deterministic analogies when predicting the future of military space exploitation.[38]

Sea power. The first new realm into which human enterprise expanded was the surface of the oceans and other bodies of water, initially along the coasts and later onto the high seas. Maritime transport offered many advantages over land-bound alternatives, especially prior to the invention of the railroad, and armed conflict followed commerce onto the seas. Navies soon developed to protect merchant vessels from pirates and other enemies, to prey on enemy shipping and to attack or defend coastlines and sea lanes.

In spite of the intuitive similarities between seafaring and spacefaring, however, there is one fundamental difference between them which makes the sea–space analogy very weak: ships primarily transport goods and people, while spacecraft (with only minor exceptions) are built to collect, relay or transmit information. This means that space piracy is not a problem, so space navies are not required to suppress it, while 'commerce raiding' threats to space systems can be ameliorated by building redundant, distributed systems of satellites; for merchant shipping this is obviously not an option. It also means that whatever threats may be posed by enemy space systems, invasion is very low on the list. In short, satellites have more in common with lighthouses than with oceangoing ships, and space commerce resembles telegraphy or terrestrial radio more than it does maritime trade.[39] This does not mean that our knowledge of sea power couldn't be applied to space, or that space strategists should not study the works of Julian Corbett and Alfred Thayer Mahan. However, there is little reason to conclude from the evolution of naval forces either that the weaponization of space is inevitable, or that it is not.

Air power. The parallels between military use of the air and of space are far more impressive. Both balloons and airplanes were used for military observation soon after they were first invented, and because aerial observation was so powerful in the First World War, armed aircraft were soon employed as interceptors and then as escorts. Airplanes and airships were also used for bombing even before the dawn of air-to-air combat, and by 1918 virtually every modern military air mission had been undertaken or proposed.[40] Serious commercial exploitation of the air came only later. In space, strategic reconnaissance was the purpose of most early satellites, and intelligence collection remains the most well-known military space application;[41] it was the value of being able to destroy enemy surveillance satellites that drove the ASAT programs in both the Unites States and the Soviet Union.[42]

However, the evolution of air and space power has not been as similar as space weapons advocates' analogies often suggest. For example, less than a decade elapsed between the Wright brothers's first flight and the first aerial combat missions, while in the fifth decade after *Sputnik* space remains unweaponized. Of course, the occurrence of a major war in the 1910s had much to do with the rapid evolution of airpower, and spacepower might look very different today if the Third World War had broken out in the 1960s. But with no major wars now on the horizon, this caveat hardly makes the parallel between the two cases look like a strong basis for space policy in the early twenty-first century. In fact, both superpowers did develop anti-satellite interceptors, but then abandoned

Both superpowers did develop anti-satellite interceptors, but then abandoned their ASAT programs, something utterly without precedent in the history of airpower that casts further doubt on the soundness of the air-space analogy

The Resurgam, an early British submarine from 1879

Warfare was the sole purpose of the first generations of subsurface vessels, joined only much later and on a vastly more limited scale by scientific research, while submarines have so far been of virtually no commercial significance

their ASAT programs, something utterly without precedent in the history of airpower that casts further doubt on the soundness of the air-space analogy. Naturally, it would be foolish to conclude from the history of the last fifty years that space will definitely not be weaponized during the next fifty, but it would also be reckless to deduce the opposite from the history of flight between 1903 and 1915.

Submarine power. Space weaponization advocates rarely mention the third new environment into which human activity has expanded: the undersea world. In this case, although there are many similarities between submarine and space operations, the two weaponization histories have little in common. Warfare was the sole purpose of the first generations of subsurface vessels, joined only much later and on a vastly more limited scale by scientific research, while submarines have so far been of virtually no commercial significance. This says little about what the future of spacepower will look like, but it provides one more reason to be skeptical about the proposition that weapons spread into new environments according to a consistent and deterministic pattern.

It is also worth noting that one of the most striking commonalities among the three historical precedents is rarely if ever predicted to hold true for space as well. Nuclear weapons were deployed in each of these environments by all the major nuclear powers more or less as soon as each was capable of doing so. Yet not only has this failed to happen in space, but those who make analogical arguments for the inevitability of space weaponization conspicuously fail to claim that the nuclearization of space will occur in the future, raising doubts about the extent to which even its supporters actually believe in these assertions.

Economic vulnerability

The third inevitability argument is that as space systems become more and more economically

Attacking satellites is certainly possible, but crippling or destroying a small object hundreds of miles overhead moving at 17,000 miles per hour (to say nothing of satellites at far higher altitudes, where most communications and navigation satellites reside) is considerably more challenging

important to the United States, these assets will naturally become attractive targets of attack for rival states, terrorists and other enemies, and therefore it will be necessary to place weapons in space in order to protect them.[43] American industry, commerce and civil society do indeed depend heavily and increasingly on space systems for communications, navigation, weather prediction and many other functions.[44] However, it is far from clear that attacking US commercial space assets would automatically appear worthwhile to an enemy seeking ways to hurt the United States, or that protecting them would necessarily require weapons in space.

In the abstract, it is apparent that an enemy seeking to harm or to intimidate the United States might want to attack important satellites, potentially causing disruption of the services they provide, destroying expensive pieces of American infrastructure, and possibly even causing significant damage to the US economy. However, an enemy that wanted to achieve such a result against the United States could do so far more easily by attacking something other than satellites in orbit, and unlike satellites, most of these targets can be attacked without first developing or acquiring specialized weapons for one exotic target set.[45] Attacking satellites is certainly possible, but crippling or destroying a small object hundreds of miles overhead moving at 17,000 miles per hour (to say nothing of satellites at far higher altitudes, where most communications and navigation satellites reside) is considerably more challenging than doing comparable damage to targets such as ships, airliners, bridges, dams, pipelines, computer networks, office buildings — the list could go on almost indefinitely.[46] That such targets are not attacked on a regular basis is due mainly to the relatively small numbers and limited capabilities of serious terrorist enemies, not to any great degree of protection for these assets. Increased defensive measure since 11 September 2001 have done little to alter the relative difficulties of attacking space and terrestrial targets. Moreover, if an enemy did want to disrupt the use of American satellites, attacking their ground control stations and launch facilities might well be more effective than striking satellites in orbit, as well as much easier.

If an adversary did wish to attack US satellites rather than something else in order to hurt the United States,[47] space-based lasers or kinetic energy weapons would be useful for defense against direct ascent ASATs or 'space mines' that were detected before attacking, but they would provide no protection against attacks by ground-based lasers or covert mines already positioned near their targets, against electronic jamming or against attacks on the infrastructure that supports satellites.[48] Instead, the greatest improvements in the security of valuable US space assets might be achieved by making satellites less vulnerable to attack and, especially, by making them individually less valuable through the construction of satellite systems that are more distributed and redundant, with more smaller satellites doing the same jobs as fewer large, expensive ones.[49] The ultimate goal would be for the communications and other satellite infrastructures to become like the US interstate highway system: economically vital, but not worth attacking because its resilience means that none of its individual components is critical.

Military advantage

The best argument for the proposition that space weaponization is inevitable is that the military utility of space weapons will soon be so great that even if the United States chooses not to build space weapons, other countries will certainly do so, in large part because of the great and still growing degree to which US military operations depend upon what has traditionally been known as 'space force enhancement': the use of satellites to provide a vast array of services including communications, reconnaissance, navigation and missile launch warning, without which American military power would be greatly diminished. This parallels the argument that the importance of satellites to the US economy will make them an irresistible target, except that military and intelligence satellites are far more indispensable,

The ultimate goal would be for the communications and other satellite infrastructures to become like the US interstate highway system: economically vital, but not worth attacking because its resilience means that none of its individual components is critical

and successful attacks against a relatively small number of them could have a considerable military impact, for example by concealing preparations for an invasion or by disrupting US operations at a critical juncture.[50] Rivals of the United States might also find space-to-Earth weapons to be a very attractive way to counter US advantages in military power projection.

This is a reasonable argument, but to conclude for this reason that space weaponization is inevitable, rather than merely possible or likely, is unwarranted, for several reasons. There is no question that space systems are critical to US military capabilities. An enemy that attacked them might be able to impair US military operations very seriously, but while this ranks high among threats that concern US strategists, it need not follow that enemies of the United States will do so, or will invest in the weapons required to do so. The US armed forces possess many important vulnerabilities that adversaries have opted not to attack in past conflicts, typically due to resource limitations, a desire to avoid escalation, or fear of the reaction of third party audiences. For example, during Operation Allied Force in 1999, Serbia apparently did not attempt to mount special forces attacks against key NATO airbases in Italy or to use man-portable missiles to shoot down aircraft operating from them, although such an action could have profoundly disrupted the alliance's bombing campaign.[51] Moreover, it is quite possible that if a potential enemy did want to develop the ability to attack US space systems, it would choose to do so in ways that would not involve weaponizing space – such as investing in computer network attack capabilities, non-space weapons to attack the terrestrial elements of space systems, or ASAT capabilities that are not weapons in the conventional sense – and against which the logical defensive countermeasures would not involve deploying US space weapons. For military as well as commercial satellites, a transition to redundant networks of satellites would do much to reduce their vulnerability, perhaps together with supplementing satellite platforms for some military functions with new types of terrestrial systems, such as high endurance unmanned aerial vehicles (UAVs).[52]

In the end, most of the inevitability arguments are weak. Even the best one, that space weapons will provide irresistible military advantages for those who employ them, is plausible but not decisive, and many of those who assert it probably harbor exaggerated expectations about the capabilities that space weapons will offer. In spite of the many people who apparently believe the inevitability thesis to be true, there is good reason for prudent policy makers to assume that the weaponization of space is not in fact predestined, and that US military space policy is one of the factors, though not the only one, that will shape the likelihood of space weaponization by other countries.

Inevitability versus primacy and urgency

The prominence of the inevitability question within debates about space weaponization is not surprising, but too often it distracts attention from two far more important issues: whether it is in fact desirable and important for the United States to be the first country to weaponize space and/or for weaponization to occur sooner rather than later. If so, an aggressive effort to develop space weapons may be called for even if weaponization is not strictly inevitable. If not, a space sanctuary strategy may be appropriate for the United States even if it is certain that space will eventually be weaponized.

For space racers, primacy is what matters most, because they believe that the first state to deploy space weapons will have a great, and perhaps insurmountable, advantage over its rivals, though they may not in fact be eager to see the disappearance of the existing space sanctuary. Knowing simply that weaponization is inevitable is of little value from this perspective, though having a reasonable idea of when it would occur would be important. For many more ardent weaponization advocates, in contrast, the right time to deploy space weapons is immediately, or at least as soon as possible, regardless of what other countries may or may not be likely to do later on. Thus, although they often make inevitability arguments, these are essentially tangential to the real basis of their policy prescriptions. Finally, for space sanctuary advocates who fear that weaponization will cause

Spacepower advocates who make space weapons their totem distract both themselves and others from the fact that many, even most, of the important space policy measures that are needed now and in the near future do not involve building space weapons per se

international instability or will erode US dominance, and who doubt that a rival could in fact establish a decisive lead over the United States by taking the first step in a space weapons race, averting the deployment of at least some types of space weapons as long as possible appears desirable even if they are only temporarily delayed.

Beyond totem or taboo

The polarization of the space weaponization debate – treating a complex, multidimensional policy question as a simple all-or-nothing choice in which weaponization advocacy and opposition take on extreme, almost theological qualities – produces several seriously malignant consequences. The most obvious of these is that it discourages real dialogue among those who favor alternative military space policies. Many of the participants in the debate appear to be interested only in preaching to their fellow believers, treating their adversaries' arguments so dismissively that they cannot possibly change the minds of those who view the issues differently from themselves. Ideas break down when contending camps turn inward from healthy competition to mercantilist isolationism.

But this extreme polarization also harms the interests of the individual camps themselves. Weaponization opponents who treat space weapons as an absolute taboo risk squandering opportunities to establish potentially worthwhile restraints on space weapons development, prohibition. They also preclude the possibility of supporting forms of weaponization that might enhance global stability or further their ultimate policy objectives in other ways.

Of course, it can be argued that compromise will invite predation by one's adversaries, so that supporting benign weaponization would backfire over the long run, but such a position should be based on open and rational debate of its merits, not on doctrinaire faith that more arms control is always better less, or that armament and security are incompatible.

Conversely, spacepower advocates who make space weapons their totem distract both themselves and others from the fact that many, even most, of the important space policy measures that are needed now and in the near future do not involve building space weapons *per se*. Better space tracking networks, systems to detect attacks against satellites, passive defenses and more effective exploitation of space-dependent terrestrial weapons such as satellite-guided munitions all promise to dramatically enhance US spacepower — and US national security. Becoming 'shooters' might make it easier for space operators to win full citizenship rights alongside pilots in officers' club bars, but in the end, with or without space weapons, they will need to make the rest of the armed forces understand that today all United States airmen, sailors, soldiers and Marines are 'space warriors'.

Beyond calling for moderation and for taking the views of others seriously, what can be done to make the space weaponization debate more intelligent and productive? A good place to start would be for all sides in the debate to acknowledge four simple but important truths about space weaponization that are often overlooked in polemical arguments about the subject.

First, space weaponization is inherently political, a fact that space weapons advocates sometimes seek to ignore – though, happily, this is gradually becoming less common. This is not a question simply, or even primarily, of science and engineering. Whether space weapons will make the United States more powerful or secure, or less, depends on political variables: how other countries will react to them, what resources we will have to redirect to build them, and so on. Military capability can be measured in static, absolute terms, but power is relative and dynamic. Moreover, the effects that weaponization would have on international politics, and even what actions would be considered to constitute weaponization, depend upon subjective and perhaps malleable perceptions, both of space weapons and of American military power.

Nobody actually knows with confidence what will happen if and when space is weaponized – and what shape weaponization takes, and what happens between now and then, will certainly affect its consequences

Second, however, the military and technical details of space weapons do matter a great deal, though weaponization opponents – and enthusiasts as well – often paint their arguments with too broad a brush. Although all satellites do share certain important properties, the specific features of particular space weapons must be taken into account when assessing their strategic, and even their broader political, implications. This became second nature during Cold War debates over nuclear weapons and strategic defenses, when the minutiae of warhead accuracy, basing modes and command and control systems were in the forefront of most nuclear policy discussions, and even ardent doves could couch their arguments in the language of throw weights and equivalent megatonnage.[53] Space weapons (like conventional weapons more generally) are a far more complicated and diverse subject, and require much effort and attention to debate satisfactorily, yet surprisingly little work has yet been done to describe and analyze them in adequate detail.[54]

Third, because of the previous point, many participants on both sides of the space weaponization debate harbor what are likely to be quite unrealistic expectations about the capabilities of space weapons, and to a lesser extent about their costs.[55] It is easy to speak in general and often glib terms about global reach, the importance of holding the high ground, and revolutions in military affairs, but it is important to develop and debate a more nuanced understanding of the ways in which space weapons truly are and are not likely to alter the strategic landscape if they are built.

Finally, everyone involved in the debate should remain aware that their arguments are necessarily based on educated speculation, not certainty. This is particularly true with respect to the political implications of weaponization. Would US space-to-Earth weapons cause other states to be more or less friendly towards the United States, for example? Theorists on all sides of the debate offer answers to this question. These should be evaluated against relevant historical experience, for there is evidence that can shed light on the question, and some of these arguments appear better than others upon careful consideration. However, at the end of the day a considerable degree of intellectual humility is in order: nobody actually *knows* with confidence what will happen if and when space is weaponized – and what shape weaponization takes, and what happens between now and then, will certainly affect its consequences.

These are burdensome calls to action. It is more work to develop analyses and recommendations about policy that are well informed by the physical and social sciences than it is to offer ones that are not. However, as in debates about nuclear weapons and strategy during the Cold War, this is an area of policy that is too important to be guided by anything less.

Acknowledgements

This article is based on a paper originally presented in the Ballistic Missile Defense and Weaponization of Space series at the Elliot School of International Affairs, George Washington University, Washington, DC. The author thanks Thomas Ehrhard, Peter Hays, Theresa Hitchens, John Logsdon, and Michael V. Smith for their many helpful comments and suggestions. The opinions expressed here do not reflect the views of RAND or any agency of the United States Government.

Notes

1. On the latter, formally named The Commission to Assess United States National Security Space Management and Organization, see Peter L. Hays and Karl P. Mueller, 'Going Boldly – Where? The USAF, Aerospace Integration, and the U.S. Space Commission', *Aerospace Power Journal* 15/1 (Spring 2001), pp.34–49.
2. See Sigmund Freud, *Totem and Taboo: Some Points of Agreement Between the Mental Lives of Savages and Neurotics*, trans. James Strachey (New York: Norton, 1950 [1913]), pp.199–200.
3. For the history and details of these programs, see Paul B. Stares, *The Militarization of Space: U.S. Policy, 1945–1984* (Ithaca: Cornell University Press, 1985).
4. See, for example, Bob Preston et al., *Space Weapons, Earth Wars*, Rand MR-1209-AF (Santa Monica: RAND, 2002), p.23.
5. To this list could be added potential systems for destroying or diverting interplanetary objects threatening to collide with the Earth, some of which might have secondary military capabilities. For an overview of orbital characteristics, see, for example, *Joint Publication 3-14: Joint Doctrine for Space Operations*, 9 August 2002, Appendix F. In general, attacking a satellite in MEO or GEO is far more difficult than attacking one in LEO due to the longer ranges involved.

6. For technological details, see *New World Vistas: Air and Space Power for the 21st Century*, Space Applications Volume (Washington, DC: USAF Scientific Advisory Board, 1995); William L. Spacy II, *Does the United States Need Space-Based Weapons?* (Maxwell AFB, AL: Air University Press, 1999); Preston et al. (note 3), esp. ch.3; Ashton B. Carter, 'Satellites and Anti-Satellites: The Limits of the Possible', *International Security* 10/4 (Spring 1986), pp.46–98; US Congress, Office of Technology Assessment (OTA), *Anti-Satellite Weapons, Countermeasures, and Arms Control* (1985), reprinted in *Strategic Defenses* (Princeton: Princeton University Press, 1986).

7. See, for example, Karl P. Mueller, 'Is the Weaponization of Space Inevitable?', paper presented at the International Studies Association Annual Convention, New Orleans, LA, 27 March 2002.

8. Under the terms of the 1967 Outer Space Treaty, which prohibits the placement of weapons of mass destruction in space. The 1972 ABM treaty also prohibited space-based weapons that could be used for ballistic missile defense, at least according to most interpretations, until the United States withdrew from the treaty in 2002.

9. See, for example, Simon P. Worden, 'Space Control in the 21st Century', in Peter L. Hays et al. (eds), *Spacepower for a New Millennium* (New York: McGraw Hill, 2000), pp.225–38.

10. US military doctrine classifies space control effects into a hierarchy of five alliterative categories (deception, disruption, denial, degradation and destruction); see *JP 3-14* (note 4) pp.IV-6–8.

11. This generalization might be offset in certain cases by more discriminate weapons appearing to be more useful for aggressive purposes.

12. See Preston et al. (note 3), Appendix A.

13. For example, James Oberg, *Space Power Theory* (Washington, DC: Government Printing Office, 1999), pp.146–7.

14. The most widely used such typology at present is that provided in David E. Lupton, *On Space Warfare: A Space Power Doctrine* (Maxwell AFB, AL: Air University Press, 1988), more recently summarized and updated in Hays et al., *Spacepower* (note 8), pp.3–4. Lupton describes four categories of policy preferences, which he calls Sanctuary, Survivability, Control and High Ground, but defines these primarily in terms of the relationship between space systems and the strategic nuclear balance, which limits the utility of his framework for understanding the current weaponization debate (for example, he characterizes his Sanctuary school as favoring vulnerable space systems, which makes it little more than a straw man). However, the discussion of pro-weaponization perspectives below does draw heavily upon the more useful parts of his framework.

15. This is equally true of many of the citations in the following discussion. The fact that an example is used below to illustrate an argument from one of these perspective should not be taken to imply that everything in the cited work, or in other works by the same author, falls into the same category as they are defined here.

16. The 'idealist' label is not intended to imply that this perspective is unrealistic, but rather that it is guided by larger normative principles, in keeping with the classical idealist tradition in international political theory.

17. For example, Robert Jervis, 'Cooperation Under the Security Dilemma', *World Politics* 30/2 (January, 1978), pp.167–214; Steven E. Miller, Sean M. Lynn-Jones and Stephen Van Evera (eds), *Military Strategy and the Origins of the First World War* (Princeton: Princeton University Press, 1991); Sean M. Lynn-Jones, 'Offense-Defense Theory and Its Critics', *Security Studies* 4/4 (Summer 1995), pp.660–91.

18. Bruce M. DeBlois, 'Space Sanctuary: A Viable National Strategy', *Air Power Journal* 12/4 (Winter 1998), pp.42–44, 52. In fact, different types of space weapons would vary greatly in their ability to strike quickly; see Preston et al. (note 3).

19. For further discussion, see Stephen Van Evera, 'Offense, Defense, and the Causes of War', *International Security* 22/4 (Spring 1998), pp.5–43.

20. See David W. Ziegler, *Safe Heavens: Military Strategy and Space Sanctuary Thought* (Maxwell AFB, AL: Air University Press, 1998); Karl P. Mueller, 'Space Weapons and U.S. Security: The Dangers of Fortifying the High Frontier', paper presented at the American Political Science Association Annual Meeting, Boston, MA, 6 September 1998; Charles S. Robb, 'Star Wars II', *The Washington Quarterly* 22/1 (Winter 1999), pp.81–6.

21. The key presentation of these arguments is Stephen M. Walt, *The Origins of Alliances* (Ithaca: Cornell University Press, 1987); they are challenged in Randall L. Schweller, *Deadly Imbalances: Tripolarity and Hitler's Strategy of World Conquest* (New York: Columbia University Press, 1998). For the proposition that the United States won the Cold War because it was a relatively unthreatening superpower, see John Lewis Gaddis, *We Now Know: Rethinking Cold War History* (New York: Oxford University Press, 1997).

22. On the Royal Navy, see, among others, Paul M. Kennedy, *The Rise and Fall of British Naval Mastery* (Atlantic Highlands, NJ: The Ashfield Press, 1983 [1976], esp. pp.205–37; Mueller, 'Space Weapons and U.S. Security' (note 8), pp.13–15; DeBlois (note 17) p.51.

23. See Robert Gilpin, *War and Change in World Politics* (Cambridge: Cambridge University Press, 1981), pp.176–9; Alexander Gerschenkron, 'The Advantages of Backwardness', in his *Economic Backwardness in Comparative Perspective* (Cambridge, MA: Harvard University Press, 1962), pp.5–11. However, following a technological trailblazer, especially one with greater resources, does not necessarily guarantee the ability to catch up

with or surpass it, as demonstrated, for example, by the US–Soviet competition in submarine and anti-submarine warfare capabilities.

24. For example, CINCSPACE Gen. Ralph Eberhart, speech to the Unified Aerospace Power in the New Millennium conference, Alexandria, Virginia, 8 February 2001; James H. Hughes, 'Warfare in Space', *Journal of Social, Political and Economic Studies* Monograph Series 28 (2000), pp.7–10.

25. 'The logic essentially boils down to a belief that weapons in space are an inevitability. Since weaponization of space is inevitable, the United States, as the country with the historical opportunity to be the first to field them, would be foolish not to do so. And should it not afford itself of the opportunity, it will likely find itself hostage to the state that does' Oberg (note 12), p.147.

26. This is analogous to arguments of reluctant nuclear arms racers in the 1970s and 1980s that having a large nuclear arsenal than one's adversary might be militarily irrelevant in a world of mutual assured destruction, yet still be important because of the political effect of appearing to be the dominant nuclear power. See Charles L. Glaser, 'Why Do Strategists Disagree about the Requirements of Strategic Nuclear Deterrence?', in Lynn Eden and Steven E. Miller (eds), *Nuclear Arguments* (Ithaca: Cornell University Press, 1989), pp.109–71.

27. A prominent example is the strong and unconditional recommendation in the USAF Scientific Advisory Board's *New World Vistas* study (note 5), p.164, that 'the Air Force should broaden the use of space to include direct force projection against surface, airborne, and space targets', in spite of the fact that the study included no analysis at all of the potential consequences of pursuing such a policy.

28. This geopolitical argument is made pre-eminently in Everett C. Dolman, *Astropolitik: Classical Geopolitics in the Space Age* (London: Frank Cass, 2001).

29. Sen. Bob Smith, 'The Challenge of Spacepower', *Airpower Journal* 13/1 (Spring 1999), p.33.

30. For example, *New World Vistas* (note 5), p.xviii: 'In the next two decades, new technologies will allow the fielding of space-based weapons of devastating effectiveness to be used to deliver energy and mass as force projection in tactical and strategic conflict. This can be done rapidly, continuously, and with surgical precision, minimizing exposure of friendly forces.'

31. Dolman (note 27).

32. For a more detailed examination of this issue, see Mueller, 'Is the Weaponization of Space Inevitable?' (note 6).

33. It is possible to argue that weaponization is inevitable because the United States will certainly build such weapons for reasons internal to itself, but this is not a useful meaning of 'inevitability' when seeking to guide US policy.

34. See Michael V. Smith, 'Ten Propositions About Spacepower', Master's thesis, School of Advanced Airpower Studies, June 2000, Proposition 10; Oberg (note 12), pp.147–9; Gen Chuck Horner, in Tom Clancy and Chuck Horner, *Every Man a Tiger* (New York: Putnam, 1999); *Report of the Commission to Assess United States National Security Space Management and Organization* (Washington, DC: The Commisson, 2001), p.100.

35. For an example of the former, see Steven Lambakis, *On the Edge of Earth: The Future of American Space Power* (Lexington: University of Kentucky Press, 2001). For a sober overview of arms control issues related to space weapons, see Peter L. Hays, *United States Military Space: Into the Twenty-First Century* (Maxwell AFB, AL: Air University Press, 2002), pp.49–114.

36. See Mitchell Reiss, *Without the Bomb: The Politics of Nuclear Nonproliferation* (New York: Columbia University Press, 1988), and *Bridled Ambition: Why Countries Constrain Their Nuclear Capabilities* (Washington, DC: Woodrow Wilson Center Press, 1995).

37. Gen. Howell M. Estes III, Commander, Air Force Space Command, speech to the Air Force Association Annual Symposium, Los Angeles, 18 October 1996 (some ellipses in the original). Available at <http://www.spacecom.af.mil/usspace/>. See also Thomas D. Bell, *Weaponization of Space: Understanding Strategic and Technological Inevitabilities*, Occasional Paper No. 6 (Maxwell AFB, AL: Center for Strategy and Technology, US Air War College, 1999), pp.16–20; Lambakis (note 34), pp.140–41; USAF Chief of Staff Gen. Michael Ryan, keynote address to the Unified Aerospace Power in the New Millennium conference, Alexandria, Virginia, 8 February 2001.

38. Regarding the dangers of faulty analogical reasoning in general, see Richard E. Neustadt and Ernest R. May, *Thinking in Time* (New York: Free Press, 1986) and Yuen Foong Khong, *Analogies at War* (Princeton: Princeton University Press, 1992). One could potentially argue that cyberspace represents a fifth environment worth considering in this context. The shape of the weaponization story for this case would depend on exactly how one defined the arena in question, and what constitutes a weapon within it. Again, some interesting parallels with the development of space technology would appear, and the overall pattern would not correspond to that of any of the other four cases.

39. As space travel expands beyond earth orbit into interplanetary space, where the transportation of material goods may finally become one of its major functions, the parallels between sea and space power may become more pronounced.

40. For discussion of this evolution, see Lee Kennett, *The First Air War, 1914–1918* (New York: Free Press, 1990). An analogy can also be drawn between airborne spotters enhancing the effectiveness of artillery in the First World War and contemporary use of GPS guidance for aerial munitions.

41. On the evolution of satellite reconnaissance, see William E. Burrows, *Deep Black: Space Espionage and National Security* (New York: Random House, 1986); Jeffrey T. Richelson, *America's Secret*

Eyes In Space (New York: Harper and Row, 1990) and *A Century of Spies: Intelligence in the Twentieth Century* (New York: Oxford University Press, 1995). On the evolution of the US and Soviet space programs, see Walter A. McDougall, *...the Heavens and the Earth: A Political History of the Space Age* (New York: Basic Books, 1985).

42. Of course, there are important physical differences between air and space warfare, such as air being territorial while low Earth orbital space is not, but these do not in themselves prevent drawing parallels between the evolution of air and spacepower. See Bruce DeBlois, 'Ascendant Realms: Characteristics of Airpower and Space Power'. in Phillip S. Meilinger (ed.), *Paths of Heaven: The Evolution of Airpower Theory* (Maxwell AFB, AL: Air University Press, 1997), pp.529–78; Michael Smith (note 33), esp. pp.43–50.

43. Bell (note 36), pp.6–7; Oberg (note 12), p.147; Thomas S. Moorman Jr, 'The Explosion of Commercial Space and the Implications for National Security', *Air Power Journal* 13/1 (Spring 1999), p.19. Worden (note 8) provides one of the more sophisticated versions of this argument.

44. Although this is true in the aggregate, it is less true than most analysts expected it to be a few years ago, and more true in some functional areas than others. Most notably, the satellite communications boom of the 1990s has substantially leveled off due to the growth of long distance fiber optic cable networks, and the anticipated rise of commercial satellite telephone networks has been overtaken by advances in terrestrial cellular telephony; see Barry D. Watts, *The Military Use Of Space: A Diagnostic Assessment* (Washington, DC: Center for Strategic and Budgetary Assessments, 2001), pp.49–56, and Hays, *U.S. Military Space* (note 34), pp.8–18.

45. A partial exception to this generalization might be the possibility of detonating an exoatmospheric nuclear explosion, which would not only destroy nearby satellites but also energize the Van Allen radiation belts, drastically reducing the lifespan of all un-hardened satellites orbiting at the affected altitudes. Such an attack – which would be of dubious short-term military value – might appear to be a way to use a single nuclear weapon to produce massive economic damage without causing many human casualties (at least directly). However, it presumably would not be a way to use a nuclear weapon free from fear of retaliation.

46. It is not particularly difficult compared to building, launching and operating satellites, however. The relative difficulty of attacking satellites in orbit is even more pronounced for non-state terrorist organizations, which are unlikely to be even remotely as capable of conducting ASAT attacks against satellites as they are of striking a wide range of terrestrial economic targets.

47. It remains difficult to envision a motive for such a course of action, however. Although attacking satellites might provide an opportunity to cause economic harm without directly injuring anyone, there are plenty of terrestrial targets where this would also be true. Satellites might be attacked more covertly than most terrestrial targets (though the opposite is more likely to be true), but terrorists or other coercers would have to reveal their actions in order to achieve their goals, and any concerted anti-satellite campaign for economic warfare purposes would quickly become visible to the victim.

48. Spacy (note 5), pp.25–6, 33–7. Terrestrial ASAT lasers could be counter-attacked by space-to-Earth weapons, but would also be vulnerable to attack by other means.

49. Robert B. Giffen, *U.S. Space System Survivability: Strategic Alternatives for the 1990s*, National Security Affairs Monograph Series 82-4 (Washington, DC: National Defense University Press, 1982); Ziegler (note 19), p.30.

50. The greatest damage might be achieved by disabling a large part of the global positioning system satellite network, which would have a wide array of devastating military (and also economic) effects, especially now that many US weapons are guided to their targets by GPS signals, but this would be difficult to achieve since the GPS constellation is large, hardened, and operates in relatively high altitude orbits.

51. Many other examples will spring to mind upon contemplating the matter, but I am reluctant to compile target lists for potential enemies.

52. Ziegler (note 19), pp.28–9.

53. See Karl Mueller, 'Strategic Airpower and Nuclear Strategy: New Theory for a Not-Quite-So-New Apocalypse', in Phillip S. Meilinger (ed.), *The Paths of Heaven: The Evolution of Airpower Theory* (Maxwell AFB, AL: Air University Press, 1997), pp.279–320.

54. Notable recent exceptions include Preston et al. (note 3) and Spacy (note 5).

55. It is widely accepted among military space professionals that such expectations, along with many other popular beliefs about space operations, are also powerfully and unrealistically shaped by the portrayals of space warfare in movies and television. This is by no means a new or surprising pattern: expectations about air warfare both before and after the First World War had much to do with the works of H.G. Wells and other authors of speculative fiction, see, for example, Michael Paris, *Winged Warfare: The Literature and Theory of Aerial Warfare in Britain, 1859–1917* (Manchester: Manchester University Press, 1992).

Artist's impression of anti-satellite weapons (ASATS)

A Sunderland Flying Boat on Lake Havel in Berlin. The aircraft is loading the products of Berlin's Industry — it was as important to keep products flowing out as it was to keep food and fuel flowing in

Britain and the Berlin Airlift

By Sebastian Cox,
Head of the Air Historical Branch (RAF)

(All photographs provided by AHB)

For they intended evil against thee; they imagined a mischievous device, which they were not able to perform

Psalm 21 verse 11

At half past six in the evening on 23 September 1949 the wheels of a heavily laden Douglas Dakota transport aircraft of the Royal Air Force lifted off the concrete runway at Lubeck airfield in the British Zone of Germany. The aircraft's destination was Gatow airfield in the western suburbs of Berlin, approximately 150 miles to the south east of Lubeck. Once clear of the runway, however, the navigator on board the Dakota instructed the pilot to fly the aircraft almost exactly due south. After flying for some 20 miles the pilot brought the aircraft round in a gentle turn until its nose pointed towards a navigational beacon on the ground near Restorf some 40 miles to the south east, and from there course was set for Berlin Gatow. Fifty two minutes after it took off from Lubeck the aircraft landed in Berlin. As it rolled to a halt on the concrete apron at Gatow the small huddle of men waiting to unload the aircraft's cargo could see an inscription on the nose of the Dakota which read "Positively the last load from Lubeck, 73,705 tons. Psalm 21, Verse 11". The biblical quotation was an entirely appropriate and pointed jibe at the Soviet Union's "mischievous device" — the surface blockade of Berlin — while the rest of the inscription conveyed both pride in a job well done, and relief that many months of hard, back-breaking toil were finally over.

It might prove impossible for the Western powers to maintain their position at all in Western Germany

For much of its flight from Lubeck the Dakota had been flying in the airspace over the Soviet Zone of Occupied Germany. The air "corridor" it flew along had been defined in written agreements made between the four occupying powers, Britain, The Soviet Union, The United States and France in November 1945, and was some 20 miles wide. The reason the Dakota's journey was necessary, and the cause of the barbed biblical comment, lay in the fact that no such written agreement had ever been drawn up between the four powers regarding access via land corridors to Berlin; the three Western Allies, the USA, France and Britain had not considered it necessary, since roads and railways were already in existence and no one had foreseen that the Soviets could deny their use to the Allies.

That had proved to be an expensive miscalculation when, on 23 June 1948, some 15 months before the Dakota's flight, the Soviets had halted all rail and road traffic from the Western Zones of Germany to Berlin. The steady deterioration in relations between the four powers culminated in the British and American decision to forge ahead with currency reform in their Zones. The Soviets saw this, quite correctly, both as the first step to German self-government, an idea which they detested, and as a threat to the economy of the Eastern Zone, which they feared. Their own behaviour had been increasingly uncooperative in the first months of 1948, and the imposition of the blockade was simply the culmination of several months of obstruction and intransigence.

As the relationship between the four powers deteriorated during the early months of 1948 the British and Americans had made some contingency plans for supplying their garrisons in Berlin by airlifting supplies. In April the British Army of the Rhine and Royal Air Force Transport Command had drawn up a plan to fly in 65 tons of supplies per day using two Dakota squadrons deployed from their base in England. They had also laid plans for flying out the families of the garrison on the return flights from Berlin. No consideration had been given to supplying the needs of the two million Berliners living in the Western sectors of the city. When the Soviet blockade was imposed the problems faced by the Western Allies seemed dauntingly insoluble. The political stakes could hardly have been higher. In the sober words of the British Foreign Office:

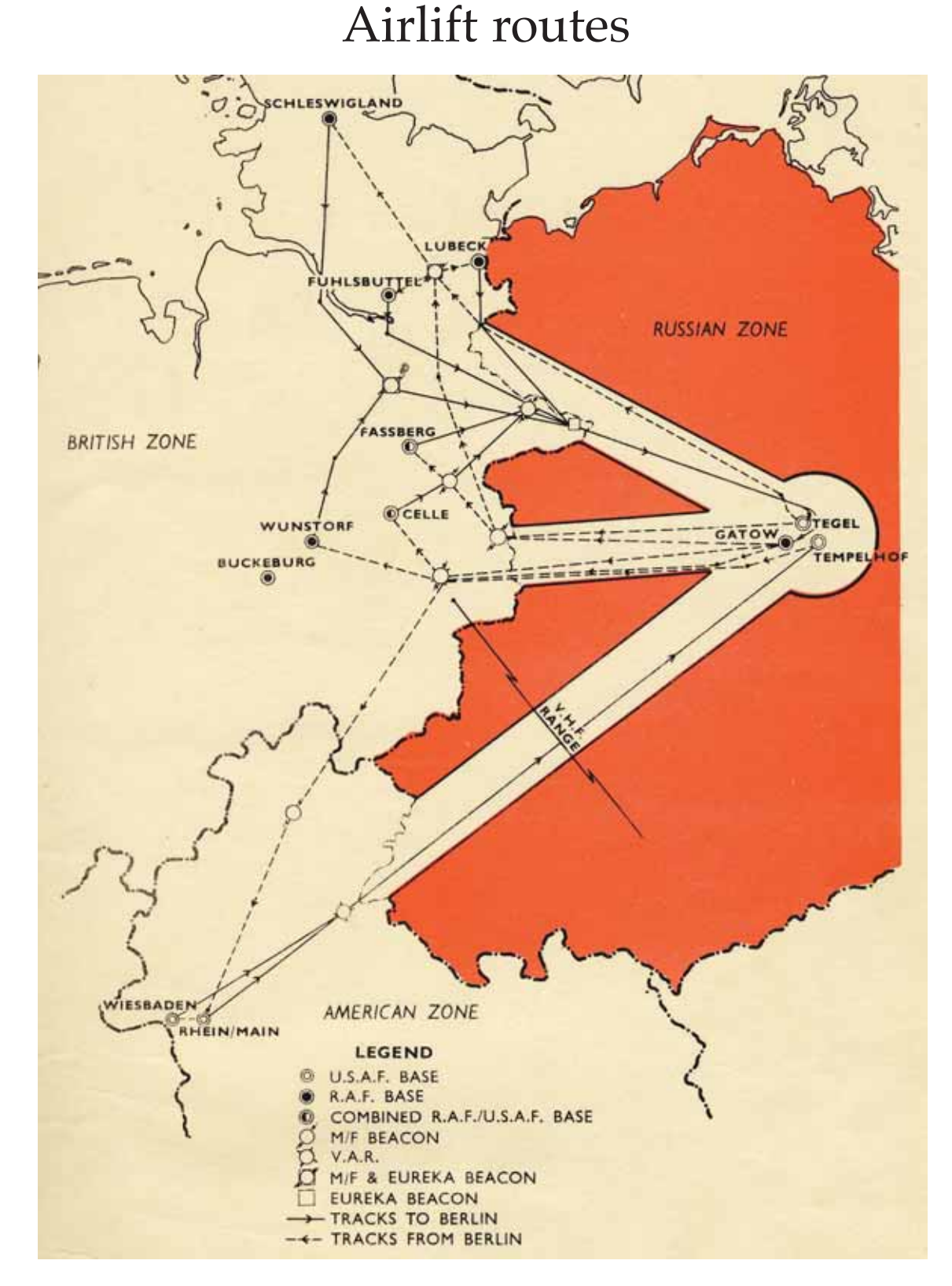
"If the Soviet Government were to succeed in their efforts to force us out [of Berlin] in humiliating circumstances the effect would be extremely grave not only in Berlin but in Western Germany and in Europe at large. It might prove impossible for the Western powers to maintain their position at all in Western Germany, if Berlin were lost to them, except by heavily reinforcing the military forces there."

With the British economy struggling to recover from six years of total war this was a deeply uncomfortable prospect. The option of attempting to force a land convoy through the Soviet blockade, as suggested by the American Military Governor, General Clay, seemed unlikely to be succsessful, and carried with it the real risk of precipitating a war with the Soviet Union. As the British Government's senior military advisers pointed out, however, the western position in Berlin was:

"militarily unsound and could not be maintained by fighting . . . if His Majesty's Government were prepared to go to war on this issue, they should realize that the Russians could squeeze us out of Berlin without themselves firing a shot, so that hostilities would have to be opened by ourselves."

The West had only two significant cards to play, one was US possession of the atomic bomb, and the other was that while the Soviet forces in

Airlift routes



RAF Yorks being loaded with supplies

Europe were powerful, the Soviet economy was in no condition to undertake another major war. Hence the decision to deploy two groups of B-29 bombers to Europe. In the meantime, and almost solely as a device to gain time for diplomacy, rather than as a serious longterm attempt to counteract the blockade, the Allies began the airlift.

The credibility of the Western position in Berlin hinged on the US and Royal Air Forces ability to keep two million West Berliners warm and fed. The prospects were not encouraging. Stocks in the city were not high with only enough food, petrol and solid fuel to keep the civil population supplied for two to three weeks. There were no appropriate plans for the scale of airlift required, and the runway at Gatow airfield was undergoing repairs. No one seriously considered it a realistic prospect to provide food and fuel by air for a city of two million people over an extended period. The daily requirement for food alone was daunting: 900 tons of potatoes; 641 tons of flour; 106 tons of meat and fish; 105 tons of cereals and so on, amounting altogether to some 1,800 to 2,000 tons of food alone every day. A fully laden Dakota could carry about 2.5 tons.

When General Robertson, the British Military Governor in Germany, telephoned the Headquarters of the British Air Forces of Occupation on 24 June he must have been aware of the scale of the problem, but he was equally aware that to do nothing was not an option. Hence his message to the Royal Air Force was simple: "Something must be done and something must be done at once." The British Foreign Secretary, Ernest Bevin, shared this view and galvanised the sceptical and reluctant with the simple exhortation "Do your best". As one of the RAF staff officers charged with organising the operation remarked "Something at once" and "Do your best" hardly appeared to be the most well considered instructions issued at the start of a military operation. It is to the credit of the United States and Royal Air Forces that they were to prove that their best was better than anyone, in Berlin, London, Washington, Paris or, most important of all, Moscow, had a right to expect.

By one of those odd coincidences, on the day after the instruction to start the airlift was given the only RAF transport squadron in Germany at the time actually left the country to fly back to England. Number 30 Squadron had been participating in an exercise with British paratroops and had been temporarily based at Schleswigland, but the exercise had finished and the Squadron departed for England as planned just after lunch. Even as the Squadron loaded its aircraft and took-off for their home base in eastern England

Stocks in the city were not high with only enough food, petrol and solid fuel to keep the civil population supplied for two to three weeks

another squadron of Dakotas was undertaking the same journey in reverse. Ordered to deploy from their home base at Waterbeach and to be ready to commence operations to Berlin within 48 hours these Dakotas also took off for Germany at lunchtime on 25 June and flew to Wunstorf airfield. They flew the first British flights of the airlift into Berlin that same evening, three Dakotas carrying in 6.5 tons of supplies.

With that peculiar knack that the military has for issuing orders at the most inopportune moment the instruction to send a second squadron from Waterbeach to Wunstorf was issued at midnight on the 27-28 June 1948, thus ensuring a sleepless night for many of those involved in preparing the second squadron, which flew to Germany the next morning. The operation was originally given the codename *Knicker,* which prompted the humourists amongst the British Army in Berlin to tie underpants to the radio aerials of their vehicles. The name was soon changed to *Carter-Paterson*, which was the name of a well-known removals firm in Britain. This prompted the sarcastic and politically damaging comment from the Soviets that the British were clearly intent on quitting Berlin rather than helping the city. The codename was rapidly changed once more to the gentle pun *Operation Plainfare,* and *Operation Plainfare* it remained.

It was clear from an early stage that two squadrons of Dakotas totalling 16 aircraft would never be sufficient for the task in hand.
The British Military Governor, General Sir Brian Robertson, made an early estimate that just over 2,000 tons of food were required each day to feed the Western sectors, and this figure took no account of other commodities such as fuel or raw materials for industry. By 30 June a further 38 transport aircraft had arrived at Wunstorf, including the aircraft of No 30 Squadron which had left Schleswigland only five days earlier. On 28 June the RAF's Chief of the Air Staff, Lord Tedder, had told a meeting of his senior colleagues that the RAF could lift 75 tons a day into Berlin at once, rising to 400 tons a day when the extra aircraft arrived in two days time, and 750 tons a day from the 3 July when repairs to the runway at Gatow would be complete. The planning in the early days of the airlift stipulated 450 short tons [1 short ton = 2,000 lb] a day as soon as possible rising to 840 short tons by 7 July. The first target was to be achieved by a force which would initially consist of 54 Dakotas (out of 112 in the RAF). These would then be replaced in due course by a reduced force of 32 Dakotas and some 40 of the larger Avro York transport aircraft which could carry 7.5 to 8.25 short tons on each journey.

Making plans was one thing, however, putting them into effect quite another. The first Yorks were intended to arrive at Wunstorf on 1 July, with 10 more arriving on each of the two following days, and eight more on 4 July. By early July, however, there was severe congestion at Wunstorf, with 48 Dakotas of numbers 30, 46, 53, 77, and 238 Squadrons, and some aircraft of 240 Operational Conversion Unit, a Dakota training unit. The

Berlin: RAF Yorks unload at Gatow — the airlift never stopped, night or day, good weather or bad.

weather was appalling, with rain and low cloud seriously impeding operations. The airfield at Wunstorf was not large and all-weather concrete surfaces were limited to the two runways, a few aircraft parking areas, and the concrete aprons in front of the hangars. These were inadequate for the large numbers of aircraft now trying to use the airfield and there was no alternative but to park them on the grass areas. The unrelenting rain made matters far worse as the constant movement of aircraft and vehicles churned the grass surfaces into a sea of ankle-deep mud. There were also shortages of all kinds of equipment which would normally be available at the home airfields of the transport squadrons, ranging from petrol bowsers, to engine-starter trollies and wheel chocks.

There were also delays at both ends of the airlift due to shortages of manpower to load and unload the aircraft. The officer in command of the transport wing at Wunstorf noted in his diary on 1 July that the airlift was well behind schedule because of difficulties loading the aircraft, and because there was a shortage of oil and petrol bowsers. The section responsible for refuelling the aircraft was also overworked and badly organised. On the 3 July he wrote that the British Army (who provided much of the labour for loading the aircraft) could not cope with loading both the Dakotas and the newly arrived Yorks. In these circumstances it was decided to postpone the arrival of the last 20 Yorks. The airlift had not started well.

Nor did the weather improve in the following week. The German summer contrived to produce thunderstorms, heavy driving rain and continuous low cloud, and even snow. When it wasn't raining it was foggy. In the first three weeks of the airlift the RAF crews flew to and from Berlin in weather in which they would not normally have been permitted to fly. The intention had been to fly 160 trips per day to Berlin, but Gatow was frequently forced to suspend operations altogether because the weather closed in, or simply to allow the ground staff time to sweep from the runway the great sheets of water which had accumulated. At other times when flying was not suspended the weather still meant that Gatow could only accept one aircraft every 15 minutes during the day instead of the normal six minute interval. The rain was so incessant that the damp began to penetrate the electrical systems of the aircraft to such an extent that on 2 July, 26 of the Dakotas at Wunstorf were unable to fly because of it: the Yorks were if anything more prone to such problems. For the additional groundcrews and loaders brought in to help, many of whom were sleeping in tents on the airfield, the conditions made life especially miserable, with the damp and the constant roar of aircraft and vehicles making sleep virtually impossible until exhaustion took over.

It was not until 14 July that the daily tonnage reached the target figure of 840 tons. This was partly the result of a change in policy. In the light of the conditions at Wunstorf and Gatow it was decided that the most efficient force which could be operated would be 40 York aircraft with 60 crews and 42 Dakotas with 63 crews. It was thought that the Dakotas could fly 50 daylight trips to Berlin and 42 at night. With the Yorks this would give a total tonnage of just under 1,000 short tons per day — *if the weather was ideal.* In addition the capacity of the Dakotas was increased from 5,500 lb to 6,500 lb, and on 16 July to 7,500 lb, by removing unnecessary safety equipment, such as dinghies, and reducing the fuel load. On the 4th July the Royal Air Force introduced a new and unusual element into the airlift.

Two squadrons of Short Sunderland flying boats alighted amidst plumes of spray at Finkewerder on the River Elbe. The next day at quarter to six in the evening any Berliner who happened to be strolling on the banks of the Havel close to Gatow would have seen a large white aircraft swoop down over the shoreline and cut a neat furrow in the water. The Sunderland was flown by a young Flying Officer who only four days before had been flying round and round a Royal Navy submarine off Northern Ireland. In the intervening days the aircraft had been stripped of much of its military equipment and loaded with 10,000 lb of supplies for Berlin.

The Sunderland crews were based in the old Blohm and Voss works on the Elbe near Hamburg. Each aircraft had to be loaded with supplies bought out to it by small boats and the aim was to fly three missions to Berlin each day.

British Army soldiers and German civilians stand by as a truckload of coal is backed up to the loading door of a Handley Page Hastings at Schleswigland

This represented some six and half hours in the air, plus loading and refuelling time, which meant a long and tiring day. The Sunderlands carried salt, meat, sanitary towels, and cigarettes into Berlin. On their return to the Elbe they carried industrial goods or refugees. One Sunderland pilot remembers flying his aircraft off the Havel without, for once, worrying about the weight and distribution of his cargo: every inch of the aircraft was crammed with boxes of lightbulbs from Siemens. The Russians protested at this unusual mode of transport, claiming, probably correctly, that the flying boats had no right to be there: the RAF ignored their protests.

The presence of the flying boats provided a much needed boost to the morale of Berliners in a city where entertainment was hard to find. Each day, but especially on Sundays, the banks of the Havel would be filled with spectators curious to see these elephantine but graceful beasts landing and taking-off, their mere presence floating serenely on the water brought a measure of hope along with the more tangible cargoes in their bulging fuselage. The crews, however, found little joy in their task, particularly since the waters of the Elbe were rough and covered in debris making the take-offs and landings potentially dangerous. One crew returning to Finkewerde at the end of a trip to Berlin found themselves stranded on their flying boat for one and a half hours when fog closed in and the boat sent out to pick them up could not find their aircraft's mooring buoy. The Sunderlands also had few of the radar landing aids and ground navigational beacons available to other aircraft, and it was difficult to integrate their operations with those of other aircraft types on the airlift. By the time ice flows on the Havel brought an end to Sunderland operations in December they had carried in 4,500 tons of food and brought out more than 1,100 undernourished refugees as well as the lightbulbs and other products of Berlin's industry.

The arrival of the Yorks and Sunderlands on the airlift did not satisfy the British Government that enough was being done to help break the Russian siege. In November the first squadron of brand new Handley Page Hastings transport aircraft arrived at Schleswigland. The reaction of the crews when ordered to fill their shiny new aircraft with sacks of coal is not recorded! Royal Australian Air Force crew also arrived to help in September, followed by South Africans and New Zealanders in October. Every little helped, but there was still a need for more aircraft. Once all the available military aircraft had been summoned, officialdom turned to the civil airlines. The initial need was for aircraft to fly liquid fuel into Berlin. Some drums of fuel had already been carried in on military aircraft, but this was both a dangerous and inefficient way to carry such volatile cargoes. Fully loaded the 55 gallon metal drums were heavy, 365 lb each, bulky, and difficult to secure inside the aircraft.

The British therefore turned to a specialist firm *Flight Refuelling Ltd*, which was run by the aviation pioneer, Sir Alan Cobham, who had many record-breaking flights to his name. Cobham had also pioneered the art of air-to-air refuelling and his firm therefore had available that rarest of commodities in 1948 — fully equipped tanker aircraft. On 27 July the first civil flight on the airlift was made by a Lancastrian tanker aircraft of Flight Refuelling Ltd carrying a bulk load of petrol to Berlin from its base at Tarrant Rushton in England. A second Lancastrian arrived and operations then continued from Buckeburg.

In August a series of contracts were let with British civil airlines, several of which had only one or two aircraft, to provide further aircraft. The first wave of civil freighter aircraft arrived at Wunstorf on 4 August, and the first sortie was flown by a Handley Page Halton of Bond Air Services, which landed at Gatow at 3 o'clock in the morning. This same aircraft flew five return trips in the following twenty-four hours which saw 33 return flights by civil aircraft in all. Aircraft of all shapes and types joined the lift, many like the Halton being converted versions of the heavy bombers which had flown over Berlin three to four years earlier, crewed in many instances by the same men who had been used to searchlights, nightfighters and anti-aircraft fire over what they had known as "The Big City".

To some of the British and American airmen it must have seemed as if little had changed since they had last been there as, during September

The one thing that the allied airmen most feared was that the Soviets would fly barrage balloons on the approaches to the airfields

especially, the Soviets chose to conduct anti-aircraft firings and air defence exercises in the corridors. Soviet fighter aircraft also "buzzed" airlift aircraft in the corridors. Protests proved of little use but eventually either the Soviet forces became bored with the sport, or were ordered to give it up. The one thing that the Allied airmen most feared was that the Soviets would fly barrage balloons on the approaches to the airfields. This they never did, possibly because it would have been difficult to claim that a collision with a tethered balloon on the approach to an airfield was the fault of the pilot!

Many difficulties had to be overcome to integrate the civil and military lifts. The civil aircraft companies did not have sufficient groundcrews to service the aircraft as efficiently as the two air forces, and the number of civil aircraft which were unserviceable at any one time was generally high. When the first civil aircraft arrived it was found that their radios operated on different frequencies from those of the military, and motorcycle despatch riders had to be sent out from Wunstorf to RAF bases around Germany to locate the necessary radio crystals to enable the frequencies to be changed. The civil aircraft did not have such sophisticated navigation equipment as those of the RAF and there was a desperate scramble to find and fit the necessary aids. As the necessary sets were in short supply and the crews had to be trained to use them this caused some problems. It also caused delays in the plan to convert more civil aircraft to tankers and since the civil aircraft were now entirely responsible for lifting liquid fuel into Berlin this could have had serious consequences.

By the end of 1948 liquid fuel stocks in the city were dangerously depleted, and from 1 January 1949 the city became entirely dependent on the supply lifted in the British tanker aircraft. The target figure had been set at 220 tons, but the problems with the civil aircraft meant that the average had only been 148 tons. The plan had been to have 31 tanker aircraft flying on the airlift by 1 January, but there were only 11 such aircraft available on the day, increasing gradually to 20 by the 14th of the month. In November the Western Allies would have run out of fuel had they not simply purloined Soviet stocks which happened to be stored in the Western Zone.

A civil Avro Tudor II is loaded with bags of flour

The civil aircraft did not have such sophisticated navigation equipment as those of the RAF and there was a desperate scramble to find and fit the necessary aids

Other improvements helped. At Wunstorf at the start of the airlift the tankers had to be filled from fuel trucks using portable pumps which were not designed for such heavy usage and frequently broke down causing delays. A new fuel installation was therefore built linked directly to the railway sidings. Fuelling points at a special aircraft apron were equipped with electric pumps capable of delivering a precise pre-set quantity of fuel at 100 gallons per minute. At Schleswigland there was a fixed underground fuelling system built by the *Luftwaffe*. The system was modified by the British Army to provide two rapid fuelling points which could load a Halton tanker aircraft in 12 to 14 minutes instead of the previous 20-25 minutes, which allowed more flights per day. In Berlin a new receiving system was installed at Gatow with five large tanks and 18 bays around a circular island in the middle of the airfield, complete with floodlight towers for night operations. The system was ready by March 1949 and could unload fourteen tanker aircraft simultaneously with two hoses attached to each aircraft — a far cry from manhandling heavy metal drums from the back of Dakotas and Yorks. Altogether by the end of the airlift the British civil aircraft had carried 147,727 short tons of supplies into Berlin. This represented just over 6% of the total tonnage lifted into Berlin. What this bare statistic does not reveal is the fact that the civilian tanker aircraft lifted in much of the liquid fuel carried to Berlin, amounting altogether to some 92,282 tons. By early 1949 every motor vehicle in West Berlin was running on fuel flown in by British civilian pilots, and for that alone they deserve great credit.

A civil Avro Lancastrian tanker aircraft of *Flight Refuelling Ltd* discharges fuel at RAF Gatow under the gaze of an armed sentry. In the background are two Avro Yorks of No 242 Squadron

By early 1949 every motor vehicle in West Berlin was running on fuel flown in by British civilian pilots

It was not only the delivery of fuel which became more sophisticated as time went on. Gradually as the RAF and USAF settled in to running the airlift they made significant improvements to the organisation and a semblance of order emerged from the initial chaos. The haste and frantic improvisation of the early weeks was replaced by a more thoughtful and professional approach. In the early days of the airlift the Dakotas had simply flown round trips as fast as they could be loaded and fuelled at one end and unloaded at the other. This was not the most efficient method of utilising the limited numbers of aircraft available. As there were eventually aircraft from several different organisations — the RAF, the USAF, the United States Navy and British civilian airlines — operating on the airlift, with, in the British case, several different types of aircraft, it became obvious that a single co-ordinating authority was necessary, and a Combined RAF/USAF Headquarters was formed in August, to be known as Combined Airlift Task Force [CALTF]. In October CALTF was formally instructed to fly "in a safe and efficient manner" the maximum possible tonnage to Berlin. The establishment of the HQ not only gave the airlift a more recognisable and permanent status and removed the notion that it was a temporary expedient, but also allowed the two air forces to plan a more rational use of their combined resources.

It is easy to forget that the air traffic control techniques and equipment available in 1948 were far less sophisticated than they are today. At the start of the airlift aircraft had flown to and from Berlin along the route of the nearest of the three available air corridors, but as the numbers of aircraft grew it was quickly decided that aircraft in the corridors should generally all be flying in the same direction to ensure safety. British aircraft therefore used the northern corridor to fly in to Berlin, and US aircraft used the southern corridor, both would then fly back out of Berlin using the central corridor. The different aircraft types added a further complicating factor, because they all flew at different speeds.

New techniques had to be developed to control the flow of aircraft. Particularly so after a bad scare in August when a heavy storm had caused chaos at Templehof, in which one aircraft had crashed, another burst its tyres avoiding the first and blocked the runway, and the following aircraft had to circle over Berlin at heights from 3,000 to 12,000 feet with increasingly anxious pilots jamming the radio waves trying to find out what was happening. Mercifully, General Tunner, the USAF General in command of CALTF was in one of the USAF C-54 aircraft trying to land. Quickly appreciating that a much greater disaster was imminent he came onto the radio and personally ordered the air traffic organisation to send all the aircraft over the city back to their home bases immediately. It was, of course, Friday the 13th.

The solution was to introduce a new pattern for the aircraft flying to Berlin. Any aircraft which arrived and found that it could not land for any reason was now instructed not to circle over Berlin but to rejoin the corridor and fly back to its home base with its cargo — there were to be no second attempts, pilots landed in Berlin the first time or not at all. The RAF made pilots who overshot fill in a form to explain why — completing bureaucratic exercises was every tired pilot's nightmare and they would do their utmost to avoid it. In one case a pilot, realising that his aircraft was too close to the aircraft landing in front and that he would have to overshoot, kept the wheels of his plane raised and when this set off a warning horn in the cockpit he placed his microphone next to it and pressed the transmit button. The pilot of the aircraft in front heard the horn in his earphones and, thinking it was his own undercarriage which had not lowered, overshot, allowing the resourceful interloper to land in his place.

After Friday the 13th it was clear that a new system was needed. The problem was simple: to find the best method of funnelling aircraft from several bases in Western Germany along the appropriate corridor and down on to the runways at Gatow and Templehof. The ideal solution of continuously despatching aircraft exactly to time was not practicable because, while RAF aircraft had their own navigator and special radar navigation equipment which meant they could keep precise times, USAF aircraft had less accurate equipment which was not accurate enough to allow precise timekeeping. When, in August, USAF C-54s were sent to the new British base at Fassberg to take advantage of

Air traffic control at Wunstorf – the duty air traffic controller, Flight Lieutenant Alan Hill and his assistant AC2 Alan George

the shorter distance to Berlin, the two air forces were forced to develop a common system to allow the USAF to operate from the British zone.

The solution was the block system. Each airlift station in Western Germany was allocated a specific time period when its aircraft were to be over the navigation beacon at the end of the air corridors. Each pilot had to arrive over the beacon within 30 seconds of his allotted time. Between the last aircraft of one block and the first aircraft of the next there was also a six minute safety gap, and between the aircraft in each block there was a three minute gap. Aircraft from each airlift base were also given a specific height to fly, so that all aircraft flying from Lubeck to Gatow flew at 5,500 feet, all aircraft flying from Wunstorf to Gatow flew at 3,500 feet, and so on. The first block system worked on a four hour cycle, which was the time taken by a USAF C-54, the aircraft with the biggest load carrying capacity, to complete a round trip to Berlin and be ready for the next.

The four-hour cycle resulted in long queues of aircraft with their engines running on the runways waiting to fill every slot in the block. This cycle was ideal for the American C-54, but was not suited to the British Yorks and Dakotas, which had different cycle times because they had longer distances to fly and they carried a much

Provided the weather was good, aircraft were landing every three minutes

higher proportion of awkward loads, which took longer to load and unload. There were times when British aircraft were kept idle because they could not be fitted into the four hour cycle, or because delays caused by weather or other problems meant that British aircraft would be held on the ground to allow the bigger C-54s to continue flying. In January 1949 the four-hour cycle was changed to a two-hour cycle and later a one-hour cycle, which made better use of all the available aircraft.

At the Berlin end aircraft were "talked down" on to the runway either by a controller in a van looking at a radar screen, or in good weather by the appropriate control tower. At the start of the operation the radar controllers, known as GCA [Ground Controlled Appraoch] were only able to cope with one aircraft every 10 to 15 minutes, but by increasing the numbers of controllers and radio frequencies, and by constant practice, this was reduced to a four minute interval. The pilots were instructed not to reply to the stream of instructions from the controller, but simply to obey them, if he heard no instruction from the controller for five seconds he was immediately to climb to 800 feet and return to the last navigation beacon and then ask for instructions.

An improved American radar was installed at Templehof later in the airlift, manned by US and British operators. This radar was able to pick up aircraft at longer range and tell aircraft to make adjustments to their height and speed very much earlier. At the peak of the airlift in good weather an aircraft would land and roll to the end of the runway, as it turned off the runway another aircraft would start its take off run from the other end, and as that aircraft's wheels left the runway another aircraft would be on its final approach to land. In this way, provided the weather was good, aircraft were landing every three minutes. In poor weather the British could also use equipment called Beam Approach Beacon System, which allowed them to land more quickly at Gatow in bad weather than the C-54s. With the block system, however, it was often the C-54s which continued to fly if the weather was bad.

There was also a difference of approach and opinion between the British and Americans about flying goods out of Berlin on the return journeys. It was obviously easier to fly a greater tonnage into Berlin if aircraft returned from the city as soon as they had unloaded, rather than spending time waiting and loading export goods. The Americans were reluctant to fly goods out for this reason, and a large backlog built up at Templehof, amounting to some 419,931 kg by October. The British, on the other hand, reasoned that if the products of Berlin's industry, such as Siemens' light bulbs, were not flown out, then the firms manufacturing them would close and the workers would lose their jobs, which could only be to the advantage of the Soviets. The British were therefore committed to flying goods out of Berlin as well as in, and eventually took over responsibility from the Americans for flying out all the goods previously taken to Templehof.

In all, British aircraft flew 35,843 tons of goods, mostly mail and industrial products, out of Berlin. The same reasoning applied to passengers. The Americans limited the numbers of passengers they would carry back from Berlin. The British decided that flying out numbers of the very young, the sick, and the elderly would reduce the burden on the city authorities and the airlift. They therefore flew out of the city 131,436 people, whereas the US figure was only 36,584. This occasionally led to problems of one sort or another. One old lady was lifted gently into the back of a York at Gatow at 4 o'clock one morning and settled as comfortably as possible amongst some mail sacks. The weather was very bad and the flight was uncomfortable and not without some heart stopping moments. The old lady, however, made no complaint about the dark and bumpy trip, and was lifted safely to the ground at Wunstorf. There she took one look at the three-ton military truck which was to take her to Hannover, and refused to board it because it looked too dangerous!

As the airlift expanded and the numbers of aircraft multiplied it quickly became clear that the original three airfields in the Western Zone, Wunstorf, Rhein-Main and Weisbaden, would not be adequate. As the northern air corridor to Berlin from the British Zone was shorter it allowed a greater number of flights per day, and it was quickly

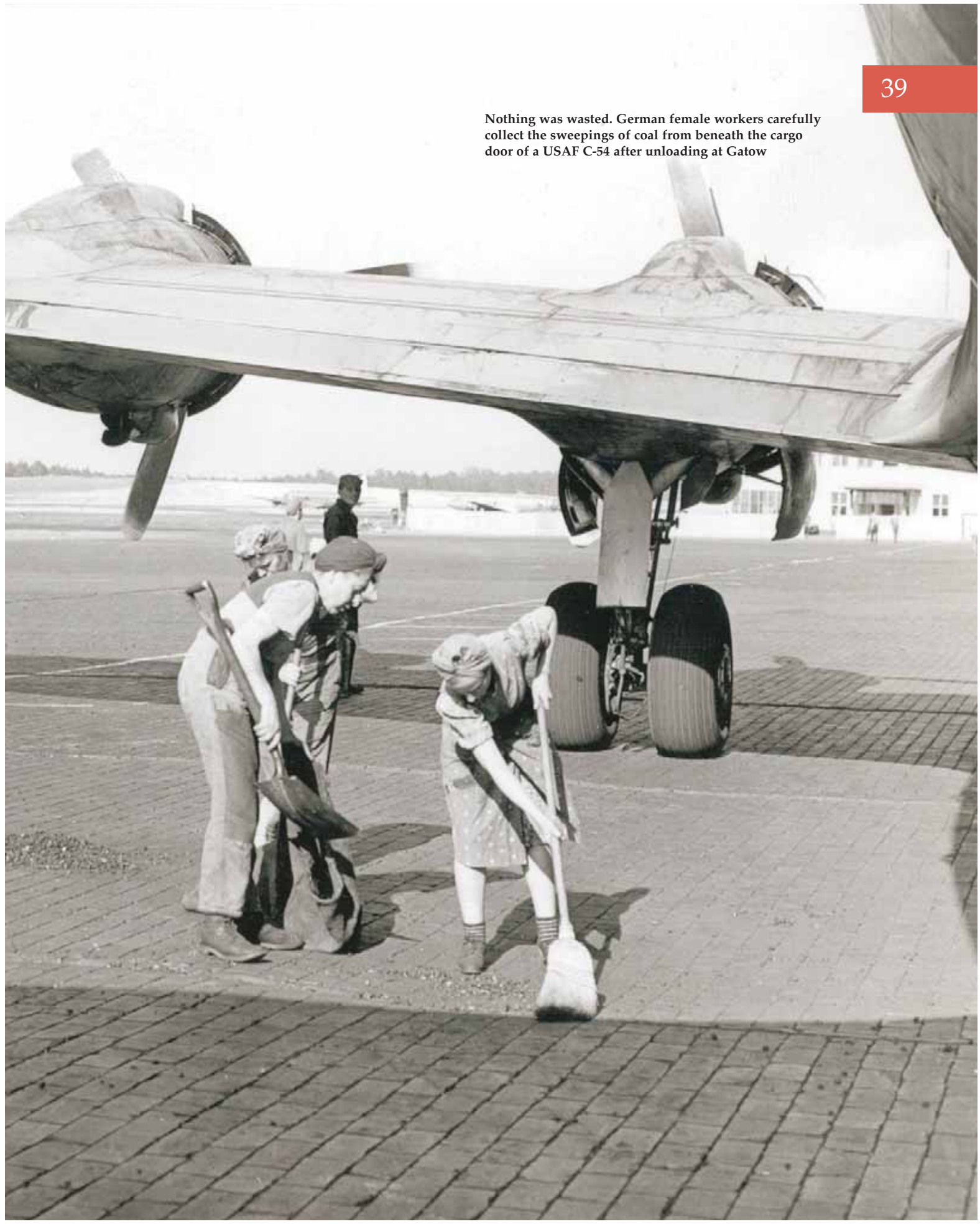
The flight was uncomfortable and not without some heart stopping moments

decided to expand the number of airfields in the British Zone to accommodate both British and American aircraft. The old *Luftwaffe* airfield at Fassberg was opened up and within two weeks the railway and runways were repaired. RAF and British Army engineers and local German labour constructed a new loading area of 140,000 sq m from Pierced Steel Planking [PSP] in just four weeks; built a new 1.4 km road in just 10 days; laid a 10-cm thick 176,000 sq m tarmac apron in front of the hangars; put down 8 km of railway sidings, and installed airfield lighting and built accommodation blocks for 3,000 extra people. Even so the American Air Force personnel who moved in to Fassberg in August were used to greater luxury and, far from impressed, believed that they must have been sent there as a punishment! Their feelings were, however, somewhat mollified when the new USAF commander arrived with his wife, who turned out to be a famous and spirited film actress of the day with a talent for making life more fun for those around her.

The RAF also renovated and rebuilt the airfield at Celle for the USAF in just three months starting in September: including building a new 5,400 ft tarmac runway, and 150,000 sq m loading and maintenance area. Three months later the first American C-54s arrived at Celle and on 16 December they flew their first mission to Berlin. Similar improvements were made to the airfields at Wunstorf, Lubeck, Schleswigland, Fuhlsbuttel and of course Gatow.

How great was the achievement of the Royal Air Force and British civilian aircrews in the Berlin Airlift? Of the 2,325,808.7 short tons lifted into Berlin British aircraft carried 542,236 tons, or just over 23 per cent of the total. This bare statistic does not, however, tell the whole story. Sixty-eight per cent of the tonnage flown to Berlin was coal, which, once some experience had been gained, was relatively easy to handle since it came in standard weight sacks which could then be assembled into standard aircraft loads on the ground. It was decided to concentrate the American C-54s, which could carry standard ten ton loads, to lift most of the coal — the British lifted only 164,800 tons. As priority in the block system was given to the larger C-54s, and as the handling of standard loads such as coal made their turn round time quicker the statistics make the US aircraft appear more efficient in overall terms at the expense of the RAF. In fact this was not entirely true; although USAF C-54s could carry larger loads, and had better reliability because the Americans had more groundcrews per aircraft, it was also because the British aircraft concentrated on handling the more awkward loads, which took longer to load and unload, thus reducing the number of flights the aircraft could make in a day.

This, combined with the willingness to fly passengers and freight out of Berlin, inevitably meant that the British tonnage flown into Berlin was less than it could have been in comparison with the Americans. Next to coal the largest tonnage was food. Here the British achievement was comparatively much greater, with 241,712.9 tons out of a combined total of 538,016 tons, which means that nearly 45 per cent of the food taken into Berlin was flown in British aircraft. We have already seen how British civilian aircraft lifted the majority of the liquid fuel [92,000 tons]. In all British aircraft flew over 175,000 trips to and from Berlin, or 31 per cent of the combined airlift total. They spent over 210,000 hours in the air, the equivalent of 24 man years, and flew over 30 million miles, which equates to flying to the moon and back 63 times. By October the daily running cost of the airlift was over £25,000 per day at 1948 prices, a figure which did not include the cost of improving and expanding the airfields. Britain's commitment to overcoming the blockade is illustrated by the diversion of grain ships from British to German ports, which resulted in the introduction



Nothing was wasted. German female workers carefully collect the sweepings of coal from beneath the cargo door of a USAF C-54 after unloading at Gatow

of bread rationing in Britain. Bread had not been rationed in Britain even at the height of the Second World War. The sacrifice made by British civilians in foregoing their daily bread, however, cannot compare with the sacrifices made by the aircrews and the people of Berlin. Flying round the clock on the airlift in all weathers with the aircraft and equipment available at the time was an arduous, dangerous and demanding task. Inevitably, there were accidents. Altogether 18 RAF airmen and 21 civilian airmen were killed in accidents of one sort or another — 39 deaths to preserve the freedom of Berliners to choose their own way of life.

Ultimately, however, it was the Berliners themselves, in concert with the airmen, who had defeated the Russians. As General Robertson had written in April 1948 "So long as the majority of the Berlin population remain firm in opposition to the Communists the Russians will not get their way".

By their willingness to survive on a diet of dehydrated potato, and to endure 20 hours a day without light and with precious little heat, the citizens of Berlin, inspired by the airlift, ensured that the Russians lost the first major battle of the Cold War. On 12 May 1949 the Russians lifted the blockade.

Flour supplies ready for unloading

In Berlin even the construction plant to make improvements to the airfields had to be flown in. A steamroller is unloaded by crane through the rear door of an Avro York at Gatow

The Allied airlift continued both to ensure that the city was well stocked should the blockade suddenly be reimposed, and to demonstrate to the Russians that the Allies remained as determined as ever. The last British flight of the airlift took place on 6 November. The Russians "mischevious device" had indeed been defeated. It seems appropriate to end this account with an example of the humour which exemplified the spirit of the Berliners during the blockade. When contemplating the difficulty of living in a blockaded city one Berliner turned to another and said "Aren't we lucky. Think what things would be like if the Allies were blockading us and the Russians were running the airlift".

Food stockpiles in the Western Zone awaiting shipment to Berlin

SOME AIRLIFT FACTS AND FIGURES

Tonnage lifted to Berlin by British aircraft

RAF aircraft	394,509 Tons
Civil aircraft	147,727 Tons
TOTAL	542,236 Tons

Tonnage lifted to Berlin by USAF aircraft
1,783,572.7 Tons

Total combined British and American airlift tonnage
2,325,808.7 Tons

Tonnage by type

	BRITISH	**USAF**
Food	241,712.9 Tons	296,303.1 Tons
Coal	164,799.7 Tons	1,421,729.6 Tons
Military	18,239.1 Tons }	
Liquid fuel	92,282.4 Tons }	65,540 Tons
Miscellaneous	25,201.9 Tons }	

British tonnage exported from Berlin
35,843.1 Tons

Passengers lifted to and from Berlin

	TO	**FROM**
British	36,218	131,436
American	24,216	36,584
TOTAL	60,434	168,020

Highest daily combined British and American tonnage
12,940.9 Tons on 16 April 1949

Highest daily British tonnage
2,314.5 Tons on 5 July 1949

Highest daily RAF tonnage
1,735.6 Tons on 17 August 1948

Highest daily British civil tonnage
1,009.6 Tons on 22 May 1949

British aircraft consumed over 35 million gallons of aviation fuel, flew more than 30 million miles, and spent more than 200,000 hours in the air flying to and from Berlin.

RAF Tornado GR1 aircraft armed with ALARM anti-radar missiles which form the primary SEAD weapon in UK service

Preparing the Way for Cooperation in European Air Power

By Flt Lt David Tucker

"Dealing with the enemy is a simple matter when contrasted with securing the close co-operation of an ally."
(Major General Fox Connor, 1918.[1])

In the St Malo declaration of 1999 Tony Blair and Jacques Chirac, the British and French political leaders, set forth their vision of European Defence cooperation that would undoubtedly lead to closer working relationships between Europe's armed forces. This was true regardless of whether one subscribed to the French view of a European Defence that would eventually supersede NATO in its role of collective defence for Europe, or the British view of a strengthened European pillar within NATO that would reinforce the Atlantic Alliance.

Following the decision by Europe's two leading military powers to increase defence cooperation the MoD began, slowly, to look at ways in which cooperation could be effected. An example was the proposal by British Defence Secretary Geoff Hoon that the RAF and German Luftwaffe (Lw) cooperate more closely in the SEAD role, a decisive area

Much has been made of the divisions between the USA and Europe over policy on Iraq, but in truth there were deep divisions within Europe

where Europe lacked (and still lacks) a credible capability, but where the UK and Germany had more capability than many other European forces.

Those idealistic days with announcements of cooperative exercises and the creation of frameworks for joint exercises now seem far off indeed. The war against Iraq in the spring of 2003 drove a rift between the most powerful military nations in Europe. Much has been made of the divisions between the USA and Europe over policy on Iraq, but in truth there were deep divisions within Europe. For any meaningful European Defence and Security Policy (ESDP) to succeed, the UK and France must work as partners for it. Additionally, Germany and Italy must be on board, as the other major military powers within the EU. Yet during the war on Iraq, the UK and Italy were America's strongest supporters. The voices against the war were led by France, with Germany playing a leading supporting role.

This essay does not cover in detail the political reasons behind the various states' reasons for choosing the sides that they did. Suffice it to say that various national agenda had an influence on the decisions taken. However, it is timely to examine what effect these rifts, among other factors, have had on ESDP, and particularly in the field of air power cooperation. Furthermore, European defence cooperation and integration is about more than air power; land and sea cooperation are also important. However, for reasons that will be discussed later, air power does have a stronger tradition of international cooperation, with more interface between air forces than other services. Air power thus lends itself well to a study for integration.

The argument for closer European cooperation
As recently as 2001, Wing Commander Kevin Baldwin argued that too much emphasis by the European states on developing their own organic airpower could lead to a greater US isolationism[2]. However, he could not have foreseen the terrorist attacks on the USA in September of that year which hastened changes in policy that were to be expected from the new Bush administration. In the mid 1990s, neo-conservatives in the USA had been urging for a more unilateralist policy from the USA. It is a matter of history that their influence with the administration has brought about this effect. The corollary is that the USA is now more committed worldwide than it was three years ago, and is feeling the effects of overstretch. This, when the US Senate had been reluctant to commit forces to Bosnia in the mid-1990s because they were already feeling overstretched as the 'world's policeman' despite far lower operational commitments than today. Thus, if another crisis like the Balkans were to occur, in Europe's backyard so to speak, while the US is so committed elsewhere, the Americans may well be less inclined to step in and assist the Europeans. Thus, they would be *de facto* more isolationist, and Europe may per force need to sort out its own problems.

KFOR troops enter Kosovo

The 1990s saw western military forces deployed on a greater variety of diverse operations than at any time during the Cold War

The rift caused by differences of opinion over policy towards Iraq has already been mentioned, and is well documented elsewhere. Strong feelings

emerged and some perhaps rather injudicious language was used between the supporters and opponents of US policy. Some commentators predicted the demise of NATO over the affair; it certainly seemed to herald problems for European defence cooperation. However, in the midst of all this, Tony Blair met Jacques Chirac at Le Touquet, and the two leaders agreed further progress towards an ESDP. The fact was that Europe's problems with respect to defence and the reasons behind moves towards an ESDP in the first place were still there. Some form of defence reform was and still is required in Europe.

The 1990s saw western military forces deployed on a greater variety of diverse operations than at any time during the Cold War.[3] Defence policy now meant defence and security policy, particularly with regard to terrorist threats. Thus, the "problems of energy, resources, environment, population, the issues of space and the seas now rank with the questions of military security, ideology and territorial rivalry which have traditionally made up the diplomatic agenda."[4] This also raises the question of asymmetric threats to national security, and this is an area in which European security cooperation is imperative. Terrorists do not respect national boundaries. Further, it has been suggested that this is an area that would respond well to 'soft security', one of Europe's areas of relative strength.

Some effort was expended in deciding whether an extant organization should assume responsibility for European defence, be it NATO, the OSCE or the Western European Union (WEU). Although it is not strictly true to say that the WEU has been completely subsumed by the EU, all its roles important to the context of this essay have been taken over by the latter. To that end, for the purposes of this work the WEU will be regarded as subordinate to the EU; additionally, it was decided that the EU should assume a role in the defence and security of Europe, whether in partnership with or independent from NATO.

The French vision of a future European defence capability is of a pure European organism, outside NATO. The British however, insist on any developments strengthening NATO's role, with ESDP separable, but not separate, from NATO. There are sound reasons for this: the first major post-Cold war conflict, which was also a noted success, "the Gulf War, while not a NATO operation, was conducted by an *ad hoc* coalition drawn for the most part from NATO members. It was conducted using NATO procedures with forces drawn from NATO nations."[5]

It is also easy to understand the French position. Their semi-detached relationship with NATO led to a number of interoperability problems during the conflict, which reduced their overall effectiveness. This in turn led to greater cooperation between France and the rest of NATO during the mid 1990s. Indeed, many commentators hoped to see France's return to NATO's integrated military structure. However, this new closeness did not bring the increase in political influence within NATO that France's political leadership had hoped for, and France has returned very much to a cool relationship with the alliance.

The USA, of course, has an interest in the way any future European defence capability develops. It would prefer to see a stronger European contribution to NATO, with a Europe broadly supportive of US policy. However, the USA would be reluctant to give up its pre-eminent role in the alliance, and therein lies the rub. Many European contributors to the Atlantic alliance would demand a greater influence as a *quid pro quo* for a greater contribution. The question is, how much would each side be prepared to compromise to reach an arrangement? In sum, the "US appears to want to encourage the development of a European subordinate, while many EU countries, such as France, desire Europe to become an equal partner."[6]

A very interesting factor in influencing which developmental path European defence integration will take will be Germany's attitude. While Britain and France are unquestionably the leading actors in European defence, and the absence of either from an ESDP would destroy its credibility, the position of Germany is also important. Germany has the largest economy in Europe, and since the end of the Cold War has slowly but steadily begun to exercise political influence more proportional to this. Germany has begun to rediscover a 'National

During the run-up to the recent war with Iraq, Germany sided unequivocally with France in opposition to military action. This was a source of some chagrin to the USA

Interest', which for so long she buried in European Interest. She also has large, well-trained armed forces, albeit still retaining too much of a Cold War posture.

Throughout the Cold War Germany was one of NATO's staunchest members. The conditions of re-armament that led to the formation of the *Bundeswehr* (Bw) in 1955 meant that Germany's armed forces were more integrated into the NATO command structure than any others. The culture within the Bw still places value upon NATO membership; NATO appointments are still held in high regard by the German military. However, since the end of the Cold War, Germany has shown a new self-confidence in foreign affairs. Perhaps the first indicator of this was Helmut Kohl's insistence upon recognising Slovenia and Croatia in 1991, effectively forcing the rest of the EU to follow suit. During the run-up to the recent war with Iraq, Germany sided unequivocally with France in opposition to military action. This was a source of some chagrin to the USA; George Bush Senior had spoken of Germany as a strategic partner to the USA, yet here was Germany firmly in the 'axis of weasels'.

But it would be wrong to assume that Germany has irreversibly chosen to side with France over ESDP. Germany has more interest in a widening of the European Union than France and has been a consistent supporter of NATO, despite French efforts at various times to tempt her out of the Integrated Command Structure. The reasons for German opposition to war in Iraq are political and populist, and are beyond the scope of this essay. However, since the end of hostilities in Iraq Germany has shown numerous signs of wishing to mend fences. Germany has been instrumental in the wake of the recent meetings with France, Belgium and Luxembourg, aimed at developing an independent ESDP (France's vision), in ensuring that ensuing declarations were written so as not to offend Britain and America and to avoid irrevocably damaging Germany's relationship with NATO. This has coincided with the resumption of

If Germany decides to throw in her lot with France, it will probably spell the end for NATO as an effective alliance, splitting the European and Atlanticist camps

NATO E-3 Sentry

Europe has been shown to be good at politically supporting alliance campaigns but to have little meaningful to contribute to an offensive air campaign

American Air Power, US F/A-18 Super Hornets

high-level contacts between Berlin and Washington.[7] It is widely predicted that Germany will increasingly set the European agenda in the coming years; with the largest population in the EU and with the centre of political gravity moving Eastwards (with the Eastern expansion of both NATO and the EU) placing Germany more and more at the heart of Europe, this remains a likely scenario.[8] It seems reasonable to assume that, as often before, Germany has kept her options open on ESDP. If Germany decides to throw in her lot with France, it will probably spell the end for NATO as an effective alliance, splitting the European and Atlanticist camps. If she throws her Strategic weight behind Britain's vision of a strengthened European arm of NATO, the Alliance will be strengthened, and it will likely lead to France once again coming on board with this vision. The signs are that the politicians of Europe's three main players have some delicate work to do in their relationships with each other.

As Baldwin notes, the UK and France are the only military actors in Europe to have maintained anything approaching a full spectrum of Air Power capabilities.[9] Thus, it would be foolish to suggest that any cooperative European Air Power enterprise could credibly proceed without the full participation of these states. This means that the RAF ought to be involved at all levels from the beginning. This is the only way to ensure that it develops to our liking, that it gives an out-of-area capability that we perceive as necessary, that doctrinally it fits with our doctrine; in short that it provides an alliance that we should be happy to go to war with. If we do not take every opportunity to be involved, there is a danger that it will be developed without us and future political decisions could force us into an institution that we do not like. "It would be a tragic mistake — repeating mistakes of British European policy over the past few decades — if Britain opted out of the debate on European defence and left the field to others. This is a debate that we must shape and influence from the start, because our vital strategic interests are affected by it.'[10]

At the same time, the UK needs to adjust its attitude. Yes, we do have a special relationship with the US. Yes, we have a habit of working closely with the USAF. But interests are diverging. The time may come when we have to work with other EU states in defence and security of Europe. We *are* EU's most effective military nation but this does not excuse what seems to be an all-too-prevalent attitude that we have nothing to learn from other European forces. This is *wrong*, particularly in areas where they have specialized: the UK does not hold a monopoly on good military ideas. Furthermore, our position of primacy is not a given. Without adequate funding, sensible structuring, sufficient training and perceptive planning, Britain's armed forces cannot remain the paragon they are. However, by remaining engaged in the European defence debate we can steer developments in the right direction.

As to concerns voiced by some that an increase in Europe's own capability would distance us from the US and reduce the US commitment in Europe,

that will rather depend on the nature of that capability. There was a marked increase in approval in Washington for such a scheme after the UK became a leading proponent with the Blair-Chirac St Malo declaration. It is therefore likely to receive greater support if the UK, the most naturally atlanticist nation in Europe, remains closely involved.

As for concerns about reduced US commitment to Europe, this is a *fait accompli* with the US focus elsewhere in the World. With their ongoing operations, and less in Europe, they cannot be as committed in absolute terms to European security as before; therefore the Europeans must be prepared to take on more of that burden. Europe has been shown to be good at politically supporting alliance campaigns but to have little meaningful to contribute to an offensive air campaign.[11]

So what does this mean when, as in the most recent Gulf Conflict, the political support is not even cast iron? It probably means an increased American willingness to go it alone and therefore reluctance to support operations that it sees as a European problem such as the next Balkans-type conflict, and therefore a need for a greater European ability to work together without relying quite so heavily on US support.

Much has been made of the capabilities gap that exists between the US and the European air forces within NATO. This was highlighted in operation ENDURING FREEDOM and the USA's desire to go it alone in Afghanistan. Many consider that NATO was snubbed by America after September 11th.[12] Whatever the truth, it remains a likely scenario that European forces may have to operate together in future at best with a semi-detached relationship with the USA in operations where their capabilities have become incompatible, even if European states do raise their defence spending sufficiently to close the capabilities gap somewhat.

It remains a likely scenario that European forces may have to operate together in future at best with a semi-detached relationship with the USA

To that end, while we in Britain may rightly desire to retain our prized interoperability with US forces as far as possible it is also incumbent upon us to increase our interoperability with our European allies. More importantly, they must improve their interoperability with US forces that will improve their interoperability with us by default. However unlikely, it is not inconceivable that European forces may have to go into action without US support in the future. With US forces already so heavily committed worldwide, there may be a scenario in which the military instrument may need to be used, perhaps for example, in Africa

Lord Robertson of Port Ellen, outgoing NATO Secretary General, highlighted the need for NATO governments to transform their armies into modern, rapid-reaction forces or face oblivion

where it is deemed necessary for the European allies to conduct an operation themselves.

The weaknesses in NATO's European arm were highlighted by the war in Kosovo. The Anglo-Italian declaration of July 1999 drew the lesson from those experiences that there was a need for a more effective European role in NATO.[13] Speaking at a recent meeting of NATO defence ministers, Lord Robertson of Port Ellen, outgoing NATO Secretary General, highlighted the need for NATO governments to "transform their armies into modern, rapid-reaction forces or face oblivion".[14]

But it is not merely a question of amount spent on defence. One of the problems for Europe, whether defined as European NATO or the EU is that we do not achieve the same order of military effectiveness from our defence budgets as do the Americans. Despite the new emphasis on expeditionary warfare, European states still field too many standing forces with a territorial defence posture. Given the economic problems that beset most of continental Europe at this time we are unlikely to see the increase in defence expenditure that would be required to push European capabilities towards America's.

This means that European forces must restructure to get a greater return for the money invested in them. Over the past 5 years The USA has spent 3-4% of its GDP on defence. The European average has been 2-3%. Since the GDPs in this period have been comparable (taking the EU GDP as a whole), Europe is not so far behind the USA. But its capability in all military fields lags badly. This is as a result of too much emphasis on maintaining large standing armies and Cold War structures. Change has begun and this is a step in the right direction, but the only answer to get better value from European defence expenditure is to restructure, reduce duplication and improve integration to ensure that money is better spent. Commentators in the USA have observed that the level of European spending and size of European forces is not, in and of itself, the problem. It is how the money is spent and the structure of those forces — two related subjects — that leads to the European reduced capability.

Dr David Gates touches upon the problems raised by the capabilities gap. "Without the active participation of the USAF and other American units, operations of the scale and complexity of Instant Thunder, Deliberate Force and Allied Force would have been utterly impracticable . . . As a result even some NATO air forces might yet conclude that role specialisation constitutes the only way out of the dilemma of trying to keep abreast of their putative partners."[15] The problems with niche roles and role specialisation are manifest. Certainly, from a British point of view, it would be undesirable to give up a capability in case the putative ally with that capability elected not to take part in a conflict to which we were committed.[16] Once a national capability is lost it is difficult to restore.

This does not alter the fact that when an allied nation does elect to join a conflict it may well be desirable politically as well as in terms of burden sharing to hand over to them a particular role in which they have specialisation. However, too much pooling of resources and role specialisation would inevitably lead to a greater loss of national sovereignty than would currently be acceptable to most European states.

As Dr Christina Goulter has it, "in an uncertain world, which is increasingly dangerous, flexibility comes from having a full spectrum of capabilities, unless you are very certain of your alliance partners and their ability to assist you".[17] This is supported by the preparatory work for the UK's SDR. In considering the nature of the UK's air power structure with regard to potential threats, the "SDR concludes that a balanced force, similar to the present forces structure, is required to meet these contingencies".[18] However, there remains the possibility of making savings by pooling of aircraft into a multinational force. Garden states that, in the near term, "it would be much more productive to look for opportunities to rationalise forces in being which can be operated more efficiently on a multilateral or EU-wide basis".[19] Baldwin also strongly supports a high level of 'pooling of forces' and argues that, at a national level, this could lead to efficiency savings and reduced overstretch for the RAF.[20]

Europe needs to field a 50% increase in all-weather capable bombing aircraft. . . With the widespread introduction of Typhoon in Europe it is questionable whether the European air forces are moving in the right direction

Clearly, to improve the European capability without an increase in defence budget it will be necessary to cooperate more closely and reduce duplication, thus improving the value obtained. In the EU Summit in Helsinki in 1999 the EU member states reaffirmed their commitment to meeting the headline goal of fulfilling the full range of Petersberg tasks set out in the Amsterdam Treaty.[21] This would include cooperating in EU led operations up to Corps level. This will lead to some level of role specialisation, and will require close coordination at a European level, something which, at the moment, could prove politically difficult to achieve. But such an aim was identified in the *Supporting Essays of the UK's Strategic Defence Review*: "Britain will usually be working as part of a NATO, UN or Western European Union (WEU) force, or an ad hoc 'coalition of the willing'. This means that we [the UK] do not need to hold sufficient national (*their emphasis*) capabilities for every eventuality".[22]

Examining the campaign in Kosovo as a model for a possible future European military engagement, Sir Timothy Garden argues that Europe needs to field a 50% increase in all-weather capable bombing aircraft, with a commensurate reduction in air defence aircraft. With the widespread introduction of Typhoon in Europe it is questionable whether the European air forces are moving in the right direction. Germany, in particular, plans to replace most of its all-weather capable Tornado IDS force with the Typhoon, leaving the Tornado occupying only the specialist roles of tactical reconnaissance and SEAD.

Of course, a major obstacle to the integration of any military power in Europe is the question of efficacy. As the allied operations in the Balkans have amply demonstrated, the threat and use of the military instrument is only effective if clear leadership is demonstrated, in this case by the USA. If the USA is absent and an EU-led operation is to be embarked upon, the question will inevitably arise as to who will lead it. Once integration has been achieved, the institutions will presumably exist to provide this leadership. But there is a suspicion that it will be uphill struggle persuading the leading military powers in NATO of the value of integration until they are convinced that the operational efficiency of such an integrated force will be at least as successful — with no questions over leadership or command and control — as their own national effort or *ad hoc* coalitions may be. However, it will be well nigh impossible to guarantee the effectiveness of any leadership function within the EU or even European NATO as long as both bodies rely on consensus or consensus minus-1 politics, giving every member a potential veto for every decision. Yet the prospect of the adoption of even qualified majority voting for foreign policy and defence related matters looks as distant as ever. As Cottey states, "the reality is that European states' views often diverge, and rarely is any single European state powerful enough to provide strong policy leadership alone".[23]

With the impending increase in membership of both the EU and NATO, and the USA's increased worldwide commitments, not only does the like lihood of an EU-led operation increase, but so does the need for an increase both in European military capabilities and institutional capabilities to provide a leadership function. All of this will be unachievable without some progress towards integration, particularly in C3 functions. A possible paradigm for the cooperation of European states in the projection of air power is provided by NATO's Combined Joint Task Force (CJTF) concept. The C2 aspects of the CJTF certainly offer a starting model for command and control of air assets in a future European-led air campaign. And, as Booth states, "military capabilities, doctrines and postures should be so organized as to maximise mutual rather than unilateral security".[24]

Another frequently rehearsed argument against any integration of European forces is that of the possibility of some member states choosing not to participate in an operation. Just because the whole of the EU cannot be guaranteed to participate in a future operation is no reason not to form an integrated command capability. The widely acknowledged successful cooperation in the Gulf War in 1991 was largely due to the principle coalition members' experiences as NATO partners. Although the 1991 Gulf War was not itself a NATO operation, NATO procedures were used, and the NATO partners had well-established ways of working together.

France found difficulties in operating with coalition forces largely due to its semi-detached relationship with NATO.[25] Baldwin touches upon the dangers of spreading assets too thinly[26] and of assigning assets to an alliance commitment but using them for national purposes. By increasing the effectiveness of the European arm of the alliance, we can have more confidence in our partners, yet by maintaining the vital core roles defined in national policy we achieve the symbiosis of a better national capability, as discussed at the beginning of the next section.

With the growing US security concerns outside Europe, "some US analysts suggested that . . . the US would gradually withdraw from Europe, where its interests were less direct".[27] Similarly, with a combined EU economy close to, or larger than, America's in the near future, it would be surprising if calls from Capitol Hill for the Europeans to take more responsibility for security in their own area did not increase in frequency and volume.

The European States probably lack the political will at present to form a coherent Europe wide defence, but this is not to say this will never happen. Monetary Union was supposed to take place in 1980; in reality it happened in 2002. We must prepare for all eventualities so that should the political will for a European defence be forthcoming, we are ready to exploit it in air power terms. There is no period of grace in defence and security.

Air forces are already better harmonised and have more experience of operating in combined forces than most land or maritime forces. Air power is inherently joint, combined and multinational in nature

The air power context
Why integration in air power? Air forces are already better harmonised and have more experience of operating in combined forces than most land or maritime forces.[28] Air power is inherently joint, combined and multinational in nature.[29] In addition, English as the *lingua franca* of the air makes communication between air power partners inherently easy. Thus, air power is already at an advantage when it comes to combined or multinational operations.

At a tactical level, some RAF units have taken advantage of this for valuable training. Returning to the example of SEAD cooperation, the ALARM-equipped Tornado GR1/4 squadrons organised their own joint exercises with the Lw Tornado ECR wing at Lechfeld. More recently, the newly conceived (E)F-3s Have carried out valuable training in the same location. The F3 crews were new to the SEAD role and the training was particularly useful in providing an increase in their corporate knowledge. Thus, value was added for individual air forces as well as improvements for cooperation.

In addition, there are definite synergistic effects to be had by combining the different capabilities of European air forces in specialist roles.[30] "Training and exercises can help expose comparative strengths and weaknesses and allow air planners to build a realistic database for potential coalition partners".[31] With financial pressures, it is likely to become necessary to integrate EU air power capabilities in some areas, particularly the more expensive, more specialized roles, such as EW.

Programmes such as the NATO Tactical Leadership Programme (TLP), TACEVAL and NATO exchange programmes have assumed a new importance with respect to the building of this corporate knowledge. With the closure of RAF Brüggen there is no longer an operational RAF presence in continental Europe. There is a very real danger of us forgetting valuable lessons previously learned with the concomitant reduction in operating with European air forces. When the RAF had an operational presence in continental Europe there was a number of joint exercises with other air forces, some set up on an *ad hoc* basis, others more formalized.

An example of the latter was Exercise GARLIC LEMON, which allowed Brüggen-based Tornadoes to carry out regular fighter affiliation with French Air Force Mirages in France. This long-running exercise led to Brüggen aircraft being invited to participate in other exercises, such as the French Voltac series. Other opportunities for interaction with European Air Forces occurred during regular detachments to venues such as Decimomannu and Goose Bay. Unfortunately these opportunities have slowly diminished and with them our chances to work with other European Air Forces.

Nor should we underestimate the value of the professional contacts made between Air Force Officers in these multinational environments. In a number of recent coalition air operations, relationships forged between senior commanders during such contacts have been cited as being of great assistance in the smooth running of campaign planning for such operations.[32]

The reduction in interaction with other air forces can seem insidious. The experience of the Canadian Air Forces bears examination. During the Cold War, the Canadian Air Force maintained an operational presence in Germany at Baden Sollingen. With the end of the Cold War, Canada withdrew its forces from Europe maintaining only a few staff posts in NATO headquarters and exchange officers. According to a senior Canadian Air Force Officer this has led to a loss of some capability by Canadian fighter pilots. The valuable experience of operating in other airspace and an unfamiliar environment was so sorely missed that Canadian Squadrons have begun, at a squadron level, to organize participation in European-based exercises, such as 416 Squadron's participation in 2003's Exercise Central Enterprise. Beside the value of taking part in the exercise itself, the process of deploying the aircraft and personnel to Europe was invaluable in relation to today's expeditionary warfare.[33]

As air forces, we are good at organizing things at a tactical level: however, more needs to be done at the operational level. Many of the most valuable combined training opportunities have been organised by individual wings or squadrons. While such initiatives are to be prized and encouraged, it would be of use for such exercises to be organized more 'top down' by higher formations. This would also give the higher formations valuable experience of working with other European air force command structures. Institutions such as the European Air Group are all well and good, but

The valuable experience of operating in other airspace and an unfamiliar environment was so sorely missed that Canadian Squadrons have begun, at a squadron level, to organize participation in European-based exercises, such as 416 Squadron's participation in 2003's Exercise Central Enterprise

we see little output from them at a squadron level. Perhaps too few operators are aware of the existence of such formations: these structures should be used to aid European air force interoperability.

The RAF should exploit every opportunity to be involved in TLP (described as a "particular nugget for the subsequent development of NATO tactical concepts"[34]), Central Enterprise, ELITE and so forth. "TLP is a success story and has greatly assisted a wider understanding of the true meaning of interoperability leading to the development of credible and achievable NATO COMAO[35] procedures".[36]

The future for military aviators in Europe

The European air forces desperately need to invest more in precision attack munitions, communications and deployability. But within this, interoperability must remain a key theme. At present, the signs of this are less than encouraging. The Tornado forces in Europe are diverging. The software technology used by the Tornadoes of Britain, Germany and Italy are now very different from one another. They are, in fact, incompatible, to the extent that a British aircraft, say, operating from a Lw base could no longer use the host nation mission planning aids, as was the case just five years ago.

Tactics have evolved differently as well. These changes were partly the cause of, but have been exacerbated by, the closure of the Tri-national Tornado Training Establishment — the very type of pooling of assets and combined training advocated by Garden. It is also likely that the Typhoons purchased around Europe will have differing capabilities. Indeed, the capabilities of the German Eurofighters will likely be very different to those of the RAF, with different role equipment and, potentially, different armaments.

Garden proposes a pooling of some aspects of Typhoon operations[37] yet the opposite seems to be the current trend. From its beginnings as a joint venture, differences have appeared in the designs of the various Typhoons to be adopted by the European nations, as discussed, to the point where interoperability becomes increasingly challenging. But the story is not entirely bleak. In fact, the RAF could take a European lead in developing interoperability. With the various UK joint doctrine publications already extant, the UK "is in a strong position to influence NATO partners and others".[38]

Political decisions will drive the moves to closer European military cooperation more than military ones. The whole European project has been propelled primarily by politics. This means that political calls for closer cooperation may come at a time less than optimum militarily. Nevertheless, as servants of our political masters we military men must give them our best advice, but must ultimately bend to their will. It is therefore incumbent upon us to work to make any such venture a success. The tightening of ties between the European militaries is inevitability. The only question is when. It would be therefore wise to prepare for it now. Professor Michael Clarke's assertion that "political commitment is more volatile in the present era"[39] remains valid.

In sum, we must be prepared for likely and unlikely scenarios. To quote an RAF front-line squadron commander: "Interoperability is not a problem — we can do that. The problem is getting the politicians to define a strategic goal so that we can shape our forces. We can do that nationally, but the question is, can we do it in a European context?" Whatever the politics, we in the military should prepare for closer cooperation in the future. This means training together, planning together and developing working relationships with those whom we may be called upon to support or who may be supporting us. This is the only way to find out about whom you are working with and to have an idea about their capabilities. Specialization nationally can improve European capabilities, but exercising together can improve individual capabilities, as the F-3s will have found in their visit to Lechfeld. Learning in a multinational environment has symbiotic benefits.

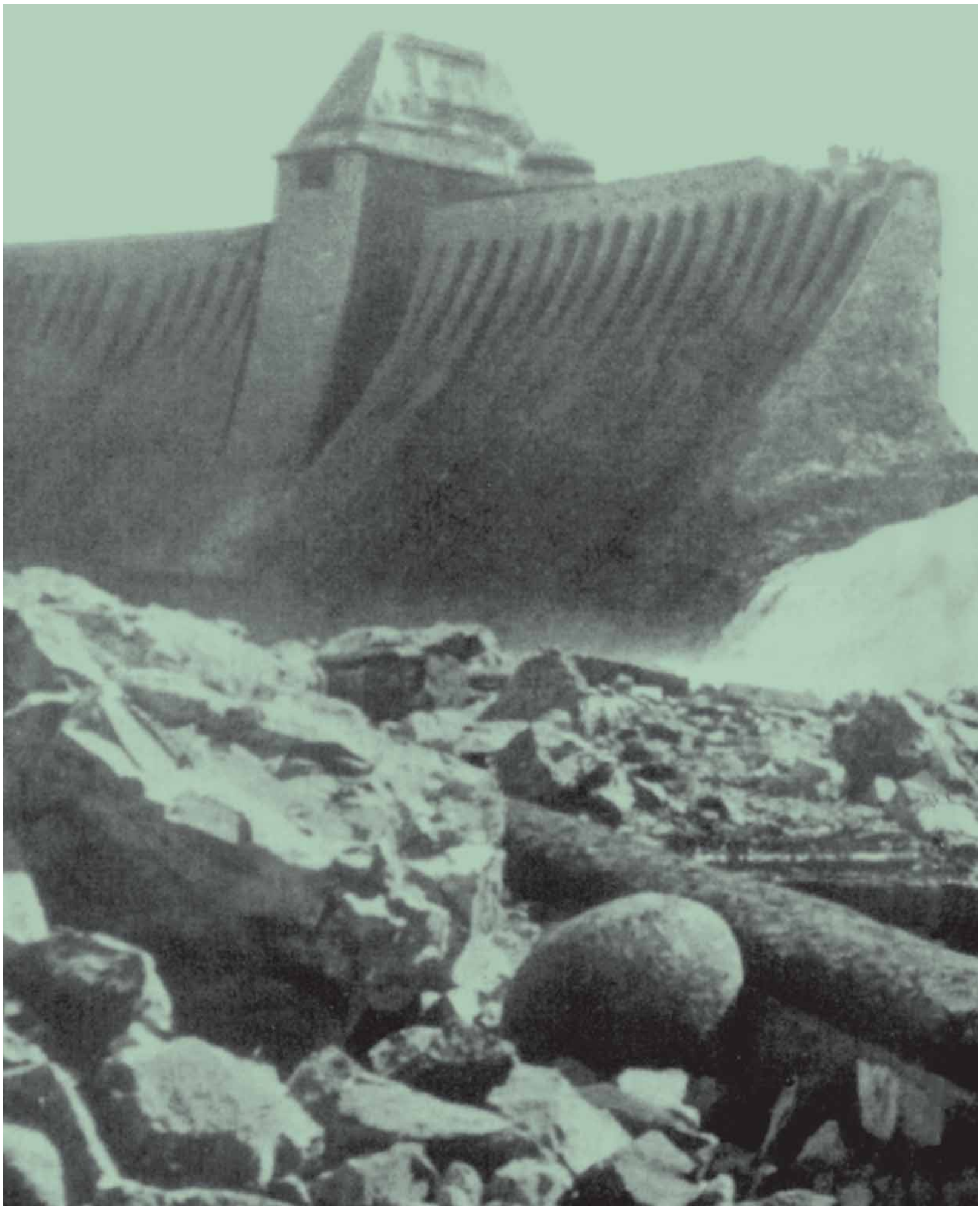
Not to prepare for the eventuality of conducting operations under the auspices of a European force without major US support would, in the present circumstances, be foolhardy. It should not be forgotten that it was in the late 1980s that the UK armed forces disposed of large quantities of desert uniforms, boots and equipment on the grounds

that 'we will never fight another war in the desert'. It should not be assumed that we shall never fight a war without US leadership. One of the most important ingredients in developing a truly interoperable capability between coalition forces is trust between partners. This is most effectively built up through mutual familiarity and understanding, in turn built up by working together.

Western air forces have shown themselves to be remarkably good at coordination at a tactical level. This should be encouraged and indeed nurtured. The next challenge for European air forces is improvement in cooperation at the operational and political levels. This is particularly pertinent with the withdrawal of most of the UK's air power from continental Europe. Despite extensive rhe toric from European political leaders in support of ESDP, they are more reluctant to provide the resources needed to make this a reality. It would appear that the impetus for effective cooperative and integrated operations European air forces continues to be driven bottom-up.

Notes

1 Quoted in Peach, S. 'Coalition Air Operations' in: *Perspectives on Air Power.* London: MOD/HMSO 1998. p55.
2 Baldwin, K J. 'Can Europe Project Air Power without the Support of the United States?' in: *Air Power Review* Vol 4 No1. Spring 2001. p60.
3 For a fuller discussion of Western post-Cold War operations see Garden, T. 'European Air Power in: Gray, P (Ed) *Air Power 21: Challenges for the New Century.* London: The Stationary Office, 2000. p99ff.
4 Kissinger, H. 'A New National Partnership' in *Department of State Bulletin* 17 Feb 1975 p199.
5 Garden, T. Op Cit. p99
6 Flockhart, T and Wyn Rees, G. 'A core Europe? The EU and the WEU' in: Park,W and Wynn Rees G(Eds). *Rethinking Security in Post-Cold War Europe*. London: Longman 1998. p75.
7 For fuller discussion and explanation of this dynamic, see Maddox, B. 'How Old Europe's Gang of Four ambushed Nato'in *The Times* London 30 April 2003 , 'Cocorico? Or the chickens come home to roost?' in *The Economist* London 19 April 2003 and Fischer, J. 'Beziehungen zu Amerika ausgezeichnet' in *Frankfurter Allgemeine* Frankfurt 17 July 2003.
8 See, inter alia, Park,W and Wynn Rees G(Eds). *Rethinking Security in Post-Cold War Europe*. London: Longman 1998 and Wyllie, J H. *European Security in The New Political Environment*. London: Longman 1997.
9 Baldwin, K J. Op Cit. p61.
10 Defence White Paper, London , December 1999, Cm 4446
11 Garden, T. Op Cit. p101.
12 'A lull between the storms' in: *The Economist* London, 27 September 2003 p39.
13 Garden, T. Op Cit. p109.
14 Evans, M. 'Rapid response vital to Nato's future' in: *The Times* London 9 October 2003 p19.
15 Gates, D. 'Air Power – The Instrument of Choice' in: Gray, P (Ed) *Air Power 21: Challenges for the New Century.* London: The Stationary Office, 2000. pp27-28.
16 For a fuller discussion of the disadvantages of national role specialisation see Gates, D Op Cit.
17 Goulter, C. 'Air power and Expeditionary Warfare' in: Gray, P (Ed) *Air Power 21: Challenges for the New Century.* London: The Stationary Office, 2000. p207.
18 *House of Commons Research Paper 98/91.* London: House of Commons Library 1998. Quoted in Bremer, G. 'Future Cost-Effective Combat Air Power for the United Kingdom' in: *Air Power Review* Vol 4 No1. Spring 2001. p86.
19 Garden, T. Op Cit. p116.
20 Baldwin, K J. Op Cit. Pp76-77
21 Presidency conclusions, Helsinki European Council, 10-11 December 1999.
22 *The Strategic Defence Review Supporting Essay.* London: The Stationary Office 1998. p6-4. Quoted in Baldwin, K J. Op Cit. p63.
23 Cottey, A. 'NATO transformed: the Atlantic Alliance in a new era in: Park,W and Wynn Rees G(Eds). *Rethinking Security in Post-Cold War Europe*. London: Longman 1998. p58
24 Booth, K. *New Thinking about Strategy and International Security*. London: Harper Collins. 1991. p344
25 For more detail on French interoperability problems during Op DESERT STORM see: Salmon, T and Shepherd, A. *Toward A European Army: A Military power in the Making.* 2003 Boulder: Lynn-Rienner.
26 Baldwin, K J. Op Cit. p61.
27 Ibid. p55.
28 For a fuller discussion of why air forces seem to be better harmonised than land or naval forces see Garden, T. Op Cit. p115.
29 AP 3000. London: MOD/HMSO 1999. p1.2.2
30 An example of synergistic effects of this type may be found in Andrew, D. 'Suppression of Enemy Air defences' in: *Air Power Review* Vol 3 No3. Autumn 2000.
31 Peach, S. Op Cit. p75.
32 For an example of the value of personal relations during coalition operations see Peach, S. Op Cit. p66.
33 Major J Knapik, Executive Officer 416 Sqn CAF, interviewed 20 Sep 2003.
34 Peach, S. Op Cit. p53.
35 Composite Air Operation.
36 Peach, S. Op Cit. p75.
37 Garden, T. Op Cit. p120.
38 Peach, S. Op Cit p55.
39 Clarke, M. 'Air Power and Military Intervention: The Political Limitations' in: Gray, P (Ed) *Air Power 21: Challenges for the New Century.* London: The Stationary Office, 2000. p9.



The Dam Busters Raid

By Wg Cdr Tim Webster

At 2128 hrs on the evening of 16 May 1943 the first aircraft of the newly formed 617 Squadron, AJ-E piloted by Flt Lt Barlow, lifted from the grass runway of RAF Scampton and set course for Germany. So started Operation CHASTISE, an attack that had been in planning on and off since October 1937[1] and that would come to be recognised as Bomber Command's most spectacular operation of World War II. By dawn the next day two major German dams had been breached, significant areas flooded, over 1,250 deaths caused and the industry of the Ruhr Valley disrupted. On the British side, 8 aircraft and 53 aircrew had been lost.

The British would use post-raid reconnaissance pictures to show the world the damage caused to the dams, to the countryside below them and, by implication, to the industrial complex of the Ruhr Valley. The post-raid propaganda was not confined to Britain but was trumpeted around the Empire in newspapers in the United States and in leaflets dropped into Occupied Europe.

While acknowledging the precision of the attack— the physical outcome of the raid was neither of fundamental importance nor even seriously damaging

The understandable wartime use of the raid for propaganda purposes may have led to overstatement of its success. The publication of Webster and Frankland's review of the air offensive against Germany brought a re-evaluation of the raid — while acknowledging the precision of the attack— held that the physical outcome of the raid was neither "of fundamental importance nor even seriously damaging".[2]

This paper will use published sources to examine the context of, and build up to, the Dams Raid, to recount the raid itself, to assess the damage directly caused and the German response to it, to outline the lessons that were or could have been learned from the raid, and finally to place the raid in perspective.

The background to the raid

Contrary to popular belief, the origins of the Dams Raid did not lie with Barnes Wallis, the Vickers' engineer who designed the bouncing bomb[3] used against the dams. As early as October 1937 planners within the Air Ministry were developing attack options for the expected war with Germany: these were called Western Air (WA) Plans and there were 13 of them. Plan WA5 required Bomber Command "to attack the German War Industry including the supply of oil with priority to that in the Ruhr, Rhineland and Saar".[4]

This was refined by Bomber Command into a plan to achieve the same effect by attacking the Ruhr's 45 power and coking plants: it was believed that these could be destroyed in a fortnight's bombing (amounting to about 3,000 sorties) with an expected aircraft loss rate of about 6%. That these estimates were wildly inaccurate was shown by the 11.5% loss rates of the RAF's then-heavy bombers in the period of the Phoney War[5] and the Butt Report's conclusions on Bomber Command's accuracy[6], which on simple arithmetic alone (and taking no account of the doubtful effectiveness of the bombs with which the RAF started the war), would suggest that perhaps 12,000 sorties would have been required. Extrapolating these figures, a loss of approximately 1,400 aircraft might have been expected.

Even on the basis of the original estimates, the loss rate for the new plan was considered unacceptable and the Air Ministry's Air Targets Sub-Committee turned to devising an alternative means to achieve the same end: the result was a plan to attack the Mohne and Sorpe dams instead. The logic behind this plan held that the Ruhr's heavy industry was dependant on the water the dams held for industrial processes, for power generation and for drinking water: if the dams could be destroyed then industry would grind to a halt.

Assuming that the logic contained no flaws, the next step was to identify a way to attack the dams themselves. Considerable effort went into this, concentrating particularly on the Möhne, which was a gravity dam[7]. Suggestions included attacking the air side of the dam with semi-armour piercing bombs, dropping high explosives onto the dams or attacks with multiple torpedoes from the waterside. None of these was considered feasible and the development of a guided-bomb based upon an anti-aircraft target drone was, for a while, considered the best option. Unfortunately, the fall of France placed the target out of the range of such a weapon.

Even before the fall of France Wg Cdr Finch-Noyes, under the auspices of the Research Department Woolwich, was working on alternative means for attacking the Möhne dam. After reviewing the papers already produced, he proposed that a 20,000 lb explosive charge detonated 40 ft from the top of the dam on its water-side and in contact with it (or a succession of 2,000 lb charges close together) would have a reasonable chance of destroying it.

His proposed weapon would be launched from an aircraft at low level, propel itself into the dam, sink and then be exploded by hydrostatic fuses at the desired depth.[8] Practical considerations meant that no single weapon could be used, no RAF aircraft was yet capable of delivering it to the target, and so multiple smaller weapons would have to be substituted. The Wellington bomber could carry a 2,000 lb charge weapon under each wing to be dropped at height and distance from the dam and,

Work on the design of the weapon that would eventually be used on the Dams Raid started in the autumn of 1939. The man behind it was Barnes Wallis, an aero-structures engineer with Vickers-Armstrongs' Aviation

with the weapon propelling itself after hitting the water, skip over any intervening torpedo nets, strike the dam, sink and explode.

It was proposed to use a total of 16 weapons, but by April 1941 Bomber Command had decided that this plan, too, was fraught with technical imponderables and it was quietly shelved. Before the Dams Raid took place other means of attack were put forward: Combined Operations suggested floating a charge down the reservoir and onto the dam, while the Special Operations Executive proposed an attack by parachutists who would place explosive charges against the dam.[9]

Weapon development
Work on the design of the weapon that would eventually be used on the Dams Raid started in the autumn of 1939. The man behind it was Barnes Wallis, an aero-structures engineer with Vickers-Armstrongs' Aviation, who was already well known for his work on the R100 airship and the Vickers Wellesley and Wellington bombers. Wallis had come to the view that modern warfare depended on industrial production, which in turn relied on sources of power. He further argued that while production could be dispersed making it relatively invulnerable to the bombs then available to the RAF, sources of power such as coalmines, oil fields and hydroelectric dams could not. They were, however, equally invulnerable to the bombs available to the RAF.[10]

Wallis believed that much heavier bombs could be effective against dams and coalmines, and he had started to work, with the blessing of the Ministry of Aircraft Production (MAP), on a massive 22,000 lb bomb, similar in shape to his R100 airship,[11] which was expected to achieve supersonic speed in its fall from altitude. This would be suitable for these targets as it buried itself deep in the earth before exploding and caused shockwaves that would shake structures apart: the same effect could be achieved by exploding the bomb in the water close to a dam.

In autumn 1940 experiments were started at the Road Research Laboratory to determine just how much explosive would need to be detonated at what distance from the Möhne dam to destroy it. Initial experiments were on 1/50 scale models, working upwards to progressively larger models and eventually to a one-off test on the disused 180 ft long, 35 ft high Nant-y-Gro dam near Rhayader, which on 24 July 1942[12] proved conclusively that such dams could be destroyed by an underwater explosion in contact with the dam, although this was not yet Wallis's intention.

The early model tests gave Wallis the information needed to support his *A Note on a Method of Attacking the Axis Powers*,[13] which he circulated widely. He argued that his massive bomb dropped from high altitude would be effective against the Möhne dam, but there was no RAF bomber

He argued that his massive bomb dropped from high altitude would be effective against the Möhne dam, but there was no RAF bomber capable of carrying it

capable of carrying it to the required altitude and so the project ran in parallel with a proposal for an equally large bomber to deliver it. The Air Staff rejected both.

Wallis, however, was not to be put off. Somehow, in June 1941, he gained the support of MAP's Aerial Attacks against Dams committee for further experiments on the effects of explosives on dams. Progress was slow, however, and Wallis himself admitted: "the growing conviction that my original suggestion was impracticable . . . led me to seek for other methods".[14] Early in 1942 he hit upon the idea of ricocheting a spherical weapon across the surface of the reservoir thus avoiding torpedo nets and other surface defences, striking the dam, sinking and then exploding in contact with it at a predetermined depth thanks to hydrostatic fuses. Wallis could not account for how he got the idea: the mythology relates it to skimming stones across a pond, but there are similarities to Finch-Noyes's earlier plan.

By the end of April 1942, Wallis had gained important support from Professor Blackett, a scientific adviser to the Admiralty, and from Sir Henry Tizard, who had influence with the Air Council, MAP and the Chiefs of Staff Committee. Their support gained him access to the National Physical Laboratory's water tanks to perfect the delivery technique that now definitely included the backward rotation of the weapon. Why Wallis decided on this is unclear although he claimed three advantages: "it increases the distance which the missile will travel after release from the carrier, before striking the water; it diminishes the tendency of the missile to plunge downwardly on impact with the water surface; it increases the distance which the missile will travel whilst ricocheting."[15]

In mid-June 1942 Wallis demonstrated his 'bouncing' spheres (the weapon was at this stage spherical in shape even though Wallis was beginning to have doubts about this) to interested spectators from both MAP and the Admiralty. The Royal Navy was quick to grasp the potential of the weapon for attacks on capital ships. By the end of June 1942 MAP had granted permission for a Wellington bomber to be used for tests involving mock-up spherical bombs commissioned by the Admiralty. The first ground spinning test did not take place until 20 October 1942[16] and the first air test until 2 December 1942 but it was then proved that it was possible to spin the weapon without shaking the aircraft apart. Two days later the first dropping trials took place at Chesil Beach in Dorset; they were unsuccessful, the spheres were destroyed as they hit the water. A further series of experimental drops continued until early February 1943 as Wallis sought to overcome this major problem.

At this stage it seemed that Admiralty interest in a medium-sized version of the weapon (codenamed Highball) to be used by Mosquito aircraft to attack ships, and the Tirpitz in particular, was greater than Air Ministry interest in the full-sized version (codenamed Upkeep) for attacks against the dams. There was also a small-sized version (codename Baseball) meant for launching against ships from a mortar in the bows of a fast attack craft.

Wallis continued to lobby for his weapon and in early February 1943 he gained support from Churchill's scientific adviser, Prof Lindemann, previously not just sceptical but actively hostile to the plan. Things also seemed to speed up at the Air Ministry and MAP although there was concern that if Wallis devoted his time to developing Upkeep, the development of the projected Vickers Windsor bomber would be neglected[17]. Indeed, Vickers was forced to admit that work on the Windsor was already behind schedule due, in part, to work undertaken to convert de Havilland Mosquito aircraft to carry Highball.

On 14 February 1943, as Bomber Command was preparing to open the 'Battle of the Ruhr', its Senior Air Staff Officer wrote a paper for his Air Officer Commander-in-Chief, the redoubtable 'Bomber' Harris, describing both Upkeep and Highball. At this time, although the Germans were being beaten in Russia, in North Africa and in the Atlantic, with the Russians calling for a second front in Europe only Bomber Command had the capacity to take the war to the continent. Its task had been set at the Casablanca meeting of the Combined Chiefs of Staff that January:

"[The] primary object will be the progressive destruction of the German military industrial and economic

An Upkeep mine on Gibson's own Lancaster

Development of Upkeep and the specially modified Lancaster that would carry it now began in earnest

system, and the undermining of the morale of the German people to a point where their armed resistance is fatally weakened."[18]

Harris interpreted this as giving him a free hand to attack any large German city: this having the effect of attacking both the industry located there and the local population despite the uncertainty of the evidence over the effect of such attacks on civilian morale. He went so far as to state that his task was "destroying the main cities of the Ruhr".[19]

There is no doubt that Harris was unimpressed by Upkeep: he claimed that it would shake the carrying aircraft apart if not perfectly balanced when spun and that the ballistics would not work. It has been noted in a number of sources that Harris did not seem initially to grasp the difference between Upkeep and Highball; it also seems he did not grasp that the concept had already been trialled or he would surely not have raised the objections he did. Harris' own account of the Dams Raid is brief in the extreme and makes no mention of his scepticism. Indeed, on the subject of Upkeep he wrote: "It was one of the weapons designed for the Command outside the official Ministry of Aircraft Production and Air Ministry organisations . . . it could be taken almost as a rule that such weapons were successful."[20]

This contrasts with his missive to Portal, the Chief of the Air Staff, in which he railed against: "enthusiasts and panacea mongers . . . careering round MAP suggesting the taking of about 30 Lancasters off the line to rig them up with this weapon, when the weapon itself exists so far only in the imagination of those who conceived it."[21]

Harris's further assertion that "we have made attempt after attempt to pull successful low attacks with heavy bombers. They have been, almost without exception, costly failures"[22] was undoubtedly a more reasonable objection.
On 21 February 1943 Wallis was finally, at the instigation of Cochrane (AOC 5 Group), able to show his film of the Chesil Beach tests and the National Physical Laboratory tank tests to a still-sceptical Harris.

By now Portal had authorized the conversion of three Lancasters for use in the development of Upkeep and on 26 February 1943 a formal decision to go ahead was taken with the weapon. It was to be ready for use that year, the latest date for its use to achieve maximum effect being just three months away. Maximum effectiveness required the dams had to be full of water, which meant the attack must occur before the end of May 1943. Time was going to be extremely short.

Development of Upkeep and the specially modified Lancaster that would carry it now began in earnest. Responsibility was split between Vickers and Royal Ordnance for Upkeep, and Vickers and Avro for the aircraft. Gradually Upkeep evolved through the series of trial drops at Reculver Bay on the North Kent coast rather than at Chesil Beach. By trial and error it became a cylinder, not a sphere, and lost the originally intended wooden covering.

Gibson had significant control over the selection and training of the aircrew, was allowed to devise the means to reach the target and to suggest amendments to the Operational Order, and was given control of his force in attacking the dams: an early example of mission command in the Royal Air Force

Wing Commander Guy Gibson

The trials were not perfect, the test pilots having difficulty effecting the drops from the right height and at the right speed: unsurprisingly, therefore, Upkeep did not behave as expected and as late as 2 May 1943 further trial drops were authorised.[23] The extra, successful trials were all to be flown at 60 ft at a groundspeed of 210-220 miles per hour with Upkeep being spun at 500 revolutions per minute. The final trial drop was on 13 May 1943: Upkeep was ready for use but only just in time.

Meanwhile, the Admiralty and the Air Ministry were still debating whether Upkeep or Highball should be used first or whether attacks against the dams and the Tirpitz should occur simultaneously. The apparently confused Chiefs of Staff had set up a committee to monitor both Upkeep and Highball developments[24] but despite, or perhaps because of, multiple and varying 'expert' opinions on the validity of the different targets it was difficult to reach a conclusion. Finally on 13 May 1943, having been informed that Upkeep trials had been successful while Highball trials had failed, the committee agreed that Operation CHASTISE (the Dams Raid) should proceed. The Chiefs of Staff who were in Washington for discussions with their American opposite numbers confirmed the decision the next day.

Preparation for the raid

Responsibility for execution of the Dams Raid fell to Bomber Command. On 15 March 1943, Harris passed that responsibility to Cochrane who had been responsible for Harris seeing Wallis's films. He was told to form a special squadron (Harris having already nominated the experienced and highly-decorated Wing Commander Guy Gibson to lead it) to attack the dams, but that this would not be the squadron's only mission. Gibson had significant control over the selection and training of the aircrew, was allowed to devise the means to reach the target and to suggest amendments to the Operational Order, and was given control of his force in attacking the dams: an early example of mission command in the Royal Air Force.[25]

That Bomber Command was well aware of the potential propaganda value of a successful raid was

Air Marshal (later Marshal of the RAF) Sir Arthur Harris, Air Officer Commanding -in-Chief, RAF Bomber Command

shown when 5 Group informed Gibson that he would be required to write a book about the mission.[26] Indeed, Harris' own account of the Dams Raid follows on immediately from comments on the difficulty of gaining public support for the Royal Air Force, which included:

"The Air Ministry had certainly had the idea that it would be a good thing to get the support of the Press and to have the operations of the Air Force reported as fully as possible. No doubt it was hoped to compensate in this way for the obvious inability of the Air Ministry, by comparison with the ministries of other services, to get the attention and the favour of those who matter; public support was to be called in to redress the balance."[27]

Harris intended to draw the new squadron's aircrew from volunteers within 5 Group who had completed or nearly completed two operational tours but this did not happen; many of the aircrew had actually completed less than 10 operational sorties and some of the flight engineers none at all. Equally, not all of them were volunteers. The original intention to draw the aircrew from amongst the very most experienced members of 5 Group, while partly meant to reduce disruption to line squadrons suggested the formation of an elite unit and also acknowledged the difficulty of the task.

Harris was on record as opposing elite units, he had opposed the Pathfinder Force saying, "I am not prepared to accept all the very serious disadvantages of a Corps d'Elite in order to secure possibly some improvement of methods . . . at a serious loss of morale and efficiency to the other squadrons."[28] But Harris himself said 617 Squadron was to be "a Special Duty Squadron under the operational control of AOC 5 Group" to undertake missions "that entail special training and/or the use of specialist equipment."[29] The difficulty of the task can be gauged by comparison with the efforts of Bomber Command's Main Force at around the same time: on 6 March 1943, 293 aircraft attacked Essen, but only 153 were found to have bombed within three miles of the target.[30]

Notwithstanding the new squadron's elite status, rigorous and realistic training would be required if they were to achieve the required standards of bombing accuracy. Cochrane's original instructions to Gibson, while giving no details of the proposed targets, made it clear that mastery of night-time low flying over water would be required. Gibson himself, with two of his senior pilots as passengers, tried out the required night-flying skills over the Derwent Reservoir: the results were not encouraging. The squadron commenced its low-level, cross-country training on 31 March 1943 and by the end of April, following intensive training in which over

Low-flying did not just cause medical problems: concerns were raised about its effects on the aircraft's structure after a number of bolts on one airframe were found to have sheared

a thousand flying hours were logged, was able to "navigate from pinpoint to pinpoint at night at low level by map reading; they could bomb accurately using a special rangefinder sight; and fly safely over water at 150 ft."[31]

Not all of 617 Squadron's night-flying training was actually done at night. A system, grandly called Synthetic Night Flying Equipment was used to simulate night-flying conditions. Blue celluloid covered the cockpit transparencies while aircrew wore amber-coloured flying goggles of varying intensities: the combination of blue and amber effectively cut the light levels transmitted from outside the cockpit to approximately that of good moonlight, but cockpit instruments could be clearly seen through the goggles. A safety pilot without goggles was able to see the outside world clearly through the celluloid. One apparently unexpected side-effect of prolonged use of the celluloid-goggle combination was that when goggles were taken off outside the aircraft, the world appeared red.[32]

A further medical problem encountered during low-flying training was airsickness. Few of the aircrew would have had much experience of low-flying in the Lancaster, an aircraft that was not designed for it and in which some of the crew sat at an angle to the line of flight. The situation was sufficiently severe to cause the squadron's medical officer to fly on a training flight to experience the problem for himself: thereafter airsickness sufferers were treated with chlorobutanol.[33] Low-flying did not just cause medical problems: concerns were raised about its effects on the aircraft's structure after a number of bolts on one airframe were found to have sheared.[34]

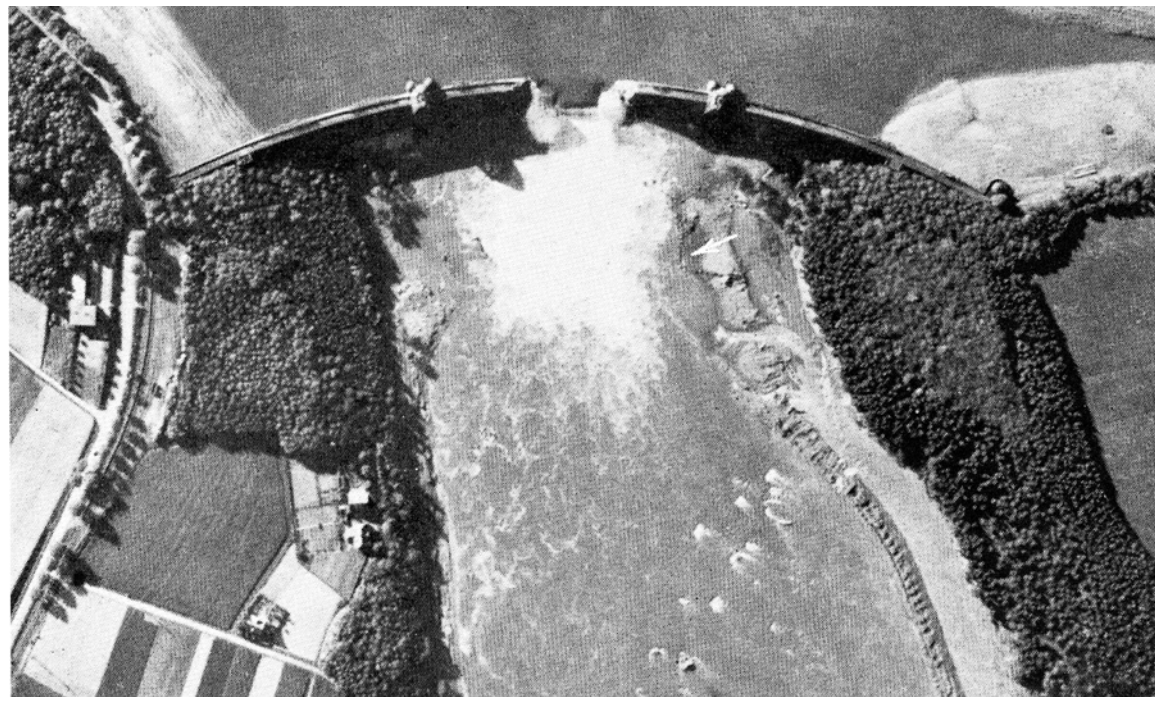
On 26 April 1943, having mastered flying at 150 ft, the squadron was required to cut the bombing height to 60 ft and the release speed to 210 miles per hour. Over the next week they trained intensively again, dropping nearly 300 practice bombs that on average fell within 120 feet of the aiming point. Training now concentrated on the Eyebrook Reservoir near Uppingham, the Abberton Reservoir near Colchester and, deputising for the Sorpe dam, the Derwent Reservoir near Sheffield. The screens previously used at the Wainfleet range to mimic the towers of the Mohne dam were now transferred to Eyebrook.

If constant practice under realistic conditions had allowed the aircrew to master the necessary flying skills[35], although none of them had yet dropped the new weapon and would not do so until 11 May 1943, there were still a number of technical problems to be overcome. One of these was the difficulty of achieving, particularly at night over water, the precise 60 ft altitude required to drop Upkeep accurately. A number of unsatisfactory solutions were tried before Lockspeiser, Director of Scientific Research at MAP, suggested the use of intersecting spotlights. This was not a new idea, Harris himself had tried it in flying boats and, having failed to make it work, was once more sceptical: Coastal Command had also tried it unsuccessfully as an aid to nocturnal, shallow-water attacks on U-boats.

617 Squadron was duly sceptical and difficulties were encountered in making the system work adequately, particularly at such low altitude. The two spotlight beams were set to meet on the water (which on a reservoir could be expected to be sufficiently smooth not to interfere with the functioning of the system) just forward of the port wing. Here it was difficult for the pilot to monitor and this duty fell to the navigator who was thus responsible for altitude[36] as well as for navigating to and from the dams.

Having devised a means to drop Upkeep from the correct height, it was now necessary to find a means to drop it from the correct range. Dropped too close it might simply bounce over the dam endangering the aircraft as the mine exploded out of the water[37] or if dropped too far away simply never reach its target. A simple device was devised at Boscombe Down to overcome this problem: a triangular sight using the bomb-aimer's eye at the base of a triangle completed by two nails mimicked the desired drop position of the aircraft in relation to the dam's towers.

In effect, with the sight correctly held by the bomb-aimer, the aircraft was in the right position to drop Upkeep when the nails obscured the dam's towers. Some crews used this sight but others used their own variations on the theme, often including a length of string and chinagraph pencil marks on the clear-view panel.



The breached Möhne dam

It was now possible to drop Upkeep at the right speed, at the right height and from the right range. If the weapon worked as advertised the dams should be destroyed. But Upkeep and the aircraft to carry it were in short supply and could not be wasted in unnecessary attacks. It would be possible after each attack to see if the dam had been breached and aircraft could be diverted elsewhere. Accordingly, Gibson needed to be able to control the attack, to call a halt when the objective was achieved and to divert aircraft to subsequent targets.

In normal area bombing practice such control was not necessary and Bomber Command's aircraft were not fitted with radios that allowed such control to be exercised. The standard TR 1196 radio was perfectly adequate for air-to ground use (and would be used to communicate with HQ 5 Group during the raid) but was found to be unsuitable for air-to-air use, especially at night. Specialist advice was sought and the fitting of the TR1143 radio used in fighter aircraft was suggested. This, with a few extra tweaks, proved suitable and was flight trialled by 617 Squadron's two flight commanders one week before the mission. In the meantime a series of booths acting as a radio simulator had been rigged in the squadron's crew rooms to enable procedural training to take place before the radios had been fitted to the aircraft.

The raid

The attack on the dams was made in three waves. Gibson led the first consisting of nine aircraft to attack the Möhne dam. The second wave, five aircraft, was led by McCarthy (it actually took off first although its leader was delayed by problems with his aircraft) and was to attack the Sorpe dam (correctly identified by the Ministry of Economic Warfare as a vital target if the raid was to achieve its desired endstate) even though Upkeep was not designed to be used against that earth-bank type of dam. The third wave, led by Ottley, comprised a further five aircraft: they were briefed to attack either the Möhne or Eder dams but also had alternate targets. Instructions as to which target they should attack would be passed by radio from HQ 5 Group as the progress of the raid became apparent.

The nine aircraft of the first wave made their way at low-level to the Möhne, losing one aircraft (Astell) to anti-aircraft fire en route. On arrival Gibson made a trial run before actually dropping his Upkeep: this appears to have fallen short and did not breach the dam. Hopgood followed but dropped his weapon too late: it bounced over the dam and destroyed the dam's power station instead. At the same time Hopgood's aircraft was shot down by the gunners on the dam. Third to attack was Martin whose Upkeep fell both short and wide of the target and failed to breach it. Young's was the fourth attacking aircraft: his mine exploded in contact with the dam and Maltby, next

The Germans captured Upkeep intact, rapidly worked out how the weapon worked and produced (but never actually used) their own, more complicated, version

to attack, reported that there was a breach in the dam before releasing his own Upkeep. Maltby's mine also exploded in contact with the dam causing a definite breach.[38]

Once the breach had been confirmed, Gibson led the aircraft which still had an Upkeep to use (plus Young as deputy leader) to the Eder dam. Maltby and Martin headed for home. Achieving the correct position from which to drop Upkeep proved very difficult at the Eder, Shannon had three unsuccessful goes before handing over to Maudslay who had two unsuccessful attempts. Shannon then tried two more times before finally getting the right alignment and dropping his Upkeep such that it exploded in contact with the dam but did not breach it. Maudslay came next and finally released his weapon on the third attempt but the release was too late, the mine hit the dam's parapet and exploded damaging Maudslay's aircraft.[39] Finally the last aircraft of the first wave, Knight, attacked: he took one practice run but on the next run Upkeep was successfully dropped and the dam breached. Gibson ordered a return to Scampton but Young's aircraft was shot down by anti-aircraft fire on the way home.

Informed by radio that both the Möhne and Eder dams had been breached, Harris — at HQ 5 Group — placed a call to Portal who was in Washington for a conference with his fellow British and American Chiefs of Staff[40] to inform him of the success. Portal in turn informed Churchill.

The second wave, intended to attack the Sorpe, actually left before the first. McCarthy should have led but his aircraft had mechanical problems and he had to change to another: he finally left well behind the rest of his wave. In the end, though, McCarthy was the only one of the wave to reach the target. It took him 10 attempts to satisfactorily drop Upkeep; the dam was damaged but it was not breached. Barlow's aircraft, which actually led off the raid, was shot down by flak over Germany and the Upkeep failed to explode in the crash. As a result the Germans captured Upkeep intact, rapidly worked out how the weapon worked and produced (but never actually used) their own, more complicated, version.

Next came Munro whose aircraft was severely damaged by flak over Holland and forced to return to Scampton. He was followed by Byers who was shot down by anti-aircraft fire over Holland, and by Rice who had Upkeep wrenched off by impact with the water without the aircraft crashing while flying too low over the Afsluitdijk. Rice had no option but to return to Scampton and so only one of the five aircraft originally destined to attack the Sorpe reached its target.

The third wave was a reserve force. Each had its own intended target such that all six dams in the Operational Order[41] might have been attacked but could be re-tasked by HQ 5 Group to attack the Möhne, Eder or Sorpe dams as required. Ottley led the wave but was shot down before 5 Group could divert him to the Sorpe, while Burpee, always destined for the Sorpe, was shot down over Holland. Brown came third and attacked the Sorpe. As with McCarthy, he and his crew found it difficult to place their Upkeep appropriately and, although they did hit it, the dam was not breached.

The fourth aircraft — Townsend's — was tasked against the Ennepe. Difficulty was experienced in finding the target and, although Upkeep was dropped, the dam was not damaged. Uncertainty exists about which dam Townsend's crew attacked. They were sure they attacked the Ennepe, but the War Diary of the Oberkommando der Wehrmacht records that the Bever dam was attacked that night and not the Ennepe.[42] Last of all was Anderson's aircraft — originally tasked against the Diemel, but diverted to the Sorpe — which never found its target and returned to Scampton: Upkeep was unused.

The effect in Germany

Breaching the Möhne and Eder dams unleashed huge amounts of water. At the Möhne 116 million cubic metres of water escaped within the first 12 hours (approximately 88% of the total contents of the reservoir) while at the Eder, 154 million cubic metres of water were lost (approximately 76% of its total contents). Downstream of the Möhne, in addition to the damage done to its two electricity generating stations, significant damage was inflicted by the passage of the flood-water. Bridges were destroyed up to 50 km away and buildings up to 65 km away.

The official German figures give the final death toll for the Möhne as 1,294 killed or missing while 11 factories and 92 houses were destroyed, 971 houses and 32 farms damaged, 2,822 hectares of farmland made useless with a further 1,221 hectares damaged, and over 6,300 cattle and swine killed. In addition, nearly 50 road and railway bridges were damaged and several kilometers[43] of railway embankment required repair. On top of this, a large number of power or pumping stations and gas or water supplies were damaged[44].

The results below the Eder caused less loss of life. Only 47 people were killed, but the effects reached far from the dam. Floods requiring the use of boats for mobility were recorded up to 140 kilometers away and the damage to the river system was considerable: both the Rivers Fulda and Weser had to be dredged to restore them for navigation.

By today's standards the collateral damage, the loss of non-combatant life would be unacceptable: the current RAF would not countenance attacking such a target

Over 5 km of riverbank needed rebuilding and 50 hectares of land was made unusable. It is worthwhile to digress at this point on the morality of this attack and the legality of the target. By today's standards the collateral damage, the loss of non-combatant life would be unacceptable: the current RAF would not countenance attacking such a target. But in 1943 high levels of civilian casualties were part and parcel of the strategic bombing offensive. The need to aim at city centres because bombing accuracy was insufficient to allow anything else was bound to mean significant levels of collateral damage.

The civilian casualties caused by Operation CHASTISE would be eclipsed within 3 months by the Battle of Hamburg. On the night of 27-28 July 1943, Bomber Command's incendiary attack raised a firestorm, which within 30 minutes, had covered 22 sq km of the city. The exact casualty numbers will never be ascertained but figures of 40,000 killed with a similar number of injured seem likely[45]. In such a climate, the loss of around 1,300 lives was considered entirely acceptable in the pursuit of the disruption of German industry; Harris even defended the results of the attack on Hamburg:

"In spite of all that happened at Hamburg, bombing proved a comparatively humane method. For one thing, it saved the flower of the youth of this country and of our allies from being mown down by the military in the field, as it was in Flanders in the war of 1914-1918."[46]

Albert Speer who had responsibility for the German war economy as Minister of Armament and War Production led the German response to the raid. He flew from Berlin the following morning to inspect the damage, initially from the air. Speer recorded that the flooding of the valley below the Möhne had caused the "seemingly insignificant but grave consequence that the electrical installations at the pumping stations were soaked and muddied, so that industry was brought to a standstill".[47] He rapidly mobilised manpower to repair the damage: 7,000 men were diverted from constructing defences on the Atlantic Wall to repair the dams.

Sweetman[48] records that a further 20,000 workers, again many of them drawn from the Todt Organization's workers on the Atlantic Wall, were diverted to help with the clean-up. It seems likely, therefore, that a total of over 10,000 construction workers were diverted from constructing defences against the invasion of Europe, which would occur the following year for a period of several months. What impact might the fortifications that they would otherwise have built, have had on that invasion? In addition to construction workers, both military and civilian specialists of many types were involved in the clean-up operation.

Hitler was furious . . . he blamed the Luftwaffe for failing to prevent the attack. This failure reinforced Hitler's prejudices about air power; he did not believe that an effective defence against bombing could be mounted

In order to restore electricity and water supplies in the Ruhr, Speer ordered the requisitioning of electric motors and the importation of experts from elsewhere in Germany regardless of the consequences. His aim was to restore armament production in the Ruhr to half-production within one week and to full production within two weeks[49]. While this did not represent the total or prolonged suspension of production that Wallis and others had hoped for, it did represent the loss of three-eighths of the Ruhr's monthly production: not an insignificant achievement considering that it takes no account of production losses elsewhere caused by the concentration of efforts into the Ruhr.

Any attempt to quantify the actual production losses caused by the raid is fraught with difficulty. At this stage of the war, the German economy was (surprisingly) still transforming itself onto a war footing and output was rising rapidly so production losses are difficult to show definitively. What can be shown is that water production in the Ruhr dropped by 75% in the aftermath of the raid and took six weeks to return to normal levels, Ruhr steel production of over 300,000 tonnes was lost in both May and June (normal production loss was less than 100,000 tonnes per month) and gas availability fell by 50%.[50]

Commentators have argued that this did not represent a good return on the training time invested in preparation for the raid or on the lives of the aircrew lost. The flying hours put into training for Operation CHASTISE were approximately equivalent to those taken up in a 500-bomber raid on the Ruhr, yet CHASTISE caused far more damage than any normal raid. No normal raid halved the Ruhr's production for a week and, at a 4.7% loss rate[51], a 500 aircraft raid would have expected to lose 23 or 24 aircraft compared to Operation CHASTISE's eight: for the effect achieved the loss was acceptable, if heavy to bear for a single squadron.

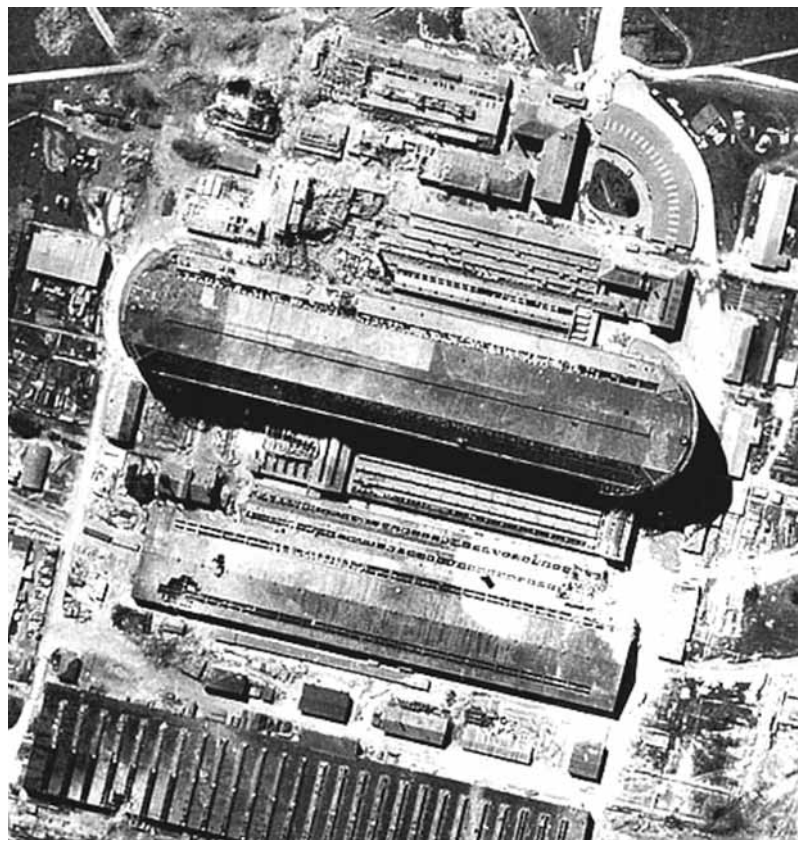
Another rapid response to the raid was the strengthening of defences around German dams. The level of commitment can be illustrated by reference to the Eder dam. A total of 48 barrage balloons, nine searchlights, six rocket-launching vehicles, 36 anti-aircraft guns varying in calibre from 20-88 mm and a smokescreen system were provided. In addition, there was an infantry company to guard against parachute attacks so that up to 1,500 men were tied up in protecting one dam. Taking all the German dams into account 10,000 front-line troops were involved, the equivalent of a full division that could not be employed elsewhere.[52]

The final effect, and surely not one that the Allied planners intended, was that on German air plans. Hitler was furious: an entry in the Reich's Propaganda Ministry's log recorded: "The Führer is extremely angry and impatient at the inadequacy of our defensive measures"[53] and he blamed the Luftwaffe for failing to prevent the attack. This failure reinforced Hitler's prejudices about air power; he did not believe that an effective defence against bombing could be mounted. He refused to allow the Messerschmitt Me-262 to be developed as a pure fighter (a role in which it was pre-eminent) instead insisting that it be developed as a fighter-bomber.

Allied effects

With the surviving aircrew back at Scampton and a reconnaissance Spitfire on its way to Germany to photograph the aftermath of the raid, the Air Ministry set to exploit the publicity and propaganda benefits of the raid. The news was broken by the BBC's morning news bulletin, the Air Ministry's communiqué coming too late for the morning newspapers. They would not report the raid until their 18 May 1943 editions but they made up for the delay with the enthusiasm with which they greeted the news in their headlines. In a generally more restrained era these included, "Huns Get A Flood Blitz" (*The Daily Mirror*), "Floods Sweeping Ruhr From Smashed Dams – RAF's Major Victory" (*The Daily Sketch*) and "RAF Blow Up Three Key Dams in Germany" (*The Daily Telegraph*). Every front page carried aerial reconnaissance pictures of the destroyed dams, but already inaccuracies were creeping in, as evidenced by *The Daily Telegraph* headline's implication that three dams had been destroyed.

News of the attack was quickly spread in the United States: Portal briefed the Combined Chiefs



The RAF had now proved that it had the potential ability to apply his concept to other 'choke points' in production and other such attacks would be undertaken

The Zeppelin factory on Lake Constance, considered to be an important 'choke point' in German radar production

of Staff on 17 May 1943. On 18 May 1943 the *New York Times* reported: "The RAF has secured another triumph" and hailed the "unexampled daring, skill and ingenuity".[54] Such headlines must have been welcome to the British contingent at the Trident conference: they were facing an American military establishment which was, to say the least, sceptical about British military capability. Churchill made the most of the opportunity in his address to the US Congress on 19 May 1943 saying, to cheers from the floor of the House:

"You have just read of the destruction of the great dams which feed the canals and provide power to the enemy's munition works. That was a gallant operation costing eight out of 19 Lancaster bombers employed but it will play a very far-reaching part in German military output. It is our settled policy, the settled policy of our two staffs of war-making authorities — to make it impossible for Germany to carry on any form of industry on a large or concentrated scale, either in Germany, in Italy, or in the enemy-occupied countries . . . In the meanwhile, our air offensive is forcing Germany to withdraw an ever larger proportion of its war-making capacity from the fighting fronts."[55]

Such declarations were doubtless aimed also at the Russians who, already fighting the Germans on the Eastern front, were as we have seen calling for the opening of a second front in Europe. The raid dramatically demonstrated Bomber Command's ability to take the battle to Germany. A successful precision raid was also useful for propaganda purposes in occupied France. The British War Cabinet had debated the effect of inaccurate British bombing on support there. Leaflets were dropped both in France and in Holland which used pictures of the aftermath of the raid accompanied by explanatory text to stress the precision of the operation: factual accuracy was not complete here as the text claimed a breach of nearly 100 metres at the Sorpe, in addition to the Möhne and Eder successes.[56]

On a less positive note, the realisation soon dawned in Britain that if an unexploded Upkeep had fallen into German hands, as Barlow's had, it would be possible for them to reverse-engineer their own version and use it to attack British dams: the Heinkel He-177 was, at least theoretically, capable of carrying such a weapon.[57] The Ministry of Home Security continued to debate the problem for nine months without reaching a definitive conclusion although steps were taken to protect the dams above Sheffield. As it happened the Germans did not attack, neither did they reverse

Gibson had been the first to use the 'master bomber' technique, controlling the actions of formation and directing them from one target to another by radio

engineer Upkeep preferring an unsuccessful attempt to produce a more sophisticated version. This did not work effectively and was never used operationally.

Benefits and lessons

In addition to the direct results in terms of the damage caused by the floodwater, which have been detailed previously, there were a number of indirect benefits too. The most obvious of these was the continuing existence of 617 Squadron, albeit that it took some time to recover from the crew losses sustained. The presence of a squadron that had proved its ability to deliver novel weapons, using new techniques and with great precision enabled the RAF to look towards further such precision raids. The original variation of WA5, which envisioned crippling the industry of the Ruhr by attacking its power and coking plants, was a 'choke point' plan seeking strategic effect by targeting precise locations rather than by area bombing.

The RAF had now proved that it had the potential ability to apply his concept to other 'choke points' in production and other such attacks would be undertaken. An example was the 20-21 June 1943 attack (again carried out by crews from 5 Group but with the assistance of a small number of Pathfinder aircraft) on the Zeppelin factory on Lake Constance which was thought to be vital to German radar production. The concept of attacking 'choke points' remains firmly part of RAF doctrine, although more likely these days to be applied to attacks on infrastructure, logistic chains or communication nodes than to production facilities, a task made easier by the development of truly precision-guided weapons.

Allied to 617 Squadron's continued existence was a willingness by the Air Ministry and MAP to look more favourably at Barnes Wallis' other ideas for large bombs. These would evolve into Tallboy and Grand Slam: respectively 12,000 lb and 22,000 lb penetration bombs: 617 Squadron was to use the Tallboy with great accuracy on a number of occasions. In a four-week spell in June and July 1944 alone they successfully attacked the Saumur railway tunnel preventing the transit of a Panzer division on its way to attack the Normandy bridgehead, the E-boat installations at Le Havre and Boulogne, V-1 launch sites in the Pas de Calais and the first launch site for the proposed V-3 weapon.[58] In addition, the 617 Squadron-Tallboy combination destroyed the Dortmund-Ems canal, the Krebs Dam (using delayed-action fuses and low-level attack, not the high-level attack for which Tallboy was designed) and twice (in conjunction with 9 Squadron) attacked and finally sank the German battleship Tirpitz. The massive Grand Slam bomb was successfully used against the Bielefeld viaduct that had resisted all previous attempts to destroy it.

Gibson had been the first to use the 'master bomber' technique, controlling the actions of formation and directing them from one target to another by radio. Three months later Gp Capt Searby would attack as 'master bomber' in the raid against the V-weapons research site at Peenemünde. This raid was altogether larger in scale with nearly 600 attacking aircraft, controlled by air-to-air radio as Searby circled the site for the duration of the attack[59] and caused Goebbels to comment that, in relation to V-weapon attacks, "preparations were set back by four or even six weeks".[60]

The combination of this technique and of radio control from Group HQ would eventually lead to the development of sophisticated airborne command and control systems. The use of ground-spotters using ground-to-air radio to talk tactical aircraft onto targets would become common-place in Normandy following D-Day. In Afghanistan we have recently seen ground troops calling in close air support from B-52 heavy bombers via controllers in an orbiting AWACS aircraft.

Conclusions

If the sole criterion of success is the permanent paralysis of the Ruhr's munitions industry and Germany's consequent inability to prolong the war, then Operation CHASTISE was not successful. The Air Ministry and the Ministry of Economic Warfare both knew that the destruction of the Sorpe dam was vital if this aim was to be met, but that Upkeep was not really a suitable weapon for the task. It is interesting, however, to speculate on what might have happened if more of the second and third wave aircraft had reached and attacked

this target. If the disruption to German transport infrastructure reduced agricultural production and the diversion of labour from the construction of Atlantic defences are considered, a picture begins to emerge of the dams raid as a triumph.

As we have seen, however, there are other important factors to take into account. The raid had very important moral and psychological effects. It was one of a number of Bomber Command 'set pieces'[61] which raised both the British public's confidence in the Command's ability to take the fight to the Germans and public morale in general. Allied to this, the timing of the raid was fortuitous as it allowed the British to parade an aerial success before the Combined Chiefs of Staff Conference and Churchill to exploit that success before the United States Congress.

Furthermore, the dramatic pictures could be used both in persuading the Russians that Britain was doing its share against Germany and in showing occupied Western Europe that Britain could now attack precision targets. The Germans were not immune to the psychological effects: Speer records that the raid made "a deep impression on the Führer".[62] Reinforcing Hitler's prejudices as it did, this assisted the move to the misemployment of the Luftwaffe as an offensive rather than defensive force. In addition, fear of repeat attacks (never undertaken or even apparently contemplated) caused the equivalent of an entire regular division to be tied down protecting the remaining dams: in itself this was probably worth the loss of eight aircraft.

There were other gains for the RAF: the start of the 'master bomber' technique allied to the demonstration that bomber aircraft could be effectively controlled by radio; the demonstration that Bomber Command could undertake precision attacks (albeit with specialized training and selected crews); the creation of an 'elite' squadron which would go on to develop new techniques and undertake other precision or novel attacks; and the impetus the raid gave to the Command to take Wallis' other specialized bombs seriously.

At the time, it was undoubtedly — in Webster and Frankland's words— "the most precise bombing attack ever delivered"[63] even if their assertion of " a feat of arms which has never been excelled" smacks of hyperbole. Allying this precision to the dramatic post-raid reconnaissance photographs, the undoubted bravery of the crews involved and a pre-determination to use the raid for propaganda purposes, it is hardly surprising that the Dams Raid remains the RAF's most famous single operation and 617 its most famous squadron.

All in all, the Dams Raid was an all-round success and not a sideshow.

BIBLIOGRAPHY

Andrews, C. and Morgan, E. *Vickers Aircraft since 1908.* (London: Putnam, 1988).

Brickhill, P. *The Dam Busters.* (London: Evans Brothers, 1951).

Cooper, A. *The Men who Breached the Dams*. (London: William Kimber, 1982).

Cooper, A. *Air Battle of the Ruhr.* (Shrewsbury: Airlife Publishing, 2000).

Euler, H. *The Dams Raid through the Lens*. (London, Battle of Britain International, 2001).

Gibson, G. *Enemy Coast Ahead*. (London: Michael Joseph, 1946).

Harris, Marshal of the RAF Sir Arthur. *Bomber Offensive.* (London: Collins, 1947).

Hastings, M. *Bomber Command*. (London: Michael Joseph, 1979).

Messenger, C. *"Bomber" Harris and the Strategic Bombing Offensive, 1939-1945.* (Cape Town, SA: Timmins Publishers, 1984).

Morpurgo, J.E. *Barnes Wallis.* (London: Longman, 1972).

Ottaway, S. *Dambuster: A Life of Guy Gibson VC*. (London: **Leo** Cooper, 1996).

Philpott, B. *The Encyclopedia of German Military Aircraft.* (London: Bison Books, 1980).

Rumpf, H. *The Bombing of Germany.* (London: White Lion Publishers, 1975).

Speer, A. *Inside the Third Reich: Memoirs*. (London, Nicholson, 1970).

Sweetman, J. *The Dambusters Raid*. (London: Arms & Armour, 1990).

Terraine, J. *The Right of the Line*. (London: Hodder and Stoughton, 1985).

Verrier, A. *The Bomber Offensive*. (London: Batsford, 1968).

Webster, Sir Charles and Frankland, N. *The Strategic Air Offensive Against Germany 1939-1945, Volume II, Part 4.* (London: HMSO, 1961).

British Air Power Doctrine AP3000 Third Edition.

RAF No.5 Group Operation Order No. B976 dated 16 May 1943.

The Strategic Air War Against Germany 1939-1945: Report of the British Bombing Survey Unit. (London: Frank Cass Publishers, 1998)

Notes

[1] Sweetman (1990) p.1.
[2] Webster and Frankland (1961) p.168.
[3] The "bouncing bomb" is part of the mythology of the raid. The weapon is more accurately described a ricocheting depth charge: it ricocheted across the water rather than bouncing and its explosion was triggered by hydrostatic pistols of the kind used in Royal Navy depth charges.
[4] Sweetman (1990) p.1.
[5] Sweetman (1990) p.12.
[6] Quoted in Terraine (1985) pp.292-3, the Butt Report assessed the accuracy of Bomber Command's efforts for the period 2 June 1941- 15 July 1941 by studying the photographs taken when bombs were dropped. It reached the depressing conclusion that of all aircraft taking off on raids only about a quarter actually got within 5 miles of the target, and of those actually claiming to have attacked only one in three was within 5 miles of its target.
[7] Two types of dams were involved. The Sorpe was an earth dam (a waterproof concrete core surrounded by earth banks on either side) and not susceptible to destruction by shockwaves; the rest were gravity dams which derive their strength from their own weight but are vulnerable to shockwaves.
[8] Sweetman (1990) p.8.
[9] Sweetman (1990) p.43. Neither plan progressed, though there is a suggestion that Combined Operations' effort was held in reserve in case the bombing raid should be unsuccessful. It is hard, however, to see how a charge floated down the reservoir could have avoided the Mohne's existing defences.
[10] Sweetman (1990) pp.18-19.
[11] Sweetman (1990) p.14. The intention was to achieve supersonic speeds in the drop from height to bury the bomb as deep in the ground as possible before it exploded.
[12] Sweetman (1990) pp.32-34.
[13] Sweetman (1990) p.18.
[14] Sweetman (1990) p.28.
[15] Sweetman (1990) p.30. The third point is counter-intuitive: most golfers realize that a back spun golf ball stops short on pitching rather than leaping forward. Wallis was a golfer; indeed he was working from offices at his own golf club.
[16] Sweetman (1990) p.35. These timings appear to be correct. Although Wallis would later claim that initial dropping trials occurred in September 1942, there is no documentary evidence to support his assertion.
[17] Andrews & Morgan (1988) pp. 387-9. The Vickers Windsor was a four-engine bomber developed to meet Specification B3/42 but which would, in fact, never enter series production: four prototypes were built of which only three flew.
[18] Terraine (1985) p.514.
[19] Terraine (1985) p.518.
[20] Harris (1947) p.157.
[21] Messenger (1984) p.119.
[22] Sweetman (1990) p.44.
[23] Sweetman (1990) p.56. It appears that the extra trial drops were requested by MAP and Air Ministry officials rather than by Wallis. At this stage the attack was only 2 weeks away and 617 Squadron were well into their training for the operation but the method of attack was not yet fully proved.
[24] Sweetman (1990) p.76. Initially chaired by Rear-Admiral Renouf the appointment soon passed to AVM Bottomley, ACAS (Ops).
[25] AP3000 p.1.3.4. Mission command gives instructions on what is to be achieved and why rather than what to do and how to do it.
[26] Messenger (1984) pp.73-74. Harris was not averse to publicity. He had authorized the "Thousand Bomber" raid against Cologne in May 1942 as much for domestic propaganda reasons as for operational ones.
[27] Harris (1947) p.156. One does not have to be unduly cynical to infer that the potential propaganda and public relations benefits of a successful attack on a high profile target helped to smooth the way for high-level support of the Dams Raid.
[28] Messenger (1984) p.85.
[29] Sweetman (1990) p.83. The statement suggests that Harris, despite his avowed dislike of elites, accepted from the start that 617 Squadron was to be an elite squadron kept in-being for specialised tasks.
[30] Verrier (1968) p.220. Whilst these results clearly show that an average heavy bomber squadron could not bomb sufficiently accurately to destroy the dams, they also show that standards in Bomber Command were improving. By comparison with the Butt Report's one-third of attacking aircraft bombing within 5 miles of the aiming point, the Main Force was now achieving one-half bombing within 3 miles.
[31] Sweetman (1990) p.64.
[32] Sweetman (1990) p.66. This simulation was effective but is no longer used. A similar visual anomaly (magenta eye) is, however, experienced after prolonged use of night vision goggles. This is caused by suppression of the sensitivity of retinal green cones by the purely green light transmitted by night vision goggles while at the same time the sensitivity of red and blue cones is increased. The response of the eye when re-exposed to white light is to produce over-reaction to the red and blue frequencies and hence a magenta image.
[33] The phenomenon of airsickness caused by low-level buffet in aircraft not originally designed for low-level flight is still encountered in the RAF where Nimrod MR2 rearcrew are particularly prone to it for precisely the same reasons. 617 Squadron's suffer-

ers were treated with chlorobutanol, now recognized as a hypnotic and sedative: it is interesting to speculate on the potential impact on performance of using such a drug in low-level flight. It is impossible now to establish whether any aircrew actually used chlorobutanol during the raid and whether their performance might have been degraded by it.

[34] Sweetman (1990) p.68. Bomber Command would have further experience of the damage done by low-level flight to aircraft not specifically intended for that role in 1965. The Vickers Valiant was designed as a high-speed, high-altitude unarmed bomber but in early 1964 was switched to the low-level role as high-altitude operations were deemed to be too dangerous. Less than a year later the entire fleet was grounded with fatigue damage to the wing main spar.

[35] In many ways this was an innovation as most World War II aircrew had to master their operational flying skills on operational sorties.

[36] Getting Upkeep on target was a genuine team effort: the pilot set the line, the air engineer who controlled the throttles was responsible for airspeed, the navigator monitored altitude and the bomb-aimer was responsible for the timely release of the weapon. Given the precise requirements in all parameters to drop Upkeep successfully, it is a testament to the crews' skill that the weapon was delivered with sufficient accuracy for it to function at all.

[37] This happened to Flt Lt Hopgood, the second aircraft to attack the Möhne. It is not entirely clear that the destruction of this aircraft was caused by the explosion of Upkeep and it is felt it was more likely to be due to defensive gunfire from the dam.

[38] It seems likely that, on balance, the Möhne dam was breached by the first Upkeep to explode in contact with it and that Maltby's mine merely widened the breach.

[39] The evidence on the fate of Maudslay's aircraft is unclear. At the time it was thought to have been destroyed by the mine's explosion but radio transmissions were heard afterwards and German records suggest that the aircraft was actually shot down by anti-aircraft fire on its way home.

[40] Euler (2001) p.40. The "Trident" conference was held to clarify future Anglo-American operations: these included confirmation of POINTBLANK, the joint strategic bombing offensive aimed at fatally weakening Germany. The directive was issued on 10 June 1943.

[41] Operation Order B.976. The six, in the order of importance attached to them, were the Möhne, Eder, Sorpe, Lister, Ennepe and Diemel dams.

[42] Euler (2001) p.108.

[43] Cooper (2000) p.72. Experience with flood damaged railway tracks in the US suggested that it took up to 25000 man-hours per mile to repair them and the Ruhr-Kassel railway line was, indeed, unusable for several months.

[44] Sweetman (1990) pp. 154-5.

[45] Terraine (1985) pp.546-7.

[46] Harris quoted in Terraine (1985) p.548.

[47] Speer (1970) p.281.

[48] Sweetman (1990) p. 162.

[49] Sweetman (1990) p. 162.

[50] Sweetman (1990) pp.180-2.

[51] Terraine (1985) p. 518. Bomber Command lost 872 aircraft out of 18506 sorties despatched during the 1943 "Battle of the Ruhr", a loss rate of 4.71%.

[52] Sweetman (1990) pp. 184-5.

[53] Quoted in Rumpf (1975) p.74.

[54] Sweetman (1990) p.174.

[55] Euler (2001) p.117.

[56] Sweetman (1990) p.175.

[57] Philpott (1980) p.114.

[58] Sweetman (1990) p.189.

[59] Terraine (1985) p.541.

[60] Morpurgo (1972) p.282.

[61] The first "Thousand Bomber Raid" against Cologne, for example, could be seen in the same light. Harris needed a major raid wreaking significant damage to demonstrate that his ideas on the employment of Bomber Command could work. Nonetheless, the need for 1000 aircraft rather than 900 was undoubtedly for propaganda purposes.

[62] Speer (1970) p.280.

[63] Webster & Frankland (1961) p. 168. It is a testament to advancing technology that what in 1943 was thought of as remarkable precision would be routine with today's laser and GPS guided weaponry.

21
03241

The Chinese Air Force and Air and Space Power

By Lt Col Thomas R McCabe, USAFR

Analysts who predict that China will become the next peer competitor of the United States often cite as evidence China's large population and latent industrial potential. If they are correct, a critical component of US-Chinese relations will involve understanding the strategic perspective, composition, and doctrine of China's People's Liberation Army Air Force, because the unique characteristics of Chinese society and culture discourage using historical war-fighting models as foundations for strategy.

In an informal interview with James Reston of the *New York Times* in 1971, Zhou Enlai, Premier of the People's Republic of China (PRC), laid out in broad terms the PRC's foreign-policy objectives: (1) unification of the mainland and Taiwan, (2) removal of US military power from Asia, (3) withdrawal of the massive Soviet military force deployed along the Sino-Soviet border, and (4) prevention of the rise of Japan as a military power.[1] Meeting these objectives would have established the PRC as the dominant military power in Asia. Even more important, meeting

China is a profoundly dissatisfied power in psychological terms. It craves respect, but the United States is not likely to give it such respect as long as the PRC remains a dictatorship

them today would produce the same effect. Equally notable is their ideological neutrality: any Chinese nationalist, Communist or otherwise, can support such policy aims.

If the Chinese Communist Party continues its gradual drift from Marxism to Chinese nationalism as its justification for ruling, these objectives are not likely to change. Although diplomacy can finesse and conveniently obscure the issue to a degree, and although the events of 11 September 2001 may have changed its tone, the overall circumstances of US-PRC relations make possible a future of fundamental hostility.

Even though China's primary focus today remains on its internal development and even though it is probably satisfied with its land borders, such is not the case with its maritime borders — especially with Taiwan and secondarily, the South China Sea.[2] The status of Taiwan in particular could lead to war sometime in the future. Even more important, China is a profoundly dissatisfied power in psychological terms. It craves respect, but the United States is not likely to give it such respect as long as the PRC remains a dictatorship.

To the degree that the PRC ultimately aspires to the leadership of Asia, it is likely to clash with the United States, Japan, and probably with Russia. A policy of containing China as a strategic competitor will be regarded by its government as hostile, while a policy of 'engagement' has been and will likely continue to be regarded in the same light as one of smiling containment and subversion. Some sources have indicated that the PRC government already regards the United States as a rival and has done so for several years; indeed, anti-Americanism is evidently widespread among the population.[3] The overall circumstances of US-PRC relations provide at least considerable potential for a fundamentally hostile Sino-US relationship.

For these reasons, it is prudent to study China in general and its military in particular. If the Chinese are not an enemy, it is worthwhile to understand them so as to minimize the chances of inadvertently identifying them as such.[4] If they are, we need to understand why and to judge accurately whether they represent a threat since a powerless enemy is more a nuisance than a danger.[5] If they are indeed a present or emerging threat, we must understand them in order to deter or, if necessary, defeat them.

In studying the Chinese military as a potential enemy, one must pay attention to more than just the capabilities of the People's Liberation Army (PLA) and its component services. Specifically, one would do well to begin with the PRC's military doctrine, since it shapes objectives, strategy, force structure, procurement, and training. This article addresses the air and space power doctrine of the PRC's People's Liberation Army Air Force (PLAAF) and analyzes its ability to carry out that doctrine.

Doctrine

Drew and Snow define three levels of doctrine: (1) fundamental, which deals with basic characteristics such as the nature of war, purpose of military power, and the relationship of military force to other instruments of power, (2) environmental, "a compilation of beliefs about the employment of military forces within a particular operating medium" (functionally speaking, this is air and space power doctrine — a statement of how today's air and space power capabilities should be used to have a decisive effect on military operations and wars), and (3) organizational, which includes basic beliefs about the operation of a particular military organization and its roles, missions, and current objectives.[6]

In the US Air Force, Air Force Doctrine Document (AFDD) 1, *Air Force Basic Doctrine,* covers environmental doctrine, defining it as "most fundamental and enduring beliefs that describe and guide the proper use of air and space forces in military action"; AFDD 2, *Organization and Employment of Aerospace Power,* covers organizational doctrine.[7]

The PLA and its component services do not use the term *military doctrine.* The closest analog they have to Western doctrine is what they call *military science,* which links theory and practice.[8] Chinese military science consists of (1) basic military science, the fundamental concepts that govern PLA military operations at the various levels of war (basic military science would include whatever environmental doctrine — air and space power

The battlefield will be extremely fluid and dynamic. Airpower and precision strike are now the primary means of conducting warfare, with ground operations secondary

doctrine — the PRC might have),[9] and (2) applied military theory, the specifics of how to apply military force at each level of warfare (similar to US organizational doctrine).[10]

PLA military concepts, including those of the PLAAF, are not couched in terms of roles and missions, as is the case with the US military. Instead, they use the alternative concept of *campaigns,* defined as a series of battles fought under a unified command to achieve a local or overall objective.[11] Campaigns primarily take place at what the US military would call the operational level of war using a wartime operational structure called a *War Zone*. Depending on the size of the operation, a War Zone can encompass either a portion of or more than one Military Region.[12]

A critical point of the PLA's campaign planning lies in its expectations of the military environment in the type of war it expects to face. These expectations will obviously have a dramatic effect on strategy, force structure, and procurement. At present, the PLA views the primary threat as a local (i.e. regional) war under high-technology conditions.[13] It expects such a war to have the following general characteristics:

• It will be a limited war, fought in a restricted geographic area for limited objectives with limited means and a conscious effort to curtail destruction. It will not be a comprehensive or total war, fought to destroy the Chinese state and to invade and occupy the homeland. It will not threaten the survival of the states involved. In many ways, such a conflict is the modern equivalent of a border war.[14] Overall, the threat of world war is minimal for the indefinite future, due to the revolutionary changes in external circumstances faced by the PRC over the last 15 years (i.e. the collapse of the Soviet Union and the end of the Cold War).[15]

• Such a war will be fought with comparatively small, highly trained joint forces using mostly long-range, precision-strike weapons made available by the ongoing revolution in military technology.

• The objective in such warfare is to defeat the enemy rapidly by inflicting strategic and operational paralysis through attacks on his weaknesses. In fact, it may be possible to defeat the enemy with one strike. This kind of war will not require annihilation of the enemy or physical occupation of his territory.

• This multidimensional war will unfold in all dimensions (air, sea, ground, space, and the electromagnetic spectrum) simultaneously. Warfare in one dimension will integrate with that in the other dimensions. Forces will fight throughout the depth of the theater (a "full-depth strike"), and the battlefield will be extremely fluid and dynamic. Airpower and precision strike are now the primary means of conducting warfare, with ground operations secondary.[16]

This type of war, of course, represents a revolutionary change from the traditional PLA concept of People's War, which assumed a total war fought primarily by ground forces and a comprehensively mobilized population against an invading enemy seeking to destroy and occupy the PRC. At first glance, it would appear that this new war is tailor-made for air and space power which can have a major impact by waging an independent air campaign against vital targets and supporting other arms of the military.[17]

Thus, one would reasonably expect the PLAAF to have a concept of air and space power that calls for such an air force and to restructure itself along the lines of the US Air Force (i.e. emphasizing all-weather offensive aircraft; precision-guided munitions, and sophisticated command and control, intelligence, surveillance, and reconnaissance capability). However, little evidence suggests that PLAAF military science thinks in these terms or that the PLAAF is building this kind of an organization. If anything, a massive disconnect seems to exist between what we might expect the PLAAF to do and what it is actually doing. Several likely explanations account for this situation.

For one, by assuming that the PLAAF would choose a course parallel to our own, we are mirror-imaging — that is, projecting our assumptions and thinking onto the PLAAFs. This practice proved dismally common and nearly disastrous during both the Cold War and in fact at times

PLAAF Chengdu Chinese F-7E fighters

The PLAAF now faces the worst of all worlds: it has a huge legacy force of obsolescent or obsolete equipment that was inadequate for the old strategy and that is utterly unsuited for the new one

during our past dealings with the PRC.[18] It is essential to remember that we are not dealing with Americans or, for that matter, Westerners. The PLAAF's aims are not necessarily the ones we would choose under similar circumstances (even if the PLAAF's aims were identical to ours, it might choose drastically different ways of pursuing them); its assumptions are not necessarily our assumptions and its tactics and strategies are not necessarily the ones we might choose. We must remember that the PLAAF's history is not ours and above all that the circumstances it faces are profoundly different than those we face.

Beyond this explanation for the apparent disconnect, I suggest two others. The first is that local war under high-tech conditions is what some authors call *aspirational doctrine*.[19] The second is that, at present, PLA military science, strategy, and procurement do not seek to *wage* a high-tech local war but to *defeat* an enemy who wages high-tech local war against them. These two explanations are not mutually exclusive.

Aspirational doctrine

In aspirational doctrine, military theory is much more advanced than actual military technology and capability, and the concepts of a local war under high-technology conditions detail the kind of offensive war the PRC wants to be able to wage. Such doctrine does not necessarily suggest that the PRC can in fact fight such a war today. In this respect, China's military science bears a marked resemblance to Soviet doctrinal writings such as Marshal Sokolovskiy's classic *Soviet Military Strategy* which originally laid out an extremely ambitious strategy for fighting a nuclear war at a time when the USSR was only starting to deploy the capabilities necessary to fight such a war.[20] One should note that the highest levels of the Chinese leadership have evidently recognized that at present the PRC cannot fight a high-tech local war.[21]

Preventing it from doing so are the PRC's geopolitical and historical circumstances, economic limitations, and technological limitations, as well as the legacy of its past military policies. Obviously, these factors have had, and continue to have, a profound impact on shaping the PLAAF and its military science. They constitute an enormously unfavorable legacy for the PLA and PLAAF and their military theory — one that will be difficult to overcome.

Geopolitical and historical circumstances

Historically for the Chinese war has been a home game fought on and over their territory; until recently, their military science has reflected this fact.[22] In recent centuries, China has endured humiliation and partial dismemberment from invasion, and in recent decades it has largely been surrounded by states perceived as hostile or powerful or both. The PRC's strategic concepts and military strategy have reflected this situation by focusing on a People's War, mentioned above — a strategic, defensive war to defend the mainland from attack and invasion.

China expected to wage a war of attrition designed to wear down and ultimately expel invading enemies. In this strategy, the PRC's ground army would be the pre-eminent service, supplemented by a comprehensively mobilized population. Power projection beyond China's borders was only a secondary concern, and any power projection would be by ground forces into adjacent territory. The air force played an even lesser role. In the conflict envisioned by People's War, the PLAAF's function was primarily defensive, with very limited offensive capability. China did not expect to use air and space power but did expect an enemy to do so.

The very name of the Chinese air force — the People's Liberation Army Air Force — speaks volumes in this regard. Clearly, China considered its air arm an extension of the army. Under such conditions, the PRC had no need for air and space power doctrine. Only recently has China, facing the challenge of local wars under high-technology conditions, reportedly granted the PLAAF an enhanced role. However, having a new role on paper does not equate to the ability to carry out that role. In many ways, the PLAAF now faces the worst of all worlds: it has a huge legacy force of obsolescent or obsolete equipment that was inadequate for the old strategy and that is utterly unsuited for the new one.

Economic limitations

China's lack of wealth has severely restricted the resources available for military-related matters.[23] Until fairly recently, the country spent much of its available military funds on infrastructure such as tunnel systems and the construction and dispersal of military industry to remote areas. Although economic reforms of the last 20 years have led to impressive (although often overstated) economic growth, the PRC still has neither a wealthy nor modern economy. Even partial replacement of the PLA's and PLAAF's antiquated equipment with modern assets suitable for major power projection would be enormously costly at best and ruinous at worst— undoubtedly one of the major reasons that the PLAAF's acquisition program for new equipment is proceeding so slowly.

China's attempts to design and build more sophisticated aircraft such as the F-8 have met with limited success as have its attempts to import, integrate, and maintain foreign technology

PLAAF Shenyang F-8II fighters

It might be more accurate to say that the PLAAF does not have an air and space power doctrine so much as it has an anti-air and space power doctrine

Technological limitations
Because of its poor and developing economy and society, China has had only a very limited technology base to draw upon to support its military. Although the PRC has established an increasingly significant industrial base, its ability to support a technologically sophisticated military, let alone build one by itself, remains very much open to question. The country's aviation-related military industry is limited, technologically backward, and inefficient.[24] Most of the PLAAF's equipment, especially its aircraft and surface-to-air missiles (SAM), is based on Soviet designs of the 1950s and 1960s, such as F-6 and F-7 fighter aircraft, based on the MiG-19 and MiG-21, respectively, and the B-5 and B-6 bombers, based on the Il-28 light bomber and Tu-16 medium bomber, respectively.

At best, these aircraft have only limited ability to operate at night, in bad weather, and in an electronic-countermeasures environment. Few are capable of using precision-guided munitions. China's attempts to design and build more sophisticated aircraft such as the F-8 have met with limited success as have its attempts to import, integrate, and maintain foreign technology.[25] The PLAAF and PLA evidently have major programs aimed at developing high-technology weapons, but generally they are still in the technology-development phase — years (or decades) away from actual deployment.[26]

Campaign theory of the PLA and PLAAF
Clearly, the PLA and PLAAF have only an extremely limited ability to wage a high-tech local war at present, even against an enemy such as Taiwan, and any gains in capability are proceeding slowly.[27] This situation suggests the second, probably more important, reason for Chinese military science's adoption of this concept of war: It is the kind of war the PRC expects to have imposed upon it in any future conflict, especially one with the United States or a US-led alliance.28 Within the limits of the circumstances discussed earlier, China is preparing to try to survive and defeat this kind of war. Thus, it might be more accurate to say that the PLAAF does not have an *air and space power* doctrine so much as it has an *anti–air and space power* doctrine.

At present, the national military strategy of the PRC calls for 'active defense', which involves a nominal strategic defensive that uses offensive tactics, including preemptive war. In such a war, the PRC aims not necessarily to conquer enemy territory but to win decisively and coerce the enemy to change the particular policy that prompted the PRC to go to war in the first place.[29] More than likely, the PRC will base its campaign strategy on three principles:

1) Using elite forces and sharp arms. The cutting edge will consist of 'fist forces' — comparatively small, well-equipped, and highly trained elite joint forces.

2) Gaining the initiative by striking first. Evidently, the PRC is prepared to launch a war if diplomacy fails in a crisis. PLA preparations for such an attack emphasize a campaign of deception and disinformation to maximize the chances of surprising the enemy. Furthermore, the PLA seems prepared to launch a pre-emptive strike, preferably before enemy deployments are complete.

3) Fighting a quick, offensive battle to force a rapid, successful end to the war. A long war would likely prove both economically and militarily costly. Even more important, because any PLA superiority would probably be temporary, a long war would enable an enemy to recover, mobilize, reduce the PLA to a position of inferiority, and eventually defeat it.[30]

War-Zone campaign
The PRC will likely structure the War-Zone or overall campaign as a joint effort aimed to integrate ground, naval, air, and special operations forces as well as surface-to-surface missile forces of the II Artillery Corps, with service-based subsidiary campaigns functioning with relative autonomy within the campaign plan. Any PLAAF campaign would probably be subsidiary, but some writers theorize that it might serve as the primary campaign.[31]

PLAAF air campaign
The Military Region Air Force (MRAF) commander will direct aviation units assigned to the air campaign and have responsibility for coordinating with any other service units (e.g. II Artillery

Corps, special operations forces etc) operating in support of the air campaign. The commander's purview will include the air defense campaign, the offensive air campaign, any air transport, and, presumably, any air support provided to other services, such as the ground forces and navy.[32]

Air defense campaign. Historically, the PLAAF's primary campaign entailed strategic air defense of the PRC mainland, especially the Beijing and Shanghai areas, with the air force's major arms (aviation, SAMs, and antiaircraft artillery) operating in parallel, not as parts of an integrated air defense system. It would provide defense in depth, with light screening forces located in a forward area and most forces concentrated close to key potential targets ('light front, heavy rear'). Strategic air defense remains the PLAAF's principal campaign; some authors suggest that, under some circumstances, it may be the war's only campaign.[33] In fact, its importance is increasing, for three reasons:

1) In a local war under high-tech conditions, air and space power represents the major threat faced by the PRC. Air and space power has been central to all such wars fought since 1990.

2) The threat from air and space power is growing, a fact acknowledged by the PLAAF in its "three offenses and three defenses" training program.[34]

3) The PLAAF's legacy interceptor aircraft are suited only for short-range air defense missions and most of its newer aircraft (F-7s and F-8s) face similar limitations. This situation is likely to change only very slowly as new aircraft enter the inventory.

The PRC's air defense campaign seeks to establish and maintain strategic air superiority over the War

Strategic air defense remains the PLAAF's principal campaign; some authors suggest that, under some circumstances, it may be the war's only campaign

SA-10 air defence missile transporters

Zone by (1) achieving complete deterrence through denial (psychologically, the enemy becomes reluctant to attack because he expects any such attack to fail), (2) resisting attack by targeting hostile intelligence and surveillance platforms, as well as airborne warning and control system (AWACS) and jamming aircraft, with either long-range fighters or, preferably, long-range SAMs (resisting attack remains PLAAF's priority and will become an increasingly multidimensional activity with the integration of advanced surveillance systems), and (3) launching timely counterattacks against enemy air bases (PLAAF writers stress that a purely defensive air effort surrenders the initiative to the enemy and would likely guarantee defeat).[35]

Currently, the PLAAF is working to upgrade its extremely limited strategic air defense capabilities by deploying better equipment and developing an integrated (though probably rudimentary) air defense system, something it has lacked until very recently.[36] However, modernization is proceeding slowly due to the relatively small number of Su-27s acquired thus far, either purchased from Russia or manufactured under license in China, and problems with other systems.[37]

The PLAAF is in the early stages of building an AWACS component through indigenous development and the leasing of aircraft from Russia after the United States vetoed a sale from Israel.[38] Furthermore, it has just a few advanced SAMs (SA-10s purchased from Russia) although this situation may change if and when it initiates major deployments of FT-2000s.[39] Overall, the PLAAF's limited means of projecting airpower, whether for timely counterattacks or any other reason, renders its ability to conduct an air defense campaign largely aspirational.

The Chinese air force will likely find itself relegated to nothing more than a supporting role in any offensive campaign with the major burden carried by missiles of II Artillery Corps and by information warfare for which the Chinese have vast enthusiasm

PLAAF Sukhoi Su-27 fighters

A PLAAF Sukhoi Su-30MKK fighter-bomber

The PLAAF has moved very slowly to build the force it requires: out of a force of approximately 2,500 combat aircraft, fewer than 150 can be considered modern

Offensive air campaign. This campaign seeks to maximize enemy weaknesses by "moving the battlefield as far as possible toward the enemy's side" and forcing the enemy to fight on the defensive at China's initiative.[40] It intends to exploit air and space power's advantages of initiative, versatility, and suddenness. The campaign can either stand alone as an independent air force effort or, far more likely, become part of an integrated joint campaign of surface-to-surface missiles, special operations forces, electronic and information strikes, and attacks by aircraft. The PRC could aim such a campaign at either strategic-level or campaign-level enemy target systems. The former includes political and economic systems, transportation and lines of communication, and supply and mobilization targets that will have strategic-level effects. The latter encompasses air defenses, air bases, and aircraft carriers (damage to or destruction of such targets can influence events in the War Zone).[41]

Historically, the PLAAF has not considered offensive attack a major mission since it has no capability for conducting strategic intercontinental air attack and extremely limited means for either a strategic or campaign-level offensive in a local war — a situation subject to gradual change at best.[42] Most of the PLAAF's current aircraft might prove useful only as a sacrificial first wave to soak up the defensive armaments of targets attacked in an offensive campaign. As mentioned earlier, its aircraft have little or no capability to operate at night, in bad weather, and in an electronic-countermeasures environment — and the greater part of the B-5/B-6 bomber force is obsolete.[43]

Furthermore, few if any of its aircraft can use precision-guided munitions against land targets: it has only a modest force of fighter aircraft (Su-27s) with the capability (not to mention the range) to conduct air-to-air offensive counter-air, and aside from the Su-30s coming from Russia, the PLAAF lacks the aircraft and specialized munitions necessary for airfield attack and suppression/destruction of enemy air defenses.[44] Thus, the Chinese air force will likely find itself relegated to nothing more than a supporting role in any offensive campaign with the major burden carried by missiles of II Artillery Corps and by information warfare for which the Chinese have vast enthusiasm.[45] If the conflict should expand to intercontinental ranges, the PLAAF would probably have no role at all.

Direct support of ground units. The PLAAF has a record of scant participation in close air support,

battlefield air interdiction, and interdiction, and shows no signs of improvement in the foreseeable future. Interestingly, it evidently does not consider this mission a separate campaign. Although the PLAAF has a substantial force of attack aircraft, they are not equipped — nor are their crews trained — for direct support of ground units; nor is the PLAAF organized and equipped to function in support of a highly dynamic surface war of maneuver.[46] Evidently, the air force has never successfully carried out direct support, preferring to provide indirect support by attacking targets in the enemy's rear area such as air defenses, campaign reserve forces, logistics support, communications, and helicopters.[47] The PLAAF shows no sign of initiating major efforts to improve its capabilities in this area.

Conclusions and implications

PLA military science's concept of high-technology local wars gives the army an accurate assessment of the military environment it faces in the early 21st century in the form of challenges from either a local enemy or a 'powerful country' such as the United States. The PLA's strategy of relying on surface-to-surface missiles, fist forces, and asymmetric warfare, while gradually modernizing its massive and obsolete military, is reasonably sound so long as it deals with an isolated Taiwan. Over time the strategy may provide plausible capability to coerce or overwhelm Taiwan, so long as the United States does not intervene. But it does not provide plausible capability to defeat or even deter the United States at any time in the foreseeable future.

The situation is even worse for the PLAAF which wishes (1) to move from the primarily defensive strategy and force structure of the past to one that combines offensive and defensive elements and (2) to initiate a qualitative transformation that reflects the ongoing revolution in military technology. In theory these wishes make reasonable sense. At present, however, they remain an aspirational concept that exists largely on paper. The PLAAF has moved very slowly to build the force it requires: out of a force of approximately 2,500 combat aircraft, fewer than 150 can be considered modern, and that number is increasing by fewer than 50 a year, with no sign of accelerating the acquisition process.

The air force has not taken the obvious interim step of upgrading the capabilities of existing aircraft (e.g. by adding modern missiles, especially standoff weapons, and improved electronics). Nor has it taken more than preliminary steps toward making the qualitative improvements in organization, training, and tactics that have proved so central to the success of American air and space power. Finally, the PLAAF has not undertaken a major effort to build the intelligence, surveillance and reconnaissance capabilities it will need if only to partially duplicate American capabilities.

The PLAAF's military science, force structure and acquisition make considerable sense if it is not expecting a conflict with the United States within the next 20 years. But the unsettled status of Taiwan makes that assumption uncertain at best. Against a major American effort, the PLAAF fundamentally would remain in the same position it found itself after Operation Desert Storm: incapable of either effective offense or defense and its current efforts will not change that status in the foreseeable future. In fact, in all likelihood the United States is widening its lead and will do so even more rapidly as it deploys new capabilities such as the F/A-22.

Chinese military science and strategy for a war with the United States over Taiwan call for defeating the island rapidly and presenting America with a *fait accompli* before it can intervene. China's published writings are extremely vague as to what it intends to do if its first effort does not succeed and a million tons of US diplomacy come roaring across the Pacific at flank speed and/or the speed of sound before Chinese forces have won. It seems that China hopes the United States will not be willing to endure the casualties and costs of a major war, but in that hope may lie an immense potential for danger.

Such a mind-set has ominous parallels to the wishful thinking of the leadership of the Hirohito Shogunate before Pearl Harbor. The Japanese felt that they could rapidly overrun the western Pacific and that the soft, materialistic United States would not have the stomach for a long and bloody war. Three and a half years later, their country in ruins, they surrendered unconditionally. However, it is

difficult to conceive of a nuclear-armed China surrendering on the aft deck of the *USS Ronald Reagan*.

Notes

1. Tillman Durdin, James Reston, and Seymour Topping, The New York Times Report from Red China (New York: Quadrangle Books, 1971). See p. 107 for the summary and pp. 81–106 for the actual interview.
2. China is probably satisfied with its land borders, but one cannot necessarily say the same of its neighbors- especially India. Over time, that satisfaction may change with circumstances, as the demographic balance of the Russian Far East changes with the loss of ethnic Europeans to western Russia and the illegal entry of Chinese. If, at some point, a significant majority of the population there becomes ethnic Chinese, they may start to demand annexation by the PRC.
3. Richard Bernstein and Ross Munro, The Coming Conflict with China (New York: A. A. Knopf, 1997), 22. For a more optimistic view, see John Pomfret, "China Sees Interests Tied to U.S.," Washington Post, 2 February 2002, 1.
4. Although I am extremely skeptical of the claim that wars are caused by misunderstandings, they may very well be caused by miscalculations that grow from misunderstandings. A particularly relevant example is the misunderstanding of the United States that led to Japan's miscalculation in going to war with America in 1941.
5. Fidel Castro is an obvious example. With the collapse of the Soviet empire and the bankruptcy of Communism, he has shrunk to irritant status.
6. Col Dennis M. Drew and Dr. Donald M. Snow, Making Strategy: An Introduction to National Security Processes and Problems (Maxwell AFB, Ala.: Air University Press, 1988), 167–70.
7. AFDD 1, Air Force Basic Doctrine, 1 September 1997, 2; and AFDD 2, Organization and Employment of Aerospace Power, 17 February 2000.
8. Dr. David Finkelstein, "Thinking about the PLA's Revolution in Doctrinal Affairs," draft paper, November 2002. Cited with permission of the author.
9. Adm Shi Yunsheng, "PLA Navy Military Science," in Chinese Navy Encyclopedia, vol. 1 (Beijing: Haichao Publishing House, 1998), 16–31. Many thanks to Dr. David Finkelstein of the Center for Naval Analysis for bringing to my attention the PLA's naval encyclopedia (and the book The Science of Campaigns).
10. Shi Yunsheng, 16–31.
11. Wang Houquing and Zhang Xingye, eds., The Science of Campaigns (Beijing: National Defense University Press, 2000), especially chap. 1.
12. A Military Region is a peacetime administrative entity whereas a War Zone is a wartime operational entity for the command and control of campaign-level operations. Military Regions provide forces and assets to a War Zone. Dr. David Finkelstein, Center for Naval Analysis, correspondence with author.
13. An excellent basic source is Chinese Views of Future Warfare, ed. Michael Pillsbury (Washington, D.C.: National Defense University Press, 1997). For a more recent and representative Chinese view, see Gen Fu Quanyou, "Deepen the Study of the Characteristics and Laws of High-Technology Local Wars and Raise the Standard of Guidance for Winning the High-Technology Local War of the Future," Beijing Zhongguo Junshi Kexue, 20 February 1999, on-line, Internet, 25 May 2002, Foreign Broadcast Information Service (FBIS) Online [hereafter FBIS Online], serial FTS19990701001913, available from http://199.221.15.211.
14. One should note that, for the United States and the PRC, the Korean War was the equivalent of a border war. Nevertheless, it was a major war.
15. One should note that some events, especially the bombing of the PRC embassy in Yugoslavia, reportedly prompted some Chinese leaders to warn that US hegemony was increasing regional wars, which could lead to a world war. See Yueh Shan, "Beijing Sets Forth New World War Theory," Hong Kong Cheng Ming, 1 May 1999, on-line, Internet, 25 May 2002, FBIS Online, serial FTS19990516000908, available from http://199.221.15.211. See also Li Tzu-Ching, "The Chinese Military Clamors for War: Vowing to Have a Fight with the United States," Hong Kong Cheng Ming, 1 June 1999, on-line, Internet, 25 May 2002, FBIS Online, serial FTS19990626000913, available from http://199.221.15.211.
16. In December 1995, the Central Military Commission- the Communist Party organization that oversees the military- concluded that the ground battle was now secondary to the air battle. See Mark Stokes, "China's Missile, Space, and Conventional Theater Missile Development: Implications for Security in the Taiwan Strait," in People's Liberation Army after Next, ed. Susan M. Puska (Carlisle Barracks, Pa.: Strategic Studies Institute, US Army War College, 2000), 109.
17. Wang Houquing and Zhang Xingye, chap. 3, p. 9.
18. Dr. Jeffrey Record, "Thinking about China and War," Aerospace Power Journal 15, no. 4 (winter 2001): 69–80.
19. The concept is from Paul Godwin, quoted in Kenneth W. Allen, "Focus on China's Air Force Modernization," unpublished paper, n.d., 3.
20. Marshal V. D. Sokolovskiy, Soviet Military Strategy, 3d ed., trans. and ed. Harriet Fast Scott (New York: Crane, Russak, and Company, 1975). The original Soviet edition was printed in 1962.
21. In 1999 Jiang Zemin recognized that the PRC could not fight and win this kind of war. See "Review of Jiang Zemin's Views on

High-Tech Warfare," Beijing Jiefangjun Bao, 13 February 2001, on-line, Internet, 25 May 2002, FBIS Online, serial CPP20010213000086, 4, available from http://199.221.15.211.

22. This, of course, differs most profoundly from the situation of the United States, which, surrounded by friendly countries and far away from the main battlegrounds of the world, has implicitly or explicitly assumed for nearly the last century that any wars it fought would be expeditionary and conducted somewhere else. China has not enjoyed that luxury.

23. Mao Zedong's ideologically driven policies of the 1950s and 1960s, particularly the Great Leap Forward in the 1950s and the Great Proletarian Cultural Revolution in the mid-to-late 1960s, were disastrous, even by the standards of Communist economics; they led directly to repeated economic and political upheavals that set PRC economic growth back decades.

24. For information on the technological limits of Chinese military industry, see Bernard D. Cole and Paul H. B. Godwin, "Advanced Military Technology and the PLA: Priorities and Capabilities for the 21st Century," in The Chinese Armed Forces in the 21st Century, ed. Larry M. Wortzel (Carlisle Barracks, Pa.: Strategic Studies Institute, US Army War College, 1999), 159–215. See also John Wilson and Xue Litai, "China's Search for a Modern Air Force," International Security 24, no. 1 (summer 1999): 64–94.

25. For information on China's past difficulties with integrating foreign technology into its aircraft, see Wilson and Xue Litai. In "China Hikes Defense Budget Again," Washington Post, 5 March 2002, 5, John Pomfret reported that 60 percent of China's Su-27s were grounded. The Chinese consider the Su-27s inadequate. See Chi Mo, " 'J-10' Fighters Set to Become Air Force's Main Arms-50 'J-10' Fighters Set to Be Built; General Secretary Jiang Zemin Watches Test Flight," Hong Kong Sing Tao Jih Pao, 29 May 2002, on-line, Internet, 25 May 2002, FBIS Online, serial CPP20020529000059, available from http://199.221.15.211.

26. Mark A. Stokes, China's Strategic Modernization: Implications for the United States (Carlisle Barracks, Pa.: Strategic Studies Institute, US Army War College, 1999).

27. Michael O'Hanlon, "Why China Cannot Conquer Taiwan," International Security 25, no. 2 (fall 2000): 51–86.

28. PRC writings often assume a US-Japanese alliance, and some of them imply that the PRC expects to confront NATO. See Gen Liao Xilong, "PRC General Discusses Civilian Air Defense," Beijing Zhongguo Junshi Kexue, 1 April 2001, on-line, Internet, 25 May 2002, FBIS Online, serial CPP20010416000146, available from http://199.221.15.211.

29. Mark Burles and Abram N. Shulsky, Patterns in China's Use of Force: Evidence from History and Doctrinal Writings (Santa Monica, Calif.: RAND, 2000), vii.

30. This description draws extensively from Nan Li, "The PLA's Evolving Campaign Doctrine and Strategy," in The People's Liberation Army in the Information Age, ed. James C. Mulvenon and Richard H. Yang (Santa Monica, Calif.: RAND, 1999), 146–74. See also Huang Jialun, "Attach Importance to Operation at Outer Strategic Line," Beijing Jiefanjun Bao, 30 November 1999, on-line, Internet, 25 May 2002, FBIS Online, serial FTS19991231001520, available from http://199.221. 15.211; and Nan Li, 154.

31. Maj Gen Zheng Shenxia and Senior Col Zhang Chazhi, "The Military Revolution in Air Power," in Pillsbury, 301.

32. The main transport capability of the PLAAF consists of 25 Y-8s (Chinese-built AN-12s) and 25 Il-76s. See "World Defense Almanac," Military Technology 26, no. 1 (January 2002): 301. The demands on PLAAF's transport force are likely to be extreme. In addition to providing force-projection capability, they will have to redeploy troops from other parts of the PRC to reinforce the War Zone. The PLAAF's very small force of transports is likely to be totally inadequate for either mission, let alone both. Although Chinese civilian transports can deliver troops, they cannot move much equipment. In addition to these wartime campaigns, PLAAF writings discuss an air-blockade campaign, intended to isolate a target country. See Wang Houquing and Zhang Xingye, chap. 13.

33. Zong Fangsheng, "PLA Merges Artillery and Air Defense Forces," S&T Daily, 25 July 2000. He is evidently thinking in terms of NATO's war against Yugoslavia in 1999.

34. Kenneth W. Allen, "China and the Use of Force: The Role of the PLA Air Force," unpublished paper, 2000, 26. The three new offenses include those against stealth aircraft, cruise missiles, and armed helicopters. The three new defenses include those against precision bombing, electronic interference, and reconnaissance and surveillance. See Guo Jia, "Building Stronger Armed Forces through Science and Technology: Train Crack Troops for Winning Future Wars," Beijing Renmin Rebao, 17 December 2001.

35. Strategic air superiority results from establishing air superiority for the entire war over the entire War Zone, or for specific periods of time over a specific location or locations. The Chinese aim to establish such superiority not only over the PRC mainland, but also over the area into which they are trying to project power. See Kenneth W. Allen, "PLAAF Strategic Thought," unpublished paper, n.d., 1–3; and idem, "PLA Air Force Operations and Modernization," in Puska, 224.

36. In 1999 a US Department of Defense report estimated that it would take up to 20 years for China to fully establish a national integrated air defense system. Cited in Allen, "Focus on China's Air Force Modernization," 13.

37. China has purchased 76 Su-27s from Russia, and licensed production of an additional 200 is under way. See "World Defense Almanac," 301. However, this is hardly a crash program: the production agreement between Russia and China set the maximum production rate at 10–15 per year. See Allen, "Focus on China's Air Force Modernization," 7–8 n. 16. In addition, the F-10 fighters entering production will replace the comparatively new F-8IIIs,

not the elderly F-6s- a situation that presumably indicates serious problems with the F-8IIIs.
See Chi Mo.
38. Four Russian-built A-50M/U airborne early warning and control (AEW&C) aircraft are reportedly on order. See "World Defense Almanac," 302. China seems to need 15–20 such aircraft. See Allen, "Focus on China's Air Force Modernization," 10–11. The indigenous aircraft is the Y8AEW. See Department of Defense, Report to Congress Pursuant to the FY 2000 National Defense Authorization Act, Annual Report on the Military Power of the People's Republic of China (Washington, D.C.: Secretary of Defense, 2000), 17, on-line, Internet, 15 April 2003, available from http://www.
defenselink.mil/news/Jun2000/china06222000.htm.
39. Jim O'Halloran, "New Missile for Chinese FT-2000 SAM System," Jane's Defence Weekly, 15 August 2001, 15.
40. Zhou Shijun, "Try as far as Possible to Move the Battlefields toward the Enemy Side," Beijing Jiefangjun Bao, 14 September 1999.
41. Allen, "China and the Use of Force," 12.
42. In 1999 PLAAF commander Liu Shunyao said that the PLAAF would change as fast as possible from territorial air defense to gain both defensive and offensive capabilities, indicating that offensive capability was an aspiration, not a present capability. See Sun Maoqing, "Air Force Commander Liu Shunyao Says That He Is Endeavoring to Build a Powerful Modern People's Air Force with Both Offensive and Defensive Capabilities," Beijing Xinhua Domestic Service, 8 November 1999, on-line, Internet, 25 May 2002, FBIS Online, serial FTS19991130000440, available from http:// 199.221.15.211.
See also Huang Jialun.
43. Allen, "China and the Use of Force," 40. Although the specific reference is to F-6s and F-7s, this could just as readily apply to the B-5s and B-6s of the PLAAF bomber force. The PLAAF evidently has about 150 B-5s (being retired) and
120 B-6s. See "World Defense Almanac," 301.
44. The PLAAF has taken delivery of 38 Su-30s, signed a second contract for a second batch of 38 more in 2001, and is reportedly expected to buy at least a third batch. See "China Expected to Buy Third Batch of Su-30MKKs," Jane's Defence Weekly, 21 August 2002, 14. The PLAAF, which is reportedly procuring them as replacements for older B-5s, may be considering producing them under license. See Allen, "PLA Air Force Operations and Modernization," 215.
45. The Chinese are enthusiastic about the potential of information warfare, which they seem to regard as something of a magic bullet. However, their actual capabilities may be quite limited. See James Mulvenon, "The PLA and Information Warfare," in Mulvenon and Yang, 175–86.
46. The PLAAF has about 500 Q-5 attack aircraft, which are redesigned F-6s. See "World Defense Almanac," 301.
47. See Allen, "PLA Air Force Operations and Modernization," 201; and idem, "China and the Use of Force," 6.

RAF Ethos & Culture in the 21st Century

Aircrew or Air Power?

By Sqn Ldr Anthony J Seabright

"Air power is the most difficult of military force to measure or even express in precise terms'
(Winston Churchill)

British military ethos and culture has usually been studied in the context of the British Army rather than the Royal Navy or Royal Air Force (RAF). This is possibly because the Army provides a richer variety of material for what has traditionally been regarded as an area of academic study, particularly for historians and sociologists[1]. It is only comparatively recently that the RAF has begun to seriously examine and seek a better understanding of its own particular ethos and culture. Such internal studies that have been undertaken have sought to support short-term decision making at Air Force Board level.[2]

A possible reason why it has taken so long for the RAF to generate a debate about the subject may be due, in no small part, to the nature of air forces and air power. Meilinger states that airmen "have had a difficult time attempting to analyse, define and explain the concept of air power, not only to the other Services, decision makers and the public at large, but even to each other"[3] and defining and explaining the ethos and culture of air forces is little different. The various internal studies have raised a number of pertinent issues relating to the future ethos and culture of the RAF and the Service's response to various societal pressures.

When compared to the Royal Navy or British Army only a small proportion of RAF personnel, primarily officer aircrew, has traditionally sought to engage in combat

However, the studies have not critically examined the underlying assumptions concerning the RAF's specific ethos and culture, nor the adaptation of that ethos and culture to the operational imperatives of the 21st Century.

Within the limits of this paper, ethos is defined as a "system of values and governing principles that influence and characterize the way in which members of a group interact with one another and respond to the world around them".[4] Culture is defined as "the symbolic, learned, non-biological aspects of human society including language, custom and convention"[5] that reflects and supports this ethos. Often described by the British military as "Core Values. . . [they] always include such recognisably military virtues as physical courage, total commitment and service before self"[6]. Schein argues that these values then "serve as a guide and as a way of dealing with uncertainty of intrinsically uncontrollable or difficult events"[7].

The RAF, like its sister Services, has always accepted that its ethos and culture needs to be different from the society its personnel are drawn from if it is to sustain the moral component of air power[8], because of the 'unlimited liability' [9] that its personnel accept. RAF ethos is currently defined as:

"The distinctive character, spirit and attitude of the RAF which together inspire people to face danger, and even death. It is underpinned by tradition, esprit de corps *and a sense of belonging. It encompasses the will to contribute to the delivery of effective air power that arises from confidence in the chain of command, trust in colleagues and equipment, respect for individuality, sustainment for high professional standards and the courage to subordinate personal needs for the greater good"*[10]

However, the RAF has long recognized that its ethos and culture is different in many respects from those of its sister Services. When compared to the Royal Navy or British Army only a small proportion of RAF personnel, primarily officer aircrew, has traditionally sought to engage in combat. Many of the remainder of RAF personnel are well-educated technical specialists whose primary role is to enable aircrew to engage in combat. It is the ethos and culture of the RAF's officer aircrew that has dominated the organization, not least because it is from their ranks that the senior leadership of the Service is drawn. Forged in an era of total war and profound technological change, this ethos and culture has primarily been sustained within the Service throughout the 20th Century by the stations and squadrons that provide its organizational foundation. However, that foundation and the ethos and culture it supports may be vulnerable to future changes in the nature of conflict.

This paper will critically examine future influences on the ethos and culture of the RAF and the possible consequences for the Service as it conducts operations in the 21st Century. The paper will focus on the possible impact that any reduction in the role of manned combat aircraft and the increasing use of jointery and contractorization may have on the RAF's ethos and culture. Such operational and organizational changes may have a profound effect on the Service's position at the 'right of the line'[11]. But for the ethos and culture of the RAF to be understood it is first necessary to understand the historical context that has influenced the development of ethos and culture within the RAF.

The ethos and culture of military organizations

"What are the morals of the military world . . . The military world is characterized by the absence of freedom — in other words, a rigorous discipline-enforced inactivity, ignorance, cruelty, debauchery and drunkenness."
(Leo Tolstoy)

Military organizations have often been perceived as being a world apart from the societies they serve, not least because of their functional imperative of being able to inflict violence. Military ethos and culture is based, in part, on the wider social ethos and culture of the society from which soldiers are drawn. However, this is then developed by military organizations through the processes of both formal and informal socialization in which recruits are dispossessed of large parts of their previous civilian, ethos and culture and assimilate a distinctive military ethos and culture. As Massey states:

"In the military sense ethos comprises a distinctive style of thought and behaviour, related to a specific

A patrol of the 1st Battalion, The Queen's Regiment in Basra

The ability to conduct high intensity war fighting operations remains the ultimate raison d'être for the British armed forces

professional purpose within the wider cultural and moral setting of the parent society. It is typically manifested at both the individual and institutional levels, and its defining characteristics normally include: marked corporate solidarity and unit cohesion; a pronounced sense of patriotism, duty, loyalty and honour; the subordination of individual needs to those of the larger group; acquiescence in a rigid and hierarchical structure, founded on firm discipline; and an attachment to tradition, ritual and symbolism."[12]

The purpose of this is to ultimately ensure that military personnel carry out their functions in combat, because a natural individual reaction would be to avoid combat in an effort to stay alive[13]. This requirement to get men to fight is still an accepted part of British Defence Doctrine that identifies the need for motivation, leadership and effective management as the moral component of fighting power.[14] This need to ensure that men would fight also contributed to the development of professional armed forces. As Hackett argues:

"It has evolved into a profession, not only in the wider sense of what is professed, but in the narrower sense of an occupation with a distinguishable corpus of specific technical knowledge and doctrine, a more or less exclusive group coherence, a complex of institutions peculiar to itself, an educational pattern adapted to its own specific needs, a career structure of its own and a distinct place in the society which brought it forth"[15]

Physically separated from the rest of society the distinctive ethos and culture of this profession flourished, as Howard states:

While the military have accepted the increasing role of women and adapted themselves accordingly they have, to date, resisted the incorporation of women into units whose principal task is deliberately to close with and kill the enemy face-to face

"They were a self contained universe, with their own routine, their own ceremonies, their own music and dress and habits; that whole tedious but obsessive way of life known as 'soldiering"[16]

The armed forces have thus evolved into separate and distinctive institutions within British society. They also exhibit the traditional features of a Weberian bureaucracy[17]: they are hierarchical, have a formal body of rules and role specialization, impersonal relations between members, provide long-term employment, promotion and pay dependent upon merit and a rational decision-making process. In particular, all armed forces have evolved structures that support both their functional ability as well as their ethos and culture, both of which are required to ensure that they can effectively manage and apply violence on behalf of the state.

These structures reinforce the subjective 'psychological contract' that is often said to exist between the Services and each individual Serviceman and which commits the individual to risk his life in return for suitable rewards and support[18]. Keegan argues that this 'western' military culture, readily apparent in the British armed forces has been very successful in getting men to fight and win wars.[19]

This war-fighting ethos is also closely associated with the concept of the nation-state and the idea that soldiers "were not primarily members of a warrior caste, fighting from a concept of honour or of feudal obligation; nor were they contractors doing a job for anyone who would pay them. They were servants of the state, or rather of their country"[20]. Nevertheless professional western armed forces still retain elements of all the above, not least the British armed forces who still take an oath of loyalty to the Monarch as head of state. The war-fighting ethos continues to provide the cultural paradigm for the British Armed forces and "The ability to conduct high intensity war fighting operations remains the ultimate *raison d'être* for the British armed forces".[21]

There remains a general acceptance that the armed forces do need to be different from the societies "because of the functional imperative that underpins all their actions, namely war fighting".[22]
However, since the Cold War there has been societal pressure for the armed forces to adapt their ethos and culture. Some senior military officers have expressed their concern about this, General Rose has commented that "Today, our military ethos . . . is being actively destroyed by a mixture of cultural change within our society and new national and international legislation"[23].

In 2000 the Chief of the Defence Staff, General Guthrie, warned that if this process, together with under-funding, continued then the British armed forces could become "little more then a gendarmerie, all symbolism and no substance".[24]
There are three main reasons why the war fighting ethos and culture of the services are perceived as being at risk. Firstly, there are the significant cultural and social changes occurring in British society that have resulted in the composition of the British armed forces being altered; principally with an increasing number of roles for females, the acceptance of homosexuals and the influence of human rights legislation.

Secondly, for primarily economic reasons more civilians, both civil servants and private contractors, now carry out tasks within the military that were traditionally performed by Service personnel. Finally, there are the profound changes to the nature of operations that the armed forces are now required to conduct, many of which are not related to war fighting. Consequently, armed forces are now "more multipurpose in mission, increasingly androgynous in make-up and ethos, and with greater permeability with civilian society".[25] Together these changes have led to the label 'Post-Modern' being applied to military organizations to differentiate them from 'Late Modern'[26] forms of military organizations of the Cold War that had an essentially masculine war fighting ethos and culture.

Many of these societal pressures, such as allowing homosexuals to serve, have been forced onto a reluctant military; others such as the greater involvement of women have been successfully

Women can now fly combat aircraft, and are excluded only from service within the RAF Regiment

accommodated by them. Dandeker has argued that the British armed forces should embrace certain changes, accommodate others with caution and resist those changes that are likely to impact upon their operational effectiveness, such as permitting women to serve in infantry units.[27] The Services are now attempting to react to societal changes while retaining their military effectiveness as they accept that they will only be able to recruit and retain personnel from Generations X and Y if they do change[28].

As the Vice Chief of the Defence Staff, Air Chief Marshal Sir Anthony Bagnall stated in relation to recruit training: "Youngsters of today are different. They are less committed to a long-term career, they are more materialistic, better educated and more questioning".[29] However, this need to accept change has been balanced against the need of the Services to retain war-fighting effectiveness. This is most apparent in relation to the Service's attitudes to women. While the military have accepted the increasing role of women and adapted themselves accordingly they have, to date, resisted the incorporation of women into units whose principal task is "deliberately to close with and kill the enemy face-to face"[30]. This is primarily because of their physiological and psychological limitations.

For the RAF this has meant that women can now fly combat aircraft, and are excluded only from service within the RAF Regiment. Both Dandeker[31] and Massey[32] argue that the Services have often resisted change in the past, but once forced to accept it have found that their operational effectiveness has not yet been compromised.

Dandeker and Massey reflect the primary concern of the Services that social changes and pressures should not effect their 'war-fighting' ethos and culture or that any resistance to social change, because of that imperative, does not effect their own legitimacy. Recent debates over such issues as the role of women and the training of recruits have been of real concern to the Army for these reasons. The Services have generally been more successful at resisting organizational changes that they believe could affect their war fighting ethos and culture, particularly the Army when defending its regimental system.

However, the need to find cost-effective ways of achieving capabilities has resulted in the increase in the number of 'joint' units and the use of civilian contractors. These changes coupled with technological developments and the possible nature of future conflicts may have a greater impact on the Services distinctive ethos and culture, although the effects will vary between each Service. It is easy to understate the variations in war fighting ethos and culture that exist between the Services: each has developed differently because of the nature of the

The RAF remains focussed on maintaining a technological edge over any potential adversary

An RAF Harrier GR7 armed with a laser guided bomb

environment in which they operate. Consequently, it is likely that any change in the nature of war fighting will also effect them differently and this may be particularly so for the RAF.

The development of RAF ethos & culture
"We few, we happy few, we band of brothers"
(William Shakespeare)

The differences in ethos and culture between the Services have often been accentuated and celebrated by the Services themselves for a variety of reasons including *esprit de corps* and bureaucratic rivalry. But the major difference between the RAF and its sister Services is primarily because "only a small minority of RAF personnel – aircrew – directly and regularly engages in combat".[33] A common perception by the detractors of air forces is that when compared to the other Services "Air-forces are undisciplined, they do not fight real battles; they are populated by a glamorous elite rather than real warriors; the higher echelons are remote technocrats who raze cities and kill civilians without compunction"[34] and that their ethos and culture reflect this resulting paradigm.

The RAF accentuated the differences in its ethos and culture from the other Services as it struggled to retain its independence during its early years of existence. It has always placed significant emphasis on the technical skills of individuals within the Service rather than what are, to many, secondary skills such as weapon handling or 'tactical' leadership and teamwork 'in the field'. Its airmen are identified by the variety of specialist 'trade groups' to which they belong; most RAF

The Air Force Board accepts that respect for individuality is a more dominant aspect of RAF culture than that of the Army or the RN

personnel are also usually less concerned about what has been called traditional military 'bullshit'.[35] Consequently, the Air Force Board accepts that "respect for individuality is a more dominant aspect of RAF culture than that of the Army or the RN".[36]

In historical terms there a variety of influences that have shaped the culture and ethos of the RAF. Firstly, the RAF was born in an era of total war between nation states. For many of the original proponents of air power, such as Douhet, World War One showed that warfare on land and sea could become rapidly stalemated, but that in a war of attrition it would be difficult if not impossible to defeat a well-supplied enemy army. In contrast, Douhet argued, the new centres of gravity for states were now the civil populations whose industrial efforts sustained their armed forces. Air power could be used to bring about the rapid collapse of an enemy "by bombing vital centres and thus breaking his will"[37] at little cost to the attacking side.

Trenchard used these arguments to help justify an independent Service with a distinct operational role at the expense of the other two Services when defence expenditure was being reduced during the 1920s and 1930s, a success that exacerbated the bureaucratic rivalry and conflict between the Services.[38] This sense of an independent role was supported by the RAF's self-belief that was based on the certainty of airmen that their profession represented the future of war fighting, compared to the other Services whose own pride and self belief was perceived as being rooted within the past. As Meilinger asserts, "Soldiers tend to look backward to the great captains and the great wars whilst casting only furtive glances towards the future. For airmen the opposite tends to be true- our gaze is forward."[39]

Secondly, the RAF could only exist because of the technological advances that permitted men to fly into combat. As Howard states, "war in the air became an immensely sophisticated exercise in tactical and technological ingenuity in which the professional fighting men were at least as dependent on the expertise of the scientist as they were on their own skills to carry out a task".[40]

The utilization of technological advances such as radar and monoplanes is still celebrated by the RAF as they enabled 'the few' to win the Battle of Britain in 1940.[41]

The RAF remains focussed on maintaining a technological edge over any potential adversary, as the Chief of the Air Staff recently stated: "Our ability to carry out the roles I have outlined will remain inextricably linked to our weapons systems and so to the speed of technological change"[42]. The centrality of weapons systems is a key feature of the RAF. The Army may talk about 'equipping the man' but the RAF is focussed on acquiring complex weapon systems and then manning them with relatively small numbers of highly trained aircrew, many of whom could be more lucratively employed within the commercial airline industry. The successful military utilization of technology by the RAF has primarily depended upon the performance of these individuals both in the air and on the ground because, as Westenhoff states: "The most prized military trait of air power, flexibility, stems from individual performance, trustworthiness and initiative".[43]

However, even though the RAF was created because of technological developments in the 20th Century it could not escape from the older military traditions of the other Services. The RAF likes to emphasise its unique 'light blue' ethos[44] and its uniforms and rank titles also highlight its organizational and cultural distinctiveness; yet much of its organization and culture is an amalgam of Royal Navy and Army organization, traditions and rituals that have changed surprisingly little over the years.

Thus, while the RAF has sought to be different from its sister Services it remains tied to the rituals and symbols inherited from both the Royal Naval Air Service (RNAS) and the Royal Flying Corps (RFC), as Congdon states: "the cut of the [RAF] uniform is Army, the method of portraying rank Navy. The eagle badge is RNAS, and the brown gloves a legacy of the RFC".[45] Many in the other Services remain dismissive of the RAF's attempts to be different, as a Royal Navy Petty Officer writing to *The Times* stated: "The RAF do not have traditions, they only have habits".[46]

More significantly, organizational influences on ethos and culture inherited from the RFC and the RNAS came from stations and the flying squadrons that were sustained by them. Flying squadrons, like Army regiments, celebrate their own unique history, battle honours and customs. The RAF has always believed that "identity with specific squadrons has proved to be a powerful tool in the development of ethos for *ab-initio* aircrew".[47] In many respects stations and squadrons became, like garrisons and regiments are for the Army, self-contained institutions that acted as the focus for the RAF's military capability and helped sustain and develop its distinctive ethos and culture.

The nexus for RAF ethos and culture on stations and squadrons was the RAF's aircrew and it was the aircrew that primarily provided the senior leadership of the Service. The command of major stations and flying squadrons has traditionally been the preserve of aircrew. However, unlike the other two Services, this leadership "is distinctive for the narrowness of its gene pool".[48] It is equally true that the leadership of both the Royal Navy and the Army is dominated by 'war fighters'.

However, in both these Services the function of combat is neither confined to, or defined by, such a relatively small number of individuals who, within the RAF have never totalled more than about 20% of the officer corps. For the Army, as Terraine argues : "to lead their men in battle is what army officers are for — not the only thing, but a very important one. The RAF is different and peculiar".[49] As Terraine makes clear in reference to RAF personnel in World War Two:

"The overwhelming majority [of RAF personnel] . . . were to be found in the ground crew — that assembly of skilled, educated, individualistic, irrelevant, dependable men without whose untiring labours the aircraft would not have flown, the operations would not have happened, the victory could never have been won"[50]

The majority of ground branch officers are technical specialists who, though they may command men, will probably never lead their men into battle or have the opportunity to reach the highest ranks of the Service. Consequently, the war fighting ethos and culture has been established by the aircrew and has been largely assimilated by the remainder of the RAF whose primary role is to support those who fight, even though they may have distinctive sub cultures of their own.

Subcultures and fragmentation

"Every airfield should be a stronghold of fighting air-grounds men, and not the abode of uniformed civilians in the prime of life protected by detachments of soldiers. It must be clearly understood by all ranks that they are expected to fight and die in defence of their airfields"
(Winston Churchill)

This war fighting ethos and culture based upon stations and flying squadrons commanded by aircrew arguably reached its apogee during the Cold War when the RAF's combat power was based around Main Operating Bases (MOBs) located within West Germany and the UK. The MOBs were located well behind the expected front line but were intended to conduct operations against Warsdaw Pact forces. These MOBs (or 'citadels') were fighting units in their own right; they were maintained at a high state of military readiness and all ground personnel were trained to operate within an NBC environment and protect their airfields against attacks by enemy special forces. Consequently, this war-fighting ethos was well developed and easily maintained amongst all RAF personnel and reflected in a distinctive MOB or 'citadel' culture. Many personnel, both aircrew and non-aircrew, spent many tours on these MOBs living and training together.

However, this MOB culture masked, to some extent, the complexity of air power and the subsequent demands for a large number of specialists to support air operations, provide logistics and force protection. This ensured that the RAF increasingly consisted of non-aircrew officers in a variety of branches together with the various 'tradesmen' they commanded. While MOBs had a distinctive culture many of these supporting specializations, such as the RAF Regiment, medical personnel or the RAF Police, could be classed as distinct subcultures within them because by virtue of their own specialist training and occupation.

As Gudykunst states: "they are groups within a culture whose members share many of the values of that culture, but also have some values that differ from the culture".[51] Some of these sub cultures have their own distinctive esprit de corps that improves their effectiveness and enhances their contribution to air power. This is a common phenomenon and few large organizations have a completely universal ethos and culture. As Reiner has argued in relation to police forces (which are not dissimilar to armed forces as they are also involved in the application of force on behalf of the state):

"The values, norms, perspectives and craft rules which inform their conduct is, of course, neither monolithic, universal nor unchanging. There are differences of outlook within police forces, according to such variables as personality, generation, career trajectory and structural variations according to rank, assignment and specialization"[52]

The RAF's sister Services are equally obliged to differentiate between occupational specializations. However, research tends to suggest that because of the role and organization of air forces there are much sharper divisions between the various occupational sub cultures within them compared to the other Services. In a detailed examination of cultural perceptions within USAF, Smith found evidence that the USAF is fractionalised, with internal divisions between 'pilots and all others'[53] Smith's research indicates that the 'others' of the USAF were also divided into distinct occupational subcultures.

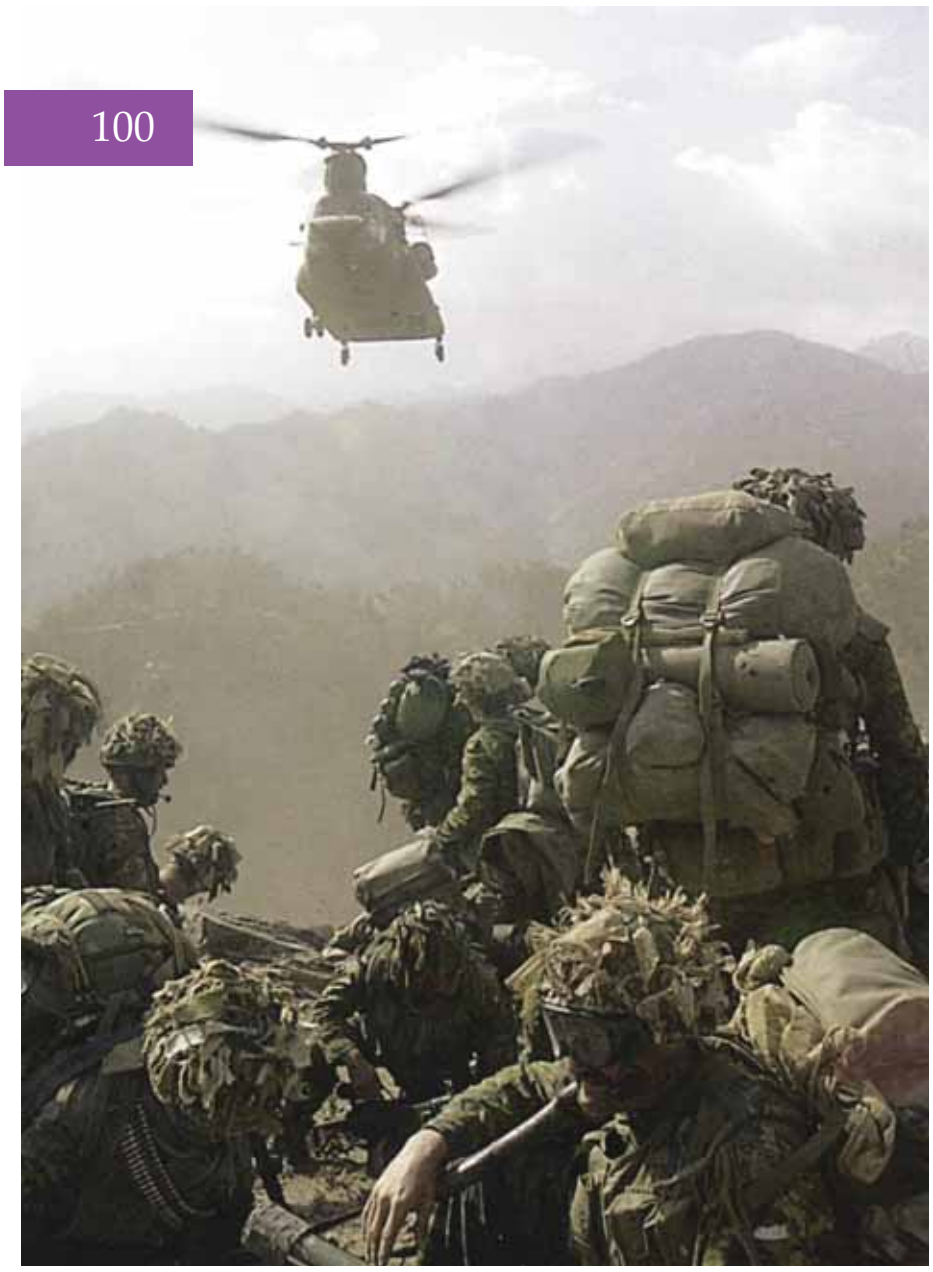
When comparing the USAF to the other US armed forces, Smith argues that the US Army is the most cohesive and this was attributed to the mobility between specializations and the fact that soldiers serve together in interdependent combined arms teams who live (and may die) together in combat. Smith believes that the US Navy is the second most cohesive service because of the confined operational environment of a warship in which all live and operate together for prolonged periods of time. In contrast Smith sees the USAF as the least cohesive of the Services, being fractionalised by diverse and specialized technologies and operating concurrently at the strategic, operational and tactical levels. Consequently, Smith argues that "there is much less 'glue', less single mission simplicity, and less combined physical contact than is seen in the other Services"[54].

It may be difficult to draw direct parallels between Smith's research and the situation that exists within the UK armed forces, not least because of the fractionalisation caused within the British army by the regimental system[55] (although this may be more apparent than real). However, there appear to be distinct similarities between the USAF and the RAF in this regard, with both officers and airmen within the RAF being divided into a variety of different branches (and sub-specializations for officers) and trade groups, all focussed on their specific roles.

The end of the Cold War and the increasing pressures to reduce costs, together with the associated contractorization and civilianisation of many tasks traditionally performed by military personnel has also led many in the RAF to view the RAF as just another employer and themselves as merely employees, rather than members of an organization with a specific military purpose.[56] It has been argued that given their propensity to leave the Service to fly with commercial airlines even aircrew "see themselves as technicians first and military professionals second".[57]

Following the Cold War the RAF has had to culturally adapt to operating from unprepared bases and supporting its sister Services in a manner arguably not seen since the use of tactical air forces in North Africa and Europe during World War Two. It has not been an easy process for the RAF to move away from the certainties of operating from MOBs against a well-defined enemy, although this is becoming easier as personnel recruited since the 1990s have become accustomed to regular deployments. In this regard the RAF is also similar to the USAF and the Chief of the USAF recently admitted that:

"This new generation of air and space warriors has to be tougher minded. It has to get back to the mentality of the old composite air strike force, where they used to live under the wing—they fly in set up the tent city and live off meals ready to eat for a week or so before



Since the end of the Cold War conventional military power has been used to achieve political objectives where diplomacy has failed

A Chinook prepares to pick up troops in the Tora Bora region of Afghanistan

sustainment airlift starts . . . in this culture you have to get back to some basic institutional values: every airman is a warrior"[58]

However, particularly since the 1999 Kosovo campaign, the RAF has begun to adapt to the needs of expeditionary operations and proved itself capable of successfully operating within Afghanistan during 2002. Indeed since that campaign there appears to be an increasing acceptance within the RAF's hierarchy that such operations are no longer the exception to the rule:

"Following the Afghanistan campaign the Royal Air Force really understands what is meant by the term Expeditionary Air Operations . . . no notice deployments to remote parts of the world . . . to absolutely bare base conditions with the most basic and harsh living conditions with exceptionally challenging operational flying conditions"[59]

Stations and squadrons that have traditionally sustained the RAF's ethos and culture have been marginalized, to a great extent, by the nature of expeditionary operations. In these expeditionary operations most MOBs rarely have an operational role. In addition, technological and operational requirements dictate that flying squadrons often do not operate together as cohesive units during operations and that, unlike in the Cold War, composite formations are more usually the norm.

The RAF's Deployed Operating Bases (DOBs) are usually manned by an *ad-hoc* mixture of personnel,

both regular and reservists, some deployed as formed units and others as individuals. This makes it far harder to ensure that there is a cohesive war fighting ethos and culture within both units and DOBs and imposes further strains on the moral component of air power. The changing nature of conflict in the 21st century may create further challenges to the ethos and culture of the RAF when it is involved in expeditionary operations.

The changing nature of future conflict

"Tomahawk cruise missiles may command the air but it is Kalashnikov sub-machine guns that still rule the ground"[60]

Since the end of the Cold War conventional military power has been used to achieve political objectives where diplomacy has failed. In Kosovo, Afghanistan and Iraq, conventional armed forces have achieved decisive effects. However, some commentators, such as Van Crefeld argue that the use of armed forces on such operations only delays their eventual obsolescence;[61] others such as Krepenevich argue that the current revolution in military affairs will continue but that military organizations will have to undergo significant adaptation if they are to remain relevant.[62]

In the future military operations will be conducted in a globalised and interdependent world in which potential conflicts are exacerbated by resource scarcity and political, social and economic inequalities between populations and local elites.[63] These conflicts may not be wars between states that 'western' militaries have long trained for and often fought. Van Crefeld argues that Clausewitzian 'Trinitarian' wars in which governments, armed forces and national populations are all easily identifiable may well become less frequent.[64]

Van Crefeld believes that the state's traditional monopoly on the use of violence is increasingly being challenged and that future wars will often be waged within societies amongst the civilian population. As Kaldor observes, at the start of the 20th century eight soldiers died for every civilian killed in war, but by the end of the century that ratio had been reversed.[65] Van Crefeld argues that in future "wars will not be waged by armies but by groups whom today we call terrorists, guerrilla, bandits and robbers";[66] he also argues that other state and commercial organizations such as police and intelligence organizations, private security and private military companies, will become increasingly prominent and that in parts of the world "crime will be disguised as war, whereas in other cases war itself will be treated as if waging it were a crime".[67]

Van Crefeld's view is considered to be somewhat extreme by many and other commentators such as Sabin argue that "Neither microchip warfare nor unconventional warfare will soon make traditional weapon systems obsolete".[68] However, the concept of future military operations championed by the Strategic Defence Review (SDR) New Chapter and based upon Network Enabled Capabilities (NEC) is likely to be only marginally less challenging to military organizations. If NEC is to be successful then we may well see a pressure to modify existing hierarchical command structures and the development of new information based 'elites' who may challenge the traditional supremacy of the 'war fighters' in the three Services. Torpy argues that increasingly operations will have to be conducted in urban environments with the minimum risk of collateral damage and subjected to an increasing number of legal and ethical constraints[69] and these are likely to make the task of war fighting even more complex.

Despite the future possible complexities of war fighting it is likely that traditional armed forces will continue to play a significant part in operations even if their organization and role undergo major changes. Air power may have to be applied in complex non-linear battle-spaces full of legal and moral uncertainties, dominated by urban terrain and complicated by difficulties in identifying an enemy that may attempt to merge in with a civilian population. However, it seems likely that the importance of air power will not be diminished and may become even more ubiquitous. But applying air power in these battle-spaces is likely to generate a number of additional strains to the ethos and culture of the RAF.

Future influences on RAF ethos & culture

"Those skilled in attack move as from above the nine-

There is realization at the highest levels within the RAF that the Joint Strike Fighter might be the last manned combat aircraft in the RAF's inventory

fold heavens. Thus they are capable both of protecting themselves and of gaining complete victory"
(Sun Tzu)

In the 21st Century the RAF is likely to face challenges poised by the increasing use of Unmanned Aerial Vehicles (UAVs) and the increasing reliance on air power by its sister Services. In addition, the increasing use of jointery and the contractorization of support functions could also threaten the RAF's ethos and culture.

Following the recent experience of operations in Afghanistan and Iraq it appears that the use of UAVs and eventually Unmanned Combat Air Vehicles (UCAVs) will become increasingly significant. There is realization at the highest levels within the RAF that the Joint Strike Fighter might be the last manned combat aircraft in the RAF's inventory.[70] The increasing use of UAVs may well lead to the development of groups of personnel within the RAF engaging in combat but who are not aircrew in the traditional sense of the word:

"the certain influx of substantial numbers of uninhabited vehicles into military inventories in the coming decade will cultivate a new and influential group of people with core skills proximate to those that were previously the sole preserve of pilots, namely: expert knowledge of the performance characteristics of various air platforms; acute situational awareness in three dimensions; specialist understanding of weapon effects; and tactical expertness. Furthermore, the same kinds of skills will be resident in the emerging class of battle space managers who populate airborne systems such as AWACs and JSTARs"[71]

The RAF has appeared slow to accept the potential of UAVs to contribute to the projection of air power. At the present time only the British Army currently operates UAVs and the introduction of the 'Watchkeeper' UAV into the British inventory is likely to be conducted on a joint basis. Debates as to the role of individual services in UAV operations and who are to 'fly' them may become lively, as it has in the US armed forces.[72] Although lack of available funding is invariably an issue, as well as

What would be the ethos and culture of an RAF that contained few if any manned combat aircraft?

to doubts about their capabilities, it may also be that the RAF has been slow to accept that UAVs because of the implicit threat they pose to the cultural paradigm of the RAF's senior leadership.

As Stephens states: "fighter pilots are definitely in a class of their own when it comes to resistance to learning".[73] If that has been the case then it would be little different from the British Army's unwillingness to embrace the role of air power in the early 20th Century. As Smith notes, organizational ethos and culture has a major impact on organizational behaviour: it provides an organization with a sense of identity and professional focus. However, it also shapes "the responses of the organization to its mission rivals and those with whom it must operate in carrying out its mission . . . and it will seek to defeat any challenges to those functions that it associates with its core. It will be largely indifferent to functions it sees as peripheral to its core"[74]. Wise supports this, stating that "The dilatory rate of change of organizational structures and culture act as brake on the uptake of new concepts and is the greatest cause of friction".[75] This is unfortunate because the RAF should arguably be leading the way with the development of UAVs.

However, if the RAF has been slow to accept UAVs there are indications that the RAF is seeking to adapt and reduce its reliance on officer aircrew. The RAF is now improving its professional 'air power' and leadership training for all commissioned officers. In addition, the introduction of the General Duties Branch for all RAF Wing Commanders in 2003 may open up more senior appointments to non-aircrew. Improved leadership training is also being introduced for junior and non-commissioned officers and this may improve the cohesiveness and effectiveness of the Service's leadership.

Nevertheless the ethos and culture of the RAF currently, but unsurprisingly, remains very much that of a Service dedicated towards the support of manned combat aircraft. But in the future, when such combat aircraft numbers are reduced, is there a critical mass of officer aircrew, of which any reduction could affect the current ethos and culture of the RAF? What would be the ethos and culture of an RAF that contained few if any manned combat aircraft? It is possible that the impact of this on the RAF would be greater than the 'loss' of the tank would be to the Army's ethos and culture.[76] This is because, unlike the Army, the RAF's ethos and culture is still primarily defined by a small group of men and women who fly combat aircraft.

The traditional belief that the application of air power is the primary preserve of air forces may also be challenged by the increasing need by the other Services for air power. Vallance has observed that since the mid 1980s surface force units in many armed forces have reduced by between 30-60% while air units have grown by a similar amount because "air power — in all its purple forms — is seen by the military as well as the politicians as likely to play a growing role in future crises and conflicts.[77] The change in the nature of military operations, coupled with declining defence budgets have led to the increasing use of jointery to maximise the operational effectiveness of all three Services and minimise costs by both forming joint units and undertaking joint training.

This may well lead to two further developments. Firstly, the increasing role of air power and the ubiquity of the medium in which it operates will require an inherently joint approach to its application. The fact that following the SDR three major joint operational formations: the Joint Helicopter Command, Joint Force Harrier and the Joint NBC Regiment all contain RAF force elements is not a coincidence. All three organizations, to differing extents, have to respond to the challenges poised by the different ethos and cultures of their component parts, particularly the Joint NBC Regiment which comprises of Royal Tank Regiment and RAF Regiment personnel.[78]

Secondly, as this process continues, the RAF's unique position as the main provider of air power may be increasingly challenged by its sister Services, operating as they will aircraft carriers and attack helicopters. In a truly joint environment this may not be a problem; Day has stated that "the days of arguing for a weapon system merely because their own Service operates it are long gone, and contemporary commanders are routinely

finding themselves having to put any Service bias to one side . . . The key output in terms of military capability is targeting for effect".[79] But this also raises issues about the ethos and culture of the single Services. Currently the MoD accept that differences between the Services will, and should, remain even with the increasing emphasis on jointery:

"There is great value in the separate identities and distinct characteristics of the Navy, Army and Air Force. This is not for reasons of tradition, but because of the needs of the modern battlefield still require the specialist skills and ethos of each Service, and individual units depend for their fighting capability on the training, discipline and ethos generated by their parent Service"[80]

In a future of increasingly joint capabilities how will three distinct approaches to ethos and culture be reconciled when there may be, for example, RAF and Army aircrew operating off the deck of a RN aircraft carrier or assault ship? Can a single Service ethos (and in the case of the RAF a distinctive 'light blue' ethos) be sustained in such a joint environment when the primary concern is the projection of a particular capability to achieve a desired effect? Harley is sceptical of the assertion that jointery is an acceptable means of achieving affordable capabilities, arguing that in common with any bureaucracies the three Services:

"will play any games, including jointery. In doing so, the Services will be selective in their use of language to support their case. For example single-Service forces are claimed to have benefits in terms of specialist skills, ethos and morale, while a single defence force is rejected as 'amorphous'. It would be interesting to inquire why a single defence force could not achieve a distinct identity and why such criticisms do not apply to joint units"[81].

The example of the failed Canadian attempt to create a single defence force is often held up as a good reason why the UK should not attempt to do the same,[82] but the centralising tendency of successive defence ministers, while attempting to play the three Services off against each other has been readily apparent since 1945.[83] As the Assistant Chief of the Air Staff recently stated: this "centralizing tendency creates a threat to [single service] identity".[84] However, it is likely that the pressure to achieve joint solutions will continue. The increasing numbers of Service personnel with joint-Service experience may start to have an effect on the overall culture of the three Services and the recent Defence Training Review conducted by the MoD will mean that a significant amount of training will be conducted on a joint basis.

A recent study into the effect of proposed changes to the Military Flying Training System (MFTS) has stated: "the challenge of specifying the requirements of three different approaches to ethos and culture may prove difficult to reconcile. In addition, the air environment, or battle-space, presents a unique challenge to all, irrespective of their service or mission'.[85] Westenhoff cautions that increased jointery must not compromise the inherent benefits of air power:

"As belts tighten in the world's democracies, defence staffs tend to equalize dissatisfaction and seek compromise in the name of 'jointness' rather than pursue excellence in the specialized fields of air power, sea power and land power. In this atmosphere, compromise can repress expertise and initiative, promoting a form of conformity"[86]

Defence is becoming increasingly commercialised in an attempt to reduce costs, improve efficiency and get better value for money. The armed forces are increasingly subjected to the discipline of the marketplace through the creation of agencies and their associated chief executives, devolved budgets, customer supplier agreements *et al*. Admittedly the vast majority of these agencies operate in the support area, providing logistic and administrative support but they still account for around 18% of all Service personnel.[87] This creates potential sources of conflict between "those with responsibility to engage with the enemy and those for whom defence could become another commercial, income-generating activity".[88]

The MoD has accepted that there is a role for contractors in providing support to the military both in the UK and on deployed operations so as to "enhance military capability in a cost effective way".[89] There is already an explicit acceptance within British military doctrine that there are only three areas of military activity

To use non-military undermines the spirit of international law, disavows the basic tenets of military professionalism and displays a singular lack of trust on the part of government towards its armed forces

within the combat support and combat service support areas that could not be carried out by contractors, namely policing, armed security and defence courier duties.[90]

Air power may be most vulnerable to the process of civilianisation and contractorization. This is because on the majority of deployed operations most support activities for air operations are currently conducted in relatively benign environments and there are currently clear organizational divisions between combat and non-combat units within the RAF. This is unlike the Royal Navy where all specializations are to be found in a warship and the Army where many combat support and combat service support functions are integrated into combat units.

In such environments it is possible that most if not all of the RAF's combat support and combat service support activities, with the exception of some force protection activities, could theoretically be carried out by contractors under the existing MoD guidelines. The RAF is increasingly being drawn down this route, along with parts of its sister Services. For the RAF the use of a Private Finance Initiative with a commercial consortium to provide a future air to air refuelling capability, a vital combat support function and the contractorization of space based assets (the new high, and potentially vital ground of the future) shows how this process is well advanced within the UK. The impending contractorization of the UK's MFTS also potentially threatens the RAF's ethos and culture, particularly as it relates to *ab-initio* aircrew.[91]

This growing commercialisation of the Services co-exists uncomfortably with their traditional ethos and culture where effort is not linked to financial reward. As Keegan states: military men have been traditionally motivated by a "concern to enjoy the good opinion of comrades, satisfaction in the largely symbolic tokens of professional success, hope of promotion, expectation of a comfortable and honourable retirement"[92] — the 'psychological contract'. Chuter argues that where the military have become involved in commercial undertakings then corruption increases and military effectiveness declines.[93]

Associated with this trend the increasing discussion surrounding the possible use Private Military Companies. Such organizations went out of fashion in the 16th century with the demise of the *Condottieri* (literally translated as contractors), largely because they were considered "bold amongst friends, cowardly amongst enemies, they have no fear of God and keep no faith with men".[94] US commentators have argued that military contractors "would mitigate risk by allowing America to achieve military strength focussed on core capabilities instead of trying to create a force spread so thin across the operational spectrum that it is in danger of inadequacy or indecisiveness at every point on that spectrum".[95]

It is unlikely that the process of contractorization within the UK can be reversed for similar reasons. However, Mac Farling argues that this potential vision of the future poses some particular problems for air forces, particularly if UCAVs could be operated by other state or commercial organizations. He argues that to use non-military undermines the spirit of international law, "disavows the basic tenets of military professionalism and displays a singular lack of trust on the part of government towards its armed forces".[96] Unfortunately, the precedent has already been set, as the CIA has already used air power, in the guise of a Predator UAV, armed with Hellfire missiles to kill terrorists in Yemen during November 2002.[97]

If war does become increasingly 'criminalized' and military activity merely an adjunct to the activities of police and intelligence organizations and private military companies then this will place additional pressure on air forces. As previously discussed, the original justification for the use of air power was that it could achieve strategic effects in an era of total war. However in the post-modern era it is increasingly likely that those adversaries who experience the 'strategic effects' of air power will consider themselves victims and seek to have it branded as immoral and disproportionate:

"Victim-hood affords the enemy a claim to the moral high ground. The shedding of enough innocent blood can eclipse the meaning of even the noblest cause . . . These images stir outrage in the United States and Europe, fuelling the now familiar rearguard movements to stop such bombings and end such wars"[98]

Tornados of No 31 Squadron; this squadron was based at RAF Laarbruch between 1955 and 1971 and RAF Bruggen between 1971 and 2001

The high watermark for the RAF's ethos and culture as an independent Service was during the Cold War when the focus of its activities was on the various MOBs in UK and Germany

In such circumstances many operations will be conducted by military forces that may have more in common with 'constabulary' tasks rather than the overwhelming application of military force. In such situations it may be necessary only to use force as a last resort or possibly to use only non-lethal weapons. Air platforms may have a more significant role to play in the gathering of intelligence or carrying out surveillance tasks, all conducted in complex and non-linear battle-spaces, with ill-defined 'front lines' or 'rear areas', that may impose significant risk and stress on individuals. These possible changes call into question the RAF's traditional ethos and culture with distinct divisions between war fighters and non-war fighters, particularly if adversaries attempt to counter air power asymmetrically using 'terrorist' techniques and tactics. In such circumstances such distinctions between particular groups of airmen become almost meaningless and unit cohesion will become even more important.

The RAF's distinctive ethos and culture may have already been weakened by the marginalization of the station and squadron structure following the end of the Cold War. It could be further undermined by the demise of manned combat aircraft, the growing ubiquity of air power, increasing jointery, contractorization and the use of the armed forces in more complex war fighting environments. Although the RAF is aware that these changes create challenges to its 'light blue ethos', additional measures may have to be taken to protect that ethos, particularly if UAVs and UCAVs replace combat aircraft in large numbers.

First, the role that ethos and culture plays in the moral component of air power could be accorded greater importance within the RAF's 'strategy pillars'[99] so that its maintenance becomes as important as that of any weapon system. Jans & Schmidtchen argue that this has been a failing of many armed forces and cite the experience of the Australian Defence Force in this regard.[100]

Second, the doctrinal and cultural distinction between combat aircrew and the rest of the RAF could be reduced, so that the role of all RAF

personnel in generating air power could be properly acknowledged. RAF personnel should consider themselves as being 'all of one company', although combat aircrew would continue as *primus inter pares* whilst their role remains. This could be achieved through an increase in appropriate re-education and training.

Third, the role of existing flying squadrons should be enhanced. At the present time flying squadrons on a DOB require around 150 immediate operations and engineering support personnel but there are an additional 400 RAF personnel required for each squadron to provide wider logistic support and force protection.[101] A number of de facto 'Wings' already exist on MOBs within the UK, but their role is subordinated to that of the MOBs themselves and their 'commanders' are, first and foremost, station commanders.

If flying squadrons were formally 'brigaded' into 'Wings' with appropriate supporting personnel who trained and deployed together, then the squadrons and their over-arching 'Wings' could become the primary focus for, and provide support to, the RAF's war fighting ethos and culture. The 'Wings' could help to reduce fractionalization amongst the ground branches and trades, while better focussing the particular *esprit de corps* of these branches and trades towards a common goal-air power, irrespective of whether they were supporting manned aircraft or UAVs.

They should also improve teamwork and leadership, and help sustain the psychological contract between the Service and individual airmen in what could be difficult operational environments. These 'Wings' might be similar in some respects to the USAF's Air Expeditionary Forces (AEFs), although their main focus would be to provide organizational and operational cohesiveness on deployed operations, rather than a balanced range of air power capabilities supported by the AEFs.

Designated Air Combat Support Units and Air Combat Service Support Units could be more closely associated with particular 'Wings', dependent upon their specific role. High quality officers could be encouraged to command these formations rather than MOBs, most of which have an essentially 'peacetime' role. In this regard these 'Wings' may perform a role fulfilled by the Royal Navy's ships and the Army's regimental system and personnel could be posted to them rather than stations. It could be argued that 'Wings' would reduce flexibility and increase costs; however, the absence of a sufficiently cohesive ethos and culture could be potentially disastrous and far more costly. Paradoxically the RAF may have to become organizationally more similar to its sister Services' combat units if it is to retain a distinctive and cohesive ethos and culture that can successfully contribute to the delivery of air power in the 21st century.

Conclusion

"If you don't like change you are going to like irrelevance a lot less"
(General Eric Shinseki)

It is apparent that the ethos and culture of the RAF shares many of the characteristics of the traditional military ethos and culture of its sister services. Like its sister Services the RAF perceives itself as being a 'war fighting' organization whose personnel put service before self and are prepared to fight and possibly die on behalf of a greater good — *pro patria.* The RAF has been concerned that societal pressures do not erode its own distinctive ethos and culture and adversely affect the moral component of air power.

However, the RAF has a distinctive ethos and culture based upon the fact that traditionally only a small number of aircrew have sought to engage in combat. This war fighting ethos and culture has traditionally been supported by the RAF's organizational structure of stations and flying squadrons that have invariably been commanded by aircrew. The high watermark for the RAF's ethos and culture as an independent Service was during the Cold War when the focus of its activities was on the various MOBs in UK and Germany. However, Cold War MOBs disguised the fact that the RAF had become a culturally fragmented Service because of the inherent complexity of air power, and because the dominant ethos within the Service — that of the aircrew — could not be fully shared by the majority of its personnel. As the war fighting ethos and culture of the RAF is primarily

based around the manned combat aircraft and those who fly them, the RAF is currently more vulnerable to possible changes in how, and by whom, future conflicts may be fought than its sister Services.

The RAF is attempting to address societal pressures and cope with the new challenge of expeditionary operations; it has also accepted that jointery and contractorization may also effect its ethos and culture. However, the changing nature of future conflict, many aspects of which have already been observed during operations in Kosovo, Afghanistan and Iraq, will create additional pressures on the RAF that may have a profound impact on its future ethos and culture. Despite future battle-spaces becoming more complex, air power may become more ubiquitous. It is possible to foresee a future where air power will increasingly be applied using UAVs and the need for combat aircrew in particular may be significantly reduced.

Military force could become organized around military capabilities rather than individual Services and supporting functions may be increasingly contractorized. In the future, military personnel will probably have to undertake a wide range of 'constabulary' functions rather than act primarily as war-fighters and military operations may become increasingly constrained due to the environments in which they are conducted and the desire of societies to avoid unnecessary suffering on either side. These changes may affect all three Services, but the greatest impact is likely to be felt by the RAF, given that its current war fighting ethos is largely derived from its aircrew.

If the RAF is to maintain its war fighting ethos and culture then the current distinction between aircrew and non-aircrew, war fighters and non-war fighters, must be reduced. The occupational fractionalization that currently exists should be minimised by an increased emphasis on education and training for all RAF personnel in air power matters, particularly in relation to the use of air power in complex operations. The role of flying squadrons, possibly 'brigaded' into 'Wings', should be enhanced to compensate for the reduced role of stations in sustaining the moral component of air power and improve the cohesiveness and effectiveness of RAF units during future operations. This may require dramatic organizational change that goes to the heart of the Service's present ethos and culture, but the challenge will have to be accepted if the RAF is to retain its place 'at the right of the line' in the 21st Century.

Bibliography

Abercrombie, Nicholas. Hill, Stephen and Turner, Bryan (1988) *The Penguin Dictionary of Sociology* (Penguin Books)

Air Force Board Standing Committee (A paper by AMP)'Strengthening RAF Ethos' dated 26 Apr 02

Alexandrou, Alex, Bartle, Richard & Holmes, Richard (eds) (2001) *New People Strategies for the British Armed Forces* (Frank Cass: London)

Alexandrou, Alex, Bartle, Richard & Holmes, Richard (eds) (2001) *Human Resources Management in the British Armed Forces Investing in the Future* (Frank Cass: London)

Bellany, Ian 'Men at War the Sources of Morale' *RUSI Journal* February 2003 Vol 148 No1 February 2003 pp 58-64

Chuter, D 'Defence Transformation' *Institute of Strategic Studies* 2000 Ch 1 pp 11-21

Cohen, JM & Cohen MJ (eds) (1980) *The Penguin Dictionary of Quotations* (2nd edition) (Harmondsworth: Penguin)
Coker, Christopher, 'What Would Sun Tzu Say About the War on Terrorism' *RUSI Journal* February 2003 Vol 148 No 1 pp 16-20

Congdon, Phillip, (1985) *Behind the Hanger Doors* (Sonic Books)

Dandeker, Christopher 'Don't Ask, Don't Tell, and Don't Pursue' *RUSI Journal* Vol 144 No 3 June 1999 pp 87-89

Dandeker, Christopher 'On the Need to be Different: Military Uniqueness and Civil-Military Relations in Modern Society' *RUSI Journal* Vol 146, No 3, June 2001 pp 4-9

Day, John 'After Afghanistan –The Role of Air Power' *RUSI Journal* Vol 147 No 6 December 2002 pp 39-46

Day, John 'Joint Strike: Missiles and Aircraft in Long- Range Land Attack' *RUSI Journal* Vol 146 No 3 June 2001 pp 49-51

Directorate of Air Staff (1999) *British Air Power Doctrine* AP3000 (HMSO)

Dye, Peter 'The European Rapid Reaction Force The Contribution of Aviation Logistics' *Royal Air Force Air Power Review* Volume 6 No 1 Spring 2003 pp 11-35

Edmonds, Martin (1988) Armed Forces and Society (Leicester University Press)

Edmonds, Martin, 'Defence Management and the Impact of 'Jointery'' in Dorman, Andrew, Smith, Mike & Uttley, Mathew (eds) (2002) *The Changing Face of Military Power* (Palgrave) pp 151-176

Exeter, DW, 'Development of Military Ethos Within UK MFTS' PTC/254500/1/TGDA dated 30 Nov 00

Foreign and Commonwealth Office HC 577 'Private Military Companies: Options for Regulation' February 2002 (HMSO)

Frost, Gerald (2001) 'How to Destroy an Army: the Cultural Subversion of Britain's Armed Forces' in Alexandrou, Alex; Bartle, Richard; Holmes Richard (eds) *New People Strategies for the British Armed Forces* (London: Frank Cass)

Goldsworthy, Ellie 'The Armed Forces: Reform and the Court Martial System' *RUSI Newsbrief* Vol 23 No 1 January 2003 pp 9-10

Gray, Peter & Cox, Sebastian (Eds) (2002), *Air Power Leadership Theory and Practice* (London: The Stationary Office)

Gudykunst, WB, (1994) *Bridging Differences* (London: Sage)

Guthrie, Charles 'British Defence – The Chief of Defence Staff's Lecture 2000 RUSI Journal February 2001 Volume 146 No 1

Haysman, Kate & Johansen, Dawn (2000) 'RAF Culture & Ethos in the 21st Century' (HMSO)

Hackett, John (1983) *The Profession of Arms* (London: Sidgwick & Jackson)

Harpum, Stuart (2000) 'Military Man or Businessman?' ACSC 3 Defence Research Paper

Hartley, Keith 'The Economics of Joint Forces' Jointery'' in Dorman, Andrew, Smith, Mike & Uttley, Mathew (eds) (2002) *The Changing Face of Military Power* (Palgrave) pp 201-215

Hockey, John (1986) *Squaddies Portrait of a Subculture* (Exeter University Publications)

Howard, Michael (1976) *War in European History* (Oxford University Press)

Howard, Michael, (2000) *The Invention of Peace* (Profile Books)

Joint Defence & Concepts Centre *British Defence Doctrine* Joint Warfare Publication 0-01 (October 2001)

Joint Defence & Concepts Centre *Contractors on Deployed Operations* Joint Defence Publication 4/01 (December 2001)

Joint Defence & Concepts Centre *Joint Operations* Joint Warfare Publication 3-00 (July 2001)

Joint Force 2000 (HMSO pamphlet)

Jumper, John (1998) 'Expeditionary Air Force: A New Culture for a New Century' address to the Air Force Association Symposium 26 Feb 98

Kaldor, Mary (1999) *New and Old Wars* (London: Polity Press)

Keegan, John (1993) *A History of Warfare* (London: Hutchison)

Keegan, John, (1976) *The Face of Battle* (Harmondsworth: Penguin)

Krepinevich, Andrew 'Cavalry to Computer: The Pattern of Military Revolutions' *The National Interest* No 37 Fall 1994 pp 30-42

Mac Farling, Ian 'Some thoughts on Warfare in the 21st Century' in Olson, John ed (2002) *Asymmetric Warfare* (The Royal Norwegian Air Force Academy)

Machiavelli, Niccolo (1985) *The Prince* (Penguin)

Massey, A 'Ethos, Consensus and UK Defence in the 21st Century' *The Naval Review* Vol 88, No1 (January 2000) pp 3-13

Meilinger, Phillip, 'The Development of Air Power Theory' in Gray, Peter & Cox, Sebastian (eds) (2002) *Air Power Leadership Theory and Practice* (London: The Stationary Office) pp 90-106

Mets, David (1998) *The Air Campaign- John Warden & the Classical Air power Theorists* (Maxwell: Air University Press)

Moore, David and Antill, Peter,'British Army Logistics and Contractors on the Battlefield' RUSI Journal October 2000 Vol 145 No 5 pp 46-52

Moskos, Charles. Williams, John. Segal, David (2000) *The Post Modern Military – Armed Forces After the Cold War* (Oxford University Press)

Pullen, Andrew, 'Project Management and Resistance to Change' *International Defence Management Studies2002* Cranfield University Press, 220, pp 187-200

RAF Strategy 2002 (HMSO pamphlet)

Reid, John 'House of Commons Adjournment Debate on Racism in the Armed Forces' *Hansard* 22 January 1998 Column 1246

Reiner, Robert (1992) *The Politics of the Police* 2nd Edition (Harvester Wheatsheaf)

Robinson, Tim ''Transformational War'? Air Power Lessons from Afghanistan' *RUSI Newsbrief* April 2002 Vol 20 No 4 pp 41-42

Rodgers, Paul 'Conflict and Peace in the Early 21st Century' *RUSI Journal* April 2001 pp9- 14

Russel, JDK, 'Wrong War Wrong Army' *The British Army Review* No 130 pp21-25

Sabin, Phillip 'Are Traditional Weapons Platforms becoming Obsolete' *The Royal Air Force Air Power Review* Vol 1 No 1 1998 pp 45-57

Schein, EH *Organizational Culture and Leadership* (San Francisco: Jossey Brassey 1997)

Spacey, Bradley & Trapp, Michael 'Train Like We Fight, Fight Like We Train' *Air & Space Power Journal* Winter 2002 pp 59-68

Squires, Peter 'From Spitfire to Eurofighter – The RAF's Legacy' – *RUSI Journal* October 2000 Vol 145 No 5 pp 1-7

Stephens, Alan, 'Command in the Air' in Gray, Peter & Cox, Sebastian (Eds) (2002), *Air Power Leadership Theory and Practice* (London: The Stationary Office) pp 1-14

Strachan, Hew (1997) *The Politics of the British Army* (Oxford: Clarendon Press)

Sturley, Phillip, Air Vice Marshal, Assistant Chief of the Air Staff, Address to RAF Students ACSC No 6 on 5 March 03

Terraine, John (1985) *The Right of the Line* (Wordsworth Editions)

Torpy, Glen 'Future British Military Operations' *RUSI Journal* February 2001 Vol 146 No 1 pp 8-14

Tripp, Robert, 'Contractors on Deployed Operations' *RUSI World Defence Systems* Vol 3 No 3 Dec 2001 pp 94-95

Vallance, Andrew 'Purple Air Power the Future Challenge' *The Royal Air Force Air Power Review* Vol 1 No 1 Spring 1998 pp 16-26

Van Crefeld, Martin (2002) 'The Transformation of War Revisited' in Bunker, Robert (ed) Small *Wars & Insurgencies* (Frank Cass) Vol 13 Summer 2002 No 2. pp 3-15

Weber, Max (1977) *From Max Weber: Essays in Sociology* (Routledge & Keegan Paul: London)

Westenhoff, Charles 'Air power and Political Culture' Air Power Studies Centre Paper No 45 http //www.dod.au/apsc/publish/paper42htm printed 02 May 00

Williams Phil, 'Transnational Crime and Corruption' in White, Brian, Little, Richard and Smith Michael (eds) *Issues in World Politics* (2nd Edition) Palgrave 2001 pp 232-251

Wise, GJ (2002) 'Network Centric Warfare: Evolution or Revolution' *Royal Air Force Air Power Review* Volume 5 No 4 pp 65-85

Women in the Armed Forces (Executive Summary) May 2002 (HMSO)

Notes

[1] Hockey (1986)
[2] Strengthening RAF Ethos dated 26 Apr 02
[3] Meillinger (2002) p 90
[4] Massey (2000) p 3
[5] Abercrombie et al (1988) p 59
[6] AP 3000 (1999) p 1.2.15
[7] Schein (1997) p 18
[8] AP 3000 (1999) p 1.2.15
[9] Hackett (1983) p 202
[10] Strengthening RAF Ethos 26 April 02
[11] Terraine (1985) p 686
[12] Massey (2000) p 3
[13] Bellamy (2003) p 58
[14] British Defence Doctrine (2001) p 4-4
[15] Hackett (1983) p9
[16] Howard (1976) p 72
[17] Weber (1977)
[18] Command Scientific Support Branch Working Paper 7/98 p 5
[19] Keegan (1993) p 391
[20] Howard (1976) p 54
[21] Joint Warfare Publication 0-01 (2001) p 3-4
[22] Dandeker (1999) p 87
[23] Rose, Michael,'How Soon Could Our Army Lose a War?' *The Daily Telegraph* 16 December 1997
[24] Guthrie (2001) p 7
[25] Moskos et al (2000) p 1
[26] Ibid p 1
[27] Dandeker (2001) pp4-9
[28] Haysman et al (2002) p 1
[29] 'New rules aim to stamp out bullying racism and sexism in the armed forces' *The Independent* 11 February 03
[30] Women in the Armed Forces May 2002
[31] Dandeker (2001) p 6
[32] Massey (2000) p 9
[33] AP 3000 (1999) p1.2.15
[34] Stephens (2002) p 3
[35] Dixon (1976) pp176-188
[36] Strengthening RAF Ethos 26 April 04
[37] Metz (1998) p 22
[38] Ibid (1998) p 25
[39] P Meilinger (2002) p 92
[40] Howard (1976) p 130
[41] Squire (2000) p 2
[42] Ibid (2000) p4
[43] Westenhoff (1997) p 10
[44] Strengthening RAF Ethos 26 April 04
[45] Congdon (1985) p 29
[46] Cohen & Cohen (1980) p18
[47] http://www.raf.mod.uk/news/linton. Html 05 Dec 02
[48] Stephens (2002) p 5
[49] Ibid (1998) p 4
[50] Terraine (1998) p 686
[51] Gudykunst (1994) p 38
[52] Reiner (1992) p 109
[53] Smith (1998) p 4
[54] Ibid (1998) p 32
[55] Strachan (1997) pp 195-233
[56] Command Scientific Support Branch Working Paper 7/98
[57] Stephens (2002) p 7
[58] Jumper (1998)
[59] Day (2002) p 43
[60] Howard (2000) p102
[61] Van Crefeld (2002) p 3
[62] Krepenevich (1994) p 30-42
[63] Rodgers (2001) pp 9-13
[64] Van Crefeld (2002) p 8
[65] Kaldor (1999) p 8
[66] Van Crefeld (1991) p 197
[67] Ibid (1991) p 204
[68] Sabin (1998) p 57
[69] Torpy (2001) p 9
[70] Lecture by Air Chief Marshal Squire, CAS, to ACSC 6 students on 20 March 2003
[71] Stephens (2002) p 8
[72] Ibid (2002) p 7
[73] Ibid p 1
[74] Smith (1998) p 8
[75] Wise (2002) p 80
[76] Russel (2002) p 24
[77] Vallance (1998) p18
[78] Lecture by Air Vice Marshal Sturley, ACAS, to ACSC students 4 March 03
[79] Day (2001) p 49
[80] Joint Force 2000
[81] Hartley (2002) p 210
[82] But arguably if that was applied to all areas of defence then the UK would never consider another collaborative project.
[83] Strachan (1997) p 262
[84] Sturley Op cit
[85] Exeter (2001) p 3
[86] Westenhoff (2000) p 11
[87] Harpum (2000) p 6
[88] Edmonds (2002) p 155
[89] Joint Doctrine Publication 4/01 (2001) p 1-1
[90] Tripp (2001) p 95
[91] Exeter (2001) p 7
[92] Keegan (1993) p 270
[93] Chuter (2000) p 18
[94] Machiavelli (1982) p 77
[95] Smith (2002) p 117
[96] I Mac Farling in Olsen (2002) p 368
[97] 'CIA 'killed al Qaeda' in Yemen' http://news.bbc.co.uk/1/hi/world/middle_east 6 Mar 03
[98] Bowden, Mark 'The Bomb Squad' *The Sunday Telegraph* 15 December 2002
[99] RAF Strategy (2002) p 6
[100] Jans & Schmidtchen (2002) p 28
[101] Dye (2003) p 23

ZG506

A Vulcan B.Mk 2A equipped with an Avro Blue Steel missile

How capable was the V-Bomber Force militarily of delivering Britain's nuclear deterrent in the late 1950s and 1960s?

By Ms Alexis Tregenza

"Then it may be that we shall, by a process of sublime irony, have reached a stage in this story where safety will be the sturdy child of terror, and survival the twin brother of annihilation."
(Winston Spencer Churchill 01/03/55)[1]

In the summer of 1952 the British Joint Chiefs of Staff met to discuss the future of Britain's defence policy. In what became known as the *Global Strategy Paper* the thesis was put forward that nuclear weapons had revolutionized the character of war. Accepting this, the paper went on to argue that the most effective deterrent against Soviet aggression would be recognition by the Soviets that such aggression would bring instantaneous atomic reprisal. It was therefore recommended that the Western powers openly declare that Soviet aggression be punished by nuclear retaliation at the Russian heartland.[2]

This strategy would be at the heart of NATO doctrine for the following 39 years. From the mid 1950s to the end of the 1960s, Britain's primary tool for carrying out this threat was the V-bomber

Britain's V-bomber force was militarily capable in the main of getting in the air in time in the scenario of a Soviet nuclear attack

force, the fleet of three types of bomber: the Vickers Valiant, Avro Vulcan and Handley Page Victor. The purpose of this study will be to examine how capable the V-bomber force was of carrying out this retaliation throughout the time that it was entrusted with carrying Britain's nuclear deterrent.

It shall be assessed in two main parts. Firstly, by examining how vulnerable the V-force was on the ground to a Soviet surprise nuclear attack: namely, was it capable of getting into the air in time, given the brevity of warning Britain had? Secondly, the ability to penetrate Soviet air defences once it had got into the air and deliver its weapons on strategic targets in the USSR shall be considered. These targets were agreed upon between RAF Bomber Command and the Strategic Air Command (SAC) from 1957 onwards.

It is important to point out at this stage that such an examination is hypothetical as thankfully, none of the strategic nuclear weapons on either side in the Cold War period was used. Having accepted this, it does seem possible however, to build a reasonable picture of just how capable Bomber Command's V-bomber force was of carrying out the primary role assigned to it. This shall be done by using a variety of primary and secondary sources.

Further to this, it shall try to demonstrate that Britain's V-bomber force was militarily capable in the main of getting in the air in time in the scenario of a Soviet nuclear attack in sufficient numbers to constitute an effective deterrent and of penetrating Soviet defences to deliver its nuclear weapons. However, it shall also be argued that from the mid-1960s until the decommissioning of the V-force as the carrier of Britain's nuclear deterrent in 1969, advances in Soviet air defence systems and air defence fighters may have caused the attacking V-bombers to suffer such a rate of attrition that Britain's nuclear deterrent capability was seriously challenged.

It is useful at this point to outline why the military capability of the V-force was important. Due to the

We must now turn our attention to the V-bombers on the ground and their ability to get airborne in a 'worst case scenario' in order to credibly carry out the deterrent threat

The V-bombers, Vulcan, Victor and Valiant

human catastrophe that would befall Europe and the Western hemisphere in the event of a nuclear war, it was essential to make any future war as unlikely as possible. This was to be the hinge upon which nuclear deterrence worked. However, for deterrence to work, it is essential that the threat carry credibility otherwise the whole deterrent threat is undermined and therefore the chance of war breaking out increased.[3] For this reason it is also useful to examine the credibility of Britain's nuclear deterrent in this period.

Just how essential it was for Britain to have the capability to carry out its threat to deliver its nuclear arsenal was furthered with the advent of the hydrogen bomb. Whereas large countries such as the USA or USSR might have been able to withstand to a large extent an atomic attack that used lower yield atomic bombs, such as those used against Japan in 1945, the hydrogen bomb as Sir Anthony Eden observed ". . . was to diminish the advantage of physically larger countries. All became equally vulnerable. I had been acutely conscious in the atomic age of our unenviable position in a small and crowded island, but if a continent, and not merely small islands were doomed to destruction, all was equal in the grim reckoning".[4] Nevertheless, the increase in destructive power made Britain even more vulnerable. As a Soviet general said: "There are optimists and pessimists in Britain. The pessimists think five H-bombs will wipe out everyone in Britain, the optimists think it will take eight. We have 200."[5]

Given the huge increase in destructiveness that hydrogen weapons brought, the need for the deterrent to be credible was increased still further. As the Defence White Paper of 1956 stated: "The advent of the hydrogen bomb has enormously strengthened the power of the deterrent and, provided the deterrent is maintained, the likelihood of global war has decreased."[6] Thus, we can see that the greater the destructive power of nuclear weapons, the more vital it was for the nuclear deterrent to be credible in order to prevent war.

It is with this in mind that we must now turn our attention to the V-bombers on the ground and their ability to get airborne in a 'worst case scenario' in order to credibly carry out the deterrent threat.

When looking at the vulnerability of Britain's V-bombers to a sudden Soviet attack, it is necessary to consider a number of factors. Amongst these are the amount of warning time from detection to detonation of the Soviet ICBMs, the state of readiness of the V-bombers, time taken from the alert being received to aircraft becoming airborne and the dispersal of the V-bombers. In addition, a number of scenarios based upon the numbers of weapons and their capabilities at the time should be considered when trying to establish whether the V-force was capable of leaving the ground in time to retaliate and vindicate the capability of Britain's nuclear deterrent. Whether the actual nuclear weapons themselves, carried by the V-bombers affected their ability to get off the ground quickly shall also be examined.

The first raw data to consider is how long it would physically take Soviet missiles to reach Britain from their launch sites to detonating over their targets. In a declassified secret document dating from March 1960, the Minister for Aviation put forward the following argument with regard to the vulnerability of the V-bombers on the ground. This information was compiled from the 'judicial knowledge' of the British Nuclear Deterrent Study Group and the Joint Inter-Service Group for the Study of All-out Warfare. It states the following calculations:

Times of flight of Soviet Ballistic Missiles
1. On normal (minimum energy) trajectories the times of flight
- 650 nm: 8.5 minutes
- 1,000 nm: 11.3 minutes

Radar detection
1. Owing to the curvature of the earth's surface, ground radar cannot pick up missiles (or aircraft) until they rise above the 'radar horizon'. Missiles come within the radar horizon of ground radar in the United Kingdom when they are about 50 to 60 miles above the earth's surface. The time taken by missiles to reach this height is about 2.5 minutes on normal trajectory and three minutes on low trajectory.

The Russians would need to fire at only three aiming points. With six MT rockets (two aimed at each of these points), they could almost certainly wipe out the whole V-bomber force

2. From the point of pick-up by ground radar, the remaining times of flight of Soviet missiles fired at the UK would therefore be:

- 650 nm: 6 minutes
- 1,000 nm (normal trajectory): 9 minutes
- 1,000 nm (low ttrajectory): 3 minutes [7]

In the event of high international tension, the V-bombers were to be dispersed to 36 airfields in groups of four to minimize the chances of a handful of rockets destroying the entire V-bomber force on their 6 main airbases. A note by the Minister of Aviation of March 1960 pointed out:

"Our operational plans provide for the dispersal of the V-bomber force among 36 airfields in times of crisis. But it requires from 24 to 48 hours to complete this redeployment. Thus in the event of a surprise attack, out of the blue, our V-bombers would be caught on their six main bases. These are sited so close together that the Russians would need to fire at only three aiming points. With six MT rockets (two aimed at each of these points), they could almost certainly wipe out the whole V-bomber force." [8]

The document then goes on to assert:
6) Assuming that the bombers had been dispersed, but that the aircrews were not kept continuously in their aircraft, the Russians could, with about 50 rockets, destroy virtually the whole dispersal airfields, many of which are close to one another.

7) . . . even if a very high state of readiness can be achieved, it would still be possible for the Russians to eliminate 80% of our V-bomber force with about 250 rockets.

8) That would leave us only about 20 aircraft. With the Russian defences concentrated upon them, very few would get through; a threat on this extremely reduced scale would not constitute any appreciable deterrent.

10. It must also be remembered that this whole system depends upon a single warning station at Fylingdales, which could be jammed by a small number of aircraft flying 100 miles or more away over the North Sea.[9]

So, we are left with the raw arithmetic of early warning times being picked up by radar vs the time taken for the V-bomber crews to scramble and get airborne, armed with nuclear weapons. The arguments presented above at first glance appear quite convincing in proving the vulnerability of the V-bomber force on the ground.

However, in the scenario portrayed, the argument is made that so few V-bombers would get airborne after the initial pre-emptive strike, that the force would not constitute any appreciable deterrent. The estimated time of arrival (ETA) for a Soviet missile from first detection to detonation was on average 4.5 minutes. It is also the case that the above scenarios overlook some significant factors that would more than likely pre-empt a nuclear strike by the Soviets. As Andrew Brookes has argued:

". . . Whitehall reasoned that it was safe to assume that a third world war would result only from a period of escalating international tension. As diplomatic relations deteriorated and Soviet preparations for war became evident, bomber crews would have been recalled from leave and servicing personnel detailed to work round the clock to produce as many serviceable aircraft as possible."[10]

Once international relations were at a high state of tension, the V-bombers would be dispersed to their 36 separate airfields in groups of four. The 26 dispersal airfields ranged from RAF Lossiemouth in northern Scotland to RAF Aldergrove in Northern Ireland to St Mawgan in Cornwall. Added to the 10 main airbases in Lincolnshire and East Anglia, these constituted the 36 dispersal airfields.

In response to the Minister of Aviation's report, the defence board produced a detailed brief: D.F.B. (60)5 which effectively deconstructs the arguments put forward by the Minister of Aviation and presents an alternative version of events to counter it. On the subject of the strategic warning not being received and the force knocked out by three-megaton rockets, it argues: "On the subject of strategic warning, however, the British Nuclear Deterrence Study Group concluded in its last report that':

"The current Joint Intelligence Committee assessment is that we should get strategic warning of at least 24 hours before any heavy Soviet attack on this country. There is therefore no need to maintain our deterrent forces constantly at maximum readiness in order to guard against a "bolt from the blue attack".[11]

With regard to the Minister of Aviation's claim that even if the force were dispersed and at readiness, most of it could still be destroyed by about 250 three-megaton missiles, it concludes. Apart from the fact that this calculation ignores the additional warning time which would be gained by the dispersed bases to the West of the country and in Northern Ireland, the contention that such an attack is feasible has been answered by the Minister of Aviation himself. In his paper of 19 February referring to an attack with about 300 rockets on this country he says:

"It is inconceivable that the Russians would believe they could safely attack Britain on this massive scale without immediately provoking annihilating retaliation from the Americans."[12]

This last point is most important. Given the cohesion within NATO and the resolve to retaliate against a Soviet nuclear attack, the Soviet leaders would be ". . . most unlikely to risk annihilating retaliation from the Americans . . .'[13] Although as I have argued earlier, hydrogen weapons were a great leveler in terms of reducing the importance of the geographic size of a country, the US — unlike Britain at the time — had underground ICBM sites, nuclear bombers (primarily B-52s) on constant airborne alert and the first Polaris-armed submarines were beginning to come on stream.

From 1964, France too had an effective nuclear deterrent triad that relied upon a combination of

The US and NATO would have had a very substantial retaliatory capacity in the event of a surprise attack. Such a consideration on the Soviet side for a surprise nuclear attack would have to be weighed very carefully

USS John Marshall (SSBN 611)

Since peace so largely depends upon the deterrent force of nuclear retaliation, it is essential that a would-be aggressor should not be allowed to think he could readily knock out the bomber bases in Britain before their aircraft could take off from them

supersonic bombers (the Mirage IVA), ICBMs stored in underground silos and ballistic missile submarines.[14] All of these forces would have ensured that the US and NATO would have had a very substantial retaliatory capacity in the event of a surprise attack. Such a consideration on the Soviet side for a surprise nuclear attack would have to be weighed very carefully. This caution would have contributed towards deterrence and therefore the continued survival and viability of the V-bomber force.

Having accepted the relative unlikelihood of an unannounced Soviet first strike due to NATO's retaliatory capacity, how well prepared the V-bomber force was to cope with a 'worst-case' scenario and deliver Britain's nuclear retaliatory capability must now be considered.

On 30 August 1963, a 'no notice' alert exercise was put into practice to see how quickly and what proportion of the V-bomber force could become operationally ready and in how much time. 65 aircraft participated and all were loaded with live nuclear weapons. The results were as follows:

2 hours	19 aircraft	29%
4 hours	37 aircraft	57%
6 hours	57 aircraft	88%
8 hours	64 aircraft	98%[15]

Although the above record may appear relatively poor, it should be remembered that in time of international crisis, the serviceability of aircraft would be improved and aircraft kept at a higher state of readiness.

There also followed improvements in the early warning time and in the time taken for the V-bombers to get off the ground. The Missile Infra-red Detection and Surveillance System (MIDAS) promised to increase the detection time of missiles from when they were in the air, back to the time from when they were launched. This, on average, increased detection time from 4.5 minutes to 6 minutes, giving V-bomber crews a vital extra 90 seconds. MIDAS was able to do this because it was a space-based system that was not limited by the curvature of the earth. It was estimated that there should be a 95% chance that at least one satellite would see any launching.[16]

With the early warning system thus improved, improvements also followed in the take-off times of the V-bombers. As the 1957 Defence White Paper stated: "Since peace so largely depends upon the deterrent force of nuclear retaliation, it is essential that a would-be aggressor should not be allowed to think he could readily knock out the bomber bases in Britain before their aircraft could take off from them. The defence of the bomber air-fields is therefore an essential part of the deterrent and is a feasible task."[17]

Although take-off times from the six main V-bomber airbases could be kept to a minimum time of 140 seconds — provided the aircraft were armed and serviceable — this was not the case from the 36 dispersal airfields where conditions were more primitive. This delay served to under-mine the credibility of the deterrent. Air Chief Marshal Sir Harry Broadhurst, Commander in Chief of Bomber Command, insisted that the V-bomber crews had to get their scramble times down to Fighter Command Levels.

Improvements at the dispersal fields, pushed through by Air Chief Marshal Broadhurst, included the building of Operational Readiness Platforms (ORPs) leading straight to the runway threshold, permanent crew accommodation in the form of special caravans positioned close to the aircraft and temporary command posts with efficient lines of communication.[18] With these improvements in place, the ability of the V-bombers to get airborne quickly from the dispersal fields was proven, and thereby the deterrent made more feasible militarily.

In addition, a procedure was devised for the Vickers Valiant to enable it to start all four engines at the same time[19] and for the Vulcan and Victor

A Blue Steel armed Vulcan B2 of No 617 Squadron

Both the Mk 2 Vulcan and Victor had the capability to start their engines simultaneously, thus cutting down on the time taken from the order to scramble to the V-bombers becoming airborne

Mk 1, Squadron Leader Dixon — an engineering staff officer at Bomber Command — designed the 'Simsmart' trolley that enabled an aircraft crew chief to start all four engines simultaneously while the crew were strapping in.[20]

Both the Mk 2 Vulcan and Victor had the capability to start their engines simultaneously, thus cutting down on the time taken from the order to scramble to the V-bombers becoming airborne and therefore adding to the airborne deterrent credibility.

In 1962, the state of readiness of the V-bomber force was improved still further with the inauguration of the Quick Reaction Alert (QRA) plan that involved one aircraft from each V-bomber squadron (there were 20 in all by 1961)[21] being maintained in armed condition and at a later date on operational readiness platforms at the end of the runway, ready to scramble at a moment's notice.[22] V-bombers at QRA readiness were able to scramble in 90 seconds[23], a time comparable to the pilots of Fighter Command during the Battle of Britain in 1940. However, one must ask the question: 'Was one V-bomber from each squadron at 90 seconds readiness sufficient to effectively enforce Britain's nuclear deterrent?'

Once again, it must be remembered that in time of international crisis, many more V-bombers would be brought up to QRA status thereby making for a sizeable force to act as a deterrent. Thus, even in the 'worst case scenario' of a sudden and massive Soviet strike without warning which, as has been argued, was fairly unlikely, the V-bomber force could still scramble 20 nuclear bombers in 90 seconds. Although this may not have had the deterrent impact of nuclear armed bombers on airborne alert 24 hours a day as was the case with the USAF, the take-off time was still entirely feasible to allow a minimum of 20 nuclear armed V-bombers to become airborne minutes before Soviet ICBMs aimed at Britain would hit their targets.

Coupled with the nuclear deterrent capacities of the USA and from 1964, France, it would seem that the only scenario in which only 20 V-bombers alone would be launched against the USSR would be if the Soviets launched a sudden nuclear strike

A Valiant of No 214 Squadron being towed past the Bloodhound site at RAF Marham

There was the deployment of 'Bloodhound' surface-to-air-missiles at each V-bomber base that were proven to be dependable and could lock on to jamming signals from hostile aircraft as a means of guidance

against Britain and Britain alone was at war with the USSR. Given the basis on which NATO operated and still operates[24], the chances of this seem very remote. However, the UK had an independent nuclear deterrent, which was intended to operate independently of NATO if required, although operating outside of NATO would diminish its chances against Soviet defences significantly.

Britain also had the ability to defend its own airspace which would also improve the likelihood of a substantial number of V-bombers being able to get off the ground. From 1957 onwards, Fighter Command concentrated its efforts on protecting the bomber bases in order to buy the V-force time to get on its way.[25] Soviet medium and long- range bombers would have been vulnerable to these interceptors (primarily English Electric Lightnings from 1960 onwards). In addition, there was the deployment of 'Bloodhound' surface-to-air-missiles at each V-bomber base that were proven to be dependable and could lock on to jamming signals from hostile aircraft as a means of guidance.[26]

In considering the ability of the V-bombers to leave the ground in time to threaten a significant retaliatory capability, it is worth taking time to consider the nuclear weapons that the V-bombers carried and in particular, two which could have seriously affected the ability of the V-force to get significant numbers of bombers into the air.

Blue Danube, the RAF's first atomic weapon, even if rather large for a weapon with a yield of 20 KT[27] was fairly straightforward to handle and deliver. However, its successor, Violet Club, Britain's first hydrogen weapon in order to give Britain an early megaton capability was questionable in terms of its operability. Described as a 'rather delicate weapon'[28], Violet Club was so unstable, it has recently emerged that the bombs could have exploded by accident.[29] The bombs also took a long time to arm. A memo by Group Captain Tait warned that that the arming of specially modified Vulcans designed to carry the bomb would take at least 20 minutes.[30] Such 'fragility' and instability coupled with the time it took to arm the Vulcans, could have seriously undermined the ability of the V-bombers assigned to be armed with Violet Club to get airborne. This in turn meant that the V-force did not have a completely viable operational hydrogen bomb until the 'Yellow Sun' came into service in 1960.

A Blue Steel missile being refuelled with high test peroxide (HTP), RAF Scampton

Like Violet Club, although to a lesser extent, in the event of a sudden attack, serious problems could have arisen in getting a significant number of V-bombers armed with the Blue Steel missile airborne

Its successor, the 'Blue Steel' stand off missile may also have hindered take-off time of the V-bombers due to the fact that its fuel was a mixture of kerosene and hydrogen peroxide, a highly combustible mix.[31] Liquid-fuelled rockets of any kind require a lot of preparation time before being hoisted into the bomb bay and being made ready for service. The Blue Steel had to be filled with propellant in the preparation building and then taken to the aircraft on a low loader with the fuel mix and temperature kept under constant surveillance.[32] Like Violet Club, although to a lesser extent, in the event of a sudden attack, serious problems could have arisen in getting a significant number of V-bombers armed with the Blue Steel missile and airborne. However, this must be tempered with the argument made earlier that a Soviet surprise attack was fairly unlikely and that in times of high international tension, more V-bombers would be brought to operational readiness.

The picture that emerges with regard to the ability of a significant number of V-bombers to become airborne in the event of a Soviet attack is mixed, but overall it seems enough would have become airborne to effectively carry Britain's nuclear deterrent. Although there would have been little warning time from detection to detonation, systems such as MIDAS were developed to increase warning time. There were also efforts to decrease the amount of time the V-bombers took to get airborne such as practice 'scrambles' carried out by aircrews and systems to allow the V-bombers to start all four engines at once. Dispersal of the force was also important in increasing the chances of the V-force despite the destructiveness of hydrogen weapons on a country as small as Britain.

Greater efforts were also made to increase operational readiness both at the V-bombers' main airbases and at their dispersal airfields, especially with the introduction of 'QRA' readiness. Most important of all, I have argued the chances of a sudden, unannounced Soviet strike were fairly unlikely because of the capability of NATO to carry out a massive reprisal. The more likely scenario of an escalation in tension (such as the Cuban missile crisis) leading to war would allow a far greater number of V-bombers to become combat ready and prepared for war. This would allow time for the loading of the more complex weapons such as Violet Club or Blue Steel.

A No 55 Squadron Victor B1A being refuelled by a Valiant of No 90 Squadron

Flight refueling will give the V-bombers tactical freedom en-route to the target. It will also increase the radius of action of the force

"Today, shooting wars are won or lost before they start. If they are fought at all, they would be fought principally to confirm which side had won at the outset."
(General Curtis LeMay April 1956[33])

Having established that a significant number of V-bombers would be able to get into the air in the event of a Soviet nuclear attack, we must now turn our attention to the question of whether the V-bombers would be able to break through the Soviet defences and deliver their weapons. This ability was vital in order to vindicate the threat of the deterrent. This shall be done by looking at several important areas and weighing up the likelihood of whether these factors combined, indicate that there was a good chance that the V-bombers would be able to get through and deliver their weapons.

These areas shall include routing of the bombers, navigation, targeting, Soviet air defences, V-bomber counters to these defences and V-bomber development to try and stay ahead of these defences. It shall also be argued that although the V-bombers would seem to be quite effective during the late 1950s and early 1960s, by the mid to late 1960s, there was a growing likelihood, given the improvements in Soviet air defences, that prohibitive numbers of V-bombers would be brought down over Soviet air space before they could reach their targets.

In examining the capability of the V-bombers in the scenario of a retaliatory strike on the Soviet Union, the first area to be considered will be the routing of the bombers. Once in the air, the V-bombers would have to take a route towards their target that would give them the maximum possible chance of reaching their target without being brought down. This, influenced by NATO Intelligence about Soviet air defences, would dictate the routes to be taken. There was a further problem in the ranges that the respective V-bomber types were capable of.

For the Valiant, its combat radius was limited to 1,250 nm miles, whereas the Victor Mk2 had the longest range with a radius of action of 2,050 nm miles.[34] Combat radii was boosted however with the introduction of mid-air refueling. The RAF concluded: "Although we do not know to what extent flight refueling will be required in war, it

appears likely that we would require more tankers than will be available from the Valiant tanker force from 1960 onwards".[35] However, the fact that a tanker force was available at all would extend the range of the V-bombers that were able to refuel safely in mid-air. As another RAF document observed: "Flight refueling will give the V-bombers tactical freedom en-route to the target. It will also increase the radius of action of the force".[36]

Having 'topped up', the V-bombers would then proceed to their targets. As an RAF document of 1961 pointed out:

"The ranges will vary for the various marks and types according to the weapon load. If direct routes were flown from the 'V' bases in the UK, most of the targets in Russia we wish to attack would be within range, bombers being allocated to various targets according to their radii of action. However, the direct routes cross the satellite countries in Europe and the greatest distances over Russian territory and, therefore, involve the longest crossing of the Russian air defence system. It is essential now, and as the Russian defence system improves, it will be vital, to route our bombers tactically so they proceed as far as possible outside the perimeter of the Russian defence system to points from which targets are reached by the shortest penetration. This involves flying round Northern Norway and South-East Europe which increases considerably the distance to be flown."[37]

It was concluded therefore, that the V-bombers should take a longer route in order to avoid Soviet defences not just to the North but also to the South.

"Some of the distant targets can be reached from Cyprus, and the direct routes from Cyprus to some of these targets are themselves the shortest penetration routes, but planned facilities in Cyprus provide for one squadron of V-bombers only because of its vulnerability and the expense of overseas deployment."[38]

Hence, we can see that a small number of V-bombers deployed from Cyprus, along with those flying on a northerly route from the 36 dispersed airfields and all heading for different targets, would present the Soviets with a widely scattered force, converging on their various targets from different directions. The wide dispersal of the V-bomber bases and their wide scattering *en route* to target increased the chances of greater numbers of bombers getting through to their targets. There remains the question however, of the targets themselves.

Once the V-force became fully operational in 1957, Bomber Command — as part of NATO — went about coordinating its targeting with SAC. At the initial meetings to discuss targeting between Bomber Command and the Strategic Air Command (SAC), it was discovered that there was much duplication of targeting.[39] This would have undermined the effectiveness of the NATO deterrent in general. The solution was a combined plan in which Bomber Command was allocated 106 targets, including 69 cities of governmental or military significance, 17 Soviet air force airfields with nuclear roles and 20 Soviet air defence system sites. There was also to be full tactical co-ordination by joint planning of routes, the timing of attacks and electronic countermeasures (ECM) tactics.[40] However, right from the outset, the V-force was intended to have the capability as an independent nuclear deterrent for Britain, indeed, this was one of the fundamental reasons for its existence.[41]

Although it is difficult to imagine a scenario in which the British nuclear deterrent would be deployed on its own without the help of its NATO allies, war plans were drawn up for such a situation. In the event of this, Soviet targets were revised to include "131 Soviet cities whose population exceeded 100,000; from these 131 cities, 98 were chosen which lay within about 3,000 km of the UK and they were graded in order of priority according to population, administrative importance, economic importance and transportation".[42]

The high priority given to cities reflected Britain's belief in the viability of this strategy, especially targeting Moscow, otherwise known as the 'Moscow criterion'.[43] There also remained a level of ambiguity in Britain's targeting policy as it was believed that the Soviet leadership might value their own power more than their cities.[44] However, without the 'saturation' that a combined NATO attack

The next problem for the V-bombers as they neared Soviet airspace would be how to navigate to the target and deliver the weapon. An even greater problem would be how to survive the Soviet air defences

would bring and the ECM aids that the involvement of the Americans would bring, it must be concluded that the V-bomber force acting alone would suffer much higher losses.

It is also worth mentioning that Bomber Command was dependent to a significant extent on US space Intelligence and without this, very recent knowledge about Soviet defences would be quite poor.[45] To what extent it is difficult to say, but given that the V-force operated primarily as Britain's nuclear deterrent within NATO, it is more useful to consider its military capability within this context.

The next problem for the V-bombers as they neared Soviet airspace would be how to navigate to the target and deliver the weapon. An even greater problem would be how to survive the Soviet air defences. This will be discussed below.

The nature of the role of the V-bombers meant that from a navigational point of view, they would have to be self-sufficient in finding their way to the target (in much the same way that RAF Bomber Command crews were in the early raids of the Second World War from 1939-41). Although the early Valiants carried navigational aids reliant upon ground beacons, which would have been of little use on a long-range flight into the Soviet Union, all the V-bombers were soon equipped with more up-to-date systems. These included an updated version of the H2S radar, the H2S Mk 9A[46] that helped to map the ground directly below the aircraft.

The earlier model had proved useful to Bomber Command during the Second World War. This information was then fed into the Navigation and Bombing Computer (NBC). The NBC afforded V-bomber crews a degree of help their predecessors did not have. It monitored the aircraft position, track and groundspeed from information fed to it from the H2S Mk 9A and could steer the aircraft and release the bomb if required.[47] From a purely navigational point of view finding the target should not have presented a problem. An RAF document concluded on the subject of navigation, "Tests with the Valiant have shown that navigation to the required accuracy can be achieved in daylight in good weather using maps and dead reckoning. At night or in bad weather, a navigation aid

is essential".[48] As the navigational aids appeared to be satisfactory at high level, the V-bombers would appear to have been able to find their targets.

However, once the V-bombers were required to switch to low level attack from 1963 onwards due to the increasing sophistication and therefore threat of Soviet air defences, navigation was to present more of a problem. Problems soon became apparent when low-level trials were carried out by a Valiant in 1956. A document of that year summarizing the problems encountered pointed out that

"map reading was the only means of navigation available . . . A very close link between the second pilot and the navigator was particularly necessary due to the lack of view from the navigator's station. Use of the bomb aimer's position proved fruitless again due to the restricted view".[49]

Although navigational problems at low altitude at first appeared great, measures were introduced to alleviate the problem. In 1961, in operation 'Malvocation' low-level flight trials by a Valiant were carried out from Goose Bay in Canada because the terrain was thought to more closely resemble the vast wastes of the USSR and navigation would be more of a challenge because of the lack of distinctive features in the terrain. Amongst the measures introduced to improve low level navigation were the Decca Type 9033 Roller Map.[50] Installed in the cockpit for the co-pilot to read, it aided navigation considerably as the previous navigation aids were useless at such low altitude and as already mentioned, the navigator couldn't see very well out of the bomb aimer's position. The Decca Type 9033 worked by simply plotting the position of the aircraft on a map which scrolled along. Accurate information such as the aircraft's speed and direction were fed into it via the aircraft's systems and with this information, it would then work out the aircraft's position on the map.[51]

Trials in Canada were judged to be a success. The conclusion drawn from 'Malvocation' was that "Phase 1 has shown that with an experienced crew, the Valiant can be flown in the low level role very successfully".[52] Although the problems of low-level navigation would appear to be solved, there were also other problems to be overcome if the V-bombers were to be used effectively at low-level and be able to carry out their mission. These will be discussed below as part of a wider consideration of the V-bomber's ability to penetrate Soviet defences, get within range of their targets, and deliver their weapons.

In trying to evaluate whether Britain's V-bomber force was capable of carrying out the mission assigned to it, a study of Soviet air defences is vital. As argued earlier, such a study is hypothetical but it is possible to reach a balanced judgment if many of the factors are considered carefully.

With the V-bombers having got this far, they would now come upon the most significant obstacle between themselves and the target — the Soviet air defences themselves. In looking at the Soviet air defences, and the V-bombers ability to penetrate them, it will be necessary to look at several areas. These will include the structure of the Soviet air defence system, the detection systems it employed and the weapons systems it deployed, most significantly, surface-to-air missiles and air defence fighters. It will then be necessary to look at the countermeasures the V-bombers employed to overcome these defences. The last stage will be to consider the delivery system of the V-bombers and their ability to hit their targets, assuming they were able to penetrate the Soviet defences.

The Soviet Air Force of the Anti-Aircraft Defence of the Homeland (*Protivo-Vozduschniya Obarona-Strany* or PVO Strany) ranked third in order of precedence in the Soviet armed forces after the Strategic Rocket Forces and the Ground Forces and became an independent arm in 1954.[53] The Commander-in-Chief of the PVO Strany, who operated directly under the Ministry of Defence in Moscow, had four main elements under his command. These comprised:

i) Radar Troops (*Radioteknicheskie Voiska*)
ii) Anti-Aircraft Artillery Troops (*Zenit-naya Artilleriya*)
iii) Anti-Aircraft Missile Troops (*Zenitno-Raketmye Voiska*)
iv) Fighter Aviation of the Air Force (*Istrebitel'naya Aviatsiya*)[54]

All would have acted interdependently to defend

The high cruising altitude of the V-bombers had been one of the factors that they relied upon in order to be able to get through. With the MiG-19, this was brought into question

Soviet airspace. Having captured a number of German scientists at the end of the Second World War,[55] the Russians used this expertise to build their air defences. The integration of these air defence components would have presented a formidable obstacle to the attacking V-bombers. Given that cities formed such a large part of Bomber Command's targets, these defences seem all the more formidable. I shall now examine the fighter and surface-to-air missile (SAM) elements of the Soviet defences in the context of the V-bombers ability to overcome them.

Although V-bombers were designed to fly close to the speed of sound, none of them was supersonic. Soviet fighters from the MiG-19 onwards entering service in 1955[56] already represented a superiority in speed at the time the first V-bomber — the Valiant — became operational. It was also uncomfortably close to the V-bomber cruising height of 60,000 ft. The high cruising altitude of the V-bombers had been one of the factors that they relied upon in order to be able to get through. With the MiG-19, this was brought into question. As Brookes has pointed out '. . . it was clear that the PVO-Strany would soon be capable of operating in all weathers at the heights and speeds wherein the early V-bombers sought their protection".[57] Furthermore, the radar chain would enable the PVO-Strany command and control to direct their surface to air missiles and fighter interceptors with greater efficiency. Although in 1955 the Russian air defence system was ". . . thought to be comparable to that of the UK in 1939/40 . . ."[58] Bomber Command could also be sure that advances would follow.

Britain therefore, having made a major effort to get the V-force into service, would now have to ensure that it was kept up to date. The advantages of speed and especially height that were relied upon when the designs for the V-bombers were in the

design stage, no longer applied by 1955. Of particular concern (not surprisingly) were the increases in performance of fighters and surface-to-air missiles. The following tables show the performance of Soviet air defence fighters compared to the performance of the V-bombers in speed and altitude.

Chart shows V-Bomber speeds compared to Soviet Interceptor fighters

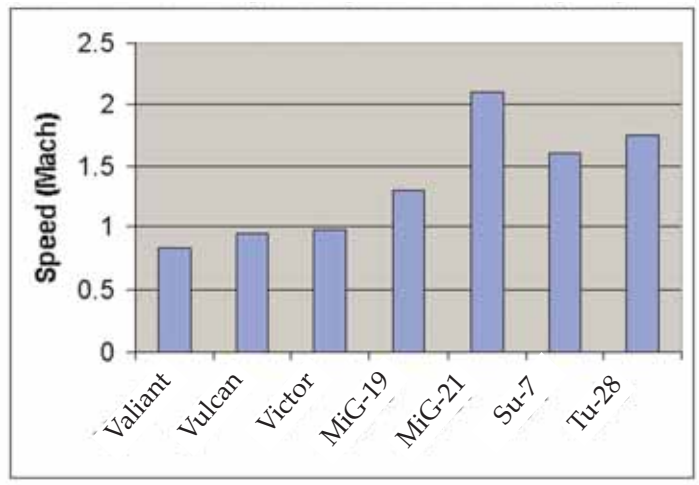
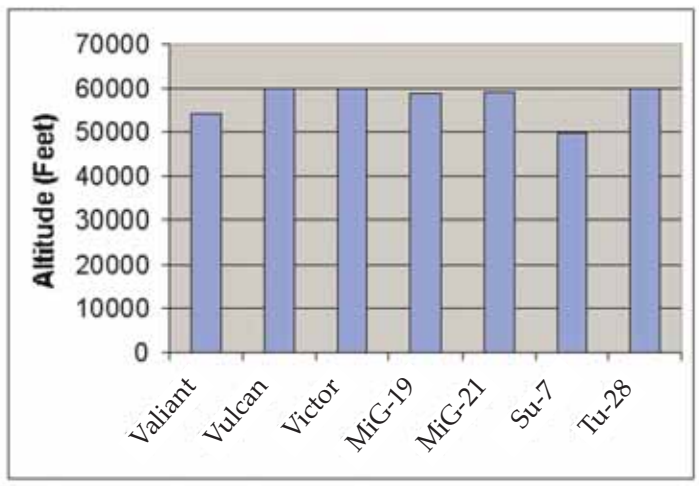


Chart shows the maximum altitudes of V-Bombers compared to Soviet Interceptor fighters



From these charts we can see that all the V-bombers were outclassed by Soviet interceptors in terms of speed. This is not particularly surprising, but perhaps a cause for greater concern is the increase in altitude of Soviet interceptors. Both the MiG-19 and MiG-21 were just below the maximum ceiling of the Vulcan and Victor and the Tupolev-28 (NATO code-name FIDDLER), entering service in 1961, could actually match them for height. The Valiant was outclassed in both speed and height and therefore it must be concluded that it would have suffered heavy losses at the hands of Soviet interceptor fighters.

In 1955 a top secret document trying to predict the vulnerability of the V-bombers by 1960 argued that ". . . the loss rate for Valiants operating by day at high level will be so high that this type of operation is out of the question".[59] This would mean that for high level daylight raids, the V-force would have to rely on Vulcans and Victors. Furthermore:

"It is estimated in J.I.C.(56)8(Final) that by 1960 against aircraft flying at sonic speeds, the Soviet air defence system is likely to be able to provide a reasonably effective defence against deep penetration raids except those made at low level in poor visibility. The fighter force consisting of supersonic day fighters and all-weather fighters may well be receiving into service considerable numbers of a new fighter combining the roles of day interceptor and all-weather fighters. This new fighter maybe armed with air-to-air guided missiles and be capable of speeds up to Mach 2.5 at 70,000ft. Surface-to-air guided weapons will be deployed for the defence of strategic target areas. A.A.A. (anti-aircraft artillery) guns may be retained to provide a deterrent against low level attack and to supplement the guided weapon defences".[60]

If one were to imagine an attack on the USSR by the V-bombers, it seems reasonable to conclude that a percentage of the bombers would have been shot down before they reached their targets. The important question is how high a percentage? The same document estimated that:

"In studying the problem of extending the Valiant operational life it has become apparent that the Vulcans and Victors are also likely to run into serious trouble in 1960. Theoretical assessment gives them a loss rate of 5% per 100n.m. by night. A penetration of Moscow therefore would cost something in the region of 55% of the attacking force."[61]

This would represent an unacceptable rate of loss for any attacking aerial force. However, it is worth remembering that the V-bombers would have had the elements of surprise in terms of where they were approaching from, were very likely be part of a much larger NATO force, thereby increasing the number of targets for the Soviet air defences to cope with, and that in such a scenario, manned bombers would have been preceded by ICBMs, including Britain's Thor missiles loaned by the USA.[62]

The other major threat to the V-bombers apart from fighters were SAMs, especially the SA-2. NATO concern over the use of SAMs increased after Gary Powers' U-2 spyplane was shot down in 1960. Given the height and speed at which the U-2 travelled, it appeared that overnight, the V-bombers had become much more vulnerable to Soviet air defences. However, Gary Powers's aircraft was a lone aircraft flying deep inside Soviet territory. Any V-bomber attack would take place with tens of aircraft attacking simultaneously and in the case of a NATO attack, hundreds. Furthermore, the V-bombers carried ECM jammers. However, as has been pointed out, by 1962 there were too many SAM sites for all of them to be avoided[63] and any V-bomber crew would have to use a good deal of initiative to avoid them all on the way into target and on the way out again.

What became of particular concern were the Soviet advances in SAM design especially the SA-2 (NATO codename GUIDELINE) and SA-3 (GOA). The SA-2 was rugged and easy to deploy in the field operating at medium and high altitudes. It achieved a good combat record against American aircraft in North Vietnam from 1965-68 and again in 1972. The more potent SA-2E could be fitted with a nuclear warhead of 15KT[64], a yield not much smaller than Britain's first nuclear bomb, 'Blue Danube'. However, with the switch from high level to low level attack, the V-bombers should only have been vulnerable to the SA-2 for a few minutes when climbing to release their nuclear weapon. This switch from high to low level did not make the V-bombers invulnerable to SAMs however. The SA-3 GOA was a short-to-medium range weapon. Deployed alongside other SAM batteries, the improved guidance system allowed it to be used against surface targets and naval vessels.[65] This ability for low-level interception would also have made it a useful weapon against low flying V-bombers. Soviet cities, the most numerous targets of the V-bombers, were well defended by SAMs.

With regard to AAA fire at low level, this was not considered such a threat as "Light AAA guns would have to rely on visual aiming or could set up a barrage in the predicted path of the bombers".[66]

Thus, we can see that from 1960 onwards, the V-bombers would face a gauntlet of fighters, surface-to-air missiles (SAMs) and AAA fire. If guided to their targets efficiently, this could represent a defence force that would inflict prohibitively high casualties and thereby undermine the credibility of the deterrent. It was with this in mind that Bomber Command looked into the possibility of using the V-bombers in a low-level role in order to overcome the increasingly formidable Soviet air defences. This was a bold proposal as the V-bombers had been designed for high level penetration and were not designed for low-level attack.

The problems of navigation at this altitude have already been discussed, but there were also other problems. Early low-level flight trials with a Valiant found that apart from the problems of navigation, other hazards included heavy flight controls, leading to premature fatigue on the part of the pilots, bird strikes and dead flies building up on the windscreen obstructing the view.[67] There were additional problems with turbulence that in turn affected the performance of all the crew as they were uncomfortably jolted around and of the temperature in the cabin as the emphasis had been on heating at high altitude, not air conditioning at low altitude.

Nevertheless, the problems of cabin temperature and heavy controls were solved and the V-bombers were configured to penetrate Soviet defences at low level to enable them to have a greater chance of getting through. On 23 January 1963, the Defence Committee approved measures necessary to give the V-bombers a low-level capability.[68] However, new problems arose apart from

In the high-low-high delivery configuration newly devised for the V-bombers, the Vulcan Mk2 would only be able to reach 16 of the 40 targets assigned to it and this did not include Moscow

the ones mentioned above. For one, low-level flying made for far higher fuel consumption which made air-to-air refueling a necessity if the V-bombers were to reach their targets.

This in itself wasn't that much of a problem, but the higher fuel consumption put many of the targets assigned to Bomber Command out of reach. In the high-low-high delivery configuration newly devised for the V-bombers, the Vulcan Mk2 would only be able to reach 16 of the 40 targets assigned to it and this did not include Moscow.[69] According to the same source, only the Victor would have been able to reach all 40 targets. Given the importance of the 'Moscow criterion' mentioned earlier, this could have represented a setback for British strategy. However, as Moscow was within range of the Victor, it must be assumed that a proportion of Victors would have been assigned Moscow as their target. Nevertheless, this limitation on the Vulcan Mk2 represented a reduction in the reach of Bomber Command and a downgrading in its capability.

There was also the additional factor of the other element that the V-bombers used to protect themselves apart from dispersion, surprise and the diminishing qualities of speed and altitude. This other factor was the V-bomber's only direct means of self-defence — electronic counter measures or ECM.

An RAF report of 1955 came to the conclusion that day operations of Victors and Vulcans in the 1958/59 period would be costly but that ". . . such losses might be relieved by the introduction of ECM. It was agreed, however, that the Valiant would suffer heavy losses if operated against long range targets by day in this period . . . The meeting further agreed that the Victor and Vulcan would be able to operate satisfactorily by night, with ECM, even against surface to air guided weapons (S.A.G.W.)".[70]

Thus it can be seen that even in the early years of the life of the V-bombers, there was already concern with regard to the vulnerability of them and that Air Staff planners were engaged in a constant struggle to keep the V-bombers one step ahead of the Soviet air defences and ECM capability would be a major counter-measure for the V-bombers against Soviet air defences. Therefore, the question needs to be asked, how effective were the ECM countermeasures?

The first problem with ECM countermeasures for the V-bombers was where to fit them. With this problem solved, it only remains to consider how effective the ECM countermeasures would have been in a combat situation. It will not be necessary here to look at the technical aspects of the ECM of the V-bombers. Rather it is important to try and understand how effective the ECM measures would have been in increasing the chances of survival of the V-bombers in hostile airspace.

Electronic countermeasures in the V-bombers fell into two categories — defensive and offensive. The defensive component consisted of warning equipment to detect when the bomber had been 'spotted' by Soviet ground radar and also a tail warning radar to observe enemy fighters attempting to move into firing position.[71] The offensive part of the V-bomber's ECM was a jamming device that used the same technique that Bomber Command had used with its heavy bombers during the Second World War, that of jamming the enemy early warning and fighter control radars with noise.

The system, known as 'Green Palm' emitted a noise that was likened to ". . . a cross between a continental police siren and the bagpipes".[72] Nevertheless, this still leaves the question of how effective would it have been in protecting the V-bombers from air defences? According to Brookes, "Fortunately for Bomber Command, Soviet fighters of the time used only four VHF channels for their radio communications, and the V-bombers carried Green Palm, which was a VHF jammer tuned in to those four frequencies".[73]

Assuming that the fighter radio frequencies set on the V-bombers were correct, this would be a very effective deterrent against interception by fighters because Soviet air doctrine favoured fighters having instructions issued and being guided from the ground.[74] If Soviet pilots were unable to receive orders from the ground, they would be in a weak position to find the attacking V-bombers for a

The last Valiant training sorties were flown in December 1964 and by January 1965 they had all been prematurely withdrawn from service

number of reasons. For one Soviet pilots were discouraged in their training from showing initiative, the vast expanse of the USSR would make them difficult to find without radar guidance from the ground and the defensive measures fitted to the V-bombers meant that the pilots would do all that they could to avoid an interceptor once it was detected. As a last resort, the V-bomber pilot could also try to out-manoeuvre the intercepting fighter.

Another problem arose in the stresses and strains that long duration low level flight placed on the airframes of the V-bombers. Most worryingly, in 1964, a fracture occurred in the rear spar of a Valiant and when other Valiants were inspected, signs of metal fatigue were found on the wing spars.[75] The last Valiant training sorties were flown in December 1964 and by January 1965 they had all been prematurely withdrawn from service. This meant a reduction of the V-force by six squadrons, a sizeable proportion of the force. This in turn meant that greater numbers of Vulcans and Victors would have to get airborne and reach their targets (with the Vulcans already being limited due to its reduced range at low level) for the force to still be a credible deterrent.

A further problem with low level flying was related to the type of nuclear weapons used. Whereas at high altitude, the V-bombers would have been high above the detonation and therefore relatively safe, it would have been impossible for the V-bombers to release their nuclear weapons at the altitude of 300 ft and survive due to the required minimum safe distance from the explosion. With regard to accurate delivery of their weapons, Bomber Command had a good record of accuracy in training exercises and bombing competitions held with the USAF.

In 'Operation Skyshield' in October 1961, eight Vulcans were dispatched from RAF Scampton to test their ability to penetrate the North American Air Defense Command (NAADC), alongside USAF aircraft.[76] The result was that five of the eight Vulcans penetrated the defences to reach their targets using their ECM to good effect. Those

It would have been impossible for the V-bombers to release their nuclear weapons at the altitude of 300 ft and survive due to the required minimum safe distance from the explosion

interceptors that tried to intercept the V-bombers at high altitude found they were too low on fuel having had to intercept lower-flying intruders earlier.[77] This experience could have been a pointer to how the V-bombers would have faired in a real high-altitude attack during the early 1960s.

Another exercise although held in 1974 is a good indicator of bombing accuracy in the V-force. Held in the USA, the competition resulted in one of the Vulcan crews taking part being awarded the Mathis Trophy for bombing accuracy, ahead of their American rivals and on American soil.[78] This seems a good testament to the ability of the V-bomber crews.

Nevertheless, there were still delivery complications in environments outside of bombing competitions. Complications with Blue Steel were further compounded by the way the stand-off missile, which entered service in 1963, operated. Blue Steel allowed the V-bombers to have to get no nearer than 100 miles of the target as once released, it would then guide itself the rest of the way to the target from information fed to it by the parent V-bomber prior to release and at supersonic speed.[79]

Blue Steel also required that it be released at a minimum altitude of 26,000 ft[80] which meant that a low flying V-bomber would have to pull up to a minimum of 26,000 ft between 100-200 miles from the target in order to release the weapon, thus revealing its position to Soviet radar before 'going to ground' again for the return journey home. This climb would take a minimum of four minutes during which time, the V-bombers would be vulnerable to defences such as SAMs.[81]

Nevertheless, Blue Steel made up for this in other ways. It had the advantage of being 'self-sufficient' once launched and needed no outside guidance to the target. This in turn meant it couldn't be jammed and so enhanced the credibility of Britain's nuclear deterrent.[82] As Jackson has pointed out, "Its importance lay in the fact that it gave the V-force a continued operational viability into the mid-1960s in the face of increasingly sophisticated enemy fighter and SAM missile defences".[83]

Further pressure was placed upon the role of Blue Steel by the cancellation of two major nuclear delivery systems — Blue Streak and Skybolt. Blue Steel's intended replacement 'Skybolt' which would have had vastly increased range and enabled the launch aircraft to be as far away as 1,000 miles from the target,[84] was cancelled by the Americans in December 1962. This made the role of Blue Steel even more important.

From 1964 until the RAF passed on the carrying of the nuclear deterrent to the Royal Navy, the V-force and the British deterrent relied upon a combination of Vulcan, Victor and Blue Steel. By the mid-1960s, 100 miles from the target would have been uncomfortably close given the sophistication of Soviet air defences by that time. The cancellation of another major RAF programme, the TSR-2 in 1965, was another blow. Although designed as a tactical strike aircraft, it had been proposed to use the TSR-2 in a minor strategic role to supplement the V-bombers. Capable of much higher speeds than the V-bombers and with a sophisticated delivery system, it was proposed that TSR-2s could be armed with tactical nuclear weapons and strike at the Soviet Union[85] in a similar way that the Panavia Tornado was designed to do during the 1980s.

Certainly this would have enhanced the RAF's deep strike capability. Sadly, this possibility was to end with the cancellation of the TSR-2 programme. It was also proposed to use the Royal Navy Blackburn Buccaneer in a nuclear role to penetrate enemy defences at low level. Flying from Lossiemouth, potential targets included Leningrad, Riga, Kaumas, Kalingrad, Talinn and Gdansk.[86] However, this was not carried through, leaving the remaining two types of V-bomber and Blue Steel to carry on. The fact that other types of aircraft were considered in a minor strategic nuclear role gives an indication of the concern over the vulnerability of the V-bombers by this time.

What then of the V-bomber force from 1964 until its retirement in the nuclear role in 1969? There were significant developments in Soviet air

The Galosh had a nuclear warhead of several megatons that would saturate an area where approaching enemy aircraft were believed to be

defences in this period that would have made any attack on the USSR more hazardous. One of these was the 'Galosh' air defence system, that deployed the A-35 Anti-Ballistic Missile (ABM). First seen in 1964 and deployed around Moscow in 1966[87], the Galosh had a nuclear warhead of several megatons that would saturate an area where approaching enemy aircraft were believed to be. Although indiscriminate, it would be a major obstacle to any attacking aircraft or stand-off missile or even a Polaris ICBM.[88] It also carried its own guidance system in the form of the 'Try Add' radar stations based just outside of Moscow.[89]

As discussed earlier, Moscow was an important target in British strategic thinking and for the V-bomber force. The deployment of the Galosh system could have been a serious setback to the chances of the Victors or Blue Steel actually striking at Moscow. As it was only deployed around Moscow in this period however, other targets would not have had such a formidable defence. Nevertheless, the Galosh system, coupled with the reduced number of V-bombers that had the range to reach Moscow at low level would have made Moscow an increasingly difficult target from 1966 onwards.

For those V-bombers that did manage to overcome all of the obstacles and deliver their weapon, all that would remain would be to find a way to return home, not an easy task considering they would have to face all of the obstacles they faced on the way to the target and there would probably have been little to return to.

Conclusion

It has already been established that a significant number of V-bombers would more than likely get airborne in the event of a nuclear attack and that their dispersal, both around the British Isles and in Cyprus would scatter the attackers leaving the Soviet defenders with a wide area to defend. Air-to-air refueling outbound to the target would increase their endurance and enable tactical re-routing inbound to the target. There was the navigational

expertise and equipment onboard the aircraft to navigate into Soviet airspace accurately at both high and low levels.

The picture that emerges with regard to the ability of the V-bombers to penetrate Soviet defences is a mixed one. When the V-force came into service, the performance of the respective types of V-bomber was sufficient to overcome the Soviet defences. However, by 1960, this was beginning to be called into question. Soviet advances in co-ordinated air defence, high performance fighter interceptors and SAMs would have made the V-bombers' task increasingly difficult.

By 1960 the Valiant was rapidly becoming obsolescent in the high level role and by 1963, all the V-bombers would be forced to fly at low level. This in turn brought problems in that the Valiants had to be retired early due to metal fatigue and the Vulcan would not have been able to reach certain targets such as Moscow. In addition, problems occurred with the delivery of nuclear weapons at such an altitude and the V-bombers would have to have made themselves vulnerable by climbing on the approach to target. Deployment of the Galosh ABM system around Moscow would have made attacking the city, an important British target, a very difficult proposition from 1966 onwards.

The task of the V-bombers was not helped by the cancellation of Blue Streak and the TSR-2, both of which would have given the RAF a more flexible strategic capability.

For all these arguments though, there are also convincing arguments that the V-bombers could have succeeded in the sense that enough bombers would have got through to make the V-force a credible deterrent. Combat exercises such as 'Skyshield' showed that high altitude bombers were difficult to intercept if the interceptor fighters had been engaged previously due to the amount of fuel required to reach 60,000 ft. The problems the Soviets had with the lack of range of their jet fighters at this time could have made this a real problem.

ECM jammers carried by the V-bombers were proven to be effective in such exercises and the navigational capabilities and bombing accuracy of the aircrews were among the best in the world. Once the problems of low level flying were solved, the V-bombers would have been difficult to intercept except during their approach to target but even then, they were exposed for only a short while.

Although the Blue Steel only afforded the V-bomber 100 miles of distance between itself and the target, this would have allowed tactical re-routing to try and avoid the worst of the Soviet defences. The use of the 'Yellow Sun' free-fall bomb up until 1966-67 would have made the task for an attacking V-bomber more difficult.

Above all, it has been argued that the best chance the V-bombers had of carrying out their mission was as acting as part of a wider NATO force. The V-bomber force acting alone against the USSR would have had little chance of success. As part of a wider NATO force however, the V-force would have had the advantages of prior strikes on Soviet targets by ICBMs, numerical strength with a large contingent of American bombers and combined ECM capability. This 'saturation' of the Soviet air defences coupled with the devastation and confusion that prior strikes by ICBMs would have caused was the V-bombers best chance of success.

The fact that peace was kept between East and West during the Cold War period can be attributed to many different factors. One of these was the deterrent threat and the capability of Britain's V-bombers.

Bibliography

Brookes, Andrew (1982), *V-Force: The History of Britain's Airborne Deterrent* (Coulsdon: Jane's Information Group)
Brown, Neville (1964), *Britain in NATO* (London: Fabian Society/Devonport Press)
'Careful with that Nuke', *New Scientist*, 23rd June 2001
Freedman, Lawrence (1989), *The Evolution of Nuclear Strategy* (London: Macmillan)
Heuser, Beatrice (2000), *The Bomb: Nuclear Weapons in their Historical, Strategic and Ethical Context* (London: Longman)
Isaacs, Jeremy & Downing, Taylor (1998), *Cold War* (London: Bantam Press)
Jackson, Robert (1981), *V-Bombers* (London: Ian Allan Ltd.)
Jones, Barry (2000), *V-Bombers: Valiant, Vulcan and Victor*

(Marlborough: The Crowood Press)
Menaul, S.W.B. and Gunston, Bill (1976), *Soviet War Planes* (London: Phoebus Publishing)
Miller, David (2001), *The Cold War: A Military History* (London: Pimlico)
Pierre, Andrew J. (1972), *Nuclear Politics: The British Experience with an Independent Strategic Force: 1939-1970* (London: Oxford University Press)
The NATO Handbook: 50th Anniversary Edition (1999: Brussels: Office of Information and Press)
Sgarlato, Nico (1979), *Soviet Aircraft of Today* (Carrollton, Texas: Squadron Signal Publications)

Public Records Office Documents
Operation of V Bomber at Low Level (1955-61), AIR 2/14578
Operation of V Bomber at Low Level (1961), AIR 2/14700
State of Readiness of V Bomber Force (1960), DEFE 13/306
State of Readiness of V Bomber Force (1960), DFB (60)4
State of Readiness of V Bomber Force (1960), DFB (60)5
Nuclear Weapons: Lay Down Nuclear Weapons for V-bombers (1963), DEFE 25/23
V-Bomber Force Future Policy (1961), AIR 2/14700 CMS 2948/III
V-Bomber Force Future Policy (1961), AIR 2/14699
V-Bombers in Low Level Role (1956), AIR 2/13415

Internet Sources
http://fas.org/nuke/guide/russia/airdef/v-75.htm
http://fas.org/nuke/guide/russia/airdef/v-125.htm
http://www.fas.org/spp/starwars/program/soviet/galosh.htm
http://www.wonderland.org.nz/a-35.htm

Notes
1 Pierre (1972) p94
2 Pierre (1972) p87
3 Heuser (2000) p94
4 Pierre (1972) p94
5 Brookes (1982) p75
6 Pierre (1972) p94
7 *State of Readiness of V-bomber Force* Public Records Office DEFE 13/306 DFB(60) 4 (1960)
8 *State of Readiness of V-bomber Force* Public Records Office DEFE 13/306 DFB(60) 4 (1960)
9 *State of Readiness of V-bomber Force* Public Records Office DEFE 13/306 DFB(60) 4 (1960)
10 Brookes (1972) p102
11 *State of Readiness of V-bomber Force* Public Records Office DEFE 13/306 DFB(60) 5(1960)
12 *State of Readiness of V-bomber Force* Public Records Office DEFE 13/306 DFB(60) 5(1960)
13 *State of Readiness of V-bomber Force* Public Records Office DEFE 13/306 DFB(60) 5(1960)
14 Miller (2001) p.142-144
15 *State of Readiness of V-bomber Force* Public Records Office DEFE13/306 SZ/702/61 (1961)
16 *State of Readiness of V-bomber Force* Public Records Office DEFE 13/306 DFB(60)5 (1960)
17 Brookes (1982) p83
18 Brookes (1982)p84
19 Jackson (1981) p22
20 Brookes (1982) p84
21 *V-bomber Force Future Policy* Public Record Office AIR 2/14700 CMS. 2948/III paragraph 4 (1961)
22 Jackson (1981) p100
23 Jackson (1981) p101
24 NATO Handbook 50th Anniversary Edition (1999) p26
25 Brookes (1982) p 83
26 RAF Museum, Hendon information plaque
27 Miller (2001) p.236-237
28 Miller (2001) p 137
29 'Careful with that Nuke' (June 2001) New Scientist
30 'Careful with that Nuke' (June 2001) New Scientist
31 Jackson (1981) p93
32 Jackson (1981) p94
33 Isaacs & Downing (1998) p151
34 'Valiant & Victor- United Kingdom Nuclear Forces' http://www.fas.org/nuke/guide/uk/bomber/valiant/victor.htm Accessed 14 August 2001
35 *Operation of V-bomber at Low Level* Public Record Office AIR2/14578 CMS.2733/55 page 7 (1955)
36 *V-bomber Force Future Policy* Public Record Office AIR 2/14700 CMS. 2228/53 Paper No. A.C. (57) 92 (1961)
37 *V-bomber Force Future Policy* Public Record Office AIR 2/14699 AF/CMS 572/64 75.B 3. (1961)
38 *V-bomber Force Future Policy* Public Record Office AIR 2/14699 AF/CMS 572/64 75.B 4. (1961)
39 Miller (2001) p139
40 Miller (2001) p139
41 Pierre (1972) p86
42 Miller p139 (2001) – H. Wynn, the RAF Strategic Deterrent Forces 1946-69 p276
43 Heuser (2001) p87
44 Heuser (2001)p87
45 Brown (1964)p10
46 *Operation of V-bomber at Low Level* Public Record Office AIR 2/14578 CMS. 2733/55 page 5 (1955)
47 Brookes (1982) p78
48 *Operation of V-bomber at Low Level* Public Record Office AIR 2/14578 CMS. 2733/55 page 5 (1955)

[49] *V-bombers in Low Level Role* Public Record Office AIR 2/13415 acas (ops) 8232 page 4 paragraph 3.8 (1956)
[50] *Operation of V-bomber at Low Level* Public Record Office AIR 2/14578 BC/S. 96737 (1961)
[51] *Operation of V-bomber at Low Level* Public Record Office AIR 2/14578 BC/S. 96737 (1961)
[52] *Operation of V-bomber at Low Level* Public Record Office AIR 2/14578 BC/S. 96737 paragraph 39. (1961)
[53] Menaul & Gunston (1976) p 54
[54] Menaul & Gunston (1976) p 55
[55] Menaul & Gunston (1976) p 52
[56] Sgarlto (1979) p13
[57] Brookes (1982) p85
[58] *Operation of V-bomber at Low Level* Public Record Office AIR 2/14578 1271/s.6 page 1 (1955)
[59] *Operation of V-bomber at Low Level* Public Record Office AIR2/14578 CMS. 2733/55 page 1 (1955)
[60] *Operation of V-bomber at Low Level* Public Record Office AIR2/14578 CMS. 2733/55 page 1 (1955)
[61] *Operation of V-bomber at Low Level* Public Record Office AIR2/14578 CMS. 2733/55 page 8 (1955)
[62] Brookes (1982) p107
[63] Brookes (1982) p107
[64] 'Soviet Nuclear Forces' http://www.fas.org/nuke/guide/russia/airdef/v-75.htm Accessed 20 August 2001
[65] 'Soviet Nuclear Forces' http://www.fas.org/nuke/guide/russia/airdef/v-125.htm Accessed 20 August 2001
[66] *Operation of V-bombers at Low Level* Public Record Office AIR2/14578 CMS. 2733/55 page 3
[67] *V-bombers in Low Level Role* Public Record Office AIR 2/13415 acas (ops) 8232 paragraph 4.1 (1956)
[68] *Nuclear Weapons: Lay Down Nuclear Weapons for V-bombers* Public Record Office DEFE 25/23 SZ/54/64 (1960)
[69] *Nuclear Weapons: Lay Down Nuclear Weapons for V-bombers* Public Record Office DEFE 25/23 RHS/26/63 (1963)
[70] *Operation of V-bombers at Low Level* Public Record Office AIR2/14578 CMS. 2733/55 page 4-5 (1955)
[71] Brookes (1982) p105
[72] Brookes (1982) p106
[73] Brookes (1982) p106
[74] Menaul & Gunston (1976) p. 55
[75] Jackson (1981) p35
[76] Jones (2000) p161
[77] Jones (2000) p162
[78] Jones (2000) p165
[79] Jackson (1981) p94
[80] *Nuclear Weapons: Lay Down Nuclear Weapons for V-bombers* Public Record Office DEFE 25/23 RHS/26/63 (1963)
[81] *Nuclear Weapons: Lay Down Nuclear Weapons for V-bombers* Public Record Office DEFE 25/23 RHS/26/63 (1963)
[82] Brookes (1982) p126
[83] Jackson (1981)p95
[84] Jackson (1981)p95
[85] *Nuclear Weapons: Lay Down Nuclear Weapons* Public Record Office DEFE25/23 RHS/23/63 (1963)
[86] *Nuclear Weapons: Lay Down Nuclear Weapons* Public Record Office DEFE25/23 RHS/23/63 (1963)
[87] Menaul & Gunston (1976) p52
[88] 'The A-35 Ballistic Missile System' http://www.wonderland.org.nz/a-35.htm Accessed 21 August 2001
[89] 'Galosh-Moscow System' http://www.fas.org/spp/starwars/program/soviet/galosh.htm Accessed 21 August 2001

Book Reviews

SHOT DOWN AND ON THE RUN

The RAF and Commonwealth aircrews who got home from behind enemy lines 1940-1945

By Air Commodore Graham Pitchfork RAF (Ret'd)

Price: £19.99
ISBN: 1-903365-53-8
Format: Hardback, 102 illustrations, 320pp
Publisher: The National Archives, Kew, Surrey

Reviewed by Wing Commander Julian Spencer

This new offering from Graham Pitchfork chronicles real-life stories of escape, evasion and ultimate rescue of Commonwealth airmen ensnared behind enemy lines during World War II. The book is divided into four parts, the first of which provides a fascinating insight into the role of the Military Intelligence body MI9, the escape and evasion training that the aircrew undertook and the escape aids they used.
The subsequent three chapters, the bulk of the book, recount the individual escape stories of 29 airmen operating over the wide range of operational theatres of Western Europe, the Middle East and the Far East. The accounts have been carefully selected to illustrate the wide disparities between, and the unique peculiarities of, the environment and cultures that the three distinct theatres of war presented to the evading airmen.

In his Preface, Graham regales his own boyhood memories of reading escape and evasion books such as *Colditz* and *The Great Escape*. Such literary memories of courage, ingenuity, adventure and downright derring-do are ones to which we can all relate from our own childhoods. However, those books along with many others were written at a time when extant security constraints meant that certain escape and evasion ploys could not be mentioned. Graham's book is not so constrained. It draws on previously unpublished historical documents held and now released at Kew and personal accounts given through interviews with the war veterans themselves.

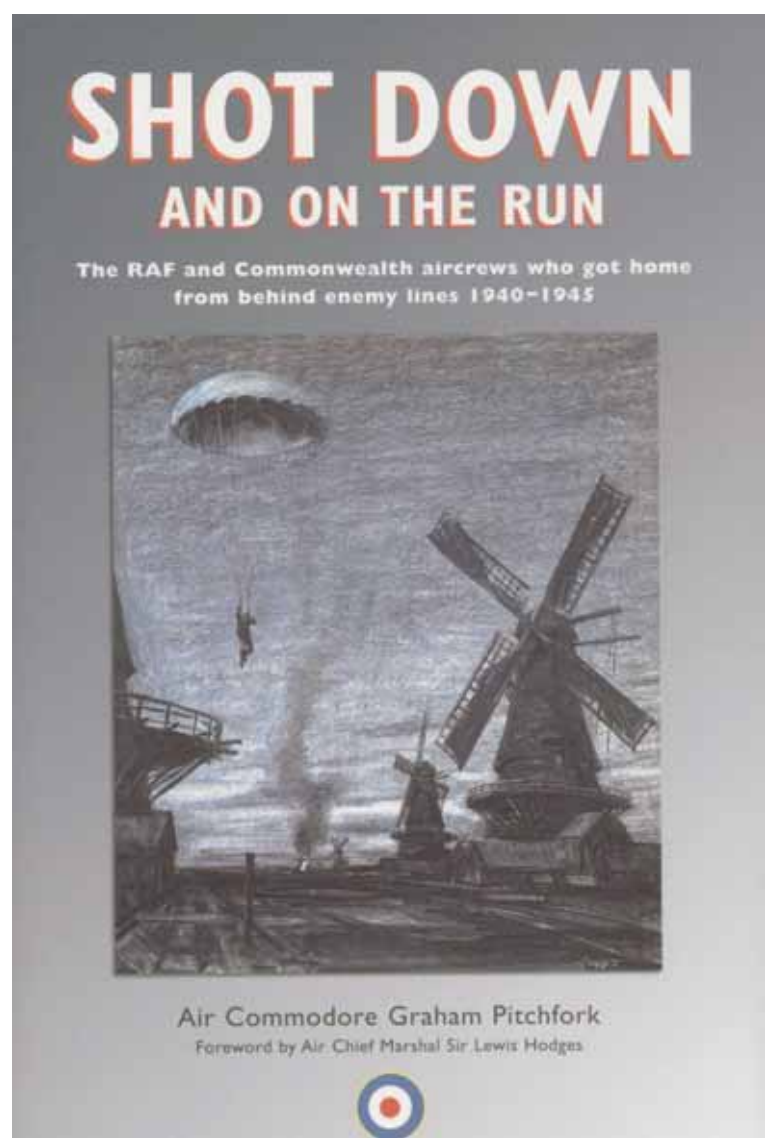
The old adage that truth is often stranger than fiction is amply borne out by this publication. The extraordinary anecdotes transcend the imaginations of even the most accomplished of fiction writers. Indeed, this is a book that refreshingly makes no attempt to reconstruct historical fact as story. It is an unadulterated compendium of real-life stories that leaves the reader eager to turn the page to discover the next daring escapade.

While all 29 of the escape and evasion chronicles share — as one would expect — common threads of fortitude, courage and steadfastness, there are also the personal tales that encapsulate the extent of human resolve when faced with dire adversity.

There is Flying Officer Maurice Garlick, a Lancaster navigator who, having had to bail out at night over enemy territory, suffered the further agonising ignominy of parachuting into a high-tension power cable. "He was in great pain, with both legs useless, there was a strong sense of burnt flesh. His right leg was paralysed and burnt from below the ankle to the calf. His left leg was also very badly burnt. He cut off his flying boots and started to bandage his legs with strips of parachute." Garlick survived to tell the tale.

Then there is the Halifax pilot, Flight Lieutenant Julian Sale, who, despite being literally blown out of his aircraft by an explosion, still managed to parachute to safety albeit into the top of a pine tree. He subsequently walked and cycled over 1,000 miles to avoid capture. The exploits of Garlick, Sale and their fellow evaders make compelling reading.

Finally, and most importantly, this book is not all about the daring exploits of Commonwealth airmen, impressive as they are. This publication rightly pays all due deference to the extraordinary courage, sacrifice and selflessness of the many remarkable people who assisted our aircrew forebears to avoid capture, many of whom paid the ultimate sacrifice for their patriotism. Those cloak-and-dagger protagonists of the underground resistance organisations are the outstanding heroes of Graham's inspiring new book.



Notices/Reunions

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.

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-u-Edge, Glos, GL 12 7ND.
Tel: 01453 843362.