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Contributions from both service and civilian authors are sought which will contribute to existing knowledge and understanding of the subject. Any topic relevant to the study of contemporary or historical air power 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. Lengthy articles may be published in instalments. Contributions from serving military personnel should be in accordance with DCI GEN 313 dated 26 November 1999.

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FOREWORD

It has almost become the norm for authors to begin their papers on the basis that the combined events of the end of the Cold War, followed so closely by Desert Storm, mark a watershed in military history so great that all that preceded them are considered ancient. 'Cold War Warrior' has, in some quarters, become an almost dismissive or even contemptuous term. Yet it was at the height of the Cold War, with perestroika in full retreat, that the junta in Argentina decided to take their dramatic plunge to regain sovereignty over the Falkland Islands. British defence policy was intractably aligned to NATO defence against what was seen as a very real threat. Capability to operate over long distance – or 'out of area' – was not only difficult, but was considered to be an undesirable aspiration. The 20th anniversary of the campaign has inevitably seen a welter of Conferences, panel discussions and new books on the war. Some aspects, arguably, are now at best well worn. Others still repay analysis.

The USAF, and increasingly the United Kingdom, adoption of the concept of expeditionary operations has highlighted the demands of projecting military force over considerable distances. Both Allied Force and Enduring Freedom (Afghanistan) have shown the potential pitfalls of over-reliance on host nation support for air bases for short-range aircraft. The need for long-range bombers *and* a viable air-to-air refuelling force is very clear for all to see.

Similarly, a robust capability for the infiltration, and extraction, of special forces is an integral part of such operations. The Falklands Campaign demonstrated these aspects with such force that it would have required a brave analyst to seek to distinguish the events of 1982 as a 'one-off'! Operation *Black Buck* demonstrated the complexity and difficulty of projecting air power over huge distances. Yet its success also showed – to the entire world – just what could be achieved with limited resources. Dr Alfred Price describes the first of seven Vulcan operations and the supporting tanker plan, in the first article in this edition. As Dr Price points out, the psychological impact of air operations can often be at least as important as the material damage inflicted. The transfer of a fighter group north to defend the homeland is powerful proof of the raid's success.

The second article has been submitted by Wing Commander Al Monkman and was based on his Staff College research paper. He looks at coalition warfare querying the extent to which a commander has scope to exercise the manoeuvrist approach to warfare in such circumstances. Manoeuvre warfare is, at first sight, relatively straightforward. It can be seen as the exact opposite of the classic '*Blackadder*' costly stalemate that is popularly considered to epitomise the First World War. The aim is to utilise movement to strike at weakness rather than merely blunting strength on strength. Air power clearly provides this in all dimensions. The manoeuvrist approach to warfare takes strategy a stage forward. Although it has not been accepted throughout NATO, it is an integral part of UK doctrine. The fundamental aim is to shatter cohesion and will, not merely seek to destroy men and matériel. Some degree of attrition is inevitable on both sides: the manoeuvrist approach is no instant panacea. Again, air power is an integral part of this approach.



In his article on Silent Trackers, Dr Emmett explores a type of surveillance which has been under-rated by the West for too long. Unlike radar surveillance, passive surveillance intercepts and analyses emissions over the whole spectrum, and introduces significant advantages in real time target tracking. Dr Emmett sounds a warning to the West that we may be falling behind.

Part of the essence of the information age is that all players should have an increasingly transparent view of the modern battlespace. In his article on Operation Allied Force, Wing Commander Chris Norton analyses the degree to which the operational effectiveness of air power may be unduly constrained by concerns over casualties, fratricide and collateral damage. He argues that these very real concerns can be partly offset by a co-ordinated information campaign, both within the military structure and to the media and the public.

In the next article, I have sought to answer the question as to why the French city of Caen was bombed in the weeks after D-Day. The city stands almost alone in its resentment to Allied action in what was generally seen as necessary violence in ridding the continent of Nazi tyranny. The article shows that the decision to use heavy bombers on the city and its environs was not arrived at without considerable discussion, but concludes that, while there was an evident audit trail for the process, there was no over-powering logic so to do. The city's self-proclaimed status as a martyr thereby remains intact.

The final article is the first of a two-part work by John Sweetman in which he looks at Barnes Wallis and his contribution to World War II technology. In particular, he gives a detailed analysis of the plans to sink the German battleship *Tirpitz* in 1943. Given that the strategic bombing campaign attracts considerable discussion in general, and the Dambusters in particular, the offensive against naval targets has become something of a Cinderella. This article redresses the balance.

D DEF S (RAF)



In April 1982 Argentina dispatched troops to capture the Falklands Islands in the South Atlantic. In reaction, the British government dispatched a large naval force to repossess the islands. At the RAF Vulcan base at Waddington in Lincolnshire, work began to prepare half a dozen aircraft and crews to move to Ascension Island, to mount extended range bombing missions over the South Atlantic. The operation bore the code-name *Black Buck*.





BLACK BUCK

TO THE FALKLANDS

This material originally appeared in *Sky Warriors Classic Air Battles* (p138-148), by Dr Alfred Price, published by Cassell Military Classics, London, 1998.

When RAF planners began looking at the feasibility of using the elderly Vulcan to support the operation to retake the Falklands, it immediately became clear that this was no easy option. From Wideawake airfield on Ascension Island, to Port Stanley on East Falkland, was 3,380 nautical miles by the most direct route. That is about as far as from London to Karachi in Pakistan. It meant a round trip of at least 6,760 nm, even with no deviations for tactical routing. It would be longest operational bombing mission attempted up to that time.



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Earlier in its life the delta-winged bomber had had a flight-refuelling capability, but for more than a decade the system had been out of use. By 1982 no Vulcan pilot was current on the system, and few remained who remembered ever using it.

The bomber's air-to-air refuelling system was soon restored to use, although it was clear that getting a single Vulcan to the Falklands and back would entail a huge supporting operation by tankers. No fewer than ten Victor tanker sorties were needed to supply the bomber and the tankers accompanying it. And on the way back, a further tanker would need to rendezvous with the bomber to provide fuel for the final part of the return flight.

One further daunting problem concerned the inadequacy of the Vulcan's navigation system for the proposed mission. The bomber's 1950s-generation ground mapping radar was adequate for operations in areas where there were plenty of land features to provide fixes. But the Vulcan's radar and other navigational systems were quite unsuitable for operations over the featureless wastes of the South Atlantic. There, fixing points were few and far between. The returning bomber, perhaps short of fuel, needed to make a rapid and accurate over-sea rendezvous with the tanker sent out to replenish its tanks for the final part of the return flight. To make up for the deficiency, the Vulcans and the Victor tankers selected for the operation were modified to carry hastily procured 'Carousel' inertial navigation systems.

The scale of the Argentine fighter, SAM and AAA defences on the Falklands was unknown, but the potential threat had to be recognised. For that reason, the Vulcan would deliver its attack at night. As the various parts of the operation came together, the big question remained: would the damage inflicted by a single Vulcan carrying 21 x 1,000 lb bombs be sufficient to warrant such a huge expense and effort? In fact, the British armed forces were desperately short of weapons they could bring to bear on the Falklands. Unless some unforeseen and insuperable difficulty appeared, *Black Buck* would go ahead. The crews selected for the operation began a phase of intensive training.

With many complex military operations, if time allows it is usual to rehearse the mission beforehand. In the case of the *Black Buck* operation there was time, but there was no attempt to run a rehearsal. As one Victor pilot later explained:

'It would have been as much trouble to run a rehearsal as to fly the mission, so it was decided to fly the mission. If the problems had become too great, we would have broken off the mission and called it the rehearsal...'

As the various parts of the operation came together, the big question remained: would the damage inflicted by a single Vulcan carrying 21 x 1,000 lb bombs be sufficient to warrant such a huge expense and effort?



Specially prepared Vulcans were loaded with 1,000 lb bombs



As the month of April 1982 drew to a close, there was no sign of a diplomatic solution to the crisis between Great Britain and Argentina. The matter would have to be settled by force of arms. As the British naval task force headed relentlessly south, the Argentine garrison on the islands was greatly strengthened.

Towards the end of the April two specially prepared Vulcans flew into Wideawake Airfield, Ascension Island, each loaded with 21 bombs. Before leaving Waddington their crews had been briefed for their initial target, the runway at Port Stanley airfield. Soon after their arrival on Ascension, they learned that the attack would take place during the small hours of 1 May. One Vulcan was assigned to fly the mission, the other would serve as airborne reserve in case the primary machine went unserviceable.

On the evening of 30 April, commencing at 22.50 hours Ascension time (19.50 hours Falklands Time), the 11 supporting Victor tankers (the 10 plus an airborne reserve) thundered into the air from Wideawake at one-minute intervals. The two Vulcans then followed them into the air. As the planes headed south, anti-collision lights flashing in the darkness, the value of the airborne reserves became clear. The cabin of the primary bombing Vulcan could not be pressurised. Also a Victor tanker had an unserviceable hose unit. Both planes abandoned the mission and returned to Wideawake. The force, now lacking any reserve capacity if there were further failures, continued on its way south.

Flight Lieutenant Martin Withers captained the reserve Vulcan. When the crew heard the news that the primary bomber was aborting the mission, there was a long and pensive silence on the intercom. Then Withers piped up: 'Looks like we've got a job of work, fellers...' Further discussion was unnecessary, for the reserve crew had briefed for the mission as carefully as their comrades forced to abandon it.

For the next one and three-quarter hours the gaggle of big jets headed south, Then, some 730 nm from Ascension, four Victors passed fuel to four others and turned back. Another Victor passed fuel to the Vulcan.

At this early stage a problem developed which would cause increasing difficulties as the operation progressed. Holding loose formation, the Vulcan and its attendant Victors flew at a compromise cruising speed that was optimum for neither machine. Also, their cruising altitude of 31,000 ft was chosen because it was the highest at which fuel could be transferred, though it was somewhat

As the planes headed south, anti-collision lights flashing in the darkness, the value of the airborne reserves became clear

The Vulcan made a big difference to the Falklands campaign



Four hours into the operation there were tense scenes at Wideawake, as the four Victors from the first refuelling bracket arrived almost simultaneously at the airfield

lower than the altitude for optimum fuel consumption for either type. As a result, both the Victors and the Vulcan aircraft consumed fuel slightly faster than planned. The four Victors that had given up their fuel at the first transfer had had to dip deeply into their reserves to pass the amount required by those continuing south.

Two and a half hours after take-off, about 1,000 nm south of Ascension, the second fuel transfer began. A Victor topped up the Vulcan's fuel tanks, then turned back. Soon afterwards two Victors passed fuel to the three Victors remaining in the formation, then they too turned back.

Four hours into the operation there were tense scenes at Wideawake, as the four Victors from the first refuelling bracket arrived almost simultaneously at the airfield. All were low on fuel. Wideawake's single east-west runway runs between rocky outcrops, and can be entered or left only at its western end. As luck would have, it the wind was from the east. That meant that each Victor's landing run took it to the east end of the runway, the end opposite from the exit. In normal circumstances each plane would have landed, pulled to a halt, turned around on the runway, and taxied to the exit point and cleared the runway before the next aircraft came in. However, now the circumstances were not normal. Had the Victors used that procedure, one or perhaps two planes at the end of the queue might have run out of fuel before they could land.

The alternative was far from ideal, but it was the only course open. The first Victor touched down, ran to the far end of the runway and stopped. The second aircraft landed and pulled up close behind the first. The third tanker landed and pulled up close behind the second. When Squadron Leader Martin Todd made his approach, at the controls of the fourth Victor, the stage was set for the aeronautical equivalent of a motorway pile-up. With any misjudgement by the pilot, or a relatively minor technical failure in his aircraft, the RAF stood to lose one quarter of its precious tanker force in the South Atlantic area. Moreover, a couple of those Victors were earmarked to carry fuel out to aircraft that, in a few hours, would be returning from the distant south. If anything jeopardised that plan, all the Victors and the Vulcan airborne would have to be recalled.

Todd placed his Victor firmly on to the runway and streamed the braking parachute. There was a reassuring tightness across his chest, as the

Todd placed his Victor firmly on to the runway and streamed the braking parachute. There was a reassuring tightness across his chest, as the parachute filled and the aircraft decelerated rapidly



Victor tankers at Wideawake Airfield, Ascension Island



parachute filled and the aircraft decelerated rapidly. In front of him sat the other three Victors, anti-collision lights blinking in the darkness. Later he commented:

'There were the other three at the end of the runway, waiting for us to stop. If our brakes had failed or anything, Christ, I hate to think of it...'

There was no failure. Todd pulled up well short of the other three aircraft, turned his Victor through a semi-circle and taxied to the runway exit. In relieved procession the other three tankers followed.

Meanwhile, the third transfer of fuel had begun 1,650 nm south of Ascension. Flight Lieutenant Alan Skelton passed all his fuel to two other Victors, then turned back for Ascension. Soon afterwards, however, he discovered that his aircraft had a fuel leak. The quantity lost was not large and in normal circumstances it would not have mattered. He was a long way from Ascension, and he had bitten deeply into his own reserve to pass the required fuel to the aircraft continuing south. The crew called Ascension and asked for a tanker to meet them on the way back to the island.

The remaining force heading south was now down to just two Victors and the Vulcan. Five and a half hours and 2,340 nm after take-off, there was a further transfer of fuel. This time there was a new problem as Squadron Leader Bob Tuxford, captain of one of the Victors, explained:

'There is an unwritten rule in air-to-air refuelling, a variation of Sod's law, which says If you're going to find any really bumpy weather, it will be right at the point where you have to do your tanking. Now that proved to be the case and the really bumpy weather duly appeared as a violent tropical storm at exactly the point where the final transfer of fuel between the Victors was planned to take place.'

From his Vulcan, Martin Withers observed the shadowy outlines of the two Victors a few hundred yards to his left, trying to transfer fuel:

'It was dreadfully turbulent, we were in and out of the cloud tops, there was a lot of electrical activity with St Elmo's fire dancing around the cockpit. The Victor was trying to refuel in that, it was having enormous problems. We could see the two aircraft bucking around, with the refuelling hose and basket going up and down about 20 feet.'

Eventually, after some superb flying, Flight Lieutenant Steve Biglands succeeded in pushing his refuelling probe into the basket streamed behind Tuxford's aircraft. The fuel transfer began but the crews' triumph was short lived. Suddenly Biglands gave a terse radio call to say that his refuelling probe had broken off. That threw the entire operation in jeopardy once more, for it meant that particular tanker could not receive any more fuel. It was to have accompanied the Vulcan to the far south, but now

From his Vulcan, Martin Withers observed the shadowy outlines of the two Victors a few hundred yards to his left, trying to transfer fuel...

there was no question of that. The only alternative was for the two remaining Victors to exchange roles, with Biglands



6 *Withers broke radio silence with a brief request for more fuel. Tuxford told him curtly that there could be no more*

giving up his fuel to Tuxford so that the latter could continue south with the Vulcan.

After the transfer, as Biglands pulled his Victor

round and headed north, there remained a possibility that the broken probe that might still threaten the continuation of the mission. What if the broken refuelling probe was jammed in Tuxford's hose basket? That would prevent the Vulcan from drawing fuel from that Victor. To find the answer, Withers closed to within six feet of the basket. Then Flight Lieutenant Dick Russell, the refuelling expert attached to the Vulcan crew as sixth member, now sitting in the co-pilot's seat, flashed a hand torch over it. In the half light the basket seemed to be all right. To make certain, Withers advanced on the basket and inserted his probe to see if it would take a little fuel. The system functioned perfectly.

By the end of the transfer the final pair of aircraft were more than 2,600 nm south of Ascension and the Vulcan was just over an hour away from its target. In the Victor there was an earnest discussion whether it was possible to continue the mission.

Bob Tuxford remembered:

"We were considerably lower on fuel than we should have been. Now we had a decision to make: either to go on, give the Vulcan the fuel it needed to make its attack, and prejudice our own position. If we didn't pick up some more fuel on the way back, we would have to ditch. Or turn back at that stage, while we both had sufficient fuel to get back to Ascension. I was the captain of the aircraft and I had to make the decision, but I asked my crew what they thought. One by one they came back and said, 'We have to go on with the mission.'"

Because of the need to maintain radio silence except in dire emergency, so far south, the Vulcan crew had no inkling of the tanker crew's worries. The two aircraft linked up for the final transfer of fuel before the target, at a point about 350 nm northeast of Port Stanley. That transfer went ahead normally until, with the Vulcan's tanks 6,000 lb short of full, Martin Withers was disconcerted to see the red indicator lights on the underside of the Victor flash on. That meant that the fuel transfer was complete. Withers broke radio silence with a brief request for more fuel. Tuxford told him curtly that there could be no more.

Later the refuelling captain commented:

'Not being familiar with the tanking game, not knowing how far I had stretched myself to put him where he was, all he knew was that he wanted a certain amount of fuel. If only he had realised how much discussion had already taken place in my aeroplane, about how far we could afford to stretch ourselves to get him there...'

Having agreed to bite so deeply into their own supply of fuel, the Victor crew had to live with the stark terms of their decision. Unless they were successful in summoning and rendezvousing with another tanker on the way, they were destined to come down in the sea about 350 nm south of Ascension. The success of the entire operation depended on the Argentine forces on the Falklands gaining no inkling of what was afoot. That meant the Victor crew could not use their high frequency radio inform base of their predicament, until the Vulcan had completed its attack.



Withers had less fuel than he had planned, but there was sufficient to continue with the next part of the operation. Also, he knew that a Victor tanker plus a reserve were scheduled to meet him during the return journey to top up his tanks.

At a point about 250 nm from the Port Stanley, Withers eased back the throttles and the Vulcan began a slow descent to remain below the horizon of the enemy early warning radar on the Falklands. At 2,000 ft he levelled off and continued towards the target. Flight Lieutenant Bob Wright, the radar operator, switched on his radar for a few sweeps and observed returns from the top of Mount Usborne, the highest point on East Falkland. That brought welcome confirmation that during the long over-water flight, the Carousel inertial navigation equipment had worked as advertised. The bomber was right on its planned track.

An attack down the length of the runway might have produced several hits if everything went perfectly, but a slight error in line would have caused all of the bombs to fall clear

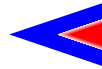
Shortly after 04.00 hours (local time), at a point 40 nm from the target, Withers pushed forward the throttles to bring the Vulcan's four big Olympus engines to maximum thrust. As speed built up he eased the bomber into a steep climb to bring it to its briefed attack altitude of 10,000 ft. Once there, the pilot levelled out and let his speed build up to the 350 knots indicated, the maximum permitted, before easing back on the throttles to hold that speed. Meanwhile the radar operator again turned on his transmitter and the crew settled into the bombing run. The aiming point was the mid-point of the runway, with the aircraft closing in at an angle of 30 degrees off the alignment of the runway. With the Vulcan's 1950s vintage aiming system, that gave the greatest chance of scoring at least one hit on the runway. An attack down the length of the runway might have produced several hits if everything went perfectly, but a slight error in line would have caused all of the bombs to fall clear.

During the bombing run Withers saw nothing of the target in the darkness below him. His job was to follow as accurately and as smoothly as possible the left-right steering signals generated by the aircraft's attack computer. Later he recalled:

'It was a smooth night, everything was steady, the steering signals were steady, and the range was coming down nicely. All of the switching had been made and 10 miles from the target we opened the bomb doors. I was expecting flak and perhaps missiles to come up but nothing happened. The AEO [Air Electronics Officer] didn't say anything about the defences and I didn't ask – I left that side of things entirely to him. I was concentrating entirely on flying the aircraft.'

In fact some Argentine defenders were preparing to engage the plane bearing down on the airfield. Flight Lieutenant Hugh Prior, the Air Electronics Officer, picked up signals from gun-control radar. It tried to lock-on to the bomber, but Prior switched on the ALQ-101 radar jamming pod under the starboard wing and the signals ceased.

At the bomb release point, the attack computer triggered the bomb release mechanism. The plane automatically released its 21 bombs at 1/4 -second intervals. As the last bomb left the aircraft, Withers ordered the bomb doors closed then he pushed open his throttles. He hauled the bomber into a steep turn, to leave the defended area as rapidly as possible. Twenty seconds after release, the bombs began exploding in a row across the airfield.



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Nobody who was in Port Stanley that night will ever forget the sound of those detonations... To the Falklanders, that opening attack provided an enormous fillip to morale

From the right hand seat of the Vulcan, co-pilot Flying Officer Pete Taylor could see the street lights in Port Stanley town away to his right. Then, much closer, he saw a series of flashes in quick succession below the thin layer of cloud covering the airfield. It looked as if someone had turned on a bright but flickering light behind a translucent window. As the last bomb exploded, the darkness returned. The other crew members felt rather than heard the 'crumps' of the distant explosions.

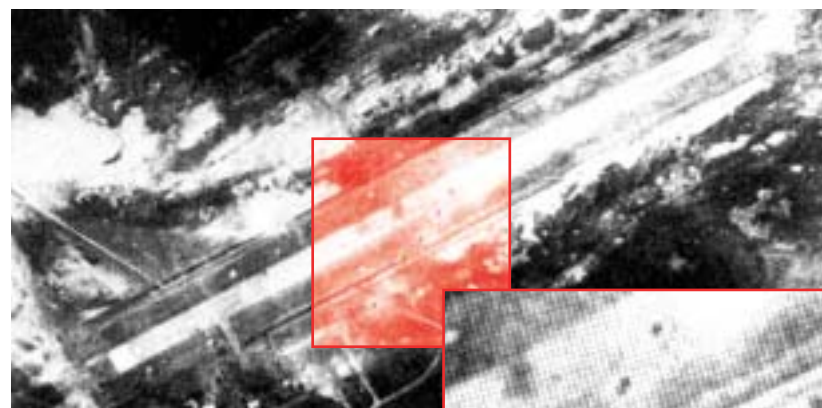
Nobody who was in Port Stanley that night will ever forget the sound of those detonations. Shopkeeper and artist Tony Chater and his wife Ann were in bed at their home in the centre of town. He recalled:

'I was half awake at the time and the whole house shook. It was as though there had been an earthquake, then we heard the 'boomboomboomboom' of the bombs going off, very muffled. Shortly afterwards I just made out the sound of an aircraft in the distance.'

To the Falklanders, that opening attack provided an enormous fillip to morale. After the depressing events of the previous four weeks, they knew that relief was at last on its way. Chater continued:

'There was terrific jubilation in Stanley. From then on we really felt very confident that the British forces were going to come to our rescue.'

When the gun positions around Port Stanley airfield finally came to life, the Vulcan was well out of range and climbing to altitude. The gunners' noisy but ineffectual tracer fire continued for several minutes, then one by one the weapons fell silent.



Bomb damage to the airfield

The bombs fell in a long stick across the middle of the airfield. The first one hit the runway close to its mid-point, penetrated the surface and detonated to cause a large hole with considerable 'heave' around the lip

In the cabin of the bomber there were no feelings of jubilation to match those of the citizens of Port Stanley. The nervous exertions of the previous eight hours had drained the crew's emotional energy. Later, Martin Withers summed up the mood:

'After the attack the crew were very quiet, rather sad. We had just started a shooting war. It had all been rather cold-blooded, creeping in there at 4.30 in the morning to drop bombs on the place. But we had a job to do and we thought that job worth doing.'

The bombs fell in a long stick across the middle of the airfield. The first one hit the runway close to its mid-point,



penetrated the surface and detonated to cause a large hole with considerable 'heave' around the lip. The second bomb clipped the southern edge of the runway. One bomb detonated between the airfield's sole repair hangar and a Pucara attack plane parked nearby, causing damage to both. Yet another bomb blew out the windows of the control tower and gave the building a severe shaking. The attack killed three Argentine military personnel and injured several. Considering the age and the known limitations of the Vulcan's nuclear attack system, the result was as good as might have reasonably been expected.

Once clear of the Falklands, Hugh Prior broadcast the code-word 'Superfuse' to announce that the attack was completed and appeared to have been successful. That was the cue for Bob Tuxford's Victor to break radio silence, to inform base that he had insufficient fuel to reach Ascension. He urgently requested that a tanker be scrambled to meet him on the way back. Otherwise, the crew's prospects were grim. Tuxford later commented:

'It was a long, dry journey back. We discussed a lot of things, including the practical aspects of baling out of a Victor into the sea – you would not try to ditch it, the aircraft was the wrong shape. We had our radar on to see if there were any ships in the area, but in fact there was none in the right place.'

In the event, Tuxford made a successful rendezvous with the tanker scrambled to meet him. So did Alan Skelton who, it will be remembered, had suffered a fuel leak early in the operation.

Just over four hours after the attack, the Vulcan reached its planned refuelling point off the coast of Brazil. By now it was daylight and the sun was high in the sky. The crew made radio contact with the approaching Victor tanker and suddenly Martin Withers caught sight of its white underbelly as it swung into position in front of him. As the tanker levelled out, he could see the refuelling hose trailing invitingly behind it. As the Vulcan captain later commented, 'It was the most beautiful sight in the world'. Yet fate had one more drama in store for the Vulcan crew. With Dick Russell once more in the co-pilot's seat, Withers advanced slowly on the Victor. He pushed his refuelling probe into the basket and initially the precious fuel flowed smoothly into the bomber's tanks. But then, as the pressure built up, fuel began to spill from the connection. The translucent liquid gushed over the plane's windscreen, so that even with the wipers running at high speed the pilots could make out only the blurred outline of the aircraft in front. The visibility forwards was rather like that from a vehicle in a car wash.

Had this been a normal training sortie Dick Russell would have throttled back, broken contact, then moved forward again to insert the probe properly into the refuelling basket. But the Vulcan was very low on fuel. There was a chance that either the refuelling probe or the basket had suffered damage. If the Vulcan broke contact, Withers could not be certain that he could regain it. Although some fuel was being lost, most of it was flowing into the bomber's tanks. For each minute that Withers could maintain the precarious contact, his bomber collected another ton of fuel.

Then help arrived from an unexpected quarter. Bob Wright, the Vulcan's navigator, had been standing on the ladder between the pilots' seats watching the operation. As the fuel gushed over the canopy he noticed that almost level with his eyes, at the

base of the centre windscreen, the airflow kept a narrow strip of glass clear of fuel. Through that strip he could see the tanker clearly, allowing him to give the pilots a running commentary on relative positions of the two aircraft.

It took about 10 minutes for the Vulcan to collect the fuel it needed. Then Russell throttled back to break contact with the tanker. As the Vulcan's probe withdrew from the basket, a valve shut off the supply of fuel to the hose. In an instant the airflow cleared the fuel from the Vulcan's windscreen. Suddenly all was sunshine and light around the bomber's cockpit. Withers felt as if a huge burden had been lifted from his shoulders:

'After that fuel was on board, the other four hours back to Ascension were a bit of a bore. Only then was the tension off and we knew we were going to make it. Those four hours seemed to last for ever.'

The Vulcan landed at Wideawake just over 16 hours after it had taken off. Later Martin Withers received the Distinguished Flying Cross for the leadership he displayed during the attack, while Bob Tuxford received the Air Force Cross for the selfless manner in which he and his crew supported it.

So ended the first *Black Buck* mission by a Vulcan to the Falklands. The operation stretched the capabilities of the bomber, the Victor tankers and all of the crews involved to the very limit. In retrospect, the effort expended to mount the operation was quite out of proportion to the physical damage inflicted on Port Stanley airfield.

Yet, as is often the case in aerial warfare, that raid on Port Stanley airfield had a psychological effect on the enemy that was also out of proportion to the physical damage caused. The attack demonstrated to the Argentine Air Force High Command that

The operation stretched the capabilities of the bomber, the Victor tankers and all of the crews involved to the very limit



Dassault Mirage

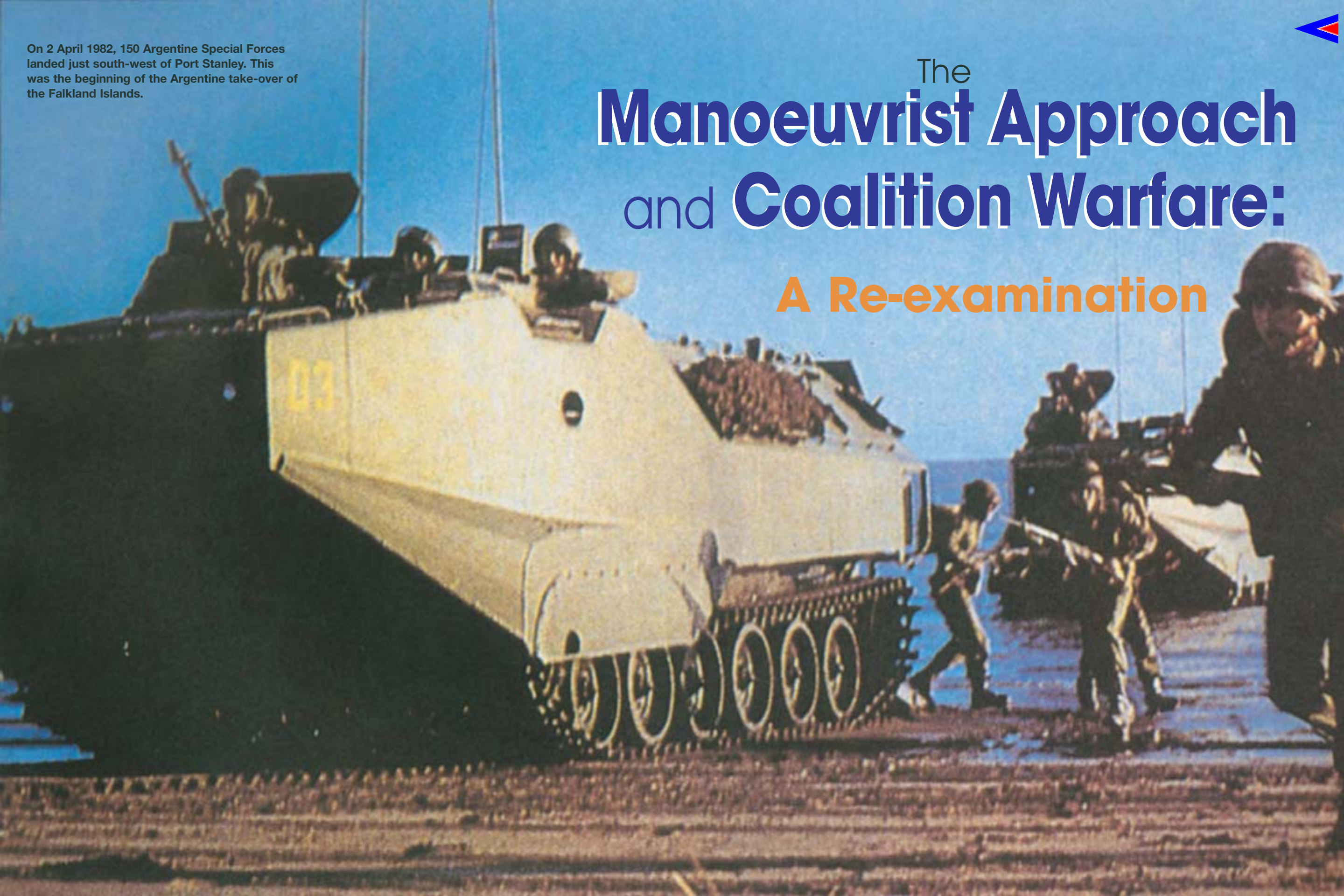
the RAF had the capability to strike at targets on the Argentine mainland, if it decided to do so. On the following day that service's only dedicated fighter interceptor squadron, Gruppo 8 equipped with Mirage III fighters, withdrew from Rio Gallegos in the south of the country where it was to have supported operations over the Falklands. To meet the new potential threat the unit redeployed to Comodoro Rivadavia much further north. Apart from a single skirmish near the end of the conflict, Gruppo 8 would play no further part in the fighting.

Thus, at a stroke, the Argentine Air Force conceded defeat in the battle for air superiority over the Falklands. It meant that for the remainder of the conflict Royal Navy Sea Harriers had free rein to hunt down enemy fighter-bombers and attack planes, without interference from dedicated enemy fighters. That was the bottom-line result of that first *Black Buck* mission, and *that* certainly justified the effort expended.



On 2 April 1982, 150 Argentine Special Forces landed just south-west of Port Stanley. This was the beginning of the Argentine take-over of the Falkland Islands.

The **Manoeuvrist Approach** and **Coalition Warfare:** **A Re-examination**





The fundamental change in international relations resulting from the collapse of the Warsaw Pact has reawakened interest, *inter alia*, in two elements of military thinking: the manoeuvrist approach and coalition warfare. These two strands of military thinking are now sanctioned concurrently by the military and the wider political leadership, but they possess separate pedigrees. Neither is explicitly *primus inter pares*; however, there exists the unspoken assumption that both elements can somehow be fused together in all types of future operation. Together they represent the accepted *modus operandi* of the UK's Armed Forces and, increasingly, by multi-national organizations such as NATO.



Both approaches have claimed credit for, and gained legitimacy from, the military successes of the Gulf War and Balkan campaigns enjoyed by the Western nations since the end of the Cold War. As the underpinning principles of current military thinking, they have a direct influence on doctrine which informs the way we, as a nation, plan to fight. When all foreseeable scenarios are of limited war and limited commitment, these two approaches have been elevated to articles of faith. Can an armed force really serve two masters and still succeed on the battlefield?

This essay will show that manoeuvrism and coalition warfare are uneasy but not impossible bedfellows. Whilst they have co-existed previously, one of the two approaches has usually dominated: neither has automatically guaranteed success. After examining the often mutually contradictory assumptions and methods of the two approaches, this essay will reveal that these contradictions can lead to innovative solutions; moreover, the likely 'asymmetric versus coalition' nature of future conflict could provide the catalyst for their fusion. Ransacking history by taking past campaigns out of context to prove a doctrinal point is a futile exercise; however, this essay aims to discuss the wider lessons of history and to note their contemporary relevance. The essay focuses on the operational level and deals exclusively with warfighting.

Section one analyses the manoeuvrist perspective and asks why this approach is currently in vogue. Bold manoeuvrist actions are inherently risky: witness *Operation Market Garden* during WWII, but, whether resulting in decisive victories or glorious failures, they can capture the public's imagination and stir the military soul. Such events have of them the magic that comes from rising above the mundane, monotonous and predictable. In so doing, the manoeuvrist approach runs contrary to the enduringly turgid characteristics of much of conflict, and herein, perhaps, lies part of its continuing cachet.

Section two reveals that most acclaimed manoeuvrist actions have been inherently independent national operations (albeit often within coalition campaigns) in which delegation of responsibility was offered to, or seized by, the commanders in the field. Contextually, these were normally small to medium-sized operations in which external involvement was noticeably absent. Manoeuvrism implies verve and breathtaking military impertinence whereas coalitions exhort integration, gradualism and burden-sharing. Analysis of past campaigns reveals that manoeuvrism thrives when freedom of action, imaginative leadership, a willingness to take risks and the opportunity for decisive engagements abound.

Section three traces coalition warfare's different bloodline and shows that it is more closely akin to attritional warfare. History reveals that coalitions are formed more often by necessity than choice and are notoriously difficult to manage. Diametrically opposed to the risk-taking and dynamism of the manoeuvrist approach, coalitions engender a more deliberate, studied approach, demanding consensus, co-operation and co-ordination. By combining forces, past coalitions accrued greater military mass with which to wage large-scale attritional warfare in different theatres and on many fronts concurrently. The coalitions of the last hundred years fought the global slogging-matches of the two World Wars and then spent the Cold War years planning and procuring to fight the ultimate attritional battle between East and West. Paraphrasing Karl Marx, coalitions exist because



‘quantity has a quality all of its own’. For coalitions, the quality is both military capability and the legitimacy that comes with securing widespread political support.

Section four analyses Operation Allied Force (OAF) as a case study and argues that, despite its individual nations’ manoeuvrist preferences, NATO’s collective methodology was more attritional than manoeuvrist, but with some modern nuances. Manoeuvre and coalition warfare, as traditionally typecast, exist on opposite ends of the spectrum of conflict. They employ differing psychologies of war, use differing concepts of risk management, and employ different linkages between ends, ways and means. However, modern Western coalitions fighting constrained wars of choice have unwittingly blurred the differences between the two approaches and created new hybrids. Conceptually, OAF could represent the vanguard of this new paradigm.

Section five examines the implications of combining the two approaches and contends that whilst some hybrids are successful, combinations can also create tensions through flawed, or absent, doctrine. Such tensions can lead to coalitions ‘making it up as they go along’ or conceivably falling apart and losing the war. No approach is inherently right or wrong, circumstances will always best dictate suitability; the trick will be to remain cognizant of their differences and to employ them imaginatively. Nations may wish to fight in a manoeuvrist style and expect to fight as coalitions; however, coalitions will probably become less attritional, more cautious and should anticipate enhanced political involvement. War has always combined attrition and manoeuvre, but in today’s climate of selective intervention, media scrutiny, legal awareness and the increasing need for governments to ‘market’ conflicts to the electorate, it has probably never been so critically necessary to understand the differences, and to get the balance right.

SECTION ONE

What’s it all about?

The UK Armed Forces’ adoption of an explicitly manoeuvrist approach is complete and there are signs that many other nations are undertaking a similar conversion. The manoeuvrist approach is not an intrinsically late 20th century phenomenon; however, interest in its revival has burgeoned since the end of the Cold War. We may all be manoeuvrists now, but why?

Manoeuvrism means different things to different people and one could be forgiven for thinking that it is easier to state conclusively what it is *not*, rather than what it *is*. Indeed, it could be argued that its widespread acceptability is based, not on consensus about what it stands for, but more on the absolute rejection of attrition. Part of manoeuvrism’s popularity lies in its ability to be interpreted differently and subtly manipulated to project unique national agenda. Politicians often find succour in vagueness, and the flexibility and versatility of this shadowy, nefarious approach makes it appealing at the grand strategic level. Manoeuvrism and diplomacy are often ambiguous by design to leave room for flexibility during negotiations, accommodate varying national interpretations, and cater for unforeseen events and unintended consequences.

Manoeuvrism, at its most basic, is the antithesis of attrition. Attritional warfare implies direct confrontation with the enemy and the bludgeoning erosion of his strength until he is forced to discontinue the contest. Attrition seeks to achieve a decisive shift in relative physical strengths by imposing upon the enemy a higher casualty rate than he can sustain.¹ In essence, attrition involves the deliberate, incremental destruction of enemy forces.

Manoeuvrism, at its most basic, is the antithesis of attrition. Attritional warfare implies direct confrontation with the enemy and the bludgeoning erosion of his strength until he is forced to discontinue the contest

Manoeuvrists aim to avoid such showdowns and seek to destroy the enemy's cohesion and undermine his will to win. More an attitude of mind than a series of conventions, it emphasises the intangibles of war such as morale, shock and initiative. The manoeuvrist avoids an even-handed fair fight, but rather, by using cunning, surprise and innovation, aims to be underhanded and is always on the lookout for some unfair advantage. Defeat is inflicted, not necessarily by destroying the enemy's physical mass, but by exploiting weaknesses rather than by confronting strengths. In essence it involves fighting clever and, where possible, fighting dirty.² In modern parlance, manoeuvrism means fighting smart, rather than fighting hard.

Sun Tzu recognised that avoiding attrition was a worthy aim, 'to fight and win 100 battles is not the acme of skill, to subdue the enemy without fighting is the acme of skill'.³ The roots of the modern manoeuvrist approach can be traced to the British reaction to the horrific attrition of the war to end all wars. In 1928 Fuller identified two ways to destroy an organization: by wearing it down (dissipating it) or by rendering it inoperative (unhinging it).⁴

The horrific scenes of war



The roots of the modern manoeuvrist approach can be traced to the British reaction to the horrific attrition of the war to end all wars

Liddell Hart, keen to avoid repetition of the Pyrrhic victories of the Great War, epitomized this thinking in his Indirect Approach, published in 1927.

Liddell Hart's premise was that while a stroke to the rear of the opposing army has effect on the minds of the enemy troops, a stroke farther back tends to have more effect on the mind of the enemy commander, and it is in the minds of commanders that battles are really decided.⁵ As Ardant du Picq so eloquently put it, 'Loss of hope, rather than loss of life, is what decides issues of war'. Liddell Hart used the analogy of a stream overcoming obstacles by probing for cracks to show how nature achieves economy of force by progressively exploiting the soft spots of defences. By identifying the psychological nature of war and the need to minimize attrition by concentrating on outflanking attacks against the enemy's rear, the Indirect Approach laid the foundations of the modern manoeuvrist school.

Liddell Hart said that 'Britishness was indirectness nationalized' and the same argument, that manoeuvrism is somehow part of our psyche, is still advanced today. However, many have questioned whether the manoeuvrist approach has any great tradition in the UK. Past land engagements have tended to follow the model of selective engagement and have relied upon the attritional impact of a favourable correlation of forces rather than a demonstrably manoeuvrist stance. Over the centuries, the UK seems to have depended on maritime operations supported by locally hired troops, with major land campaigns as the last resort.⁶ Indeed, the claim for a manoeuvrist pedigree seems to bear little resemblance to reality. Manoeuvrism's support is perhaps more indicative of a reaction to the horrors of attrition and reflects a panoply of modern socio-cultural factors, rather than a long-standing military legacy.

End of deep-freeze

The end of the Cold War was the end of a doctrinal deep-freeze

The end of the Cold War was the end of a doctrinal deep-freeze. This '40 year aberration' saw little in the way of doctrinal development, other than at the tactical level, because of the rigidity of thinking imposed by an unyieldingly fixed strategic overview.⁷ The campaigns were planned, war-gamed, and choreographed ad infinitum but, fortunately, never undertaken for real. Doctrine does not thrive under such barren conditions; it should be a living entity which needs the injection of fresh experience and the fertility of a freethinking environment.

The thaw had begun before the end of the Cold War with the acknowledgement of the rigidity of NATO's approach and the need for an alternative conventional defence, other than immediate nuclear retaliation, in case of attack by the Warsaw Pact.⁸ The enemy's overwhelming conventional strength was widely recognised, although new advantages were hoped for by exploiting

NATO's qualitative edge in flexibility and striking power. In the mid-1980s, the emergence of Manoeuvre Warfare was linked to the revival of operational art which sought to break away from the sterile Cold War thinking and permit a more dynamic and fluid style of warfighting. The US Army broke its attritional mould (as typified by 'Active Defence' published in

the wake of the Vietnam war) and established the new doctrinal agenda by publishing FM 100-5 'The Airland Battle' in 1986.⁹ Lind's *Maneuver Warfare Handbook*, written for the USMC in 1985, epitomized the new approach by declaring that 'the purpose of maneuver warfare is to defeat the enemy by disrupting his ability to react, rather than by the physical destruction of his forces'.¹⁰

Comparing manoeuvre warfare to judo, Lind argued that the theory of manoeuvre warfare belonged to Colonel Boyd and his analysis of conflict as time competitive 'observation-orientation-decision-action' or 'OODA' cycles.¹¹ In 1994 the British Army Staff College, to avoid some of the confusion surrounding the oft-used but rarely defined term manoeuvre warfare, introduced the term 'the manoeuvrist approach' which focused on psychological, rather than mobility-based, conflict. To the manoeuvrist, winning now meant defeating, in the enemy's own mind, his confidence that he could achieve success.

NATO's immediate threat disappeared with the demise of the Warsaw Pact but was left with huge quantities of high-intensity warfighting equipment. Tarned by this leftover Cold War baggage, new doctrine initially tended to be capability-based, written for the available equipment, rather than for better ways of



A Russian SS-19 silo-based missile



An American 'Peacekeeper'

Manoeuvrism is now the military mirror image of the society we live in, reflecting its beliefs and reinforcing its current norms

conducting warfare.¹² The shift towards more mobile, joint and, latterly, combined expeditionary operations has demanded innovative solutions from military personnel who are now increasingly taught how, and not what, to think. This is in concert with manoeuvrism's insistence that a questioning, imaginative mind is the modern commander's most effective weapon.

Some claim that manoeuvrism is little more than common sense in action; as R Fry has stated 'who would choose to engage an enemy's strengths when his weaknesses are available?'¹³ Manoeuvrism is always attractive to a numerically inferior side or to a stronger side which wishes to minimize the resources committed.¹⁴ Modern weapons are expensive and becoming more so; the unit costs of defence have shown a steady increase of 10% per year.¹⁵ Technology can substitute for a lack of mass, but scarce expensive assets need to be carefully husbanded. When trends to fewer military systems are allied to contemporary norms such as the drive to reduce casualties on both sides and minimize collateral damage, it is hard to imagine ever reverting to a doctrine of attrition, especially when engaged in wars of choice. Manoeuvrism is now the military mirror image of the society we live in, reflecting its beliefs and reinforcing its current norms.



Modern weapons are expensive and becoming more so; the unit costs of defence have shown a steady increase of 10% per year

The JSF variant, Lockheed Martin's X-35A

'If I must make war I prefer it to be against a coalition.' (Napoleon)

Manoeuvrists in action

Leaders such as Genghis Khan, Hannibal, Marlborough, the Marquis of Montrose, Slim, O'Connor, Patton and others highlight the fact that although great leaders have often been great manoeuvrists, rarely have coalitions managed to achieve the same effect

There are many oft-quoted examples of great manoeuvrists and it is worth examining a selection to search for any lasting parallels between them. Leaders such as Genghis Khan, Hannibal, Marlborough, the Marquis of Montrose, Slim, O'Connor, Patton and others highlight the fact that although great leaders have often been great manoeuvrists, rarely have coalitions managed to achieve the same effect.

In 216 BC, Rome, fighting the Second Punic War against Carthage, was bent on destroying Hannibal whose attacks were causing severe food shortages in the capital.¹⁶ To force a decisive encounter, Rome equipped four fresh legions and, with four legions already deployed, dispatched the force of 80,000 soldiers to track Hannibal down. The largest force that Rome had ever mobilized met Hannibal's forces, half their size, near the Roman supply depot at Cannae which Hannibal, having recently captured, realised was an ideal location from which to fight the larger force. The Romans, hemmed in by the river Aufidus, drew up their forces with a deeper than normal frontage. With twice Rome's cavalry but half the infantry, Hannibal placed his inexperienced infantry in the centre, buttressed on either side by veterans.

Once the centre ranks joined battle, Hannibal slowly retreated allowing the double encirclement of the tightly packed Roman infantry. The Romans, hampered by their own mass, were easy targets for Hannibal's cavalry and experienced infantry; the eight-hour battle resulted in the virtual annihilation of the Roman army with an estimated 50,000 dead and 20,000 captured. Hannibal's skill lay in luring his opponents into battle under favourable circumstances and then manoeuvring his forces with such finesse that the outcome was more than half-decided before the battle was joined. Interestingly, the second Punic War serves to show that being manoeuvrist in itself does not guarantee strategic success. Hannibal's manoeuvrist tactics were ultimately unsuccessful against Rome's attritional strategy and her phenomenal ability to mobilize enormous resources.



General S. Patton



Genghis Khan



Genghis Khan used speed and deception to dislocate and disrupt his opponents, despite often being heavily outnumbered.¹⁷ Fighting the Turks in 1219-1220, Genghis Khan marched 2,000 miles to face 400,000 well-armed adversaries. Having fixed the main body of the Turkish army with a fraction of his force, Genghis Khan advanced through the supposedly impenetrable Kizil Kum desert and attacked the strategically important city of Bukhara, 400 miles behind the Turkish troops. Surprised by this unexpected onslaught, the city fell and Genghis Khan immediately marched further to the Turkish rear. The capital city of Samarkand fell in six days, partly because the defenders, mistaking Khan's many prisoners for Mongol troops, over-estimated his strength, but also because the Turks lost the will to fight having seen Bukhara, a city they assumed to be safe, fall so quickly. Combining mobility with psychological warfare, Khan caused a catastrophic Turkish loss of faith in their ability to win.

The Marquis of Montrose commanded the Royalist Army in Scotland during the Civil Wars of 1644-1652. A one-time supporter of the Covenant Cause, Montrose became disillusioned by its demands and wary of its champion, the Duke of Argyll. Taking up the Royalist cause, Montrose returned to Scotland intent on raising the country for the King. Having formed an army out of a small and unlikely group of highlanders and Irish troops from Antrim, Montrose successfully waged his campaign throughout 1644-45, winning victory after victory against superior odds. In this short period he defeated the Calvinists and Campbells at Tippermuir, Aberdeen, Inverlochy, Auldearn, Alford and Kilsyth by unexpectedly crossing and re-crossing Scotland, outwitting his enemies and raising the loyal clans.¹⁸ Montrose, ultimately unsuccessful in his endeavours, was eventually hanged and disembowelled, but his marauding style of warfare ensured that his manoeuvrist expertise is still recognised today.

In the early C18th, Marlborough's leadership of the British Army against the forces of Louis XIV was revolutionary in its emphasis on firepower, flexibility and manoeuvre as the decisive elements for success.¹⁹ Favouring rapid marches and counter-marches, Marlborough maintained the initiative and kept his enemies constantly off-balance. Despite Marlborough's skill in melding many nationalities into a cohesive force, he alienated some of his allies by rejecting the old order of battle by siege. Fighting with the Dutch, Marlborough believed himself to be fettered by the alliance that frustrated him from maximizing the potential of his novel tactics. In 1704, to engage the French in a decisive battle, Marlborough rid himself of his turgid ally by splitting his forces, knowing that he could best achieve his aim by 'commanding the troops that are in the pay of England.' Marlborough's defeat of the superior French forces at Blenheim was his finest hour and was effected by his mastery of surprise (by attacking in the middle of the night), deception and continual movement which disadvantaged and dispirited his enemies.

The classic example of joint manoeuvrist warfare is the German Blitzkrieg and, in particular, the offensive in the West code-named Case Yellow. The plan involved a daring feint by strong forces through Holland and Belgium whilst the main effort pushed the weight of the German armour through the apparently impassable Ardennes forest to the south. The move had all the elements of the perfect manoeuvrist action, it was daring, risky and controversial. The Allies fell for the deception and allowed the weight of the German armour to pounce on a weakly defended point of the French lines, whilst the vast majority of



Stuka of III/StG 1

The classic example of joint manoeuvrist warfare is the German Blitzkrieg and, in particular, the offensive in the West code-named Case Yellow

the Allied armies fought a strategically pointless defensive battle in the north.²⁰ Supported by Stukas, Guderian's XIX Panzer Corps trounced the French reservists at Sedan and Rommel's 7th Panzer Division broke through at Dinant. Within 10 days the Germans had reached the Atlantic coast, the French army was destroyed and the British remnants of the Expeditionary Force compelled to evacuate via Dunkirk. An entire country fell in 10 days, suffering 1,200,000 casualties in the process; the combination of surprise, tempo and superior doctrine paralysed the defenders and destroyed their will to continue.

Equally audacious was Patton's command of the 3rd Army when, on 16 December 1944, a German counter-offensive against the thinly held line in the Ardennes struck the 1st US Army with complete surprise. Hoping to encircle the British 21st Army Group north of the Ardennes, Hitler's plan was to use the last of his reserves in a desperate attempt to breach the Allied lines, take the Belgian port of Antwerp and disintegrate the Western Alliance.²¹ It very nearly succeeded. With the US forces encircled at Bastogne, Patton moved three divisions, a corps headquarters and a large number of supporting assets over 150 miles from an eastward to a northward orientation. Patton's initiative, mobility and powerful counter-attack caught the Germans by surprise and ultimately defeated the last major German initiative against the Allies.

There are many more manoeuvrist examples to illustrate these points. Rommel's use of his Afrika Corps, O'Connor's destruction of the Italian 10th Army from Sidi Barrani to Beda Fomm during the winter of 1940-41 (10 enemy divisions destroyed and 130,000 prisoners for the loss of 476 allied lives), or Slim's execution of the Meiktila/Mandalay Campaign, are all recognised as classic manoeuvrist operations. Throughout, certain constants can be seen to emerge. Risk-taking, initiative and creativity abound, but more importantly, so do freedom of thought and action derived from the lack of constraints. As the next section shows, coalitions impose an entirely different set of working conditions on military commanders. Not every coalition commander has enjoyed Marlborough's luxury of being able to ditch a tiresome ally and prosecute the war according to his own instincts – though undoubtedly many have wished to do so!

Risk-taking, initiative and creativity abound, but more importantly, so do freedom of thought and action derived from the lack of constraints

SECTION THREE

Ancient Warfare

'History testifies to the ineptitude of coalitions in waging war. Allied failures have been so numerous and their inexcusable blunders so common that professional soldiers had long discounted the possibility of effective allied action unless available resources were so great as to assure victory by inundation.' (Eisenhower)

From the Biblical battles of the Israelites and the worshippers of Baal in 1100 BC to the air war over Kosovo, the tribulations of coalition warfare have exercised the minds of military and political leaders

Coalition warfare is an ancient phenomenon and combined operations have historically been the rule rather than the exception.²² From the Biblical battles of the Israelites and the worshippers of Baal in 1100 BC to the air war over Kosovo, the tribulations of coalition warfare have exercised the minds of military and political leaders. Coalitions remain a fact of military life; in the 20th century all the major wars have been coalition wars, apart from the Russo-Japanese and Iran-Iraq conflicts.²³ Different circumstances produce different coalitions and there can be no single universally applicable solution.²⁴ As Ian Nish has stated 'all coalitions are unusual, but some coalitions are more unusual than others.'

Coalitions tend to be transitory, emerging in response to specific threats and normally dissolving once coalition goals have been met. Often politically fragile in

nature, they develop out of necessity, sometimes uniting nations without a history of harmonious relations.²⁵ Nations play widely differing roles as coalition members, from guaranteed inaction, economic and diplomatic support, military assistance, to parallel or combined military operations.²⁶ Coalitions are formed when nations feel themselves incapable of, or unwilling to undertake, unilateral action. Some are moral crusades, but many are far from altruistic and are based on national survival or furtherance of national interest. Indeed, Churchill wryly observed that he would 'sleep with the devil if survival were at stake'.

Coalition's over-riding aims can mask a variety of national objectives. During WWII, the Russians joined the allied coalition to divert German troops from the Eastern front, whereas Churchill wanted to block Russian expansion into the Balkans, and US policy was to limit



An RAF helicopter detachment in Kosovo

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The fundamental disadvantage of coalitions is that they are notoriously difficult to manage and require careful nurturing

Russian influence in Europe.²⁷ Despite national variations, the will of the coalition is likely to be strongest when the perception of common threat is the greatest.²⁸

They are perceived to offer benefits in terms of generating greater resources, be they time, space, forces, capabilities or matériel. Coalitions confer legitimacy on their members in terms of moral, public and diplomatic support; the more participants, the more justifiable the operation appears.²⁹ Coalitions help democracies justify the use of force, especially when operations lack supra-national support from organizations such as the UN. Today the USA invariably chooses to operate as a coalition, though it has no military need for partners, to protect itself against criticisms of US imperialism.³⁰

The fundamental disadvantage of coalitions is that they are notoriously difficult to manage and require careful nurturing. There is no shortage of disparaging quotes from military leaders about the problems of dealing with coalition partners; Simpson, Raglan's successor as British commander in the Crimea, said with typical understatement in 1855:

'I feel it very irksome and embarrassing to have to do with these Allies.'

Differences in language, culture, ethos, goals, equipment, training, logistics, capabilities and doctrine all make concerted coalition action problematic. Coalitions develop their own group-dynamics and power-relationships, which change as the conflict progresses; only rarely does a coalition finish fighting for the same reason that it started. There are inevitably tensions between conflicting member's interests and intentions, sacrifices of sovereign prerogatives, and imbalances between the assets and liabilities of individual nations. Eisenhower recognised these challenges when he stated that:

'one of the constant sources of danger to us is the temptation to regard as our first enemy the partner that we must work with in defeating the real enemy.'

Limiting the discussion to 20th century Europe, coalitions have undergone fundamental changes. Before this period, coalitions were ephemeral, forming during wars and then disintegrating afterwards. During the Napoleonic Wars, seven coalitions were created against France; all were different and Austria, Prussia, Spain and Russia changed sides as the wars progressed.³¹ Recent experience has shown a tendency for long-standing peacetime alliances to be moulded into wartime coalitions.³²

Only the near collapse of the Western Front in March 1918 forced the Allies to tighten a very loose coalition and create unity of command under Foch as the Supreme Allied Commander-in-Chief

The relative strengths and weaknesses of the two World War coalitions deserve further mention as they typify the problems inherent with coalition warfare. In the 20th century the greater resources of the coalitions have tended to make wars longer, and the wider and more various interests of the partners have often

made it more difficult to conclude the conflict and achieve a lasting peace.³³ During WWI, the Allies were for the most part handicapped by age-old animosities and were unable to achieve any real integration. Only the near-collapse of the Western Front in March 1918 forced the Allies to tighten a very loose coalition and create unity of command under Foch as the Supreme Allied Commander-in-Chief.³⁴ American involvement was welcomed by the Allies who were running out of manpower having fought an extremely costly attritional war. On the Axis side, the German-Turkish forces achieved excellent levels of integration but the Austro-Hungarian Empire was so ethnically diverse (its 1914 mobilization order was communicated in 15 different languages), that its forces were barely able to coordinate with each other, let alone their allies.³⁵

WWII saw the creation of a sophisticated coalition against the Third Reich but only after an inauspicious start when it appeared that the British, Belgians and French had forgotten the hard won lessons from WWI. Despite different approaches, Churchill demanded close supervision whereas the Americans believed in a broad delegation of authority; the basic principles of unity of command and integrated combined staffs were agreed by Operation Torch, the invasion of North Africa.³⁶ Despite personality clashes, these practices were refined under the leadership of Eisenhower during the subsequent invasions of Sicily and Italy, and ultimately Operation Overlord. The opportunities for true manoeuvre warfare were constrained by the need to co-ordinate and integrate the mass of allied forces. Interoperability was invariably difficult and joint and combined doctrine was largely conceived on the hoof by visionaries such as Coningham and Tedder.

Shaping the battle space

Post WWII western coalitions have fought wars in

Korea, Vietnam, the Persian Gulf and latterly in the Balkans. Not all have matched the integration and success achieved during WWII although most have continued in the attritional mould. However, the Gulf War was a remarkable 'coalition of the willing' and involved a major shift away from the attritionalist approach. Manoeuvre warfare was successfully employed; surprise relied heavily on deception and the Iraqis were encouraged to believe that the allies' main effort would be littoral Kuwait. In reality the main effort was the long left hook into the enemy flank through Iraqi territory.

The coalition played to its strengths, used air power to decisively shape the battlespace and broke the Iraqi will to resist prior to the rapid land offensive. Special forces operated deep behind enemy lines and helped engender Iraqi psychological collapse. The political circumstances were unique to the 20th century and were conducive to this manoeuvrist approach by a coalition. Preparation time was plentiful allowing detailed planning and the military leaders, once the coalition had been formed, were left to their own devices. De la Billière has advocated caution from concluding that the Gulf War should be the template for future conflict, believing that the coalition forces were not truly put to

...the Gulf War was a remarkable 'coalition of the willing' and involved a major shift away from the attritionalist approach



A Tornado GR1 in low-level pursuit

the test.³⁷ The Iraqis made a number of strategic errors by giving the coalition time to build up forces and then failing to fight effectively once hostilities began.

Even allowing for the brevity of such a canter through the vast topic of coalition warfare, certain generic principles can be seen to emerge. Coalitions are not silver bullets but, being a necessary evil, are likely to be forced upon the military by realpolitik.³⁸ They are inherently cumbersome and tend to inefficiency because they require so much effort merely to maintain themselves; however, such self-absorption is vital because the coalition's centre of gravity is invariably its own cohesion. Coalition 'lessons learned' have a short half-life and are often re-learned the hard way by trial and error during combat.³⁹ Whilst most agree on the need for combined doctrine, it is very difficult to craft and, despite the rhetoric, is always hard to create when there is no common and readily identifiable enemy.

Coalition wars therefore tend to be ad-hoc arrangements, with best practice on the day hurriedly being substituted for pre-packaged doctrine

Coalition wars therefore tend to be ad-hoc arrangements, with best practice on the day hurriedly being substituted for pre-packaged doctrine. Often quickly assembled, coalitions tend to improve with time and are most harmonious against a serious threat. Coalitions often find themselves engaged in wars of survival, where to lose is not an option. Being complex and, if dictated by circumstances, risk-averse organizations, coalitions tend to go for what is readily achievable as opposed to what might be the ideal, but more risky, solution. Coalition warfare is very much the art of the possible and problems tend to be managed rather than

solved.⁴⁰ Above all, coalitions enhance their chances of success by keeping things simple and by relying on centralized command and control (C2) to carefully orchestrate the activities of its elements. Such a hands-on approach reduces the likelihood of error but does call for remarkable qualities of stewardship from the coalition commander.⁴¹ Operational flair and manoeuvrism is much harder, though not impossible, to action, given the need to weave each nation's political restrictions and military capabilities into the fabric of the overall coalition campaign plan.

As Kennedy concludes, 'coalition warfare requires, much more than any unilateral campaign, substantial doses of tolerance, understanding and flexibility' in order to avoid the 'Clausewitzian frictions' which could 'slow down or possibly ruin a wartime campaign.'⁴² This oil to keep the coalition moving smoothly is definitely not grist to the manoeuvrist's mill! Coalitions are therefore normally forced, by make-up, circumstance or by political compromise, to pursue attritionalist rather than manoeuvrist approaches.

SECTION FOUR

Operation Allied Force

'Something very different happened in this war, and to simply pass it off as an aberration is dangerous. (Meilinger)

This section examines NATO's participation in OAF and asks whether this most recent example of coalition warfare was as manoeuvrist in practice as its constituent nations' doctrine would expect it to have been in theory. It is a moot point whether OAF was truly representative of NATO's overarching military approach; differing perspectives have portrayed OAF as both 'a watershed in NATO's history, an overwhelming success,'⁴³ and 'an exercise in foisting onto the gullible a caricature of war.'⁴⁴ In reality, OAF was a limited war fought under severe political constraints by an unwieldy alliance of 19 nations.⁴⁵ There was no direct clash of massed forces and it was virtually an air-only war. Yet OAF exists as NATO's sole offensive campaign during its 50-year history and, successful or otherwise, it will undoubtedly play a significant role in determining how coalitions fight – and are fought against – in the future.

To provide a framework for analysis this section takes as its starting point the manoeuvrist approach, as defined in JWP 0-01.1, namely:

'An approach to operations in which shattering the enemy's overall cohesion and will to fight is paramount. It calls for an attitude of mind in which doing the unexpected, using initiative and seeking originality is combined with a ruthless determination to succeed.'

British Defence Doctrine fleshes out this core definition, emphasizing that the crucial difference between it and an attritional strategy involves breaking an opponents will rather than his matériel; pitting strengths against the enemy's known weaknesses; using momentum and tempo to induce shock and surprise; taking the initiative, and applying unacceptable pressure when and where the enemy least expects it. Using these concepts, NATO's performance during OAF will be judged according to its manoeuvrist merits under the 3 headings of overall strategy, campaign planning and execution.

Strategy

Even a cursory examination of the background to OAF illustrates how politicians and the military bring their intellectual baggage, in the form of preconceptions, to a

President Clinton stated: 'I thought that there was maybe a 50% chance it would be over in a week'. SACEUR exemplified this somewhat limited strategic vision when he declared: 'This really wasn't a war. It was diplomacy backed by force'

campaign. Following its perceived successes during the Gulf War and Operation Deliberate Force, air power appeared to offer the promise of decisive engagement without substantial commitment. This was reinforced in October 1998 when, faced with the threat of NATO air strikes, Milosevic backed down and agreed to allow in the UN-mandated Kosovo Verification Mission.⁴⁶ The evidence suggests that in 1999 western political leaders expected Milosevic to cave in rapidly in the face of another determined NATO coercive strategy based on limited air strikes backed by a united diplomatic front. President Clinton stated: 'I thought that there



Former US President Clinton

was maybe a 50% chance it would be over in a week'.⁴⁷ SACEUR exemplified this somewhat limited strategic vision when he declared: 'This really wasn't a war. It was diplomacy backed by force'.⁴⁸

However, Milosevic failed to capitulate as expected and NATO had to rethink its strategy. Critics maintain that NATO allowed the war to drift until events such as the refugee crisis dictated the emerging parallel strategies of targeting Serbian infrastructures and the fielded forces in Kosovo. Even before the air strikes started there was disagreement between the NATO allies over the use of ground troops and the air campaign. Wrangling over the air campaign concerned the choice of either an all-out initial assault or a phased gradualist campaign. USAF Chief of Staff, General Ryan said 'the campaign did not begin the way that America normally would apply air power – massively, striking at strategic centres of gravity' because her NATO allies insisted on a more gradual approach.⁴⁹

The gradualist approach was based on three factors: firstly, that it would give Milosevic the opportunity to concede before substantial damage was wrought; secondly, a major assault was unfeasible for certain NATO nations given overriding national legal and political factors, and thirdly, that the operation was designed in phases and targets were attacked in significant numbers from the outset.⁵⁰ The issue of the ground invasion is murkier still. However, it would appear that whilst some nations were more hawkish than others, an opposed assault on Kosovo was unacceptable for most, given the size of the force required – estimated at 200,000 troops – and the high numbers of possible allied casualties.

Given the humanitarian nature of the intervention, there was no NATO consensus for a Gulf War-style massive air assault followed by an opposed ground offensive. NATO's leaders were aware that Milosevic would target NATO's centre of gravity – its cohesion – and so maintaining that cohesion became an overarching strategic objective.⁵¹ Therefore, NATO's strategy was dictated, not by military best practice, but by the necessity to avoid undue political risk. Accordingly, NATO fought with a lowest common denominator strategy based on enemy attrition through sustained air attack. NATO's strategy was escalatory rather than decisive; deliberately designed to be transparent to the enemy; it was communicated to Milosevic when President Clinton stated 'I do not intend to put our troops in Kosovo to fight a war', and was avowedly risk-averse for both allied forces and Serbian civilians alike. As such, it was far from a manoeuvrist approach.

Campaign planning

Planning for air operations commenced 10 months prior to the air strikes and evolved through a series of iterations.⁵² Primarily US led, though under the auspices of NATO, the initial plans for large-scale strategic air attacks were eventually shelved as being politically unacceptable. SACEUR ultimately approved a two-day stand-alone Limited Air Response Plan which could, if unsuccessful, be incorporated into a multi-phased operation. No clear political end-state was established but considerable constraints were imposed in incorporating force protection, casualty intolerance and collateral damage. Counting on a short sharp shock to coerce Milosevic back to the Rambouillet Accords, much of the targeting analysis for the later 'tightening of the screw' was glossed over.

The enemy's centre of gravity was assessed as Milosevic's political powerbase in Serbia but attacks aimed at this critical vulnerability were disallowed. NATO's military objectives were therefore unsurprisingly vague; on 25 March, General Guthrie stated that the aim of the strikes was to 'avert an impending humanitarian catastrophe by disrupting the violent attacks against the Kosovar Albanians and to limit such repression in the future'. Lt Gen Short, the Air Component Commander (ACC), was more bluntly critical when he stated that 'we began bombing on the first night with our objective being to demonstrate NATO resolve. We need to know what our military objectives are, and we need to understand what we are trying to accomplish'.

The planning, though conceivably combined, was inherently un-joint, with minimal attention paid to co-ordinating the air aspects with the, albeit limited, naval forces. Although the ground option had already been ruled out, it was recognised that the ground force that would eventually be required as a stabilizing force in Kosovo, could also serve as a lever against Milosevic by representing a potential invasion force.⁵³ The military's belief that a ground war should be planned for, even if not executed, was disregarded until well into the war when, with Milosevic still defiant, veiled hints were dropped at the NATO Summit in Washington that all options were still on the table.⁵⁴ Even then, the land planning was undertaken out of kilter with the air campaign; as a result, the barracks identified by KFOR for its own use were destroyed during the bombing campaign. Moreover, little attention was paid to Information Operations against Serbia, although there is scant evidence to suggest that NATO possessed either the will or the means to undertake them at the time.

For cogent political reasons, the military plan was therefore fragmented and, initially at least, less robust than required. It was overly predictable and fundamentally incoherent in its lack of co-ordination between land, sea and air. The plan had an in-built lack of tempo, surprise and simultaneity. As the compromise solution by a coalition of the unwilling, the plan was not imbued with, nor perceived by its opponent to contain, a ruthless determination to succeed. The underlying theme was more concerned with encouraging the allies to continue to fight, rather than destroying Milosevic's will. As such, the war was eventually won, *despite* the campaign planning, rather than *because* of it.⁵⁵ Overall, OAF was not a triumph of pre-planning, but a huge achievement in improvisation.⁵⁶

Execution

The military's belief that a ground war should be planned for, even if not executed, was disregarded until well into the war...

The campaign was executed in an *ad-hoc* fashion, largely ignoring standardized NATO procedures. With no Joint Force Commander nominated, SACEUR undertook this role by default, leaving Gen Short as the ACC (without any strategic planning cell) to produce the Air Tasking Order (ATO) and service the target list provided by SHAPE. This arrangement effectively merged strategic and operational C2 within the NATO forces. As they provided the bulk of the assets, the C2 structure was predominantly US and highly centralized, leaving some of the allies with the impression that the coalition was merely bolted on to an extant US operation; many felt that they were 'informed rather than consulted' about the campaign's execution.⁵⁷ Where issues of releasability impinged on coalition interoperability, the solution was inevitably for the US to go it alone, as evidenced by the dual-track ATO system, which allowed the US to keep its stealth operations secret.

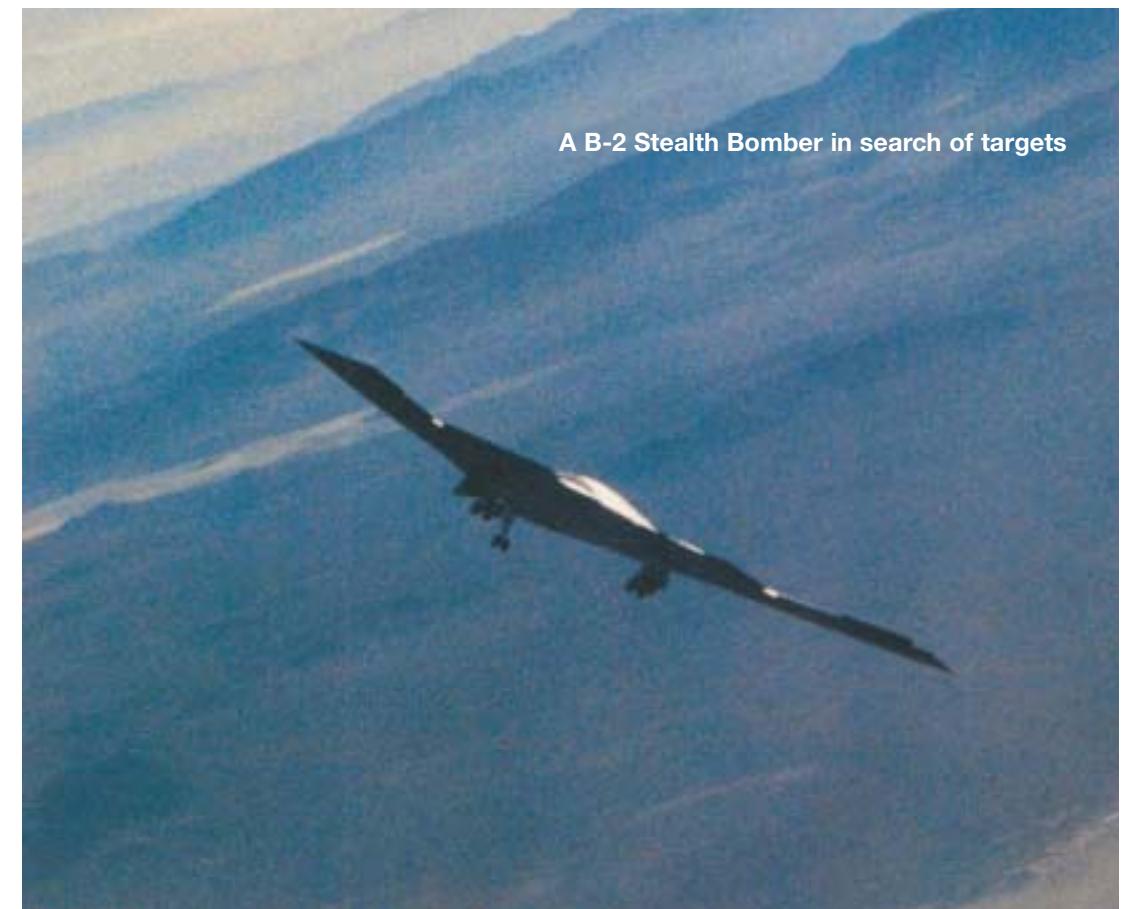
Extensive video teleconferencing was employed, ostensibly to reduce the friction of war and apply precise centralized control. As an unintended consequence, it encouraged political and military 'long screw-driving' which tended to degrade mission command at the operational level and below. The target approval process through the NATO Military Committee and national governments, all with national vetoes, was cumbersome and time-consuming. Unlike the authority delegated to Gen Horner as the Gulf War air campaign commander, during the Kosovo campaign, SACEUR, the highest military authority, personally approved every target.⁵⁸ At the tactical level, pilots engaging the Serbian fielded forces in Kosovo required permission from the Combined Air Operations Centre in Italy before proceeding with their attacks.

The weather played a major part in disrupting the tempo of operations; during the 78 days of attacks, cloud cover was assessed at greater than 50% for over 70% of the time and unimpeded air strikes only occurred on 24 days. Such lulls and an element of luck, allied to the campaign's slow start, enabled Milosevic to dissipate NATO's efforts and wrest back some of the initiative. Although cruise missiles and B2 bombers were able to operate independently of the weather, they could only be employed against static targets and were of little use against fielded forces. With bottlenecks in the politically-charged target selection process working against military calls to intensify the attritional campaign, there were frequent tensions and often more aircraft available than targets approved. Moreover, NATO's aircraft became increasingly constrained in their ability to manoeuvre and achieve surprise given the constricted airspace and fulsome requirements for self-protection.

Throughout the campaign, NATO spokesmen reiterated the quintessentially attritional nature of the operation. On 12 May, Admiral Moore, ACDS (Ops), stated that 'the air campaign is an incremental one with the gradual attrition of Milosevic's assets on the ground'. Similarly on 24 May, Gen Guthrie declared: 'the maximum attrition of Yugoslav forces by NATO will be the number one priority...and that it must be very demoralizing for the Yugoslav forces to see their military capability being whittled away'.

By shying away from all-out warfare in order to preserve its own cohesion, NATO encouraged Milosevic to wait and see if he could

Although cruise missiles and B2 bombers were able to operate independently of the weather, they could only be employed against static targets and were of little use against fielded forces



outlast the Alliance, in the knowledge that he could always broker a deal if necessary. It did not produce unacceptable pressure where and when he least expected it. The military always adjusts to the political parameters of the day; escalation and gradualism were the two political directives for OAF. As ever, the paradox lies in the fact that the politician's requirement for room to manoeuvre (especially when 'feeling their way' without defined end-states) militates against the military's freedom to be manoeuvrist.

Constrained by political guidance, NATO sought to coerce Milosevic by destroying his matériel and not his will. NATO could not directly target Milosevic's strategic weaknesses, was prevented from undertaking a bold decisive campaign, and relied on strength and technology rather than cunning to win the day. OAF was successful in that it achieved its objectives within the constraints dictated. With its emphasis on gradual degradation of the Serbian forces, there can be little doubt that OAF was an attritional, rather than a manoeuvrist operation. Perhaps the last word should go to SACEUR:

'What did the trick was the accuracy of the precision weapons, the avoidance of losses, and the increasing destruction of the Serb forces'.

SECTION FIVE

"There is only one thing more difficult than getting a new idea into the military mind...and that is getting the old one out"
(Churchill quoting Liddell Hart)

In theory, governments should ascertain the viability of coalition operations via a military informed cost-benefit analysis. In practice, the question is often stillborn as the decision is invariably pre-determined by political expediency. Despite the fact that coalitions rarely exhibit overall military synergy (the norm is for problems of integration to reduce the whole to less than the sum of its constituent parts), they do have an impressive track record. However, some recent successes mask internal flaws and some of the contests were a lot closer than is generally recognised. In the foreseeable future (discounting purely national interventions such as Sierra Leone), the requirement to fight as a coalition is likely to remain paramount, *ceteris paribus*, until such time as a coalition either wins too costly a victory, loses against an asymmetric opponent or simply becomes 'unglued' and falls apart in the process.

Are there dangers in being so coalition-centric? A coalition's mere existence does not guarantee success and their recent success has been attributed to the overwhelming military might of the USA. There are pitfalls: size can be counter-productive and capability without commitment delivers an empty message. Victory can breed complacency with winners seduced by the apparent inevitability of their continued success. Paradoxically, the vanquished often emerge with the more profound insights. Early German successes during WWII and the American-led victory in the Gulf after the debacle of Vietnam reveal how fertile a breeding area for groundbreaking doctrine a previous defeat can be.



The Lockheed F-117 Nighthawk

The danger for the western coalitions lies in the fact that they have probably never been so safe and must appear predictable, stale, incapable of objectively assessing their true weaknesses and, over-confident in their technical superiority, lacking in originality

Does the approach still retain any intrinsic value, or has it been relegated to the status of a worthy ideal, one to aspire to, but in practice, never be able to emulate? Has manoeuvrism become the latest victim to the curse of doctrinal dogma?

Some contend that coalitions sound the death-knell for a manoeuvrist approach and that manoeuvrism should be either rejected or sublimated into the use of ever more technological marvels to wow the crowds in the media amphitheatre. Confident of their

The danger for the western coalitions lies in the fact that they have probably never been so safe and must appear predictable, stale, incapable of objectively assessing their true weaknesses and, over-confident in their technical superiority, lacking in originality. It is questionable whether the guarantee of security through coalition membership induces an innovative military mindset. Valid critiques of coalitions emphasize their tendency to subjugate 'operational art' to the skills required in chairing committees. Possibly only defeat will force nations to question their default setting to coalition warfare and all that it entails in terms of the way they train and fight.

Nevertheless, lacking threats to her national survival, the UK remains avowedly coalition-centric, but also espouses manoeuvrism. Coalitions normally tend to a constrained, attritional, and more recently, gradualist, approach, in order to guarantee consensus and reduce the risk for its participants. History teaches us that the manoeuvrist approach thrives

during limited national operations, especially when the military situation justifies the acceptance of increased risk in favour of rapid success. It is hard to imagine another Gulf War scenario in which coalition forces would again be given a political free rein to employ a manoeuvrist approach in an area purpose built for manoeuvre warfare, against an enemy who made little attempt to disrupt its lengthy preparations.

However, calls for the demise of the Powell Doctrine (the use of overwhelming military force to decisively achieve clearly defined political objectives) are probably premature.⁵⁹ In choosing limited means to achieve its ends during OAF, NATO did not reject manoeuvrism outright and it would be dangerous to draw too many conclusions from this air-orientated war. In future wars with ground troops deployed, a more manoeuvrist approach may be more acceptable to force a decisive result. But if the Gulf War represents the exception rather than the rule and OAF the more likely template, what is the future for manoeuvrism?

technological superiority, coalitions can now ignore manoeuvrism's basic tenets and, being risk-averse and consensual, rely on 'winning together from a distance'. The lure is victory at minimal cost, and the danger of losing the psychological advantage to a potential enemy can be marginalised with military might and political unanimity. The anti-manoevrist heretics argue that, contrary to recent developments in the art of war, national doctrine remains overly manoeuvrist and should be re-written to reflect the changed coalition realities. Moreover, the continued emphasis on manoeuvrist doctrine is at best irrelevant, and at worst imparts a misleading paradigm to future coalition warriors; such an error only thickens, rather than disperses, the fog of war.

Others point to the manoeuvrist approach's continued relevance. In a purely national operation, without the additional resources afforded by coalition membership, the UK would have to preserve its limited assets by fighting smartly. Moreover, coalitions should not automatically reject a manoeuvrist approach. CDS's remit is to present politicians with options based on informed military advice, irrespective of how politically unpalatable they might appear. Manoeuvrism represents a national doctrinal success story that could be read across to coalition operations. Accordingly, the UK should engage its coalition partners in the manoeuvrist approach through the development of combined doctrine. Care should be taken to ensure that, when standardizing doctrine, the manoeuvrist element is not 'nibbled to death by ducks'. Ultimately, should Europe's ambitions for an independent military capability come to fruition, its forces could lack the technological superiority currently afforded to NATO by the USA, and Europe would have to rely on a manoeuvrist approach to compensate for its capability gaps.

The answer lies somewhere between the 2 extremes. The manoeuvrist approach will remain paramount in national operations because a return to a more

Manoeuvrism represents a national doctrinal success story that could be read across to coalition operations

attritional style of warfare is both inconceivable and impossible given our current force structures. Moreover, it remains our best weapon against an asymmetric opponent. However, current national doctrine overplays the manoeuvrist line and underplays the different approaches required during coalition operations.

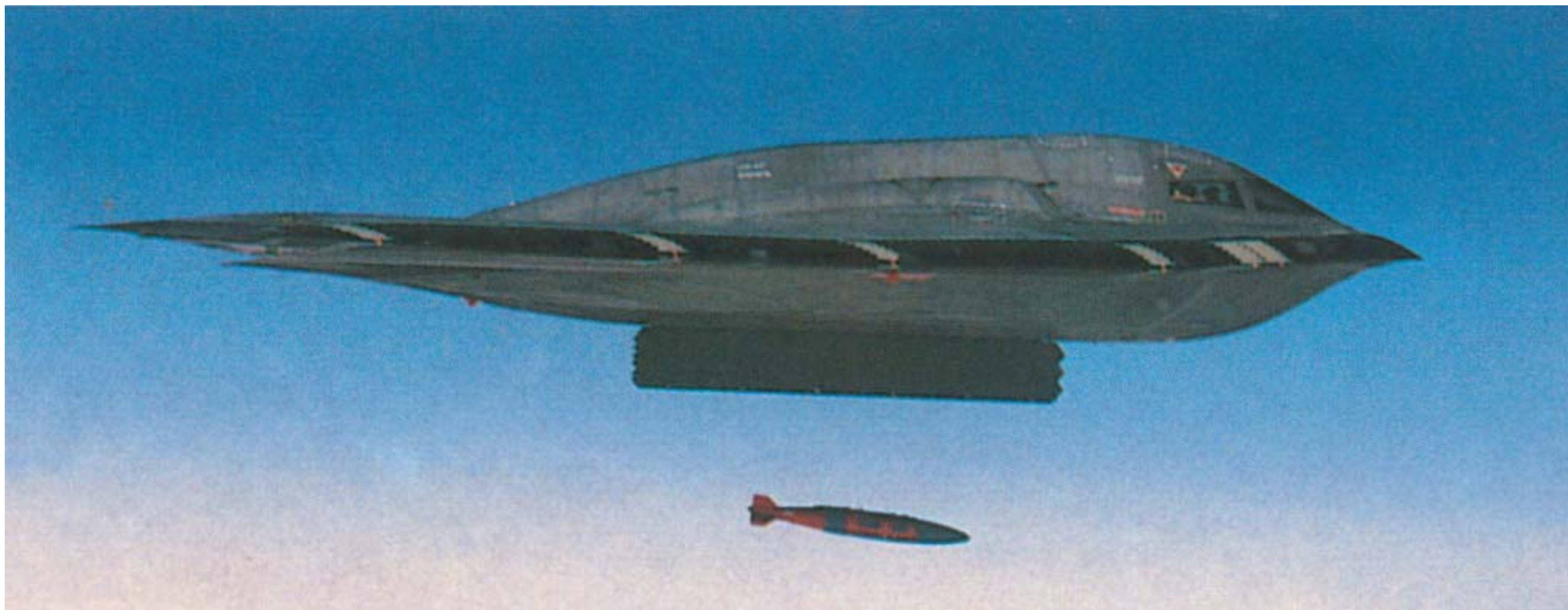
Significantly, future changes to coalitions and manoeuvrist operations could facilitate symbiosis of the two approaches. Realpolitik requires the military to live with the politics of the moment, so harmony of political objective and the military method could be better achieved by careful coalition selection. 21st century coalitions could be more situation specific, with objectives tailored to conflicts rather than broad global norms; regionally based, with those close-by having the greatest stake; or ad-hoc, and separate from existing frameworks such as NATO.⁶⁰

Security in the 21st century may be characterised by a complex array of institutional and international links that engage different coalition partners for different levels and types of missions.⁶¹ Therefore, future coalitions could be better placed, or forced, to employ a manoeuvrist approach, especially in more equal fights against worthy opponents. Ad-hoc coalitions of like-minded nations will need to be small enough to allow manoeuvrist action but large enough to confer legitimacy. Similarly, larger

coalitions could develop manoeuvrist approaches through burden-sharing, allowing the willing and capable to do the manoeuvrist war-fighting whilst the rest perform the follow-on missions.

Hybrids resulting from the merger of the two approaches could herald a 'third way' between the two extremes. During OAF, the attritional legacy was evident in the gradualist use of incremental force to coerce an enemy by destroying his critical assets, but

If a single B-2 armed with Joint Direct Attack Munitions can deliver massed precision with impunity, then what more of a manoeuvrist weapon could one wish for? The corollary of this argument is of course that the West, with all its technological sophistication, gains a new Achilles heel



The B-2 Stealth Bomber shows off one of its 340 kg (750lb) M117 bombs

with limits placed on the acceptable damage wrought. Likewise, the manoeuvrist approach has changed, metamorphosing from the realm of the psychological to the technical. The medium for this new manoeuvrism could be, amongst others, air power (stealth delivering mass precision) or through Information Operations (cyber warfare).

This new ‘ersatz manoeuvrism,’ predicated on the benefits of technological advance and the Revolution in Military Affairs, maintains the unexpected element, but has changed its dimension. If a single B-2 armed with Joint Direct Attack Munitions can deliver massed precision with impunity, then what more of a manoeuvrist weapon could one wish for? The corollary of this argument is of course that the West, with all its technological sophistication, gains a new Achilles heel. Current concerns about asymmetric threats to coalition operations highlight how the manoeuvrist approach can be used to target Western weaknesses such as alliance cohesion and sensitivity to casualties.

The principles of risk-aversion and manoeuvrism are not necessarily mutually exclusive. Developing manoeuvrist techniques such as Information Operations could involve pre-emptive cyber attacks to influence the enemy before he is set on his intended scheme of manoeuvre. If these tactics are to be employed, the politicians’ natural reluctance for early action will only be overcome with convincing arguments about their ability to reduce overall costs and casualties in the long run and thereby support the notion of conflict prevention.

Manoeuvrism remains enshrined in the UK’s Joint Vision draft paper out to 2015.⁶² The balance between the two approaches is still not yet right, but any anti-manoevrist backlash will be counter-productive. The manoeuvrist baby must not be thrown out with the doctrinal bathwater, but allowed to grow. Manoeuvrism is not dead but it must evolve to meet the new challenges. Nations need to be doctrinally multi-capable; what will be required will be a ‘golf-bag’ approach, allowing for the selection of a contextually suitable methodology, be it coalition or manoeuvrist, or some novel combination of the two.

CONCLUSION

‘The only thing worse than fighting with allies is fighting without them.’ (Churchill)

The reality of conflict is that warfare is subjective and offers few absolutes. This essay has sought to avoid advancing prescriptive doctrinal recommendations; instead, it has shed some light on the approaches that shape current military thinking. Ideally it has also highlighted some inconsistencies and identified avenues of thought worthy of further consideration. The military has a tendency, when caught analyzing its navel, to sometimes search a little too hard for hidden axioms and answers, and runs the risk of missing the wood for the trees.

When balancing on the fine fulcrum between becoming hidebound and succumbing to spin, the military must understand how its approaches fit into the wider framework. Moreover, it must remember that its personnel are part of the society it protects, and therefore mirror its preconceptions, prejudices and principles. A wise strategist knows himself as well as he knows the enemy and should be prepared to follow Captain Blackadder’s dictum and, when appropriate, not be afraid to ask himself some pretty searching questions!⁶³

Both manoeuvrism and coalition warfare possess validity but require a caveat and can be shaped to suit the occasion.

The manoeuvrist approach is not a panacea to be advanced on every occasion, nor should it be rejected as outmoded or irrelevant

The manoeuvrist approach is not a panacea to be advanced on every occasion, nor should it be rejected as outmoded or irrelevant. Doctrine will never be perfect but it should at least aim to reflect the realities of conflict and represent best military practice. By emphasizing the ideal manoeuvrist approach at the

expense of the pragmatic coalition approach, UK national doctrine has yet to get the balance right. Enhancing the coalition aspects of our national doctrine and developing the manoeuvrist perspective in combined doctrine will nurture a virtuous circle of improved military capability and intellectual debate. Above all, we should search for means of combining the best elements of both approaches and foster a spirit of innovation. A manoeuvrist coalition is not an oxymoron but it will demand much attention in its development.

Doctrine has always represented differing national strategies, force structures, equipment capabilities, and the demands of varied theatres of operations. Despite the disparate backgrounds of the two approaches, doctrine should continue to evolve by expanding upon the realities of coalition warfare without neglecting the advantages of manoeuvre warfare. It took the hard-won lessons of WWI and the attritional wars of the 20th century to convince the UK of the efficacy of the manoeuvrist approach, and it would be a backwards step if it were allowed to wither on a coalition vine. The manoeuvrist approach, if not always directly applicable due to the nature of the operations we may find ourselves engaged in, will always be useful and we reject it at our peril. It should remind us of the attritional alternative, offer a different perspective to coalition operations, provide a fertile breeding ground for new doctrine and methods, and reveal clues as to how coalitions might be targeted in the future.

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Silent Trackers

The Spectre of Passive Surveillance
in the Information Age





A spectre is haunting the Information Age – the spectre of passive surveillance. In recent years passive surveillance systems have evolved to such an extent that they are set to overtake radar as the preferred means of target tracking. To be susceptible to passive surveillance a platform must emit. In the West, the level of pulsed communication between inter-linked weapon systems has increased markedly, particularly since the advent of Information Warfare in the early 1990s, rendering individual platforms more susceptible to detection and targeting by passive means. Such is the digital dependency of modern warfare that if a platform does not emit, then it is unlikely that it can perform a useful role.

The major feature of passive surveillance is that it is a 'silent' process. There are no signal emissions from a truly passive system. Nor are passive sensors susceptible to electronic jamming. A jammer simply provides a stronger signal-of-opportunity which a passive detector can readily exploit. One effective counter-measure to passive surveillance would be to locate the passive sensors using imagery and then physically destroy them. However, the compact antenna and electronic systems used in modern passive systems allow them to be blended into their surroundings, whether natural or urban.

Passive surveillance systems normally use low power compared with conventional radar and the compactness of the antennas and electronic sub-systems is such that they could also be mounted in small, pilotless platforms. As a result there are potentially significant cost advantages compared with a radar-based surveillance system.

The current proliferation of passive surveillance systems in increasingly dense electromagnetic environments represents a significant military challenge. Although passive surveillance is a threat to any military platform, this article emphasizes its operational significance from the standpoint of air power. Some of the unrecorded history of passive surveillance is described for the first time, with particular emphasis on the remarkable contributions of the Czechs.

NATO'S COLD WAR DILEMMAS

The current proliferation of passive surveillance systems in increasingly dense electromagnetic environments represents a significant military challenge

Passive surveillance played a pivotal role for Soviet air power during the Cold War, providing a means for tracking NATO aircraft that was wholly independent of radar. Soviet investment in passive surveillance for tracking purposes greatly exceeded Western levels and the surveillance systems they developed far outpaced Western equipment. Only in the late 1990s has NATO begun to consider the procurement of passive surveillance equipment for tracking purposes on a comparable footing with active sensors.

Had the Cold War broken out at any stage through the 1980s into active air engagements over the Central European plain, it is arguable that unexpectedly high Allied losses would have been incurred and could have resulted in military disaster for the West. There are many factors to consider and this is likely to become a controversial issue in years to come. Western planning assumptions concerning the prospective air battle in Central Europe failed to take adequate account of the passive surveillance threat.

The failure lay not in a lack of awareness of passive surveillance as such. There was ample awareness, for example, of Soviet Signals intelligence (SIGINT) activity, and selective emission control (EMCON) was an integral part of NATO operating procedures. Yet at some stage a platform must emit in order to play a useful role and EMCON can only do so much when the navigation aids of an aircraft have to emit continuously in order to complete the mission (the Tornado GR1 is an example of an aircraft designed

around the radar threat. Its terrain-following radar would allow it to penetrate Soviet radar at low level, but passive tracking would have negated this capability).

The failure lay in insufficient appreciation in the West of the specific Soviet ability to generate an air picture using tracking and the utility of this information during the engagement, when radar, communications and other aircraft emissions become unavoidable. Whatever the claims and counter claims of what was known about the passive threat during the 1980s, the simple fact remains that one side possessed a passive tracking capability and the other didn't. Moreover, that advantage was one-sided tactically as well as technically. The NATO view was radar-centric and its operational planning was orientated to a threat perceived as the mirror image of its own sensor mix, not against the actual threat which existed.

A parallel can be drawn from military history. By the summer of 1940 German intelligence had become aware of the British Chain Home raid reporting system. By then, the Germans had independently developed excellent radars.¹ Yet the Luftwaffe held an all too restricted view on the role and utility of radar in general ² and of Chain Home in particular. Their High Command lacked, at that critical juncture, sufficient recognition of the primacy of role of Chain Home in tracking the threat and the vital early warning this provided to RAF fighter squadrons.³ Consequently, with little, the “few” did much; their limited assets concentrated just when and where they were needed. During the Battle of Britain, German attacks against Chain Home were ineffective and half-hearted, with only Ventnor RDF station on the Isle of Wight briefly put out of action in the one concerted attack against the RDF network on 12 August 1940.⁴ It was not just that the Chain Home towers were difficult targets; simple intelligence analysis would have been sufficient to identify the critical receiver and operator nodes in the immediate vicinity of the towers which the Luftwaffe possessed the means to destroy. Rather, it was a matter of the cultural addiction of the German high command to outdated concepts which misconceived enemy tactics and capabilities as the mirror image of its own. A more intelligent strategy based on systematic targeting of the enemy's ‘eyes and ears’ could have produced a different result in 1940.

In the Battle of Britain, the Germans had no effective radar counter-measures and their defeat was a setback that led ultimately to their downfall. After the experiences of 1940 the Germans changed their views on the utility of radar and engaged in an earnest war of radar counter-measures with the British from which the military science of Electronic Warfare was to emerge. NATO's failure to respond

Whatever the claims and counter claims of what was known about the passive threat during the 1980s, the simple fact remains that one side possessed a passive tracking capability and the other didn't

During the Battle of Britain, German attacks against Chain Home were ineffective and half-hearted...



Typical Chain Home (CH) radar station

in the 1980s to the threat posed by passive surveillance compares with the Luftwaffe's shortcomings in 1940 because in neither case was there sufficient emphasis on counter-measures. Awareness of the passive threat during the 1980s would have triggered a contest of passive counter-measures, although this never emerged during the Cold War and Western cultural habituation to radar resulted in a hidden and one-sided advantage. Mercifully, there was no Battle of Central Europe yet concerns for the future mean that it remains vital to analyse this historical background and the capabilities of the passive surveillance equipment in question.

In the early 1960s, NATO formally committed itself to a policy of defence as far forward in Western Germany as was militarily feasible. Defence in-depth was not a politically desirable option and unwise from a military standpoint since loss of the thin band of West German territory, with its concentrations of industry, manpower and lines of communication, might put NATO at an irretrievable disadvantage. The policy shift from 'trip-wire' to forward defence was marked by new emphasis within NATO on what might be achieved with its all too limited conventional forces. NATO's strategic planners wrestled with the intractable dilemmas inherent in the policy of forward defence and by the early 1980s many had concluded that military logic ultimately dictated that the best form of defence lay in the adoption of pre-emptive tactics. A notable exponent of this viewpoint was the distinguished American scholar, Samuel Huntington, who argued that NATO's defensive strategy almost guaranteed defeat and that the only way to defend West Germany was to contemplate retaliatory offensive attacks against Soviet weak points.⁵ This new thinking had its echoes in a significant re-shaping of US Army and Air Force doctrine as both services sought to revamp the defensive mind-set of the nuclear era and replace it with a readiness to use conventional forces in the exploitation of depth, initiative, mobility and the synergies of joint offensive action. Airland Battle was the main doctrinal product of these efforts and in 1982 it was incorporated into the US Army Manual, FM 100-5.⁶

Shifts in the US doctrinal paradigm undoubtedly influenced SACEUR and his staff at SHAPE in their re-evaluation of NATO doctrine aimed at improving NATO's conventional force posture. Although great emphasis was placed on the force multiplication potential of then emerging technologies, such as precision-guided munitions, the influences of Airland Battle were evident in the NATO's concept of Follow-on Forces Attack (FOFA), which was promulgated by NATO's Defence Planning Committee in 1984. Deep attack into the enemy's hinterland by both ground and air



Canted antennas on this FuG 220 reduced interference

After the experiences of 1940 the Germans changed their views on the utility of radar and engaged in an earnest war of radar counter-measures with the British from which the military science of Electronic Warfare was to emerge



The electronic battle, particularly in the early phases of the air campaign, was vital to the achievement of surprise

forces was envisaged in the FOFA concept, in which the element of tactical surprise was crucial. The electronic battle, particularly in the early phases of the air campaign, was vital to the achievement of surprise. Equally important was the ability to identify well-dispersed friendly and enemy units engaging one another in fluid tactical environments. The major aim of the electronic battle was denial of early warning by Soviet radars – the supposed ‘eyes and ears’ of the enemy. However, the pivotal role of passive surveillance for the Warsaw Pact and the inherent advantages of passive surveillance in distinguishing between friendly aircraft and hostiles, were barely recognised by NATO’s military planners.

This failure was not confined to NATO but was, and remains, deeply embedded within Western military and military-academic culture. For example, in an assessment of NATO air power in Central Europe, the distinguished military author, Alfred Price, while recognizing NATO’s weakness in identification friend-or-foe (IFF), shows scant regard for Soviet electronic capabilities:

*‘...although the provision of reliable identification for aircraft is a high priority NATO requirement ...the problem is likely to haunt air commanders well into the 1990s. The only consolation is that the Warsaw Pact air forces face a similar problem, made worse by the fact that they have many more aircraft and their electronic systems are less advanced than their Western counterparts’.*⁷

SOVIET SECRET EYE

What was so special about the Soviet passive surveillance network was its ability to fuse information received from many sites...

In passive systems, a clear distinction needs to be made between the ability merely to detect an emission by passive means, for electronic intelligence or SIGINT purposes, and an ability to track the movements of an aircraft or other platform using only the radio-frequency emissions from its radar, communication or navigation equipment. Electronic intelligence capabilities were nothing exceptional and were widely available in both the East and West. What was so special about the Soviet passive surveillance network was its ability to fuse information received from many sites, in order to provide autonomous tracking capabilities that were comparable with or better than radar.

The principal advantage bestowed on the Soviets by passive surveillance was continuity of air situation coverage, even during periods of sustained and intensive electronic jamming of their air defence radars. NATO planners assumed that electronic suppression of Soviet radars would sufficiently diminish Soviet awareness of the air situation during the early and critical phases of air battle that it would permit that deep NATO interdiction and strike against Soviet airfields and territory with sustainable or

tolerable allied losses. Yet when the Soviet passive surveillance capability is weighed in the overall balance of forces, the reverse scenario is more plausible.

In the opening phases of air battle, the major thrust of NATO effort would have involved electronic jamming to suppress the early warning and fire control radars of surface-to-air missile sites. Suppress these systems, so the argument ran,⁸ and you create windows of opportunity in which to execute surprise attack against Soviet weak points. Yet NATO's airborne jammers would have provided massively enhanced radio illumination (in the sense of self-illumination of individual platforms) of the air space over Central Europe and so actually have assisted Soviet exploitation of passive means.

The Soviets, on the other hand, could have flooded Western air defence radars with electronic noise confident in the knowledge that this would have minimal effect on their own ability to visualize the air battle passively. Furthermore, while NATO air forces had no effective covert means for distinguishing between friend and foe, the Soviet passive surveillance network provided a built-in and covert IFF capability. It is a surprising yet proven and highly effective feature of passive surveillance that when signals analysis is applied to the detected emission, both target track and track identity can be displayed. NATO's air order of battle would have been constantly and literally 'in-picture' on Soviet display screens and available for distribution to all major centres of Soviet air command and control. In today's parlance, information advantage would have rested squarely with the Warsaw Pact and greatly aided Soviet efforts to carry out a campaign of deep attack and strike within Western air space.

Ramona was capable of generating multiple tracks on enemy aircraft based only on their radar emissions and provided fast and accurate identification of the target through near instantaneous analysis of the target's radar electronic signature

RAMONA

NATO's planning assumptions were probably reasonable up to 1981. After 1981, NATO's military planners ignored Ramona, a fully automatic air surveillance system that formed the backbone of the Soviet passive surveillance network throughout the 1980s. Ramona was capable of generating multiple tracks on enemy aircraft based only on their radar emissions and provided fast and accurate identification of the target through near instantaneous analysis of the target's radar electronic signature. This was a major advantage for the Soviet side because in Western systems the IFF function had to be derived from separate primary and secondary radars that were non-covert and could be exploited for passive tracking by an opponent.

Ramona was developed in the 1970s for use within the Warsaw Pact by the Czech Military Technical Research Institute at Brno and produced by the Czech company, TESLA (TEchnika SLaboproudA which roughly translates as 'Low Voltage Technology'), with the involvement of some other companies. Although



The Ramona fully-automatic passive air surveillance system. Throughout the 1980s, it formed the backbone of the Soviet passive surveillance network

not the first such system produced by TESLA, Ramona's capabilities as a fully automatic 'silent tracker' put it very much in a class of its own. Ramona introduced into air defence an automated aircraft tracking capability that was sustainable in hostile electromagnetic environments. East or West, there was no other system quite like it.

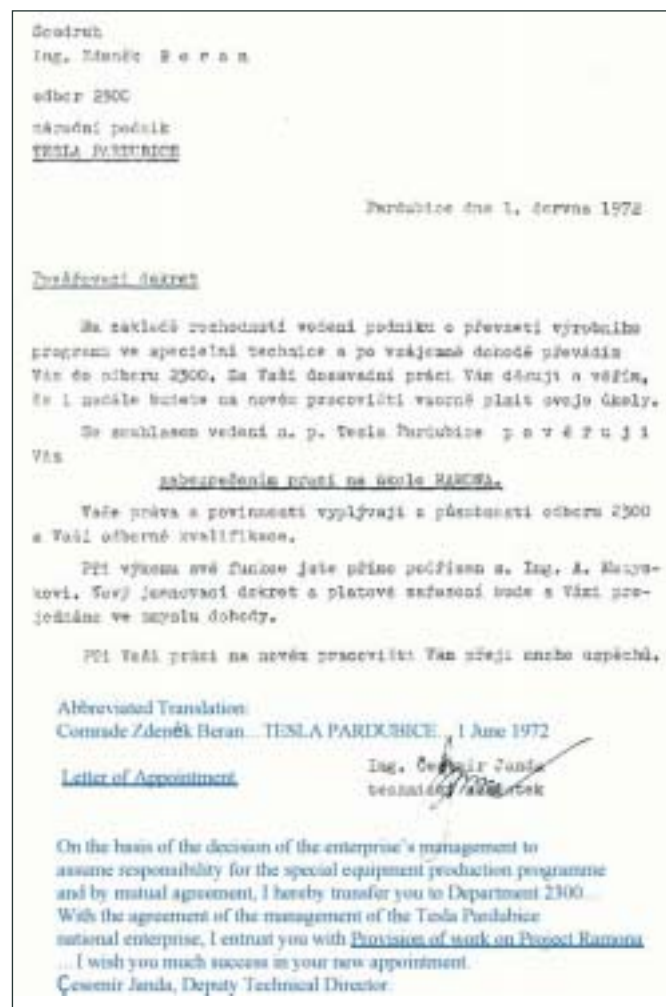
The first Ramona was exported to the Soviet Union in 1981 and was followed by many more. With more than 20 Ramona systems deployed across the European theatre by the early 1980s, Soviet coverage of the air battle in Central Europe was comprehensive. The tracking provided by Ramona was effective up to the radio horizon (about 450 kilometres), well beyond that of most conventional radars, and at least as accurate. This allowed the deployment of Ramona in depth, far behind the forward edge of the land battle. Early warning of NATO air missions would have been available to Soviet air commanders, enabling air defence units to be put into readiness states in advance of any NATO incursion. With ample early warning, the allocation and cueing of surface-to-air missile batteries would in most cases have occurred before NATO jets crossed the forward edge of battle. If hot war had broken out, Western combat aircraft of all types would have encountered unexpected speed and efficiency in Soviet air defences. On board radar warnings received would probably have been short, if anything was detected at all. Western SIGINT collectors would also probably have encountered an unexpectedly low level of early warning radar activity in general, interspersed by floods of electronic noise jamming.

In short, NATO would have been hit forcibly by that most devastating weapon – technological surprise...

In short, NATO would have been hit forcibly by that most devastating weapon – technological surprise – leaving its air command and control network dislocated and confused. How did such potentially devastating circumstances arise?

Each country of the Warsaw Pact tended to have its own specialisation to serve the wider needs of the alliance. For the Czechs, it was passive surveillance. They pioneered passive surveillance and to this day remain undoubted world leaders in the technique. It is indeed fortunate that the Cold War ended when it did, for a still more deadly successor system called Tamara was developed by the Czechs in the second half of the 1980s. This is the first occasion this once highly classified and historic material has been seen in the West. It was passed to the author during detailed discussions on the history of passive surveillance with many of the Czech scientists and technologists originally involved in the development of Ramona. (The author acknowledges and warmly thanks Zdenek Beran for providing this important historical material. Mr Beran has been a pioneer of passive surveillance since 1952 and was one of the leading players in the development of both Ramona and its successor system Tamara).

These pioneering achievements are part of a larger, longer and fascinating story, as yet untold in the West (the author is writing a book on the history of radiolocation in Czechoslovakia). It is a story of extraordinary persistence by the Czechs over several decades, initially in the face of Russian rejection.



Letter of authorization for the production of Ramona

The story of aircraft tracking using passive surveillance begins in the 1950s at UVR (Institute for Radio Technological Research), Opočinek, a research and development institute involved in civil and military projects, located in the district of Pardubice in the East Bohemian region of former Czechoslovakia. UVR Opočinek specialized in radio-location, more commonly known today as radar. The initial intellectual stimulus which led the Czechs to investigate passive surveillance was provided by a gifted young scientist called Vlastimil Pech. Many talented and hard working individuals have contributed over the years to the research, development and production of passive systems in Czechoslovakia. Without Pech's initial vision and drive in the late 1950s, it is doubtful that such research would ever have begun.

Pech joined UVR Opočinek in 1951, shortly after its creation from the research elements of nearby TESLA Pardubice, a large state concern which manufactured a wide variety of radio and electronic equipment. Although notionally separated, TESLA and UVR continued to work very closely and effectively as a single organization. TESLA/UVR policy was to take only the best graduates and deliberate reliance was placed on the creative energy of youth. This approach rings falsely with the Western image of the former Eastern bloc as plodding and lacking innovative skills: this was far from the case at TESLA/UVR. There was even a practice of brainstorming in the 1950s and ample freedom of expression was granted for this purpose. This was, of course, an intellectual freedom of the technical variety, not to be confused with political freedom of expression.

Pech worked in a section that looked at future technologies and he was involved in many innovative projects at TESLA/UVR. In 1958, misfortune struck when he fell victim of a political purge and was summarily dismissed. Despite the easy intellectual atmosphere at TESLA/UVR, such arbitrary treatment – and far worse – was not uncommon in the Czechoslovakia of that era. Mercifully for Pech, the purge proved to be of a temporary nature and such was his evident value to the Czechs that he was soon allowed to work at another TESLA plant at Lanskroun, which specialized in electronic component technology. Here, once again, he was given ample freedom to express his technical ideas and was even on one occasion allowed to visit the United Kingdom. It is likely that by 1959 Pech had already begun to ponder the problem of the long range detection of airborne radars and at TESLA Lanskroun he persuaded influential figures in the Czech military to look seriously at his ideas for passive tracking.

Conventional ground-based radar suffers several critical disadvantages. Chief amongst these is that it relies for target detection on extremely faint radio echo returns from the target aircraft and this signal weakness leaves the radar receiver vulnerable to

What was new was the elegant mathematical treatment employed by Pech that made the construction of a tracking system a practical proposition using a network of time-delay circuitry

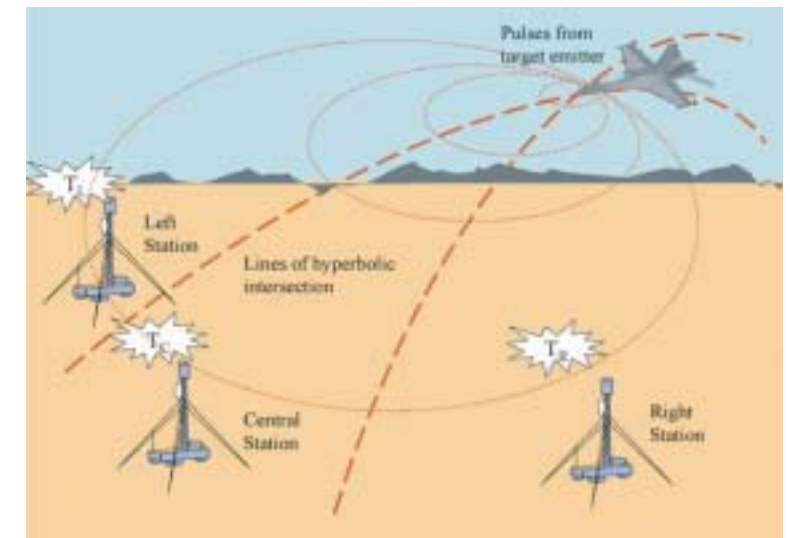
jamming and limits the maximum range of detection. Why not, Pech reasoned, exploit the signal energy emitted by the aircraft's own radar system? Since such emissions were increasingly prevalent, Pech realized that the pulsed emissions from aircraft radars were highly vulnerable to passive detection and would be ideal for tracking purposes because the available signal energy is incomparably greater than the radar 'skin echo'. Moreover, any attempt at jamming ground-based radars would simply generate an even stronger signal that could itself be used to locate the jamming source.

The Czech military were so impressed by Pech's ideas that they took them back to the Military Technical Research Institute at Brno, a research centre of the Czechoslovak Army. Pech himself soon followed and it is at Brno that the first serious efforts to develop a practical passive surveillance system began in 1960. His concept was based on near-simultaneous measurements at different ground locations of the time of arrival of pulses emitted by a target aircraft radar for, if three or more ground stations are available to detect a signal from a common source, the tiny differences in time of arrival between each of them can be used to calculate the target position in two or even three dimensions.

The time-difference-of-arrival (TDOA) technique was not new, even at that time, and it had previously been used both in the East and the West⁹ in diverse direction-finding applications. What was new was the elegant mathematical treatment employed by Pech that made the construction of a tracking system a practical proposition using a network of time-delay circuitry. A TDOA system dedicated to the aircraft tracking function was also a major departure that went well beyond the angle-of-arrival information obtained in standard direction finding, to the provision of highly accurate aircraft tracks displayed in real-time. However, the significance of this achievement has been unrecognized in the West even to the present day.

The crucial feature of Pech's novel mathematical treatment, which he successfully patented and termed the 'Chronometric-Hyperbolic Principle', was that it related time and position directly, with no intermediate angle calculation, greatly simplifying and speeding up the computational process needed to establish an emitter's position. If a set of three or more detectors can be arranged to intercept and correlate the time of arrival of individual pulses, then the location of the target can be determined with a precision that depends mainly on the accuracy of the timing measurement. Pech's mathematics are then applied directly to the timing measurements to generate hyperbolic curves (comprising planes not lines of intersection), such that the target lies at the point of their intersection.

Pech's ideas were also presented to the Russians who studied them with considerable interest. They performed their own assessments but at first concluded that the method



Chronometric-hyperbolic principle

could not be made to work. Undeterred, the Czechs persisted and after three years of effort developed a practical prototype TDOA system christened the PRP-1 Kopáč, which was ready for operational service with the Czechoslovak air defence forces in 1963. Kopáč was the world's first passive TDOA surveillance system dedicated to aircraft tracking.

Tamara was a significant improvement on Ramona, providing not only full mobility but a still greater capacity for target tracking

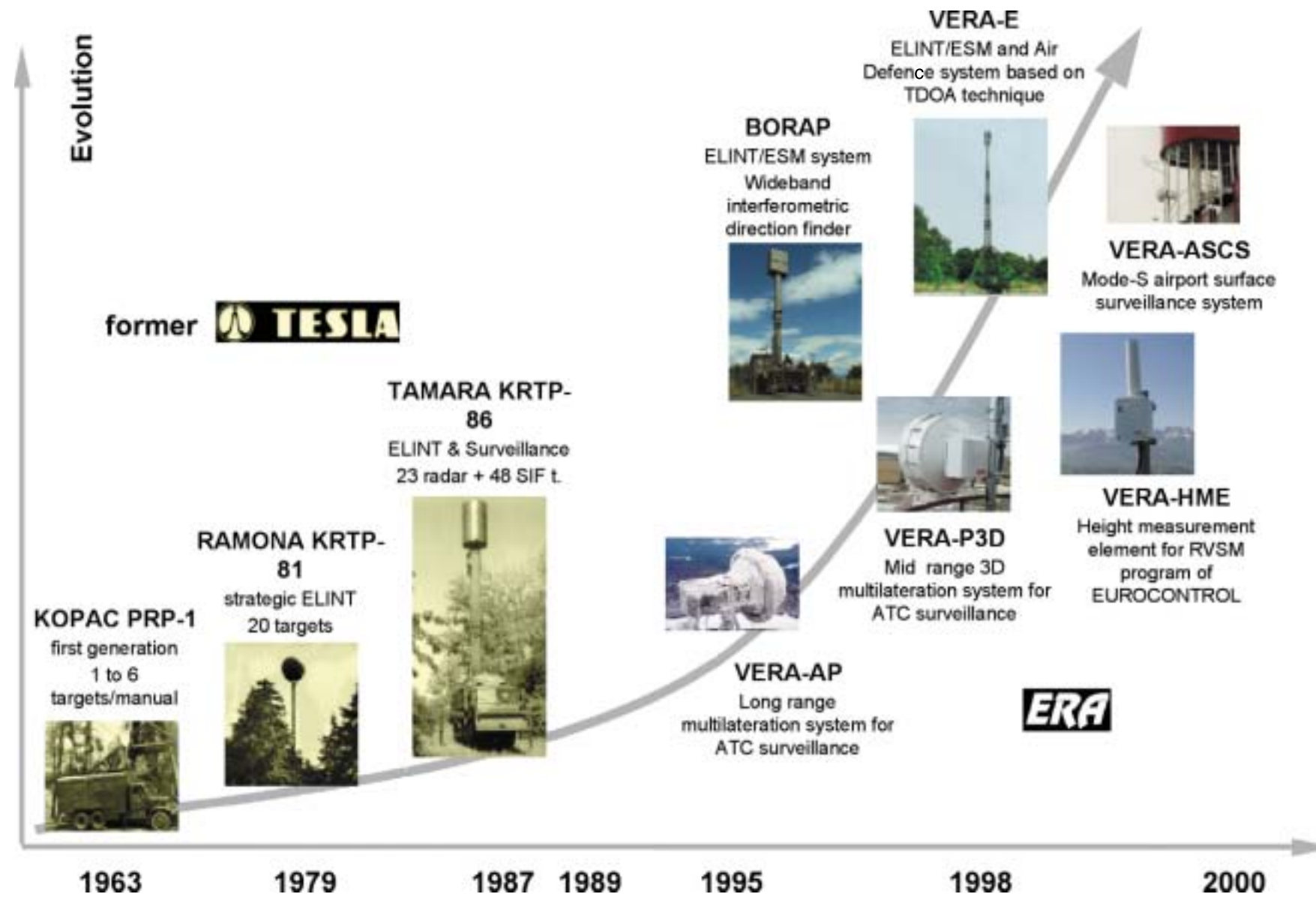
The technologies available for PRP-1 Kopáč in the early 1960s were far from ideal and the capabilities of that system were severely limited by the need for manual intervention in the tracking process. Nevertheless, the operational utility of the long range and early warning of NATO incursion provided by Kopáč was quickly recognized within the Warsaw Pact and in

1972 massive funding was authorized by the Soviet Union for the development of a more advanced and fully automated successor system – Ramona. The first prototype of Ramona was ready for deployment in 1978 and more than 20 systems were later exported to Russia. A small number of additional units were also exported outside the Soviet block. Ramona was highly successful and gave reliable service in the Soviet passive surveillance network throughout the 1980s. However, Ramona was a static system which the Russians considered would be increasingly vulnerable to precision attack, should NATO be alerted to its significance. To rectify this weakness a mobile successor system called Tamara was developed during the 1980s and the first production unit was completed in 1986. Tamara was a significant improvement on Ramona, providing not only full mobility but a still greater capacity for target tracking. In particular, it extended the target set so that aircraft communications and navigation equipment could be detected, including TACAN (TACTical Air Navigation equipment), DME (Distance Measuring Equipment) and even the all important NATO JTIDS (Joint Tactical Information Distribution System) communication link.

An order for around 20 Tamara systems had been delivered to Russia by 1990. However, with the collapse of the Warsaw Pact all development funding was frozen, leaving TESLA with several unsold systems and the collapse of its entire market. These events had a devastating effect on the company. The Czech government decided to privatize TESLA and in 1994 a sale was organized in which Thompson CSF put in a bid for the radar segment of the company. However Thompson lost out to a bid led by a former Czech general, Mr Barak, who promised to keep the company intact. The newly privatized company was called HTT (High Technology Transfer) TESLA. During the 1990s it made heroic attempts to survive: the unpalatable truth was that no market could ever match the scale of that once provided by the Soviet Union. The inevitable collapse of HTT TESLA commenced in 1997 on the sale of the company to an asset stripper, with final declaration of bankruptcy in 1999.

TESLA encountered difficulties across a broad front. The United States was irritated by marketing strategies that included discussions with states hostile to Western interests, while the management style of the new owners alienated much of the TESLA workforce whose support was so sorely needed. For many in the company the writing was on the wall by 1994 and far-sighted and talented employees decided to leave HTT TESLA and set up their own companies. Altogether 46 new companies were spawned from HTT TESLA during the 1990s. The most important of these in the story of Czech passive surveillance was undoubtedly ERA, which was founded in 1994.

Today, ERA is a successful and thriving company of about 150 employees. It manufactures a wide range of civil and military passive surveillance equipment, including airport and runway surveillance equipment in use by Eurocontrol and several major airports in the EU. The main military product of ERA is the VERA-E system, which is a powerful though compact passive surveillance capability that uses state-of-the-art Western electronics. VERA-E is the true successor to Tamara. The export of VERA-E and other military equipment is strictly controlled by the Czechs in full compliance with their newly found responsibilities within NATO.

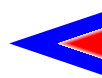


Evolution of Czech passive surveillance systems

GROWING MENACE OF PASSIVE SURVEILLANCE

With the demise of the Soviet bloc and the Western re-alignment of the Czechs, Russia and the Ukraine turned, throughout the 1990s, to indigenous production of passive surveillance equipment. During the Cold War they had witnessed for themselves the power of passive surveillance and set high priority on the development of new passive systems, despite an appalling shortage of military funds. Russia developed the VEGA/Orion series equipment for passive surveillance and Ukraine followed suit with Kolchuga. Both VEGA/Orion and Kolchuga are currently available for export.

The technology and range of application of passive surveillance has not stood still through the 1990s in the countries of the former Eastern bloc



The technology and range of application of passive surveillance has not stood still through the 1990s in the countries of the former Eastern bloc. These newer systems deliver potent air and surface surveillance capabilities. Novel extensions to passive surveillance will undoubtedly generate new capabilities for use in both land and naval warfare. Nor will the applications of passive surveillance remain purely defensive as digital linkages are extended between sensor and shooter. Yet, in the West, the operational utility of passive surveillance continues to be almost wholly neglected. The reasons for this neglect are manifold, but certainly at least part of the explanation lies in long standing and hard-to-break cultural habits within the EW community. It is a habit which pervades both military and academic establishments as well as their publications. For example, a recent and otherwise outstanding textbook¹⁰ on EW fails to make any mention of tracking using passive surveillance. If Western EW experts show such scant awareness of the problem, what more can be expected of the operational community? This failure to wake up to the dangers posed by passive surveillance increases the danger the West faces and, if it persists, sooner or later Western air forces will be badly exposed in future conflict. OPERATION ALLIED FORCE was an early warning of trouble ahead.

In OPERATION ALLIED FORCE an unprecedented conflict between NATO and a minor military power took place. Despite the availability of precision long-range weaponry, NATO failed to destroy the most important targets within the Federal Republic of Yugoslavia's integrated air defence system, which were mobile or 'time-critical'. There was precision weaponry but insufficient precision knowledge delivered in near real-time, that would have enabled NATO to suppress Serbian air defences with the speed and effectiveness it would have wished. The Federal Republic of Yugoslavia was ultimately defeated by NATO. This had more to do with the sheer tonnage of ordnance directed at her fixed infrastructure than damage inflicted on her mobile air defence assets, which survived largely unscathed.

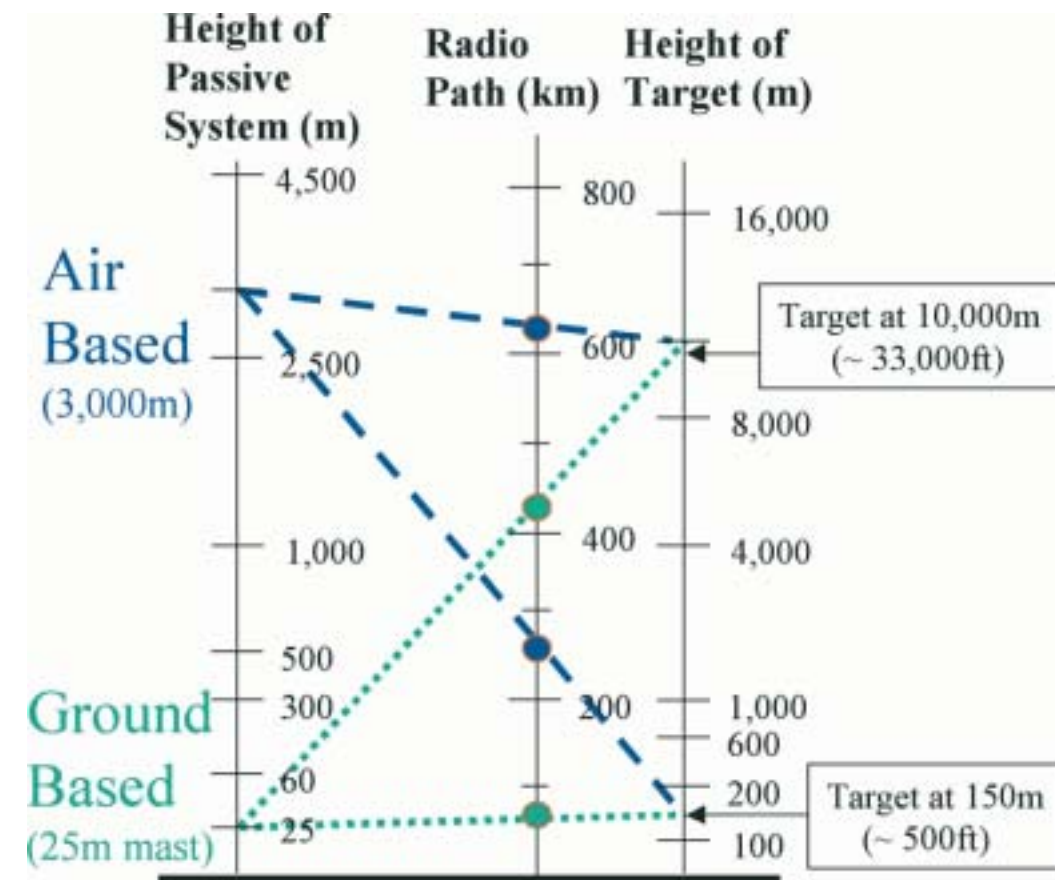
In the heady aftermath of The Gulf War, instant analysts of the day christened it 'The First Information War'. This was always an absurdity, even though it was taken seriously and led in subsequent years to a rush to embrace concepts of 'information based warfare' that were criticized by this author.¹¹ In the somewhat more sobering aftermath of OPERATION ALLIED FORCE, 'The First Lack of Information War' is a more fitting epithet given the panoply of information systems and sensors brought to bear against this little country. As NATO struggled to find the positional information it so badly needed, the Serbs, on the other hand, using limited means, were remarkably adept at interpreting what NATO was doing. With little they knew much, greatly aided by NATO's massive electronic footprint, while NATO, with much, in crucial areas, knew little of what they really needed to know – the precise location of the enemy at any given time.

OPERATION ALLIED FORCE is evidence that something is not right with the information revolution; it has already gone sour and has itself introduced dangers stemming from the massive and wholly avoidable flood of military digital messaging that today pervades the electromagnetic ether. The panoply of information systems procured since the Gulf War has had precisely the opposite effect to that intended and left their users at best confused and at worst blind in the moments of most acute need. The misuse of information and its associated technology has locked the military command element into cumbersome,

technology-driven processes that are inflexible and unresponsive in fluid tactical environments. Because worse circumstances than OPERATIONAL ALLIED FORCE are both conceivable and foreseeable, pre-emptive action against the menace of passive surveillance is essential, not least because the technologies of passive surveillance will not stand still.

THE NEXT GENERATION

The current generation of passive surveillance equipment, whether Czech, Russian or Ukrainian, suffers from one crucial limitation: all equipment is ground based



A nomogram shows the extension of passive surveillance coverage for ground and airborne targets using an air-based passive platform flying at 3,000 metres. Low level targets are detected to a range of 250 kilometres and high level targets are detected out to 640 kilometres. The nomogram shows that coverage for the ground based platform is much more limited, and assumes a smooth and spherical '4/3 earth', to allow for the effects of atmospheric refraction. As the height of the surveillance platform increases, the area of ground that can be surveyed expands dramatically. Even at the limited and easily achievable height of 3,000 metres, an area coverage of 40,000 square kilometres is feasible.

The current generation of passive surveillance equipment, whether Czech, Russian or Ukrainian, suffers from one crucial limitation: all equipment is ground based. Just as surveillance radars reached a stage in the 1970s where an airborne early warning (AEW) capability became feasible in order to extend the range of coverage of both air and surface targets, so passive surveillance technology has now reached a stage where it too can and will go airborne. The most important advantage of an airborne passive surveillance system is that the radio horizon of ground and airborne targets is greatly extended.

In a ground-based system the area of terrain that can be surveyed is very small. In practice, irregular or mountainous terrain will complicate the assessment. As a general rule, the radio horizon greatly restricts the operational utility of a ground-based system.

Surface systems are highly vulnerable to passive surveillance because there are few maritime or land-based operational platforms that can operate effectively without emitting at least some form of communication. Most vulnerable of all are the many tactical systems that are deployed at short notice and forced to rely on communication by open broadcast. An important advantage over imaging methods is that surface survey by a passive surveillance system can be executed at short notice and it takes minimal time to complete; there is no need to be within imaging range of the target. In contrast, the competition for scarce imaging resources,

whether satellite or overflights, is generally fierce and the delays before a result is obtained can be too great for the detection of time-critical targets, such as early warning radars and surface-to-air missile batteries, which may relocate in a matter of hours.

We can now see that an airborne passive surveillance capability would also have significant advantages in the detection of airborne targets. Airborne targets below the radio horizon normally escape detection. This limitation is solved in the airborne passive system because of the rapid expansion of the radio horizon with increasing platform height. A detection range of 630 kilometres is feasible against airborne targets flying at 10,000 metres. With platforms flying at high level, still greater detection ranges are possible – beyond 800 kilometres – greater than is achievable using a radar AEW system. This promises to open the way to air defence surveillance on a continental scale using a small number of passive systems. For large countries, such as Australia, air surveillance coverage of the whole country has long been a goal but one that was never achievable using conventional radar.

CLOSING REMARKS

In today's digitized battlespace, passive surveillance for real-time target tracking is set to play a much more significant role than it did during the Cold War. In the West, the rush to fill every available data-link with information – the essential along with the unfiltered trivial – has created avoidable vulnerabilities. As kilobytes grow into megabytes and now into gigabytes, the mass of data pulses surging through the electromagnetic ether presents a free gift to any opponent who wishes not only to detect allied platforms, but continually to track and identify them in real-time.

New initiatives, if quickly and actively pursued, can reverse current disadvantages and keep the West ahead of its potential opponents. The alert must be vigorously sounded, for whatever is done in the West, passive surveillance is fast becoming the preferred surveillance system of choice in many non-Western states. The Information Age has everywhere loudly advertised its presence, not only in the military presses but also in the electromagnetic ether. Against the Serbs, NATO just about coped; against tougher and larger opposition it could be a very different story.

The alert must be vigorously sounded, for whatever is done in the West, passive surveillance is fast becoming the preferred surveillance system of choice in many non-Western states

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Operation **Allied Force**

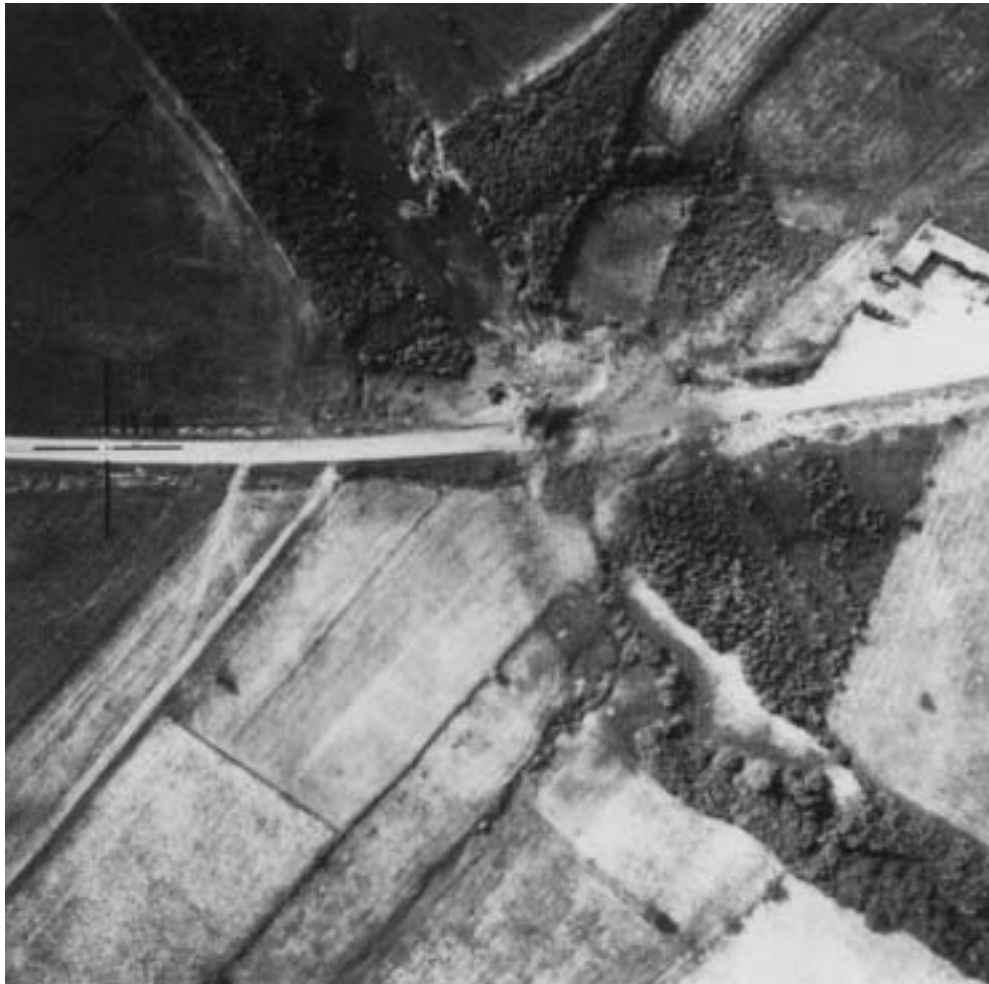




Since the end of the Cold War British governments have shown little hesitation in using military force to back up their diplomatic and international objectives. The British Government has dictated that the military should be a '*force for good*.'¹ Future operations are likely to be limited, low-intensity wars of choice and it is almost inevitable that UK forces will be part of a coalition, usually a US-led alliance.²

In recent combined operations, alliance cohesion has been identified as the coalition's strategic centre of gravity. At a national level, the key contribution to that cohesion is the will to fight, which is characterized by public support for the use of force. Gaining and maintaining public support is essential, especially during lengthy conflicts of choice, and it is generally accepted that there are 4 critical vulnerabilities: moral legitimacy, collateral damage, casualties and fratricide. This essay examines whether these vulnerabilities are real or merely politico-military perceptions. Armed with the results, it goes on to propose ways to mitigate their secondary effects: an extensive coordinated information campaign; the increased delegation of targeting decisions; formal legal training and advice for operators; and a doctrinal formula for the use of offensive air power³ at the land-air interface. These improvements could make our operational capability more robust at little or no financial cost and at acceptable political risk.

In interventions, the strength of the national will to fight is dependent on the clarity of the national interest or on the operation's moral legitimacy. If the public has ownership of the issues it shows surprising strength of character but, often since the end of



Once the military is engaged on operations, human, environmental and structural collateral damage is assumed to threaten public support. 'It is expected by the public that the military use increasingly humane [and] discriminate attack methods'

A precision attack on the Orlate Bridge, Kosovo, by the RAF

the Cold War, these 2 cornerstones have been articulated poorly to the people. The paper will propose engendering strong and enduring support through a coordinated, open and honest information operation (IO), aimed at both the media and the public, that commences long before military action starts.

It is widely accepted that the US public is casualty averse; it is perceived that British people are more robust. But there is now evidence that political bodies have overplayed public casualty aversion. The politico-military leadership's perception is that public opinion will not stand for casualties. Is this true? If not, what are the ramifications for the military?

Worse than casualties resulting from enemy action is the impact of fratricide.⁴ The public perceives it as wasteful, unprofessional, avoidable and unforgivable, yet history shows it to be almost inevitable. Fratricide and casualty aversion now constrain British air

power doctrine and procedures and, as a result, air power has been used increasingly conservatively over the last 10 years. How might we improve our operational effectiveness at the land-air interface?

Once the military is engaged on operations, human, environmental and structural collateral damage is assumed to threaten public support. *'It is expected by the public that the military use increasingly humane [and] discriminate attack methods'*.⁵ Recent opponents have publicized their civilian casualties to undermine allied public support and thereby attack its centre of gravity.⁶ The public would understand *jus in bello*, proportionality, discrimination, legitimate targeting and precautions in attack if these concepts were explained. However, it has not been educated in the harsh realities of war. The paper goes on to describe the basic ingredients necessary for the second phase of the IO – maintaining national support.

Closer investigation finds that the public is relatively unconcerned about collateral damage, expects casualties but is dismayed by fratricide. It appears that it is the politico-military leadership that really fears media vitriol concerning these realities of war and, therefore, it hamstringing its operators. Decentralized execution has become a thing of the past; targeting is controlled from the strategic level; rules of engagement do not permit aircrews to operate under the principle of mission command; and aircraft operations are confined to the relative safety of medium-level airspace. Insufficient space means that examination of the nascent technological solutions to these challenges is beyond the scope of this paper; instead the essay concentrates on pragmatic doctrinal and procedural solutions.

The main body of evidence has been culled from Operation ALLIED FORCE. This coalition humanitarian intervention lasted 78 days, long enough for public support to be affected by political and military strategies, the media and the operational results. It highlighted major flaws in doctrine, capabilities, information operations, targeting, air interdiction (AI) and close air support (CAS).⁷ Therefore, it provides a number of lessons from which to develop better ways to use air power.

MAINTAINING PUBLIC SUPPORT FOR WARS OF CHOICE

*'No enduring threat [to the UK] is likely to emerge during the next 20 years.'*⁸

Future conflicts are increasingly likely to be of low-intensity and generated by ethno-nationalistic or humanitarian issues.⁹ The UK is likely to be but one partner in a coalition. If a country has anything other than rudimentary defences the UK cannot get involved in the future without expecting casualties. For example, in a conflict against any integrated air defence system, stand-off jamming would be required; the UK does not have this capability. Since the Gulf War, the US has always provided the non-lethal suppression of enemy air defences (SEAD) capability and, because it will not place its forces under external command, the major portion of air power for a conflict too. Therefore, the US has both run the campaigns and defined the rules.

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A US Navy Hornet launches an AGM-88 HARM missile. SEAD (Suppression of Enemy Air Defences) enables the missile to reach and destroy an enemy transmitter before it can be shut down

(UNSC). NATO embarked on air strikes because it was deemed that military force was required to avert a potential humanitarian disaster. This required the application of natural law principles to legitimise the intervention¹⁰ and has set a powerful precedent for the future.

Immediately prior to Operation ALLIED FORCE there was widespread public consternation that NATO would get embroiled in a costly and lengthy war that might not be won. Few, however, doubted that something needed to be done. Political strategies to halt the collapse of law and order in Kosovo had failed. Politicians and the public remembered Rwanda where only minimal military intervention was carried out and over 800,000 people died at a

During Operation ALLIED FORCE, NATO attacked a sovereign state; many claimed this was illegal. The bombardment violated the principles of non-aggression and non-intervention in formal international law and it was not legitimised by the UN Security Council



Ethnic cleansing: Kosovo identity papers destroyed by the Serbs

Politicians and the public remembered Rwanda where only minimal military intervention was carried out and over 800,000 people died at a rate greater than the Holocaust; it seemed increasingly likely that such an unthinkable disaster would happen in Kosovo

rate greater than the Holocaust; it seemed increasingly likely that such an unthinkable disaster would happen in Kosovo. In Chicago one month after commencing the Operation, Blair outlined the 5 criteria to be met before his Government would commit to a military intervention. These were that national interests were involved; all diplomatic options had been exhausted; there was certitude that military intervention was morally just; military options could be sensibly and prudently undertaken; and that there was an acceptance of a long-term commitment.¹¹

There are problems in the first and last of Blair's criteria. Britain's national interests are global; if Britain wants a central place in the increasingly globalized world, they have to be. But the linkages between distant wars of choice and the national interest are often obscure to the man on the street. In fact, for Kosovo, the politicians demonised Milosevic in order to engender support. Even if the linkages can be identified, with a limited national budget, it is inevitable that expensive military operations fought over vague national interests will be lower in the public's priority list than domestic issues such as unemployment, health, social security and education. Explaining convoluted connections to the sceptical British public can be difficult. However, it is an essential leadership task to rally support for an intervention. The 'statement to the nation' favoured by US presidents may not sit well with the British psyche, but it does provide clear leadership. British politicians should consider appropriating (and probably anglicising) the technique. The current technique of relying on partial and subliminal messages interpreted by the media does not provide either leadership impact or a focused message.

TV pictures of refugees being expelled from the country on overcrowded trains conjured up images of the Holocaust. First-hand stories of the horrors were widely publicized

The strength of public support for wars of choice is directly related to the public's ownership of the issues. Embarking on somebody else's war without ensuring public ownership engenders only weak and fragile support, which directly impacts the UK's centre of

gravity and constrains the military in 2 major ways: there may not be an acceptance of a long-term commitment (Blair's fifth criterion) and there may be a high degree of casualty aversion. In both cases the secondary effect is that the public's will to support an operation may falter. In contrast, if the public has ownership of the cause, it is likely to accept both long-term commitment and casualties. The Kosovo crisis is just such an example. Throughout spring and summer 1999, increasing proof of Serbian humanitarian atrocities slowly filtered out of Kosovo. TV pictures of refugees being expelled from the country on overcrowded trains conjured up images of the Holocaust. First-hand stories of the horrors were widely publicized. As the air campaign went on, even as the effects of the bombing were questioned, public support grew rather than diminished. The public swung into line behind the politicians and an opposed land entry was not only considered, it even met with approval. Such an operation would have meant numerous casualties yet the public did not balk.

Government does not have to consult or even inform the public before intervening, but if the public does not believe in an operation's overall aim, its resilience and support will be low. In such situations, as the US involvement in Somalia graphically displayed, even small numbers of casualties, especially those treated inhumanely, can mean public support for an operation vanishes. Interestingly, political resilience decays even faster. President Clinton withdrew US forces from Somalia before a public furore because his perception was that public would not stand for a military mission that had crept to 'warlord hunting'¹² and he feared a public backlash. It was wasting lives for an unsupportable mission that led to the withdrawal, not the casualties themselves.

Therefore, the first military line of operation should be an IO, one aimed not at the enemy but at our own public. In order to engender strong support and, thereby, to protect our centre of gravity before committing the military to such humanitarian operations, our political leadership should prove the operation's legitimacy. As Lieutenant General Cosgrove realized prior to

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deploying to East Timor in September 1999, he 'needed to talk to the mums and dads...to persuade them that their children, [his forces], would be all right', and that the mission was necessary.¹³ The media will ensure that 'mums and dads' extend beyond progeny to the wider public at large. Such IOs cannot be defensive; they must lay out strongly, clearly and unambiguously the reasons for an intervention, justify it morally, be honest about the risks and persuade the public that those risks are worth taking. If the IO fails the Government should think hard about getting involved at all. A bold IO at the outset will not only stymie enemy opportunities to attack our centre of gravity, but it will also send a clear deterrent message to him.

The realities of differing national perspectives within a coalition mean that devising a coherent IO will be no easy task. But this challenge will have to be surmounted sooner or later and, furthermore, the dialogue between coalition members will result in an increased openness between countries that will either shore up cohesion or expose the tensions that need to be protected against. Rehearsing arguments is always useful.



An American gun ship withdraws from Mogadishu



A Luftwaffe Tornado prepares to refuel from an RAF tanker during Operation ALLIED FORCE

At the outset of Operation ALLIED FORCE President Clinton ruled out the use of ground forces in Kosovo; British political and military...

At the outset of Operation ALLIED FORCE President Clinton ruled out the use of ground forces in Kosovo; British political ¹⁴ and military ¹⁵ leaders did too. While this protected Alliance solidarity during entry into the war, it neutered the air campaign because air strikes were not backed up by the threat of land power. As part of an IO strategy, the comments were deeply flawed. It was casualty aversion in our military and political leaderships that led to this stance because the assumption that the public was casualty averse was not challenged.

WHERE DOES CASUALTY AVERSION REALLY LIE?

During Operation ALLIED FORCE aircrews were ordered not to take unwarranted risks with their lives. The commander's '*first requirement was to avoid losses, principally losses of aircraft.*'¹⁶ This was a manifestation of the military and political perception that the public (throughout the Alliance) was casualty averse. But is the British public really casualty averse?

Western casualty aversion has been widely studied over the last 30 years. However, while there is a great deal of conjecture about the British public's position there is little evidence. The common view is that, primarily because of the Northern Ireland struggles, the British public has a more robust attitude to military casualties than the US. This perception is borne out by evidence from the Falklands War where the British public showed surprising resilience in the face of the deaths of 255 men, the wounding of 777 more and the loss of 6 ships and 9 Harriers.¹⁷ However, perceptions have changed since the Gulf War

because, in spite of dire predictions,¹⁸ actual casualty figures only numbered a few hundred. *'Advances in technology have led to a widespread expectation that military operations can be conducted with few or no casualties, on either side'*¹⁹ and *'pressures will increase for Rules of Engagement [ROE] that minimize the risk of casualties.'*²⁰



British troops on patrol in Northern Ireland

Western casualty aversion has been widely studied over the last 30 years. However, while there is a great deal of conjecture about the British public's position there is little evidence. The common view is that, primarily because of the Northern Ireland struggles, the British public has a more robust attitude to military casualties than the US

The politico-military elite believes that casualties have to be avoided at all costs. During Operation ALLIED FORCE, *'the reason [for minimizing aircraft losses] was, this had to be an air campaign of infinite duration. We knew at the outset that you can't start an air campaign if you go into it losing 4, 5, 6 aircraft a day with the headlines screaming NATO loses twelfth aircraft, because then the clock's ticking.'*²¹ This belief has led to a doctrinal shift in the way that the Western powers conduct air campaigns. As casualty rates decrease over time the expectation that the trend²² can continue has meant that minimum (although not necessarily zero) casualties has become an end in itself. In turn air power is used ever more conservatively in conditions of ever increasing air dominance. This paper advocates an expansion of the doctrine. Of course we should continue to minimize the risk of casualties, both the public and the military would not accept otherwise, but we should recognize that there are situations in which we need to risk taking casualties in order to achieve the task. Furthermore, we should communicate that recognition to the public.

The trick is to balance the risk of taking casualties against both maximizing military effectiveness and ensuring target discrimination. It will be a delicate balance, but operational decisions should be made on the basis of a scientific derivation of the acceptable casualty level not unsubstantiated perceptions. This analysis has to be broken down nationally, because the distribution of the casualties amongst the coalition partners is crucial. For instance, President Chirac threatened to withdraw French troops from Bosnia in 1995 because it was predominantly France that was taking the casualties in what was perceived as an increasingly futile peace keeping mission.²³ Acceptable casualty levels depend on national resilience and ownership of the conflict's issues. The UK has not assessed the scale of its vulnerability scientifically. Rather than continue to develop doctrine based on intangible, debatable, military perceptions, a representative statistical survey needs to be conducted.

The aim of the survey should be to determine the extent of public support for different types of issue in which military operations would be used, and to correlate those results with the casualty level that would be both expected and acceptable. Comparison of the results to similar surveys conducted amongst the military leadership and the political leadership groups, (accepting the limitations of sample size) would establish baseline relationships. The results of such a study carried out on a sample of 4,900 people by the Triangle Institute for Strategic

It is apparent that the latter elites, who were lieutenants, captains and majors in the Vietnam War, are still scarred by the Vietnam Syndrome. The public, however, is much less so

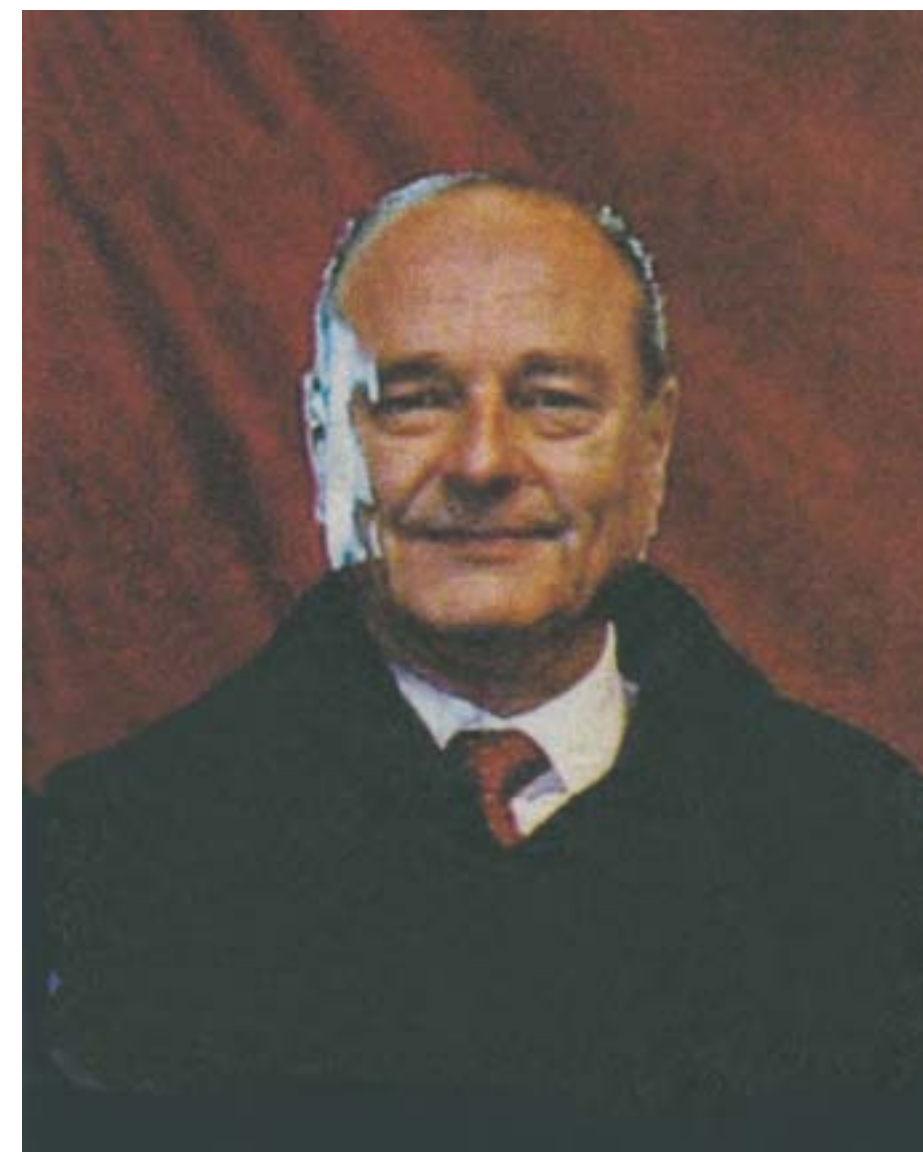


Captain Steve Ritchie – the only USAF fighter pilot ace of the war in Southeast Asia

Studies in the US are illuminating.

The evidence shows that the public is not nearly as casualty-averse as the military and political leadership. It is apparent that the latter elites, who were lieutenants, captains and majors in the Vietnam War, are still scarred by the Vietnam Syndrome. The public, however, is much less so. It shows that the military and political elites... 'believe that the American public is casualty-averse and will not tolerate deaths except when vital interests are at stake. [It] reached this conclusion by posing three plausible intervention scenarios (defending Taiwan against a

For instance, President Chirac threatened to withdraw French troops from Bosnia in 1995 because it was predominantly France that was taking the casualties in what was perceived as an increasingly futile peace keeping mission



President Chirac

Chinese invasion, preventing Iraq from acquiring weapons of mass destruction, and stabilizing a democratic government in the Congo) to senior military officers, influential civilian leaders, and the general public and by asking them to consider how many American deaths would be acceptable to complete each mission (*Table 1*).’

Number of Deaths Acceptable

Mission	Military Elite	Civilian Elite	Mass Public
Congo	284	484	6,861
Iraq	6,016	19,045	29,853
Taiwan	17,425	17,554	20,172

Table 1. Relative Casualty Aversion Across Political, Military and Public Groups ²⁴

‘As the authors point out, one must interpret these averages in general terms and must realize that they do not necessarily reflect the actual casualties the public will accept once real soldiers start dying. But the *sheer numbers* and *dramatic differences* between the groups are significant. More importantly, they are consistent with the previous research ²⁵...The Taiwan case is a holdover from the Cold War and represents deep-rooted American sentiment [against] the... Chinese and the *long-standing commitment to defend Taiwan*. [These are considered] very important, if not vital, national interests. It is not surprising, therefore, to find consensus on the costs that all three groups are willing to accept to accomplish the mission. The Iraq and Congo cases are examples of post-cold-war interventions, which have sparked the contention that the American public is casualty-averse. The Iraq case is significant because it demonstrates the effectiveness of leadership and cueing ²⁶ from public leaders.’ ²⁷

If the British military and politicians had access to the results of a similar national study they would have a powerful tool with which to gauge more accurately their vulnerability to casualty aversion. During a conflict, both the military and the political leadership groups could test their own reactions to casualties in order to assess by comparison the public’s will to support a fight.

At the operational level, the fact that we might have a higher resistance to casualties means that our forces could undertake higher risk tasks. The protection of KFOR in 1999 during Operation JOINT GUARDIAN by Harrier GR7s conducting low-level CAS is one such example.²⁸ Furthermore, the US doctrinal assumption that it will be able to gain and sustain both air superiority and sufficient forces for an indefinite war begs a question. What if the situation became so critical that lines of operation had to be taken without total control of the battlespace and in spite of higher casualty risks? This could be where Britain comes to the fore, as it did in the Gulf War when only the Tornado GR1 could fulfil the runway denial role. Obviously there would have to be significant military benefits before military commanders should take greater risks with their subordinates’ lives; this paper does not advocate needless squandering of lives or materiel. For instance, during Operation ALLIED FORCE, low-level, fast-jet operations were offered to General Clarke but were prohibited from the outset, even during the numerous bad weather periods

when the RAF's operational effectiveness was almost completely negated.²⁹ The increased military effect of low-level bombing, and the increased discrimination potential that going lower would have afforded aircrews, was deemed not to outweigh the casualty risk. But there may be times when it does.

...during Operation ALLIED FORCE, low-level, fast-jet operations were offered to General Clarke but were prohibited from the outset, even during the numerous bad weather periods when the RAF's operational effectiveness was almost completely negated

In reality though, is the politico-military leadership willing to risk losing public support in a war of choice? With casualty aversion, the Achilles heel is not really the public; it is the media. Journalists constantly harangued General Jertz during Operation ALLIED FORCE questioning NATO's capability to discriminate targets, to be proportionate in attack and to be effective from the relative safety of airspace above 15,000 feet. But NATO commanders believed that the fickle media would accuse them of squandering aircrew if they lost aircraft and they feared that scenario more than accusations of being ineffective.³⁰ Moreover, at the grand-strategic level, the politicians feared that losing media support would impact their power-base; the potential impact of a military miscalculation drove them to conservatism long before the public's culminating point.

The logical conclusion of this analysis takes us to the fact that it is the media themselves that should be another target of our ongoing IO strategy. If the media can be persuaded to take ownership of the issues, to support the military methods being used to achieve the ends and to be consistent in their reporting, then the halter can be lifted off the military. Targeting the national media smacks of propaganda, but the emphatic strategy should be, and has to be, to explain honestly the military constraints, capabilities, risks and challenges so that the military does not become subject to ill-informed sniping from television pundits and the national press. This, in turn, would guard against losing public support.

COLLATERAL DAMAGE – DOES THE PUBLIC CARE?

Once involved in a conflict, maintaining public support is a vital line of operation. Ownership is fundamental, strong political leadership is crucial, but competent military progress towards the end-state (winning) and *jus in bello* (the legitimacy of the methods used) are also very important.³¹ The principal manifestation of being incompetent and/or illegitimate is collateral damage. The primary constraints on military effectiveness resulting from the need to remain competent and legitimate are expressed in the ROE and in targeting restrictions.

The laws of armed conflict concerning collateral damage are relatively unambiguous, although their application often requires a good deal of judgement. Collateral damage is an unavoidable consequence of war. The Geneva Convention and the

subsequent 1977 Additional Protocols clearly state that making mistakes is not illegal. Additionally, one is judged on the information available at the time, not on information that came to light after the event. However, the risks of erring must be outweighed by the expected military gains. British politicians, legal advisers, commanders, targeteers and operators alike are responsible, on pain of punishment by the International Court of Justice, for being discriminate, for protecting civilian objects, for taking precautions in attack and for using proportional force – the principles behind the laws. Moreover, anyone in the targeting chain can stop an attack if he realizes that it will break any of these principles; in fact everyone is responsible for doing so and can be held accountable if he knowingly continues.

During Operation ALLIED FORCE, political and military perceptions about the effects of collateral damage on national/alliance public opinion hamstrung RAF effectiveness in 3 ways. The Government restricted the types of targets that could be attacked, determined how they could be struck and, for much of the war, retained the final target-attack clearance. This bureaucracy slowed down the RAF's operational tempo.

With improvements in communications this 'long-screwdriver' effect has become increasingly prevalent. It is a result of political concerns and is a clear example of politicians reaching down ³² below their grand-strategic level. The military accepts the phenomenon as a fact of life: 'military operations are subjected to intensive scrutiny, especially with the immediacy of media broadcasting, and sensationalism, which often drives newspaper sales and TV ratings. This often invites political intervention, thereby limiting the delegation of military command authority and the acceptance of risk'.³³

What this fact of life means is that either we do not adhere to our doctrine or our doctrine is fundamentally flawed. There is centralized control and centralized planning but very little decentralized execution. Mission command ³⁴ is dying out and reach down is increasing.³⁵

Yet Operation ALLIED FORCE showed British aircrews to be highly professional. During the 870 Harrier GR7 missions flown, pilots brought their weapons home over 350 times. The aircrew that drop the bombs have the ultimate responsibility as the final link in the chain. They are required by law not to attack if they believe the target is illegitimate and

The laws of armed conflict concerning collateral damage are relatively unambiguous, although their application often requires a good deal of judgement. Collateral damage is an unavoidable consequence of war



Sudanese demonstrators protest against the US bombing of a pharmaceutical plant in Khartoum in 1998



Politicians should delegate the responsibility for targeting further down the command chain than they currently do

they exercised that right many times during the Kosovo conflict.³⁶ As Sir Richard Johns put it: this 'represents a discipline within the ranks of our operational aircrew of which I am deeply proud'.³⁷ Recognizing that aircrews take the legal responsibilities invested in them under the laws of armed conflict extremely seriously and that they can be trusted to show restraint, the political and military leaderships should live by the doctrine. They should give the operators enough rope to be

effective or alternatively to hang themselves. Concurrently, aircrew training on the laws of armed conflict should be formalized and legal advisers for operators should be provided.

Politicians should delegate the responsibility for targeting further down the command chain than they currently do. It is natural and appropriate that ROE will be approved, if not written, by national political bodies. However, ROE do not define targets; they give guidance and intent. They provide a framework within which target suitability can be assessed. Target authorization decisions themselves should be delegated to those running the campaign. At the highest level this should be the Military Committee, but more often it should be the Joint Targeting Coordination Board³⁸ or, for routine and unexceptional targets, the Joint Force Air Component Commander (JFACC).³⁹ For coalition operations national target authorization should be delegated to the national component commander (NCC) advising the JFACC. The NCC himself will be advised by legal experts and would retain the option of ratifying any contentious targets with superior formations up to the Attorney General and the political body. This would accord with UK doctrine and would speed up the operational tempo. The aircrews will provide an additional safety net at the tactical level during detailed target planning and according to the latest intelligence and the conditions on the day. Such a system was proven during the Gulf War but, since then, reach down has taken hold.

Collateral damage should be minimized for two reasons: it demonstrates military competence and it is a legal and moral requirement. This helps to maintain public support, although there is a key balance that must be maintained. Minimizing collateral damage can reduce or negate military effects. Operators might be forced to attack from ineffective directions or to use ineffective weapons. Of course, if the military can achieve the aim anyway there is little need to change the balance. But collateral damage concerns must be kept in perspective. Public opinion itself is less sensitive to collateral damage than the leadership perceives it to be; it is the media that make the hue and cry.⁴⁰ And the public does care about military effectiveness, witness the recriminations in the aftermath of Kosovo; evidence of military success is an important positive part of maintaining public support in a conflict.⁴¹

Since the Gulf War, extremely impressive video footage of precision attacks has given the public the impression that air power is supremely surgical; it can be, but not always. There are very limited numbers of laser designators and laser-guided weapons are only

Since the Gulf War, extremely impressive video footage of precision attacks has given the public the impression that air power is supremely surgical...

practical against static targets in permissive weather conditions. Precision weapons cannot be guaranteed to hit the target even in perfect conditions; statistically a third miss. If they miss, they can cause collateral damage. Over the past 10 years, the military has tacitly perpetuated the myth that air power *in toto* is as exact as its precision tip can be. Protecting that myth has exposed the vulnerability of collateral damage sensitivity. Accepting operational security, the IO has to portray air power's capabilities honestly and describe how it minimizes collateral damage.

Operation ALLIED FORCE exposed the public to these truths and, while it was disappointed in the RAF's lack of capability, legitimate collateral damage did not unduly concern it.⁴² For instance, following the destruction of a Serb train on the Gredelica railway bridge General Clarke's detailed explanation (with video) of how the mistake occurred effectively silenced media criticism of the pilot.⁴³ Conversely, when the bombing of a stationary refugee convoy near Dakovica was not explained adequately for over a week, the implied military incompetence did enormous damage to the Alliance's credibility and the media called into question the efficacy of NATO tactics and procedures.

The most penetrating question was how is flying high enough to minimize the risks to aircrews reconciled with the need to fly low enough to identify targets? While the Chief of the Air Staff stated after the war that *'war is and will remain a nasty and brutal business in which the aim is to achieve political objectives with the least possible loss to one's own side ... no prizes are awarded for manufacturing an evenly balanced fight let alone for sustaining unnecessary casualties. I should also point out that the airspace above 15,000 feet was **not** a safe haven.'*⁴⁴ The dilemma was balancing the minimum casualty risk with the legal



For instance, following the destruction of a Serb train on the Gredelica railway bridge General Clarke's detailed explanation (with video) of how the mistake occurred effectively silenced media criticism of the pilot

remit to be proportional and discriminate. *'If an issue is worth fighting for, it should be worth dying for.'*⁴⁵ The overriding issue at the time was casualty aversion. In hindsight, if the public were not as casualty averse as was believed at the time, perhaps the JFACC should have permitted aircrews to go lower in order to locate and identify targets. Alternatively, there are those that argue that the war could have gone on indefinitely and that NATO would have outlasted Serbia in the slow one-sided war of attrition that was fought. Fortunately, Milosevic's capitulation prevented NATO having to discover if this was true.

A Serb train is destroyed



Within the IO sphere, there must be a system in place whereby if a mistake occurs, it can be admitted and explained. The public will accept a reasonable mistake but it does not take kindly to being lied to or to cover-ups. IO cells need representative displays to prove their points which, in most cases, will require the digitization of cockpit video and very fast links from the front line to the rebuttal cells. An open, straight talking, reasonable and, above all, truthful explanation will minimize the impact of collateral damage. Systems should be put in place.

WHAT IS THE IMPACT OF FRATRICIDE?

Estimates of Iraqi losses during the Gulf war vary considerably but even using a conservative 3,000 the fratricide level would be approximately 1.5 per cent

Fratricide is not new; as long as men have fought each other, they have made mistakes and killed their own. However, since the Gulf War, the prevention of fratricide has risen high on military agendas.

Simply put, the fratricide level of a conflict can be calculated by dividing the number of fratricide casualties by the total number of friendly casualties. Historically, the level has been a steady two per cent⁴⁶ although a reluctance to admit fratricide and the fog of war may hide a true reflection of the level.⁴⁷ In the Gulf War, where 35 of the 146 US

casualties were due to fratricide, this calculation produced a figure of 24 per cent. Unsurprisingly, there was widespread outrage in the US, a sentiment that was echoed in the UK after the destruction on 26 February 1991 of 2 Warrior Fighting Vehicles and 9 British soldiers by a marauding A-10 pilot who mistook them for the enemy.

It can be argued that this fratricide-level calculation method exaggerates the problem. It may be more pertinent to divide the number of fratricide casualties by the number of enemy deaths. This produces a number that links the number of friendly casualties generated by getting it wrong to the number of enemy casualties generated by a force getting it right. Estimates of Iraqi losses during the Gulf war vary considerably but even using a conservative 3,000 the fratricide level would be approximately 1.5 per cent. Undoubtedly this method affords significantly more protection to our centre of gravity than the first. However, playing statistics will lose commanders their human touch. The raw data needs to be made available and the tragedy of the human loss needs to be sensitively handled. Following fratricidal mistakes the military needs to be ready to defend itself against charges of lethal incompetence. Comparing the number of mistakes to the offensive effort provides a useful tool to deflect bad publicity, but fratricide will still seriously damage support.

The effects of such errors are widespread and extremely damaging. First, there is the direct consequence of loss of fighting materiel. Secondly, firepower wasted on friends cannot be brought to bear on the enemy. Thirdly, fratricide undermines trust between forces, services and even coalition partners. Fourthly, it devastates military morale. Fifthly, it can affect how fratricide-scarred personnel and units fight future battles⁴⁸ and make units fearful of making a mistake become indecisive. Whether this

happens at the individual level, for instance air defence battery operators, or at the operational level for instance in the generation of restrictive ROE, the message is clear: fratricide hamstring combat effectiveness.

Fratricide occurs at the land-air interface. With air power, it can be caused by weapons malfunction and by inaccurate weapon aiming but, in the main, it occurs because of misidentification. Misidentification can occur through the carelessness, bullishness or expectancy of individuals, through poor communications or because fielded technology does not give the military a reliable capability to identify friend from foe.⁴⁹

Technology that can recognize friends on the battlefield already exists⁵⁰ and has proven itself worthy of procurement. However, it relies on all units being 'on the net'. The sheer numbers of individual technological units required to digitise the battlespace creates a financial burden that has so far proven too heavy to bear. This is exacerbated by the fact that each nation needs to procure a system that is compatible with its coalition partners' systems. One nation needs to set the trend but, since each US Service has procured different technologies, not even the US is giving a lead. Until combat identification technology enters widespread service, (and probably forever more to provide for system failure), doctrinal and procedural fratricide limitation systems need to be put in place.

LAND AND AIR INTERFACE

How can we rationalize air power's doctrine of centralized control and centralized planning with land's doctrine of mission command in the tactical chaos of the battlefield?

Without combat identification technology, there is only one method of eradicating air/land fratricide: the complete disassociation of land and air environments. In the joint environment the challenge is to create an effective doctrinal and procedural structure that allows air and land to mesh safely. How can we rationalize air power's doctrine of centralized control and centralized planning with land's doctrine of mission command in the tactical chaos of the battlefield? Executing joint fires in the close and deep battlespace is fraught with dangers. The two doctrines are completely at odds especially with the demise of decentralized execution resulting from politico-military casualty, collateral damage and fratricide aversion. How should we employ our forces to operate effectively under these limitations?

RAF FAST JET CAPABILITIES AND CONSTRAINTS

In order to acquire⁵¹ tactical targets, RAF aircraft need to operate below 10,000 feet. During the day especially, this makes them vulnerable to prolific, relatively low technology, infra-red (IR) surface-to-air missile, anti-aircraft artillery and personal weapon threats. At night, these predominantly optically-aimed threats are extremely difficult to bring to bear so the aircraft are more survivable.



Ready for combat! Harrier GR.Mk 7

The target acquisition sensors in British fast jets comprise the aircrews' naked eyes, night vision goggles (NVGs) and the Thermal Imaging Airborne Laser Designation (TIALD) targeting pod

The target acquisition sensors in British fast jets comprise the aircrews' naked eyes, night vision goggles (NVGs) and the Thermal Imaging Airborne Laser Designation (TIALD) targeting pod. The Tornado GR4's and Harrier GR7's Forward Looking Infra-red (FLIR) sensor and the Tornado's ground mapping and terrain following radars do not allow autonomous tactical-target identification. The FLIR is a navigation sensor not a targeting one; it is incapable of allowing the aircrews to reliably acquire (far less identify) tactical targets.⁵² Tornado's radars can be used for ground mapping, terrain following and targeting infrastructure-type targets but cannot identify mobile targets.

During the day, from medium level, it is possible to use hand-held, image-stabilized binoculars⁵³ to recognize and attempt to identify targets acquired by the naked eye. At night, this is impossible. Then, even from low level, NVGs offer only 20:40⁵⁴ visual acuity making it extremely difficult to acquire tanks and impossible to recognise them at greater than 500 metres range (which is closer than the range required to release a bomb).

TIALD, with its optical (day only) and electronic zoom facilities, permits target recognition if not identification (against tactical targets). However, using it is akin to looking through a drinking straw; it requires very accurate cueing in order to lay the sensor over the target in the first place, which is a rare luxury when attempting to acquire mobile targets. The chances of finding the target are significantly increased if the operator can relate the picture on the TIALD display to an image of the target area that he has pre-studied; for this reason pre-planned targets are much easier to acquire than targets of opportunity.

These sensors allow navigation and targeting against infrastructure by day and night. Tactical targets can be acquired visually during the day but only with an attendant casualty risk. At night, it is almost impossible to find tanks. Only those found by ground based forward air controllers (FACs) that can be triangulated with respect to nearby, unique, electro-optically significant, identifiable

ground features offer any chance of success. On grounds of effect, fast jets against can only be use rarely against dispersed tactical targets at night, especially if friendly forces near or amongst the target set add to the fratricide risk.

It follows that fast jets should be used for AI against infrastructure both by day and night, while attacks against tactical targets are likely to fail at night and to result in either high casualty rates or mission failure in the day.

APACHE CAPABILITIES AND CONSTRAINTS

Apache-D is a mature, combat-proven, attack helicopter. It is potent, robust and capable. It will give the Joint Task Force Commander the means to exploit the battlefield with increased tempo, firepower and flexibility, in both close and deep operations. Designed with survivability in mind, the Apache-D can withstand up to 12.7 mm calibre hits throughout, and up to 23 mm calibre hits on critical systems such as the main rotor hub, gear-boxes and cockpit glass. It is furnished with redundant flight control systems, two well-separated and shrouded engines with angled exhaust diffusers and oil-less angle and tail-rotor boxes that are greased for life. A radar frequency interferometer radar warning receiver, radar and IR jammers, chaff, and a laser warning receiver provide passive and active defence, while numerous wire cutters guard against wire-strikes. It has to be survivable; at £18 million per copy, Apache-D is too expensive an asset to risk losing and, therefore, arguably, to risk using. Task Force HAWK, the Apache-A deployment to Tirana during Operation ALLIED FORCE, suffered from just such a dilemma.⁵⁵



Apaches took an active role in Kosovo

...at £18 million per copy, Apache-D is too expensive an asset to risk losing and, therefore, arguably, to risk using

The key to Apache-D's capability is its sensor suite. The LONGBOW fire control radar excels in finding tactical targets. Coupled with the interferometer, able to detect 1,000 potential targets out to approximately 7-km range in a snapshot, tracking 256, while displaying 16, it can then data-link results to, and inter-link results with, other Apaches close by. Apache-D's target identification systems are primarily electro-optic. The pilot's night vision system, a steerable IR sensor, offers up to 39 times (optical and electronic)

magnification and is allied to the TV (127 times magnification but daylight only) and IR Target Acquisition Designator Sight (TADS). Although its sensor technology is of the same generation as current fast jets, Apache crews have the critical advantage of time to study the target. The Apache's weapons are likely to be fired from the hover. Therefore, its crews have time to identify the target. If they cannot, they have the ability to move to somewhere (closer) from where they can. Thus, the use of a helicopter, instead of a fast jet, against armour significantly decreases the chances of fratricide.

With up to 16 Hellfire missiles, or up to 76 CRV7 rockets, and a 30mm gun, the Apache is extremely potent against armour but is less so against infrastructure targets. Consequently, the target sets against which it should be employed are defined by type and effect not space. Armies are the Apache's preferred target set. Moreover, conceptually, it should achieve a 'one shot – one tank' kill ratio because its weapons are guided, or in the case of its 2.75in-rockets pointed, and the chances of their missing are small. Against modern armour, especially when compared to a fast jet (which has a 'one pass – one tank' capability using cluster bombs of questionable effectiveness against post-80s armour) the attack helicopter has an order of magnitude more utility.

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than helicopters and can carry more firepower to the target and can be easily integrated with SEAD for these Battlefield Air Interdiction (BAI) missions.⁵⁶ On the other hand, in raids, Apache can be more discriminate and, because it would normally be controlled by a land component commander (LCC),⁵⁷ could be better coordinated and integrated into the land scheme of manoeuvre, potentially operating at a faster tempo than fast jets.

'Air Manoeuvre is manoeuvre unconstrained by the ground.'⁵⁸ AMO are rightly the focus for the British Army Apache doctrine. The LONGBOW and the TADS have significant utility for reconnaissance operations and Apache brings sustained presence (compared to fast jets), accuracy, discrimination and substantial firepower to attack, escort and support operations. CAS is not mentioned by name but the Apache-D's strengths play to this role. 'CAS is optimised when fully integrated with other fire support assets. [It] is a tactical level operation which can create and exploit operational opportunities.'⁵⁹

In 1939, Slessor defined three circumstances when air power would be used in direct support of armies: 'to break the crust of the [enemy] defence... to turn a retreat into a rout... [and] in a critical situation... to stop a hostile breakthrough...'⁶⁰ The former used to be called BAI. The second could be termed Offensive CAS and for the purposes of this essay is expanded to include AMO. The last is Defensive CAS where air power is applied to relieve beleaguered ground forces.

Apache's concept of operations, comprises Raids and Air Manoeuvre Operations (AMO). Raids are sorties flown against specific targets such as headquarters, marshalling areas and logistic nodes. These missions have historically been carried out by fast jets that, intelligence and tasking timescales permitting, are not only more capable but are, in many cases, preferable choices of platform for the role. Fast jets have longer range

Apache will be based with or near the land component headquarters. Its crews will be as well placed as anyone to know the current disposition of forces and the commander's scheme of manoeuvre and intent. Their proximity to the battle means they can be responsive. Apache's slow speed and hovering capabilities mean that it can be allocated a very small piece of airspace from which to engage the enemy. Apache should be easy to control;⁶¹ however, only other Apaches can receive their picture so, today, they have to be trusted, in accordance with the principles of mission command, to hit the critical targets, at the right time, without fratricide.

Attack helicopters are better placed to take these Offensive CAS responsibilities than fast jets. Invariably, fast jets are based well to the rear. The incompatibility of intra-theatre, inter-service and international communications means their crews carry 'latest intelligence' that is hours, if not tens of hours, out of date. They are unlikely to be aware of either the LCC's detailed scheme of manoeuvre or his intent. Unless there are sufficient aircraft to be held in a cab rank, fast jets have response times measured in hours. They require large areas of airspace, both to hold and to attack, and require close coordination and control to bring them to bear at the right time down the correct route to the correct target. The FAC has to verbally describe the chaos inherent in the manoeuvrist approach from his constricted viewpoint, with the limited information he gleans from his commander, through unreliable communications.

The aircrew have to translate this description and identify the target either from two or three miles high (if they are to survive and from where they can see hundreds of square miles) or alternatively, in a few seconds from a low-level attack. The scope for misidentification is huge. As we have seen, even in near perfect conditions in the desert of Iraq in 1991, 24 per cent of US casualties were due to fratricide. From the LCC's point

Attack helicopters are better placed to take these Offensive CAS responsibilities than fast jets. Invariably, fast jets are based well to the rear



Attack helicopters have many advantages

of view, the requirement to ‘*check fire*’ other joint fire systems means his simultaneity and battle rhythm have to pause while the fast jet makes its pass. To add insult to injury, fast jets give a low probability of kill and a significant risk of fratricide, especially at night. It follows that Apache is the platform of choice for Offensive CAS; fast jets should only be used in desperation.

For Defensive CAS any air power platform can and should be used. The risks of fratricide become more acceptable if air power alone offers a way out of an otherwise hopeless situation. Apache would have greater utility as described above, but fast jets can deliver a significant weight of weapons with tremendous physical effect and considerable impact on both enemy and friendly troops’ morale. Just as No 1(F) Squadron accepted in June 1999, if friendly troops are in contact, and especially if they are losing, the benefits of changing the local balance of power might outweigh the risks of fratricide.

CONCLUSION

Increasingly, the RAF will be engaged in low-intensity wars of choice. While acting as a force for good is comfortingly altruistic, the British public may not wish to see its sons and daughters die ‘*saving strangers*.’⁶² The Government has to balance the risks it takes in becoming involved in these conflicts with losing the support of the public at home. Over the last 10 years mitigating those risks has involved increasing reach down, gradualism, and the increasingly conservative use of air power. These effects hamstringing military effectiveness so this paper has questioned the assumptions and proposed some solutions.

Fratricide is perceived as tragically wasteful incompetence. The British military has been slow to tackle the problems of combat identification on the battlefield with technology. In the meantime, at the land-air interface procedural deconfliction has to be used. RAF fast jets have a limited survivability over the battlefield during the day, especially at the heights at which they need to fly to make their targeting sensors effective. At night their finding tactical targets from any height is nigh on impossible. Nevertheless, they can provide effective AI in the close and deep battlespace to presage and facilitate land manoeuvre.

Additionally, when the Army is pinned down, fast jets can bring decisive firepower to a contact if the Army accepts the significant risk of fratricide and the RAF accepts the risk of casualties. However, the imminent introduction to service of Apache permits the transfer of Offensive CAS, the role in which fast jets are least effective, to the attack helicopter force. In the manoeuvrist chaos of the close battlefield, fast jets cannot reliably provide the service that the Army wants. There is a significant risk of fratricide in the day, the effect is unlikely to be decisive to a land force that is winning anyway and there is almost no capability provided at night.

In order gain and maintain public support for an intervention there needs to communication of and, if necessary, debate of the issues. If the public can be persuaded to take ownership of the conflict, for altruistic or national interest reasons, public support

In order gain and maintain public support for an intervention there needs to communication of and, if necessary, debate of the issues

unambiguous and achievable aim should be communicated at the earliest opportunity. Subsequently, evidence that the military is winning, is acting decisively, morally, legally and legitimately, and that the mission is not creeping needs to be communicated. Dithering gradualism does not pay. 'We should always be sceptical when so-called experts suggest that all a particular crisis calls for is a little surgical bombing or a limited attack. When the surgery is over and the desired result is not obtained, a new set of experts then comes forward with talk of just a little escalation – more bombs, more men and women, more force. History has not been kind to this approach to war making. In fact this approach has been tragic.'⁶³

While retaining command and making their political and military intent clear to the operators, the political and military leaderships should follow the doctrines of mission command and decentralized execution. Reach down limits effectiveness and lays the military open to accusations of incompetence. Support decays in concert. 'Given the potential importance and complexity surrounding targeting issues, policy and direction of UK targeting is [and should be] retained at the strategic level,'⁶⁴ not the grand strategic. Relying 'on political approval'⁶⁵ for the clearance to strike every target is inconsistent with mission command and slows down air power's 'observation, orientation, decision, action' cycle (its OODA loop). The military has the legal and strategic skills to approve most targets, should and can shoulder the responsibility for doing so and has demonstrated highly professional restraint on operations. Airmen are well aware that their tactical acts can have strategic consequences.

This paper has found wanting the widely accepted assumptions that the public is casualty averse and will not accept collateral damage. It finds that collateral damage, while it provides sustenance to media sensationalism, is a legitimate consequence of war about which the public is sad but that it both expects and accepts. An honest IO, clearly portraying air power's capabilities to minimize collateral damage, within the context of maximizing military effectiveness and limiting the casualty risk, would undermine the media's opportunity to be sensationalist. Without straying into propaganda, but contrary to the current IO policy, the national media and the public need to be fully informed about the laws of armed conflict, the theoretical realities of war and the specifics of each conflict using the IO campaign.

The public can withstand higher casualty levels than the politico-military leadership but acceptable casualty levels need to be objectively assessed. Casualty aversion would be reduced by outlining the inherent risks in using military force and by articulating why those risks need to be taken through the IO campaign. Casualties are almost inevitable in war and lives should not be squandered but the importance of the issue may require risking the ultimate sacrifice.



Above all and throughout, the IO campaign must be truthful; one lie will undermine everyone involved and everything that might have been achieved. Furthermore, the IO line of operation should continue beyond a conflict's end. Inevitably there will be public recriminations, assessments of effectiveness and lessons identified. The military needs to prove that it was competent, professional, and effective, that it was proportional, discriminate and took the required precautions in attack, even after the fact. Without completing this last chapter of the information campaign, it will fail to set up the preconditions for the next conflict and that operation will be all the more difficult for it.

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INTERVIEWS

General W Jertz. German Air Force, 15 March 2000.

General Jertz was a NATO commander during Operation ALLIED FORCE and during the latter half of the campaign doubled up with Jamie Shea as a NATO media spokesman for the Operation.

Squadron Leader C R Huckstep. Royal Air Force, 30 Jan 2000.

Squadron Leader Huckstep was the Officer Commanding Attack on No 1(Fighter) Squadron during Operation ALLIED FORCE.

1. *Strategic Defence Review*, (SDR) The Stationery Office, London, 1998, para 21.
2. Ibid, para 45.
3. This essay defines RAF offensive air power as fast jets (Tornado GR1/GR4, Jaguar [all marks] and Harrier GR7) and helicopters (currently the Lynx-Mk7 but imminently the Apache-D on which it focuses).
4. This essay adopts the US Army Training and Doctrine Command definition of amicide: 'the employment of friendly weapons and munitions with the intent to kill the enemy or destroy his equipment or facilities, which results in unforeseen death or injury to friendly personnel.'
5. Garden, Sir Timothy. Brief to ACSC 4 at Hendon Museum on 21 Nov 00.
6. Both Hussein in 1991 and Milosovic in 1999 identified Alliance cohesion as being the Allied operational centre of gravity. They attacked it by denuding coalition members' public support through IOs based on the premise that Allied air power was being used indiscriminately.
7. *Kosovo Lessons Learnt*, The Stationery Office, 2000.
8. Unpublished MOD Paper
9. SDR, op cit, para 45.
10. UN Charter Article 2(7) declares that '*nothing contained in the present Charter shall authorize the UN to intervene in matters which are essentially within the domestic jurisdiction of any state,*' although it would permit '*Chapter VII enforcement measures,*' to counter the '*existence of any threat to the peace, breach of the peace, or act of aggression*' (Article 39). The Charter gives the UNSC primary responsibility to decide whether a human rights violation contravenes international law and if it threatens international peace and security. Human rights violations are not, in themselves, enough to warrant intervention. Nevertheless, over northern and southern Iraq, Bosnia and Haiti, the UNSC authorized the use of military force to counter threats to international peace posed by 'human rights violations.' This implies the sovereignty of human and international norms, and the UN, over the nation state. One of the UN's purposes is to '*reaffirm faith in the fundamental human rights, in the dignity and worth of the human person, in the equal rights of men and women and of nations large and small.*' Other treaties support the argument that '*intervention on behalf of individuals or groups suffering maltreatment is in fact justified, since the moral fabric of the international community suffers if states are allowed to violate basic human rights.*' There is a customary law argument that '*human rights norms are so fundamental that they invalidate rules consented to by states treaties or customs.*' Therefore, the Government's view was that Operation ALLIED FORCE was morally just. See: Tomes, R. '*Operation Allied Force and the Legal Basis for Humanitarian Interventions.*' Parameters, Spring 2000.
11. Blair, A. Speech to the Economic Club of Chicago, 22 April 1999.
12. Hyde, C, K. *Casualty Aversion*. Aerospace Power Journal, Maxwell, Alabama, Summer 2000.
13. Lieutenant General Cosgrove. Briefing to ACSC 4 on 22 November 2000.
14. Foreign Secretary Robin Cook declared that 'UK ground troops will not be deployed to Kosovo in order to impose peace unless there is a clearly defined end-state to be achieved.' BBC News, 19 January 1999.
15. 'I would like to point out that we have no intention of employing ground forces.' Sir John Day, (DCDS Commitments). MOD Press Briefing given on 24 March 1999.
16. Clarke, W. *House of Commons Defence Committee – Fourteenth Report*. The Stationery Office, London, 2000, para 128.
17. Hastings, M, and Jenkins, S. *The Battle for the Falklands*. (London, Joseph 1983), p357.
18. There were 18,000 battlefield-casualty beds set up for Operation DESERT STORM.
19. Unpublished MOD Paper
20. Unpublished MOD Paper
21. Clarke, W. Idem.
22. The aircraft loss rate in WW2 was one in 100, in Korea one in 500, in the Gulf one in 3,000, in Bosnia one in 4,000 and in Kosovo one in 5,000. Even in peacetime, it is this order of magnitude.
23. See Hislop, P. *The Bodybag Factor: A study into the Decreasing Public Tolerance toward Attrition in War*. The Hawk Journal, 1996. p48.
24. Feaver, P, D, and Gelpi, C. '*A Look at Casualty Aversion: How Many Deaths Are Acceptable? A Surprising Answer.*' Washington Post, 7 November 1999.

25. John Mueller, Eric Larson, and Karl Mueller provide nearly 30 years of research into casualty aversion. Their papers document changing views over 3 decades. Casualty aversion amongst the public has been exaggerated, and it is the other factors (strength of leadership, likelihood of winning, ownership of the issue and nationalism) in the cost-benefit equation that decide the level of public support. It seems incontrovertible that casualty aversion really lies with the political and military leaderships. See the bibliography for details of their work.
26. An effective and positive IO campaign at home.
27. Hyde, C, K. op cit.
28. Franks, N, R, and O'Connor, M. *Number One in Peace and War*, London, Grub Street; 2000. p241; Kosovo Lessons Learnt, op cit, p36.
29. Unpublished MOD Report
30. Interview with General W Jertz on 15 March 2001.
31. Larson E,V. *Casualties and Consensus: The Historical Role of Casualties in Domestic Support for US Military Operations*, Santa Monica: Rand 1996.
32. AP 3000, p1-3-4.
33. Unpublished MOD Paper
34. AP 3000, p1-3-4.
35. Jertz, W. Op cit.
36. Many times this was due to the weather, but many times it was due to target discrimination or to collateral damage considerations. Interview with Squadron Leader C R Huckstep DFC on 30 January 2001.
37. Johns, R. *Sir Rederick Tymms Memorial Lecture*. Supplement to the Guild of Air Pilots and Navigators Newsletter, November 1999.
38. Jertz, W. Op cit.
39. Jertz, W. Idem, and Harris, P, V. Briefing given to ACSC 4 at RAF Waddington on 12 October 2000.
40. Jertz, W. Idem.
41. Larson E,V, Op cit.
42. Human Rights Watch estimated that there were 90 incidents involving fatalities with two thirds of the (approximately 500) deaths being due to just 12 incidents. *Human Rights Watch Report into Civilian Deaths in the Former Yugoslavia*, February 2000.
43. Subsequently, however, the revelation that the tape had been played at 3 times real speed opened up NATO to accusations of a cover-up. Honesty remains the best policy.
44. Johns, R. Op cit.
45. Hampson, F. Briefing to ACSC 4 on 4 November 2000.
46. Shrader, C, R. 'Friendly Fire: The Inevitable Price.' *Parameters*, Autumn 1992, p31.
47. See Steinweg, K. 'Dealing Realistically with Fratricide' for compelling arguments that historical fratricide levels are more likely to be 10-15 per cent.
48. See Shrader, C, R. 'Amicide: The Problem of Friendly Fire in Modern War.' US Army Command and General Staff College, 1982.
49. Cooperative IFF provides only recognition of a friend.
50. The US Marine Corps have proven the utility of the Position Locating Reporting System (PLRS). The US Air National Guard have proven the Enhanced PLRS known as Situational Awareness Data Link in both air-to-ground and ground-to-air environments and also its compatibility with air-specific data links such as the Joint Tactical Information Distribution System (JTIDS). The British Army has tested both the Beyond Line of Sight Battlefield Combat Identification System (BCIS) and the Situational Awareness Beacon with Reply (SABER).
51. Acquisition, recognition and identification require increasing levels of resolution in order to define the target with increasing surety.
52. Unpublished MOD Report
53. Unpublished MOD Report
54. 20:40 means half normal eyesight resolution.
55. Brigadier General Cody describes how weaknesses in training communications and electronic warfare systems were 'Why Apaches sat out Kosovo,' Defence Helicopter August-September 1999. William Cohen and General Shelton state that the Apache was not used because the risks of being shot down outweighed the benefits of using them in the 'Kosovo After Action Review,' Senate and Armed Services Committee, US Congress, 14 October 1999.



56. Although this useful term has fallen from grace, BAI is air action against hostile land targets that are in a position to affect, but are not actually engaged with, land forces. Historically, such targets are away from the battle-front but, particularly with low intensity operations, the geographically-based definition is less useful than an effects-based one.
57. Unpublished MOD Paper
58. See ADP1 Operations for detail on the concepts of Air Manoeuvre Operations.
59. ATP-27(C).
60. Unpublished MOD Paper
61. Apache is the Army's first step in digitising their battlespace. Unfortunately, its picture is incompatible with any other link so C2 functions will be radio based. Inevitably, this will involve procedural deconfliction and require positive target identification to avoid fratricide. With increased digitisation of the battlespace positive control would be viable.
62. Wheeler, N, J. '*Saving Strangers.*' Oxford University Press, 2000.
63. Powell, C. '*US Forces: Challenges Ahead.*' Foreign Affairs, Winter 1992/3.
64. AP 3000, p1.1.14.
65. Idem.

Caen: the Norman city was reduced
to a wilderness of ruins

Caen

the Martyred City





Many aspects of the air operations during World War II have attracted their share of myths and controversy. The efficacy of the strategic bombing campaign has been debated at length with considerable attention given to the primacy of targeting German morale and industrial capacity.¹ Individual raids on the Dams, attacking the *Tirpitz* and *Dresden* have also attracted much discussion.² It is, however, fair to say that this is not a new or even recent phenomenon; the various policies attracted debate and controversy both at the time and in the respective bombing surveys produced after the end of the War.³ The ardent exponents of strategic bombing such as Air Chief Marshal Sir Arthur Harris and his United States counterpart, General Charles Spaatz, decried any deviation of their assets from the attacks on the German heartland. Harris, in particular, resisted fiercely wasting time on what he called 'panacea targets'.⁴

This debate reached a crescendo in the run up to, and immediate aftermath of, Operation OVERLORD – the Allied invasion of occupied Europe in June 1944. A relatively complicated command and control structure exacerbated the marked divergence of doctrinal (and dogmatic) priorities. The positions of senior airmen in the command chain may have been essential for pragmatic reasons, especially where specific assets, such as the heavy bombers, were kept separate from the force assigned to the Supreme Allied Commander. Nevertheless, these issues did little to harmonise relationships and will be discussed in greater depth below.

Of all of the various myths, legends and controversies that have arisen since the liberation of France and the eventual overthrow of Nazi tyranny, few have left such a long-standing scar on the psyche of a city than the allied bombing of Caen – the city that considers itself to have been martyred.⁵ The strength of feeling is still evident today as any visitor to the Caen Memorial in the northern outskirts of the city is clearly able to see. In an area that is full of commemorations to the British, American and French forces, the poignancy of the Caen Memorial is most marked. Why should it be the exception? Any attempt to answer this question must include an examination of why Caen was subject to Allied aerial bombardment.

This paper will examine the various factors leading up to the bombing of Caen and the eventual capture of the city. The paper will therefore look at the planning for D-Day and the importance of Caen at the operational level of war. The planning will be set in the context of the air power strategy that pertained at the time with particular reference to the thinking on the support – direct

Of all of the various myths, legends and controversies that have arisen since the liberation of France and the eventual overthrow of Nazi tyranny, few have left such a long-standing scar on the psyche of a city than the allied bombing of Caen...



The ruins of Caen

and indirect – of ground forces. The paper will also look at the command and control structures and examine some of the tensions therein. The decision-making process will then be set in the context of the progress of the air and ground war as it evolved. From this, it should be possible to show how events gathered momentum resulting in the requests for aerial bombardment, its actual execution and eventual effectiveness.

THE PLANNING FOR OVERLORD

The prospect of a serious invasion of mainland Europe seemed remote in the dark days of 1940 and 1941. France had fallen and, although the Battle of Britain had been won, the contest in the Atlantic showed how tenuous Britain's survival was. The German invasion of Russia made a second front necessary as pressure in the east had to be relieved. For many long months, Bomber Command was the Allies' only option.⁶ The entry of the United States into the war following Pearl Harbor and the German declaration of war made a second front not only vital, but also inevitable. The key question, however, was where this front was going to be. The Americans accepted a policy of Germany first; but the demand for settling scores with Japan meant that this would have to be done quickly. Churchill and his senior advisers considered a cross-Channel invasion (Operation SLEDGEHAMMER) to be too risky in 1942.⁷

The German invasion of Russia made a second front necessary as pressure in the east had to be relieved

The decision was therefore taken to launch Operation TORCH in North Africa thereby delaying the return to the Continent. Nevertheless, planning for an eventual invasion began in April 1942 with the tasking by the British Chiefs of Staff of General Sir Bernard Paget (C-in-C Home Forces) and Captain Lord

Louis Mountbatten (Head of Combined Operations) to begin planning for Operation ROUNDUP. This early planning showed the potential of Normandy as a viable alternative to the Pas de Calais region which had seemed the most obvious choice of landing area (to the Germans as well as to the Allies). The Casablanca Conference of January 1943 saw the British Chiefs of Staff prevail over their US colleagues with action remaining in the Mediterranean with Operation HUSKY – the invasion of Sicily. Partly to keep the cross-Channel option 'in play', Lieutenant General Frederick Morgan was appointed as Chief of Staff to the Supreme Allied Commander (Designate). The acronym COSSAC was obviously less of a mouthful for those involved in the planning which quickly gained momentum. By July 1943 the outline was in place for the invasion of Normandy with the target date of 1 May 1944.⁸



The Luftwaffe disguised some of their aircraft with water-soluble white distemper. Shown are JU 87Ds aircraft

The Casablanca Conference was followed by a similar event in Quebec in August 1943. OVERLORD was high on the agenda, with the choice of Supreme Commander an important topic. The initial speculation was that the Commander would be British and Churchill was keen for General Sir Alan Brooke (Chief of the Imperial General Staff and Chairman of the Chiefs of Staff Committee) to take on the role.⁹ During the Quebec Conference, Churchill relented to American demands that their numerical superiority should guarantee them the key position. Underlying these discussions was a marked suspicion that neither Churchill nor Brooke was fully committed to OVERLORD. The almost automatic American nomination for the post was General George C Marshall, the United States Chief of Staff. But President Roosevelt was reluctant to allow his key strategy adviser out of arm's reach. General Dwight D Eisenhower became the default option. Churchill had let it be known that Eisenhower was the only acceptable alternative to Marshall and his appointment was formally announced on 6 December 1943.

Major General Omar N Bradley was selected to command United States ground forces. Competition for his British and Commonwealth counterpart was between Lieutenant General Bernard Montgomery and General Sir Harold Alexander. Churchill tended to favour 'Alex' while Brooke spoke strongly in favour of Montgomery. Brooke also doubted that Alexander had the strategic vision necessary to cope with OVERLORD. Eisenhower's marked preference was for Alexander – he considered Monty abrasive and difficult to control. The decision, in Montgomery's favour, was announced on 22 December 1943 with Alexander to remain in Italy where he provided much needed continuity. This removed any lingering barriers to the appointment of Air Chief Marshal Sir Arthur Tedder as Eisenhower's deputy: air was going to be critical to the success of the European adventure.



Winston Churchill

During the Quebec Conference, Churchill relented to American demands that their numerical superiority should guarantee them the key position

Eisenhower's first impression of the plan for OVERLORD was that the forces assigned were insufficient. Montgomery came to similar conclusions.¹⁰ Popular myth has it that the latter was solely responsible for beefing up OVERLORD. While it is true that he became the architect for many of the changes, it is typical of the man that he claimed absolute credit. COSSAC was considerably expanded with many new faces and detailed planning entered a new phase. Montgomery envisaged the rapid



Lord Louis Mountbatten

Popular myth has it that the latter was solely responsible for beefing up OVERLORD. While it is true that he became the architect for many of the changes, it is typical of the man that he claimed absolute credit

seizure of the main centres of road communication – Caen and Bayeux – and the high ground to the south and east of the former city. This area controlled the approaches and crossings of the Odon and Orne rivers and had to be captured early to prevent German reinforcement. This area would also provide vital land for the construction of airfields to reduce the flying times for close support aircraft. Montgomery also insisted on the use of airborne forces on both flanks to prevent German counter-attacks on the beachheads.

The other element of Montgomery's thinking was the simultaneous attack on Caen, the high ground around it and capture of Cherbourg by means of a Cotentin landing. Montgomery disregarded the risk of splitting his forces and not achieving sufficient concentration on Caen.

Nevertheless, he believed that the battle would be lost or won in the British sector with considerable potential for the Allies to be repulsed by heavy panzer counterattacks. As the planning matured, the importance of the capture of Caen became abundantly clear. The Allies would have to capture Caen and its associated river crossings: it could not just be by-passed. With characteristic boldness, Montgomery saw the city being taken by speed and aggression on *D-Day* itself. There was no question of using the city as 'a hinge' or maintaining a defensive posture on the flank.¹¹

AIR STRATEGY

The planning requirements for air forces generally and for those engaged in OVERLORD were set in place at the Casablanca and Quebec Conferences. COSSAC effectively saw the air campaign in four phases.¹² The first was the continued strategic bombing of Germany. The second or preparatory phase saw the addition of communications targets, coastal defence batteries and airfields. The priority in the third phase would be the direct support of the invasion fleet. The fourth phase would be more of the same with the requirement to prevent enemy movement and reinforcement.

The Luftwaffe was to be dispersed, harried and destroyed by all possible means



In flames after crash landing

morale. The USAAF, under Lieutenant General Carl A Spaatz, was also allowed to attack key, or vital, centres such as oil manufacture and storage. Harris saw the diversion of his aircraft from Germany to gun emplacements and beach defences as a disservice to the army and potentially a disaster.¹⁵

Doctrinal issues were complicated by the appointment of Air Chief Marshal Sir Trafford Leigh-Mallory as Air Commander-in-Chief of the Allied Expeditionary Air Force. Neither Bomber force took kindly to direction from a person considered to have only fighter experience.¹⁶ That Leigh-Mallory had written extensively in the inter-war years on the use of air power in support of armies only served to deepen the antagonism.¹⁷ The matter was only resolved in practice by 'direction' from Tedder acting on behalf of the Supreme Commander.

To facilitate the second phase of pre-OVERLORD operations, Leigh-Mallory set up an AEF BOMBING Committee under the chairmanship of Air Commodore Kingston-McCloughry; its membership included Professor Solly Zuckerman. The latter argued

The Casablanca Conference set the tone for the use of air power for the remainder of the war in a number of ways. The first of these was the understandable and laudable aim to achieve complete mastery of the air. The Luftwaffe was to be dispersed, harried and destroyed by all possible means.¹³ The second requirement was for the formation of large tactical air forces able to assert mastery over the battlefield and wield the firepower first seen in the desert. There was, however, less agreement on the utilisation of the bomber forces. The Casablanca directive read:

'The primary objective will be the progressive destruction and dislocation of the German military, industrial and economic system, and the undermining of the morale of the German people to a point where their capacity for armed resistance is fatally weakened'.

As Biddle has pointed out, this contained something for everyone and gave the commanders a deal of latitude,¹⁴ both in target sets and methodology. This allowed Air Chief Marshal Sir Arthur Harris (C-in-C Bomber Command) to pursue targets based on German industrial output and



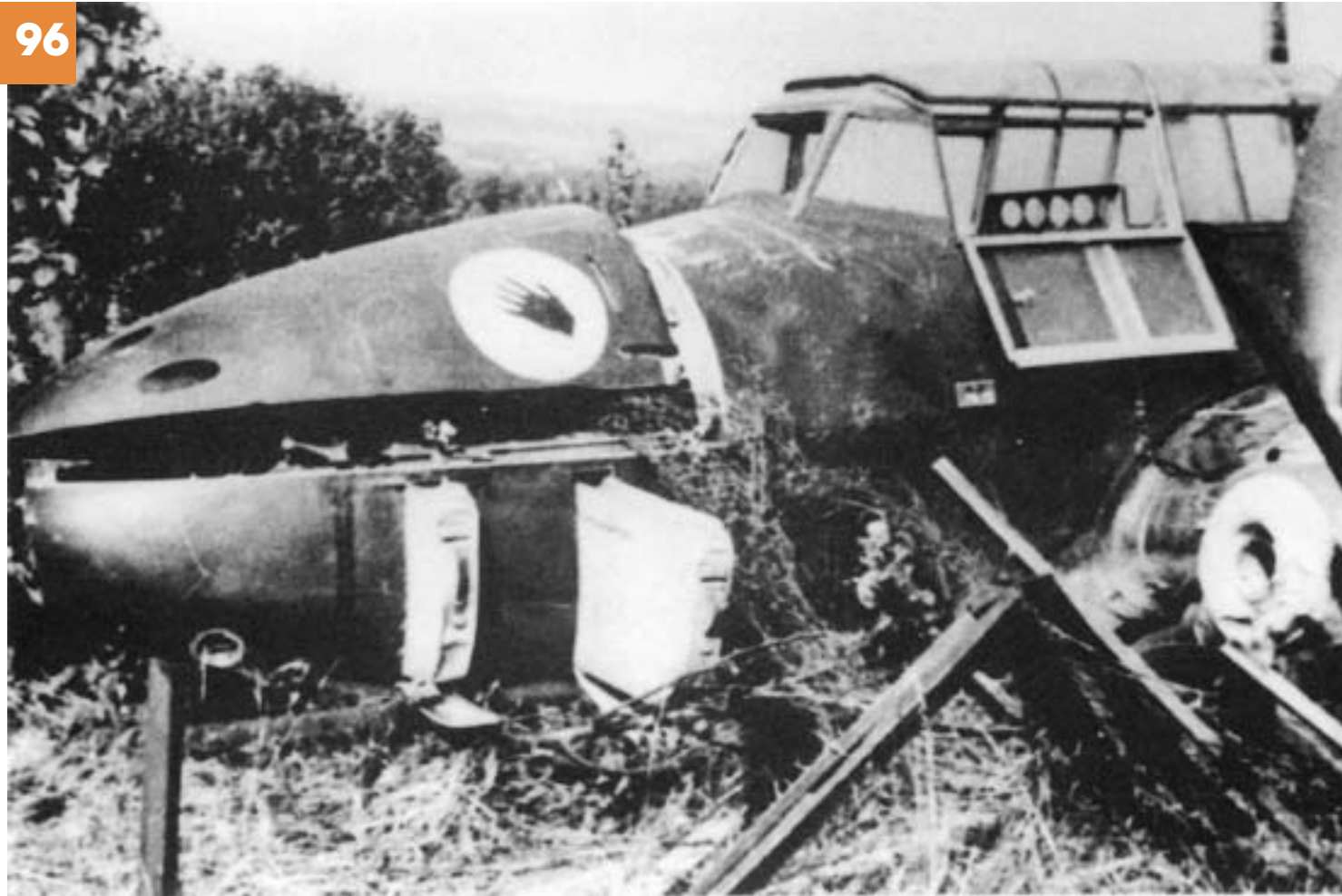
A marshalling yard outside Paris

Harris's objection that the necessary precision was beyond the capability of his crews was shattered on 6 March 1944 when 263 aircraft of Bomber Command dropped 1,258 tons of bombs on the railway centre at Trappes, southeast of Paris

that attacks on rail facilities would be the most efficacious means of disrupting German potential for reinforcement. Some 75 repair, servicing and similar targets were identified. Harris's objection that the necessary precision was beyond the capability of his crews was shattered on 6 March 1944 when 263 aircraft of Bomber Command dropped 1,258 tons of bombs on the railway centre at Trappes, southeast of Paris. The centre was so hard hit that it was out of action for over a month.¹⁸

The 'Transportation Plan' was formally adopted by the Chiefs of Staff and appropriate direction was issued to the strategic bomber commanders on 15 April 1944. Having had his objections swept aside, Harris put his Command to the task with a vengeance and the Plan was a considerable success.¹⁹ By D-Day, Bomber Command and its American colleagues had flown 21,949 sorties dropping 66,517 tons of bombs on 80 targets.²⁰ Targets were deliberately chosen to minimise collateral damage with a maximum acceptable potential French casualty toll of 150. As the RAF official historian points out, the French were stoical about the need for these operations in marked contrast to the aftermath of Caen.

The third phase of the air campaign was conducted at the tactical level by aircraft under the command of Air Marshal Sir Arthur Coningham (Second Tactical Air Force) and General Louis Brereton of the US Ninth Air Force. A range of targets was attacked from the Pas



A crash-landed Bf 110C after being shot down by Allied aircraft

de Calais area down to the Cotentin peninsula. By this time the Luftwaffe had taken a pounding on all fronts. They were still able to operate on an occasional basis, but air superiority had been fought for, won, and then maintained primarily over the skies of the German heartland.

A range of targets was attacked from the Pas de Calais area down to the Cotentin peninsula. By this time the Luftwaffe had taken a pounding on all fronts

COMMAND AND CONTROL THE VEXED ISSUE OF PERSONALITIES

Supply of good wartime commanders is always limited. It is therefore no surprise that the same old list of 'usual suspects' keeps on reappearing; stalwarts such as Harris remain in post. With success an ego inevitably comes to match Montgomery as the *primus inter pares*.

There was no love lost between Tedder and Montgomery following their experiences in the desert campaign. But the greatest dissension was between Coningham and Monty. In the desert the two men had worked together exceptionally well, proving to be the model of co-located component commanders. By the time Normandy came round, the airman considered that his erstwhile colleague had slighted him. Coningham was, however, one of the most capable and experienced senior commanders available and Tedder may also have felt that he could be used as a foil to Montgomery.

Both senior airmen considered that Montgomery had not made the best use of air power in the desert and that he needed a strong team.²¹ The batting order was enhanced further by Air Vice-Marshal Harry Broadhurst who had fought with distinction in the Battle of Britain, North Africa, Sicily and Italy. He considered that the feud between Montgomery and Coningham was badly counter-productive and sought to minimise its impact. His sound relationship with Montgomery, whilst of considerable benefit to the conduct of the campaign, did little to improve his standing with Coningham and Tedder.

The battle of the egos found its culminating point in the need to capture ground suitable for the airfield sites necessary for the full exploitation of air power. This had been requested as a priority by Leigh-Mallory as early as 20 March. The tactical aircraft had relatively little combat task time over Normandy when operating from UK bases; this had been long recognised as a limitation to the choice of this region over the more logical Pas de Calais area. Leigh-Mallory saw tactical air as being key to the push to the Seine. During the planning phase, Montgomery refused to make promises that he could not guarantee keeping. Yet the airmen's demands for territory coincided neatly with Montgomery's own operational priorities. The eventual failure to take Caen and the surrounding area quickly provided the aviators with the ammunition with which to attack Montgomery.

The delay in capturing Caen also exasperated the Americans who began to suspect that Montgomery was overly cautious. The importance of the British sector had not changed, but by 30 June Montgomery had begun to talk of containment rather than breakthrough. The lack of progress led to increasingly strident calls for Montgomery's removal, particularly from those who opposed his appointment in the first place. Bradley for example thought that it was typical 'Monty' – over-cautious, promising much and delivering little.

D-DAY AND BEYOND

Tidal conditions in the English Channel gave the Allies a narrow window for invasion in June 1944. A full-blown storm wrecked any chance of invasion on the morning of 5 June. Group Captain J M Stagg provided the meteorological brief for 6 June 1944. In what was probably the most critical met brief in the history of that rather inexact science (or black art), Stagg offered a glimmer of hope that Eisenhower and Montgomery seized upon, albeit to the scepticism of their air marshals.²² The essential surprise was achieved, not least because of the marginal nature of the weather. Indeed, Rommel was in Germany on the strength of the weather reporting!

On D-Day itself, Bomber Command flew over 1,000 sorties dropping more than 5,000 tons of bombs as well as copious quantities of window.

The third British Division in particular was tasked to 'capture Caen and secure a bridgehead over the River Orne at that place'... By nightfall, a combination between the fortifications and elements of the 21st Panzer had effectively blocked progress towards Caen



A 75 mm SP gun of 21 Panzer Division

The aerial armada was reinforced by waves of transport and glider tugs carrying out the airborne landings on the flanks. British Forces landed on their beaches at approximately 0700 with 1 Corps tasked to take Caen. The third British Division in particular was tasked to 'capture Caen and secure a bridgehead over the River Orne at that place'.²³ The move inland from Sword beach did not occur as rapidly as had been hoped with elements of the Division bogged down in front of the German fortification named 'Hillman'. By nightfall, a combination between the fortifications and elements of the 21st Panzer had effectively blocked progress towards Caen. Matters had not been helped by unusually high tides that restricted the amount of space on the beaches, which had in turn slowed the disembarkation of armour.

Hitler's prohibition to all commanders that they must not give up an inch of ground meant that they fought where they stood. Overwhelming allied air power ensured that there could be neither re-supply nor reinforcement in depth. Counter-attacks were essential German doctrine. Set piece battles were therefore the exception rather than the rule, with the war quickly degenerating into an attritional grind of vicious small unit engagements. Much of this was inevitably the province of the infantry – and they were in short supply.²⁴ Likewise, close co-ordination between armour and infantry was frequently absent. In the face of highly effective anti-tank guns, determined Panzer divisions and brutal determination, the British forces made slow going. Arguably, had the Germans had even air parity, matters could have been considerably worse. Recriminations over lack of progress surfaced quickly with an overwhelming sense that these latter-day citizen armies were reluctant to commit to the type of warfare. Commanders, from Montgomery downwards, were aware of the paucity of reinforcements. And most carried with them the legacy of the Somme and Passchendaele.²⁵

In June, Montgomery made three major attempts to take Caen. The first of these was a direct assault as a continuation of D-Day operations on 7 and 8 June. He then tried to envelop the city in the Villers-Bocage operation of 13 June. Operation *Epsom* followed on 25 June. This was to be a direct penetration by a powerful force involving all three corps. *Epsom*, like its predecessors, was a dismal failure.²⁶ The best that can probably be said was that it prevented the Germans from mounting the expected counter-attack along the River Odon where much of the fighting took place.

By early July, Montgomery was running out of time and ideas. Caen was beginning to lose its strategic importance per se as the German reinforcements were tied down and the US Army was making progress to the west. However, the high ground to the southeast was still vital and as Caen could not be by-passed it would have to be taken – head-on if necessary. The planning for *Charnwood* gathered momentum and with it, the use of air power on the city.

THE BOMBING OF CAEN

The first suggestion that heavy bombers be used to break the logjam in front of Caen came as early as 14 June when Leigh-Mallory flew to Normandy to see Montgomery. Relations between the two were strained because the airman had refused to

sanction an airborne raid on the grounds of risk. Montgomery, according to Leigh-Mallory's papers,²⁷ found the counter-proposal very attractive. The core idea had again originated with Kingston-McCloughrey and Zuckerman and involved the use of the strategic bombers in direct support of the ground forces. This had only previously been done at Monte Cassino (15 February 1944) and Cassino (15 March 1944) in Italy.

The concept was discussed further in a schoolhouse in Bayeux that was being used as the headquarters for the Second Army under General Dempsey. Their meeting was short-lived due to the arrival of Tedder, Coningham and Broadhurst. Neither Bomber Command nor the United States Strategic Air Force favoured the plan. More importantly, the nature of the terrain prevented the identification of a bomb line and suitable aiming points with the attendant risk of killing one's own troops. Furthermore, the target concentration was too low to justify the diversion of bomber assets.²⁸

The operation lasted for about an hour and featured 467 aircraft dropping some 2,276 tons of bombs



B-17Fs flying in box formation

The politics and flexing of egos may have been sufficient for the plan to die. In reality, the practical problems spoke for themselves. Tactical air continued to be used with extra tasking against particular strong points – admittedly with only limited success. What was more relevant was that the kernel of the idea remained dormant for later use.

As Montgomery was putting together his plans for Charnwood, he decided to try again for heavy bomber support. The German defences were known to be strong and intelligence suggested that they had recently been reinforced. The request envisaged the heavy bombers blasting a path through the defences in the northern suburbs of Caen. Leigh-Mallory and his staff considered the bid at their Stanmore Headquarters on 7 July. Tedder normally attended these meetings, but exceptionally, Eisenhower also attended this meeting – presumably to ensure that Montgomery received the full support that he had requested and coincidentally would have no scapegoats should Charnwood fail. With little apparent debate, the meeting agreed to task 450 heavy bombers for that night.²⁹



Bomber Command launched its first attacks at approximately 2200 on 7 July using 1,000 lb bombs. Most were fused to explode six hours later to coincide with the ground advance. The operation lasted for about an hour and featured 467 aircraft dropping some 2,276 tons of bombs. The concept had been almost identical to the plan rejected in June albeit with the aiming points reduced to two. Notwithstanding German reinforcement, the target density was no better than when the concept had been rejected in June. The target area was a box 4,000 yards wide by 1,500 yards deep and included the northern part of the city. Care was taken to avoid fratricide, but this left some of the strong points untouched.

THE AFTERMATH

Montgomery claimed that the heavy bombing had been a vital part in the subsequent capture of Caen...

Two days of heavy fighting then ensued with little evidence to suggest that the defenders had been affected by the air attacks; the northern half of Caen was eventually secured by 1 Corps. Montgomery's victory was somewhat pyrrhic in that he had captured a ruined city at high cost. The Germans had also suffered heavily, but had dug into new positions on the south side of the river. They also retained the high ground to the south and east. Many of the desired airfield sites had not been reached and those in the bridgehead remained within artillery range. The breakout into Normandy was as elusive as ever and, despite favourable press, the pressure on Montgomery remained.

An immediate by-product of the heavy bombing of Caen was that it was the first time that many of the soldiers had seen the full wrath of the heavy bomber force. General Dempsey was actually airborne with Broadhurst and watched the proceedings. Broadhurst recalled that his senior colleague had been shaken by the scale of the destruction – as well as by the damage done to their aircraft by anti-aircraft fire which necessitated a crash landing!³⁰ Some reports suggest that this beneficial effect on morale extended down to those in the slit trenches facing Caen.³¹ Montgomery claimed that the heavy bombing had been a vital part in the subsequent capture of Caen; he also praised Leigh-Mallory for his consistent support.³² Later assessments of Montgomery's analysis range from fantasy to guilty conscience.³³

Having been instrumental in the initial concept of using heavy bombers in support of the army, Kingston-McCloughry and Zuckerman conducted a survey immediately after the capture of Caen. They reported that there had been virtually no sign of enemy gun emplacements, tanks or casualties in the target area that the army had requested. This was in contrast with other areas close by that would definitely have been worthy of Bomber Command's efforts. The effect on friendly morale had been beneficial, but transitory. Kingston-McCloughry concluded that the air element of the operation was little more than a frill for a ground plan already made.³⁴

The bombing created considerable quantities of rubble and impeded the advance into Caen. This restricted the access for armour, reduced the number of exits that the Germans had to defend and allowed extra scope for snipers against the exposed infantry. The obstructions also prevented the rapid seizure of the Orne bridges which were destroyed by the defenders.

The French population of Caen had been advised to evacuate the city by the Germans and their own prefect. About one quarter had taken this advice. Many of those who remained had expressed a rather fatalistic ‘frying pan and fire’ attitude, preferring to remain in their own homes.³⁵

CONCLUSIONS

The military efficacy of Bomber Command’s attack on Caen appears to have been somewhere between negligible and counter-productive. The effect on the residents was devastating. Any impact on the morale of either side was transitory with the Germans continuing to fight fiercely for two further days. The decision-making process was hasty and totally uncoordinated from the major land offensive. What had been decreed as being too barren in target density, suddenly became worth the effort. There are therefore no easy answers, from a straightforward effects-based approach, as to why Caen was bombed.

It is, however, less cut and dried if one attempts to analyse how Caen came to be bombed. Montgomery was under increasing pressure to break the stalemate that had persisted for a full month after D-Day – the original target date. There can be no doubt that his later claims that he had always planned a ‘holding’ operation while the Americans developed their campaign in the West are anything but fabrication. The balance of German forces in his sector may have made this reality into a slight virtue, but it was not pre-planned.

Tedder recalled in his diary on the day after the bombing that: ‘The problem is Monty who can be neither moved nor moved to action’. There is no doubt that he was under considerable pressure from Eisenhower, not least because the Supreme Commander was conscious that his fellow countrymen were becoming increasingly strident in their views that the war was being fought exclusively at the cost of American lives. There is some speculation that Montgomery was under pressure directly from Churchill; Kingston-McCloughry has suggested that the Prime Minister wrote to Monty along the lines that he must make progress or be replaced. It is feasible, and in character, that Churchill would so threaten. But as D’Este points out, it is inconceivable that Monty could have been removed at that stage. The wider message proclaimed by such a move – in Moscow, with Roosevelt, the British public and among the Germans – would have been unthinkable.³⁶ Nevertheless, Montgomery was not the sort of character to risk future fame and fortune on such a gamble.

The military efficacy of Bomber Command’s attack on Caen appears to have been somewhere between negligible and counter-productive

The personalities involved on the air side make for somewhat unsavoury analysis. There was an unhealthy mix of egotism and ambition with many officers covertly looking forward to the appointments lists of the peacetime air forces. Kingston-McCloughry was an arch wheeler and dealer who had been involved in a number of backstairs controversies.³⁷ There was little

chance that he and Zuckerman would be prepared to take a back seat role. Likewise Leigh-Mallory was frustrated with having so little genuinely to *command* – especially with the heavy bombers remaining under their respective commanders. He was determined that he would make his mark on the war and his casting of straws for Montgomery to clutch was a key factor in the eventual destruction of Caen.

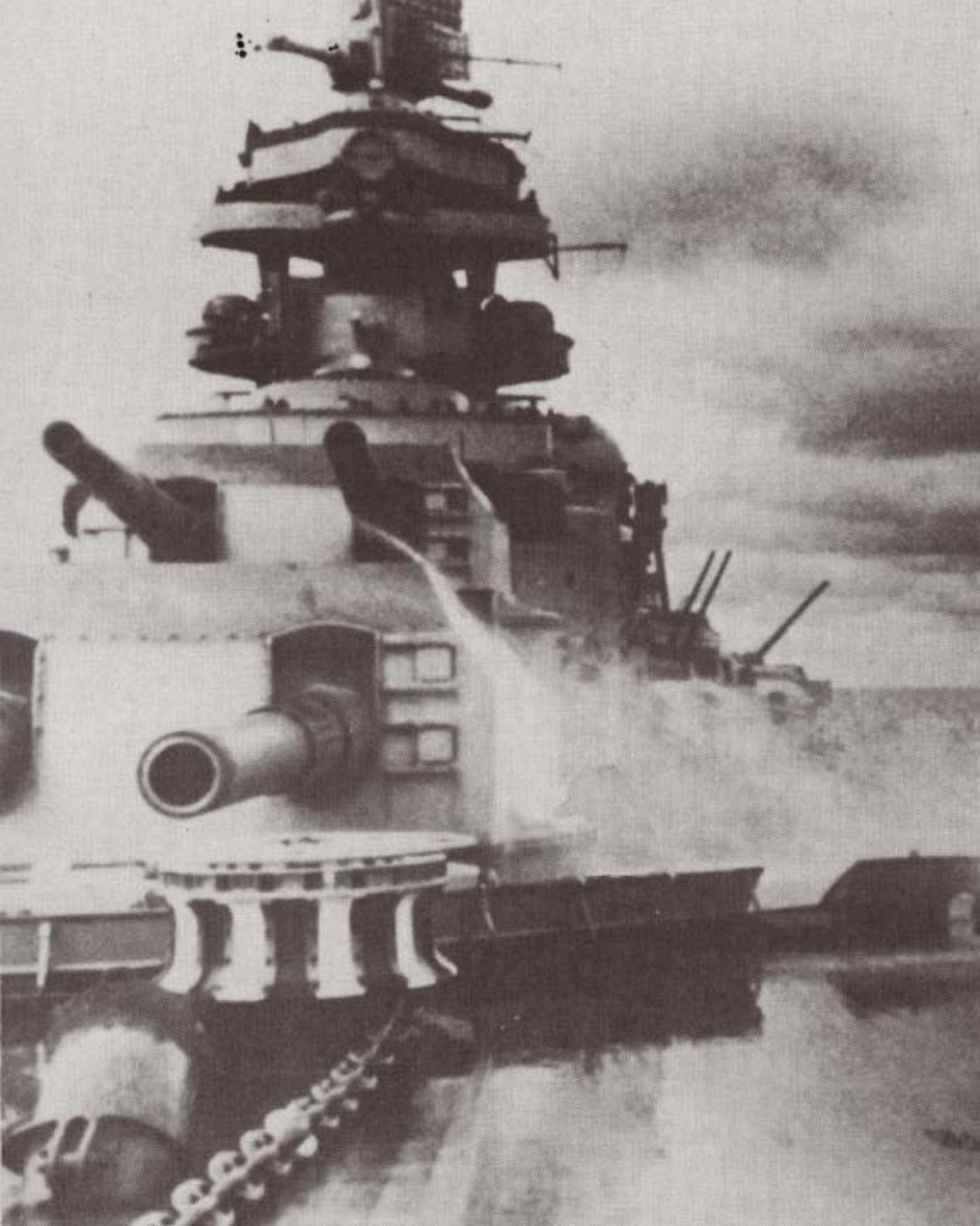
The early appointment of Montgomery can be considered to be the starting point as he was neither a visionary leader nor someone capable of improvisation when matters turned sour. Failure to take Caen on D-Day accelerated the series of events with the direct attacks on D+2 and D+3, through Villers-Bocage and *Epsom* to *Charnwood* itself, as the key milestones. That they developed a momentum of their own helps to show *how* Caen came to be bombed, but cannot satisfactorily answer the question *why*. This is why the normally stoic French response of ‘it had to be done’ is not held to apply to Caen – hence the martyred city.

NOTES

1. For authoritative accounts, see Richard Overy, *The Air War 1939 –1945*, Stein and Day, New York, and more recently, *Why the Allies Won*, Pimlico, London, 1996. See also Noble Frankland, *The Bombing Offensive Against Germany - Outlines and Perspectives*, Faber and Faber, London, 1965.
2. For an account on Dresden see Peter W Gray, ‘Dresden 1945 – Just Another Raid?’, *Royal Air Force Air Power Review*, Vol 4 No 1, Spring 2001, pages 1-14 and for the *Tirpitz* see John Sweetman, ‘Barnes Wallis’s other Bouncing Bomb: plans to sink the German Battleship *Tirpitz* in 1943’, *Royal Air Force Air Power Review*, Vol 5 Nos 2 and 3, Summer and Autumn 2002.
3. For the American version see the Reports of the United States Strategic Bombing Survey and subsequent debates on the subject: Gian P Gentile, *How effective Is Strategic Bombing? Lessons Learned from World War II to Kosovo*, New York University Press, New York, 2001. The British equivalent is *The Strategic Air War against Germany 1939 –1945; Report of the British Bombing Survey Unit*, re-published by Frank Cass, London with introductory material by Sebastian Cox, 1998.
4. MRAF Sir Arthur Harris, *Bomber Offensive*, Collins, London, 1947, pages 220 et seq.
5. This remains the perception today – the martyrdom aspect is reflected in the City Memorial.
6. Discussions between Churchill and Stalin in August 1942 confirmed the Grand Strategic level direction for Bomber Command. The leaders agreed that not only should German industry be bombed, but also the population and its morale. Stalin stressed the importance of attacking Berlin and this cascaded down to Harris later that month. Stalin’s appreciation of the efforts of Bomber Command was reinforced by Harris sending the Russian leader a book of aerial photographs of the damage wrought.
7. Carlo D’Este, *Decision in Normandy*, Robson, London, 2000, page 25.
8. D’Este, *ibid*, page 35.
9. D’Este, *ibid*, page 43 and David Fraser, *Alanbrooke*, Harper Collins, London, 1982, pages 332, 333.
10. D’Este, *ibid*, page 61.
11. D’Este, *ibid*, page 74.
12. Hilary St George Saunders, *Royal Air Force 1939 – 1945*, Vol III *The Fight is Won*, HMSO, London, 1954, page 84.
13. Overy, *The Air War 1939 –1945*, page 95.
14. Tami Davis Biddle, ‘British and American Strategic Bombing’, in John Gooch (ed), *Air Power Theory and Practice*, Cass, London, 1995, page 120.
15. Saunders, *The Fight is Won*, page 85.
16. Overy, *The Air War 1939 –1945*, page 97.
17. See for example the article by Wing Commander Trafford Leigh-Mallory in Vol 1 of *The RAF Quarterly*.
18. Saunders, *The Fight is Won*, page 87.



19. As confirmed by Professor Zuckerman in his private diary; cited by D'Este, *Decision in Normandy*, page 215.
20. Saunders, *ibid*, page 88. Harris records that Bomber Command, by the end of June 1944 had flown 13,349 sorties dropping 52,347 tons of bombs with a casualty rate of 2.6%. *Bomber Offensive*, page 204.
21. D'Este, *Decision in Normandy*, page 218 and 219.
22. D'Este, *ibid*, page 110.
23. D'Este, *ibid*, page 120.
24. D'Este, *ibid* page 252 et seq.
25. D'Este, *ibid*, page 301.
26. D'Este, *ibid*, page 245.
27. Reproduced in Bill Newton Dunn, *Big Wing, the Biography of Air Chief Marshal Sir Trafford Leigh-Mallory*, Airlife, Shrewsbury, 1992, page 131.
28. D'Este, *ibid*, page 228.
29. D'Este, *ibid*, page 310.
30. D'Este, *ibid*, pages 314 and 316.
31. D'Este, *ibid*, page 316.
32. Bill Newton Dunn, *Big Wing*, page 155.
33. Alexander McKee, *Caen, Anvil of Victory*, Souvenir Press, London, 1964, chapter 14.
34. Cited in Ian Gooderson, *Air Power at the Battlefront; Allied Close Air Support in Europe 1943 – 1945*, Frank Cass, London, 1998, page 136.
35. Max Hastings, *Overlord; D-Day and the Battle for Normandy 1944*, Pan, London, 1999, page 263,
36. D'Este, *Decision in Normandy*, page 311.
37. For a discussion on the political intrigue behind the downfall of Air Chief Marshal Sir Cyril Newall: see Sebastian Ritchie's article in *War and Society*, vol 16, No 1, May 1998, page 83.



Barnes Wallis's Other Bouncing Bomb

Part I: Operation *Tirpitz* and the German dams



Tirpitz spent much of her service in the fjords of northern Norway

On 16 January 1942, the 52,600-ton German battleship *Tirpitz* with a formidable main armament of eight 15in guns and reputedly capable of up to 34 knots, entered Trondheim Fjord in Norway. She would anchor 35 miles inland, in the off-shoot Foetten Fjord, protected on three sides by steep cliffs. In the following months, four unsuccessful operations were mounted against her there by RAF Bomber Command and the Fleet Air Arm once narrowly missed sinking *Tirpitz* at sea.

In 1943 Winston Churchill demanded renewed air action. The powerful battleship *Tirpitz* remained a potent threat to the Arctic convoys carrying supplies to the USSR and raised the spectre of a foray into the Atlantic. To guard against these eventualities,



The Tirpitz in 1943

...It is a terrible thing that this prize should be waiting and no one be able to think of a way of winning it'

the Home Fleet had a powerful array of battleships, cruisers and destroyers at Scapa Flow – ships that were urgently needed in other theatres of war. On 13 February 1943, the Prime Minister furiously minuted the Chief of Combined Operations, Paymaster-General, First Sea Lord, Chief of the Air Staff (CAS) and Commander-in-

Chief (C-in-C) Bomber Command: 'Have you given up all plans for doing anything to *Tirpitz* while she is in Trondheim?... It is a terrible thing that this prize should be waiting and no one be able to think of a way of winning it'.¹

From the aerial perspective, the omens were not good. Responding to another memo from Churchill on 27 February, ACAS (Ops) at the Air Ministry reported the lukewarm reaction of Bomber Command towards renewed attacks on *Tirpitz*: 'The ship in its present situation is virtually invulnerable to normal bombing methods. It is to all intents and purposes in a *'slit trench'*. The battleship's 'formidable and effective defences' prevented 'even moderate bombing accuracy'. Prolonged absence from main force operations of aircraft detached for duty to northern stations – where the weather often delayed projected air attacks – meant that only inadequate numbers could be spared. The pessimistic conclusion followed that any such operation 'would be yet another fruitless diversion of bombers from Germany'.²

WALLIS'S INITIATIVE

By now an unusual solution to the problem of *Tirpitz* had firmly come into focus. In 1941, the distinguished aeronautical engineer Barnes Neville Wallis, nominally Assistant Chief Designer (Structures) at Vickers-Armstrong's works in Weybridge, had drawn up a scheme for dropping a 10-ton 'earthquake' bomb at 40,000 ft from 'a stratospheric bomber' to destroy a wide variety of targets, including coal mines, dams, oil refineries and lock gates. Significantly, a 'water immersion' variation of the proposed bomb was also illustrated. However, this idea contained in a 117-page illustrated paper was turned down. The need to destroy dams then became a special focus of attention, and Wallis started to examine ways of projecting a missile dropped from a low-flying aircraft across the surface of a reservoir abutting a dam. This had obvious implications for attacking ships as well. During 1942 he therefore worked on two parallel versions of his so-called 'bouncing bomb' – one to destroy a gravity dam, the other a battleship.³

In Spring 1942, Wallis conducted initial experiments by bouncing marbles off water in a tub on the patio of his house in Effingham, seeking not only to prove the method workable but to establish consistency through a Law of Ricochet. He moved

on to trials with balls of different density fired from a special catapult at Silvermere Lake, near Cobham, and then to the National Physical Laboratory (NPL), Teddington, where active Admiralty interest was assured. On 22 April, seeing his proposal 'as essentially a weapon for the Fleet Air Arm', he outlined progress with his 'golf ball' experiments to Professor PMS Blackett, scientific adviser to the Admiralty.⁴

On 14 May, Wallis circulated more widely his thoughts in a persuasive, detailed paper, 'Spherical Bomb – Surface Torpedo'. A spherical bomb, he argued, was 'not susceptible to initial disturbance by the under-belly turbulence of the carrying aircraft at the moment of release'. Thus a more accurate flight path than for an 'ordinary bomb' resulted. The pilot would need to make a fast dive, then flatten out to release his load at a height 'not greater than 26 ft when travelling at a speed of 470 ft/sec in order that the impact angle shall not exceed five degrees'. Available data suggested that, given these constraints, a bomb would travel 3,500 ft (roughly $\frac{3}{4}$ mi) in five bounces over water; the fifth just under 4 ft high, the first one-half the height of release. Double casing, bridged 'by a series of light timber beams or roughly welded steel girders', would permit any necessary adjustments. 'The charge should sink in close proximity and may be detonated by a hydro-static valve at any pre-determined depth, the rate of sinking being comparatively slow'. Suitable targets would be hydro-electric dams 'and floating vessels moored in calm waters such as the Norwegian fjords'. In a word, *Tirpitz*. No wonder Blackett responded quickly.⁵

Despite experiments with model dams at the Road Research Laboratory Harmondsworth and possibly because no practicable method of breaching one had yet been devised, Wallis regarded his project as primarily 'a naval weapon' and a means of attacking warships at anchor. But the relevance for dams – a special interest of the Air Staff since 1937 – determined that Blackett should contact his counterpart at the Air Ministry, Sir Henry Tizard, who visited Wallis at his temporary office in Burhill Golf Club on 23 April. Both Blackett and Tizard had an advanced draft of the 14 May paper and may have exercised some influence over the final version. Without doubt, though, Tizard was instrumental in securing permission for Wallis to conduct tests at Teddington, where he aimed 'to establish the feasibility of certain full-scale trials of a method of attacking ships'. To Ernest Relf of the NPL, on 19 May Wallis explained that 'the main difficulty may be to fly low enough at high speed as the angle of the first contact with the water is strictly limited'. Eight days later, he went to Teddington to finalise administrative arrangements, and on 30 June 1942 he outlined his programme 'to determine the performance obtained at varying aircraft speeds with varying mean density of bomb and height of discharge above the water'. Use of the water tanks and wind tunnel at Teddington would be followed by dropping tests from 55ft in the Vickers-Armstrong's shed at the RAE Farnborough, first with wooden dummies then a full-sized steel bomb of the correct weight. Finally, full-scale tests would be carried out with inert-filled bombs from an aircraft.⁶

ADMIRALTY INTEREST

Between 9 June and 10 September 1942, Wallis made use of one of the two large indoor water tanks at Teddington on at least 18 occasions, often all day. 'I moored a wax model of a battleship several hundred feet up the tank, broadside on. We fired 2in dia

(sic) balls at it, when of course after hitting the freeboard of the ship, the sinking velocity of the ball combined with back-spin to move it towards the ship, and by adjusting the mean density of the ball we were able to pass it right underneath 'the soft underbelly', to quote Winston Churchill'. By now, Wallis had added back-spin to his weapon for increased range and stability after release. There is evidence that he had always intended this, but for some reason excluded it from the 'Spherical Bomb' paper. Despite Blackett's earlier enthusiasm, it seems likely that the Admiralty only became actively involved in June 1942, after Lt LHM Lane RNVR from the Directorate of Miscellaneous Weapon Development (DMWD) visited Wallis about another of his ideas and learnt of this one. As a result, Rear-Admiral E de F Renouf, Director of Mine Warfare (DMW), went to Teddington and returned with other high-ranking officers who according to Wallis, were '*tremendously* impressed'. Representatives of the Air Staff and Ministry of Aircraft Production (MAP) also made the trek into Surrey. On 21 June the Controller of Research and Development (CRD) at the MAP, Air Vice-Marshal JF Linnell, wrote that 'the model experiments have established a clear case for an air test using full-scale bombs'. He authorised allocation of a Wellington for trials on the understanding that 'relatively small ... structural modification 'to the bomb bay fairing would be necessary. Acknowledging that 'Wallis is an enthusiast for this scheme', he expressed concern that, 'as *the leading hand* in Vickers design staff' the replacement for the Wellington aircraft would suffer, if he were 'devoting too much of his time to his bombing project'. Subsequently, on 28 June, Dr DR Pye (Director of Scientific Research (DSR) at the MAP) did unequivocally inform Wallis that the aircraft must take precedence over 'this bombing project'.⁷ On 9 July, Pye reflected: 'I think we can safely say that the gravity dam is a hopeless proposition', a view endorsed by other RAF visitors who, according to Gp Capt



Upkeep in static rig

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Production Wellington

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F W Winterbotham from Air Intelligence, doubted the concept of attacking ships as well. Winterbotham condemned Pye, chairman of a committee investigating Wallis's scheme for trying 'to prove that things *cannot be done*, rather than to find *how to do them*'. Wallis wrote bitterly on 21 July that 'the profound effect of water impact waves had not yet been realised by the Air Staff, but it is now appreciated by the Admiralty'. Without Admiralty – and specifically Renouf's – support, the 'bouncing bomb' may well have sunk without trace in a Teddington experimental tank. During June and July 1942, Air Ministry enthusiasm noticeably waned. Nevertheless, following Linnell's ruling of a month earlier, on 20 July a Wellington had been made available, and two days later Wallis learned that the Admiralty's request for 12 experimental weapons (4 ft 6 in diameter) to be dropped from it had been approved. This paved the way for a series of trials quite separate from those involving model dams.⁸

Underlining the naval dimension, Benjamin Lockspeiser (D/DSR at the MAP) sought advice from the Admiralty on what would be needed to 'damage various types of ships – i.e. size and charge weight'. RAF interest soon revived and a bureaucratic turf war between the Admiralty and MAP highlighted the Royal Navy's leading role at this stage. Lockspeiser complained on 8 August: 'DMWD is usurping our authority in this matter. I spoke to DMWD this morning and emphasised that these were our trials and that the responsibility for the conduct of them would rest with MAP'. Indeed, with so many agencies involved, friction seemed inevitable. On 2 October, HQ Coastal Command wrote to the MAP about DMWD working on a project 'which can best be described as a *spherical spinning bomb*', for which full-scale trials were soon due at Chesil Beach. Coastal Command could use such a weapon and wanted to send an observer to the trials. Wg Cdr EJ Palmer replied somewhat icily that the MAP was 'handling the scheme' with DMWD assisting only when required. Early flying trials were planned that week, but there was no need for Coastal Command to be concerned. This was a 'highly secret' affair. Sharply he added: 'The fact that knowledge of it has reached you rather surprises me and from your reference to them it would appear that DMWD are the culprits ... I will let you know as soon as an interesting stage has been reached'.⁹

AUTHORISED TESTS

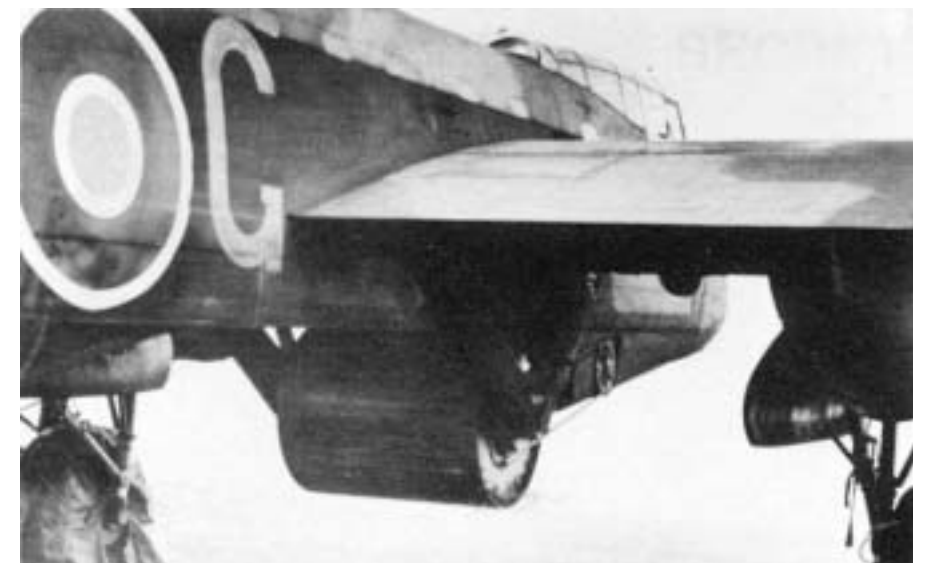
Such hiccoughs should not obscure the co-operation which did occur between Ministries and Services. On 4 June, £50 was agreed for preliminary tests at the NPL and a further £2,000 by Lockspeiser on 12 July for use of the water tank and wind tunnel, full-scale tests, modification of a Wellington and preparation of 'inert bombs' for dropping tests. This overall sum advanced to £10,000 on 4 August, indicating how seriously Wallis's idea was being taken. A report from RD Arm 4 (a) in the MAP underlined this on 18 August. Wallis intended to launch his 'novel' weapon from low level over the sea with a 'high rate of spin'. Model tests suggested that it would 'ricochet along the surface ... for a considerable distance', but no full-scale tests had yet taken place. Summarising the concept of attacking ships by sinking a charge beside them and exploding it with an hydro-static pistol, RD Arm 4 (a) concluded that 'the expected performance of the weapon appears to present several tactical advantages', though 'a considerable amount of work' had still to be done before Service use. A week later, the two Services

and the MAP decided to carry out dropping trials the following month off the Dorset coast between Chesil Beach and 'the mainland known as East and West Fleet', though these did not actually happen until December. At the meeting on 25 August, it was agreed that Vickers-Armstrong's chief test pilot, Capt Joseph 'Mutt' Summers, Wg Cdr Palmer from the MAP and Wallis should reconnoitre Chesil Beach in connection with 'the Rota mine'. Lt Lane of the DMWD went with them on 2-3 September. They found that RAF Warmwell close-by would provide lock-up facilities and the Wellington could take off from its grass runway 'except in extremely wet weather'. However, variations in the water level at Chesil Beach caused concern, and Wallis agreed to further experiments at Teddington 'to see if approximately 1 1/2 diameters of the projectile would be sufficient depth of water to avoid drag or any other factors which may occur'. This would explain why dropping tests were delayed and indirectly through the plural 'diameters' that more than one version of the weapon would be tried. By November, detonation tests had determined that the new underwater explosive Torpex would be suitable for the proposed weapon, two aerial versions of which were under consideration: the larger (codenamed Upkeep) in a Lancaster against dams; two of the smaller (codenamed Highball) to be carried by a Mosquito in a simultaneous operation against surface vessels.¹⁰

Progress on the technical side and detailed arrangements for the Chesil Beach trials had not proceeded altogether smoothly. On 13 July, Lockspeiser complained that Wallis foresaw a 54in-diameter weapon 'to conform with the density and charge weight requirements against capital ships'. This would create problems of modification in the Wellington, and he believed that a 30in-diameter would suffice to check data extrapolated from the models tests. On 14 September the Director of the RAE Farnborough raised the question of responsibility for preliminary trials, which Wallis said would be conducted by his firm. 'These tests would begin with one bomb mounted in the aircraft, and the number would be gradually increased after handling trials had been satisfactorily completed'. Once Vickers-Armstrong was confident 'that the complete bomb installation caused no damage or serious difficulty in handling, the aircraft would be handed over to the RAE for a very brief confirmatory handling trial'. The following day, Wallis wrote to Lockspeiser explaining that the RAE could not provide a suitable airborne camera for the Chesil Beach trials, but had suggested 'a theodolite camera having a traverse in azimuth of 130 degrees' for which rising ground on the landward side of the East Fleet range seemed ideal. An automatic light signal, Wallis noted, was 'usual' to indicate release from the aircraft.¹¹

That same day, 15 September, RD Arm 4 (a) summarised the 'progress of work on (the) Spherical Bomb'. One had been completed and would be filled with High Explosive (HE) substitute for static spinning trials within a few days. Eleven more

Progress on the technical side and detailed arrangements for the Chesil Beach trials had not proceeded altogether smoothly



A Lancaster equipped with the Upkeep bomb

fillings were in hand, eight of which should be ready for dropping trials by the end of the month. Model tests (presumably after Wallis's visit to Chesil Beach a fortnight earlier) had shown the depth of water at the range to be sufficient. Then, on 1 October, Pye at the MAP revealed that aerial tests would involve spinning four of the practice weapons in an aircraft. Nearly two months later, on 21 November and a day after witnessing these spheres being spun in a static Wellington, Lockspeiser wrote: 'All indications are that he (Wallis) has got over his troubles with substitute fillings' so that dropping trials could start in 10-14 days. Yet, conversely and puzzlingly, on 23 November Mr CC Aston of RD Arm 4 (a) admitted that problems were still being experienced. Three days afterwards, a meeting at the MAP learnt that chemists from the Paving Stone Company at Weybridge had approved a suitable substance, which Mr Early of the Research Department at Woolwich thought very similar to Torpex. Furthermore, one container would be filled with Mineol II and spun in Richmond Park 'to ascertain whether the HE moved and upset the balance', but this could not take place before 3 December. Altogether more promising, but progress was in truth abominably slow.¹²

On 30 November, more signs of delay surfaced. The Ordnance Board needed both to check the feasibility of the outline scheme and Wallis's 'designs (sic) of the bomb'. Two days later Wallis wrote to Aston, enclosing Drawing No 45257 which showed the device proposed for using the standard D/C Pistol Mk XIV, and explained that 'the acorn which is mounted on the end of the fusing wire is quite free within the four members of the cap, so that relative rotation can take place'. However, Aston wanted more information, and on 7 December asked Wallis for 'a general arrangement drawing of the store showing the location required by the fuze'. Three days afterwards it became clear that, contrary to an undertaking on 26 November, Weybridge could not carry out preparatory work connected with the practice weapon designated for the spinning tests. A further two days elapsed before alternative arrangements were finalised.¹³

DROPPING TRIALS

The Chesil Beach trials eventually began two months late. On 2 December, Summers took the modified Wellington BJ 895/G over the Queen Mary reservoir near Staines and reported no adverse effects as four scaled-down weapons were spun at the same time. Two days later, Wallis acted as his bomb aimer when he flew the Wellington – its bomb-bay doors removed and special spinning apparatus installed – to Dorset and released two practice bombs. Both welded spheres burst on striking the water. Undeterred, Wallis arranged for the outer casings to be reinforced. Poor weather delayed the 'Second Trial' until 15 December. Both spheres (one with a dimpled surface, one with a smooth surface) were dropped from 60 ft after a steep dive by Summers and were apparently shattered on impact. However, after recovery they were found to be damaged, not broken. Renouf witnessed the drops, remained enthusiastic and chaired a review meeting at Vickers House on 17 December. On his advice, the Admiralty pressed for further trials. A planning meeting on 19 December agreed that 'there is good reason to believe that a sound mine will behave at least as well as models have indicated'.¹⁴

On 23 December, the DMWD summarised Project No 52 as conducting trials to determine the safety of carrying aircraft,



effectiveness of Highballs hitting water, strength of Mk XIV Type D/C pistols, 'length of travel over water, height of bounces and angles of incidence and reflection'. That same day, authorised expenditure on Wallis's scheme (strictly a contract from the MAP to Vickers-Armstrong) rose to £15,000. Once more, though, signs of bureaucratic dispute appeared. CRD scribbled in the margin of minutes for a meeting at Vickers House on 23 December that with six out of the 12 present, 'the Admiralty seem to have packed the meeting'. Darkly he added: 'Special steps may be needed to ensure that the experiments are kept under control'. On 29 December, Wallis asked and received approval for two further days at Teddington to conduct more tests connected with the 'rotating spheres' following the first two Chesil Beach trials.¹⁵

...Wallis acted as his bomb aimer when he flew the Wellington – its bomb-bay doors removed and special spinning apparatus installed – to Dorset and released two practice bombs

From the Admiralty's point of view, 1942 ended on a positive note. Sufficient progress had been made for hopes of an attack with Highball in the New Year. Dropping trials at Chesil Beach gathered pace in January 1943, based on guidelines laid down on 28 December 1942: 'Smooth and dimpled Highballs' strengthened by extra welding would be followed by 'wooden Highballs fitted with cups designed to record impact forces' with the aim of confirming data from the NPL tests. The third and fourth series of trials occurred on 9-10 and 23-24 January 1943. Further drops on 5 February involved smooth wooden balls released from the Wellington at heights of 80-145 ft at an estimated air speed of 300mph and revolving at 425-450 rpm, the longest range achieved being 1,315 yds. To Lord Cherwell, Churchill's scientific adviser, on 30 January Wallis confirmed that the Chesil Beach trials had 'justified the hopes raised by the 2in-sphere trials' at Teddington. As a result, the Admiralty had given 'full priority' to develop a '3ft-sphere' for use by Mosquitoes against 'naval targets'. Independently summarising these trials, AD Grant (Wallis's administrative officer) explained that the first spheres comprised 'relatively thin steel pressings welded together and stiffened with diaphragms' and were dropped empty to make recovery theoretically easier. However, they were so severely damaged that some were then inertly 'filled with concrete'.¹⁶

INTENSIFIED RESEARCH

As these trials progressed, Wallis produced a 19-page paper which, despite its title *Air Attack on Dams*, included material relevant to an operation against *Tirpitz*. He sent a copy to Renouf on 9 January. After dealing with the German dams, in Part III he described 'the rotating sphere ... as a means whereby aircraft may attack targets which are either water-borne or in contact with water'. During the next three months, 19 other people received copies, including Cherwell and Lockspeiser at the MAP. Capt FWH Jeans, Director of DMWD, had his on 20 January and Wallis believed that this was in turn copied and extensively distributed within the Admiralty. Figure 9 in the paper showed a 'spherical surface torpedo' released 1-2000 yds from the target attaining a 'mean velocity of about 150 mph', striking the side of a ship and, with the aid of its back-spin, penetrating the water to explode 'about 15-20 ft' below the hull. With the vessel in the illustration anchored close to a steep cliff, the similarity to *Tirpitz* in Foetten Fjord was marked.¹⁷

A combination of this paper and the Chesil Beach trials, plus Admiralty long-standing keenness, ensured that prospects for a Highball attack on *Tirpitz* did not die. Inevitably, though, a plethora of meetings filled the diaries and a procession of minutes and memoranda swamped the desks of busy men. On 2 and 4 January, the MAP drew attention to problems with the trials thus far and need to strengthen the weapon's casing. On 18 January the RAE was asked to arrange for a theodolite camera at the next series of drops connected with 'Operation High Ball' (sic) planned three days hence. The following day, a meeting chaired by Renouf looked at types of aircraft suitable to attack a warship with a weapon, which Wallis said would have a charge smaller than the 750 lb currently planned for the 46in-model. The MAP revealed, on 28 January, that it had placed 'a research contract for 250 of Wallis's spherical bombs' with Vickers-Armstrong's works at Crayford and that two Mosquito bombers were to be modified for further trials. Wallis was to liaise with the Mosquito's manufacturer, de Havilland, over the modifications as 'the essential requirement is that of the highest possible speed low down near the water'. At length, a division of labour was agreed between de Havilland and Vickers-Armstrong, though the latter warned that sub-contracting to Messrs Marshall of Canterbury might be necessary. Summers would be consulted about 'special radio devices' to determine the precise height above water. The following day, DSR expressed concern at 'the scientific problems involved in hydrostatic fuzeing and sighting'.¹⁸



A PRU Mosquito

Two Mosquito IVs were formally put on contractual loan to Vickers-Armstrong on 30 January, though 10 days earlier Wallis had been asked to produce data so that Beaufighters could be considered for the operation. A meeting at the MAP on 2 February, 'to discuss the design of the Wallis Spherical Bomb for attack of Capital Ships with special reference to exploding (sic) arrangements', heard that Wallis currently saw Highball with a 35in-diameter, 1.5in-thick case, density of 75 lb per cubic foot, charge of 500 lb and total weight 950 lb. As shown in *Air Attack on Dams*, he anticipated that it would hit the ship at 150 mph and saw no difficulty with detonating the device. The Admiralty representative requested that the weapon should be able 'to

Wallis repeated that he envisaged Highball comprising a 500 lb charge in a cylinder contained in a 35in-sphere with a gross weight of 950 lb and mean density of 75 lb per cubic foot. Two would be carried in a Mosquito and released 3/4 mi from the target

jump a protecting section 6 ft high at 80yds' from a target. A meeting on 7 February learnt that three bombs filled with HE substitute would be dropped on concrete at Porton Down: woodmeal wax or soft white pinewood would be used as packing between the inner and outer casings. A week later, possible trials using Staines reservoir were ruled out for security reasons, and on 13 February, Air Vice-Marshal RS Sorley chaired yet another meeting 'to discuss the development and possible operational use of the spherical bomb'. Wallis repeated that he envisaged Highball comprising a 500 lb charge in a cylinder contained in a 35in-sphere with a gross weight of 950 lb and mean density of 75 lb per cubic foot. Two would be carried in a Mosquito and released $\frac{3}{4}$ mi from the target.¹⁹



On 16 February, Gp Capt FW Winterbotham of Air Intelligence (AI 1c) wrote a 'most secret and personal' minute to Air Vice-Marshal FF Inglis, ACAS (I), reminding him that he had spoken 'some months ago about an invention ... which consisted of a spherical bomb that was made to reach its objective by Ducks and Drakes over the surface of the water'. He confirmed that it was 'originally evolved for attacks against Axis warships' about which the Admiralty, the Chief of Combined Operations and the Prime Minister 'became enthusiastic'. The code word was 'Highball' and 'the registered inventor BN Wallis of Vickers. I understand the Prime Minister has laid on the highest security measures'. Winterbotham outlined the different versions of Wallis's weapon, adding optimistically that 'the small anti-ship bomb is nearly ready'. Revelation that Churchill not only knew about the project, but strongly supported it, once more underscored his concern about *Tirpitz*. On 22 February, the MAP laid down that modifications to the two Mosquitoes contracted to Vickers-Armstrong for test purposes should not exceed £6,000. Four days afterwards, Flt Lt AD Green of the MAP revealed that the cost of 250 35in-Golf Mines (a generic term for all types of Wallis's weapon) depended upon the results of the dropping trials at Porton carried out on 17 and 23 February, which in turn would affect the final design. That same day, Air Vice Marshal JF Linnell (CRD at the MAP) chaired a meeting at which Mr A H Palmer of Vickers-Armstrongs said that Highball and Upkeep 'would probably not be in competition for machinery capacity due to the difference in their size'. The meeting learnt, too, that the first modified Mosquito should be ready by 8 April, the second a fortnight later. Slight qualms were raised the following day, 27 February, when Gp Capt W Wynter-Morgan admitted that the 75 Upkeep and 200 Highball 'Golf Mines' scheduled to be filled with Torpex would absorb the bulk of the RAF's allocation of explosive and deny its use in 860 1,000 lb Medium Capacity (MC) bombs.²⁰

CLOSER AIR STAFF INVOLVEMENT

On the last day of February 1943, an Air Staff appreciation summarised the situation, still referring to a 35in-diameter weapon, 950 lb in weight to be released $\frac{3}{4}$ mi from a target. But it would now contain 600 lb of explosive and be back-spun at 500 rpm. 'Primarily' it had been developed to attack *Tirpitz*, and two Mosquito squadrons with 250 bombs were planned to achieve both this objective and attacks on other Axis capital ships. The prospect of a successful attack against the German battleship at Trondheim 'increased as a result of the superior performance of the Mosquito compared with current torpedo bomber types, and of the characteristics of the bomb'. Nevertheless, even in moonlight, an accurate night attack would be impossible '... in view of the navigational difficulties involved in a low-level approach to the target from outside of RDF cover ... a problematical ... and costly' daylight operation was the only option. Such an attack, whether successful or not, would compromise any operation against the German dams, so 'every effort should be made' to launch both 'at the same time'.²¹

On 3 March, the MAP confirmed that each of the bombs manufactured at Crayford cost £1,000. That same day Green laid down specifications for 250 Mk XIV D/C pistols, which must function in fresh water at 30 ft and 'may be subjected to severe side impact'. They were required by 30 April and should sink at 15 ft per sec. At its meeting on 8 March, the Chiefs of Staff established a sub-committee to report fortnightly on the progress of both Highball and Upkeep, and the Admiralty swiftly mounted a palace



Warmly, he argued that, as its squadrons would train for, plan and execute operations connected with Wallis's invention, the chairman ought to come from the RAF

coup to get Renouf appointed to its chair. Two days later, the RAF counter-attacked. Portal wrote whimsically to Pound: 'If his (Renouf's) name was mentioned at the meeting I apologize for not having heard it'. Warmly, he argued that, as its squadrons would train for, plan and execute operations connected with Wallis's invention, the chairman ought to come from the RAF. Air Vice-Marshal NH Bottomley, according to one staff officer adept at 'playing the Air Ministry organ more beautifully than anybody else', duly and rapidly replaced Renouf.²²

Sir Charles Craven (Chairman of Vickers-Armstrong) announced on 9 March that the 250 contracted Highballs would be completed by 19 June and, if told 'immediately', a further 250 could be produced at 100 a month. This business proposition, despite further advances from Craven, was not taken up. Four days later, Lockspeiser complained that 'Highball' had come incorrectly into use; the proper codename was 'Golf Mine'. Sorley thought worse confusion would occur if the error were now pointed out, and 'Highball' stayed. At this meeting, Renouf pressed for an early attack on *Tirpitz*, fearing that defences around her would be heightened now that winter darkness had ended. On 16 March, Craven confirmed that 10 'Hi-Balls' (sic) had been despatched from Crayford, 120 would be ready by 26 April. The following day, the inter-Service Joint Planning Staff, referring to 'Operation Highball' concluded that 'the present arrangements for attacks in May on German dams and heavy units of the German Fleet should be pressed on with all vigour', but accepted that this would depend upon the technical findings of Bottomley's ad hoc committee.²³

PROGRESS MEETINGS

That body produced its first report on 18 March 1943, identifying Trondheim, Narvik and Alten Fjord as the normal Norwegian anchorages for German heavy units; Kiel and Gdynia their repair ports. Of these only Kiel and Trondheim were within range of Mosquitoes from the United Kingdom. Noting that any attack on the German dams must be delivered before 26 May, the committee assumed that Highball would be used 'at about the same time'. Two days later, Bottomley received a sharp reminder from the CAS that his committee had been appointed 'to accelerate development and trials and to get the weapon into action as soon as possible'. It should not stray into operational matters which were the province of the Air and Naval staffs. The next day, 21 March, an Air Staff paper about an attack on 'enemy capital ships in Norwegian waters' pointed to the 'formidable' defences which would surround any of them at anchor. Carrying two Highballs, a Mosquito's range would be reduced to 1,140 mi, allowing Trondheim to be attacked from Sumburgh. Narvik and Alten Fjord were out of return range, 'but under most favourable conditions might allow of aircraft reaching Russian territory'. An alternative would be to 'abandon' (presumably bale out of) the aircraft over Sweden. A memorandum by Bottomley, dated 24 March, noted that a Mosquito unit for the purposes of attacking *Tirpitz* would be formed shortly and that

'Operation Highball' concluded that 'the present arrangements for attacks in May on German dams and heavy units of the German Fleet should be pressed on with all vigour'...

Bomber Command had agreed to supply 'an adequate number of trained crews and maintenance personnel' to assist with its creation. Meanwhile, on 22 March, exercising overall professional responsibility for targets in the area of the enemy shoreline, Coastal Command took over the task of attacking *Tirpitz*.²⁴

If dropped from 100 ft at 300 mph, the range would be 1,250 yds and its 'primary purpose' was to attack capital ships

Another meeting of Bottomley's committee on 25 March heard that 30 'Highball bombs' had been delivered from the factory and filling was

about to start. Fifty of the total ordered would be inert-filled for trials, one go to Vickers-Armstrongs for spinning tests. Four days later, from the Air Ministry Air Vice-Marshal JC Slessor complained to Bottomley about expanding proposals to attack capital ships in Norway, *Graf Zeppelin* in Gdynia and the Italian fleet, which would require 2 1/2 dedicated squadrons and 'wreck' 2 Group operations. At best crews would need two months' special training and then success could not be guaranteed. 'It isn't worth just taking any old squadron with its ration of P.O. Prunes and re-equipping it with Mosquitoes and arming it with this potentially decisive weapon'.²⁵

Clearly making use of Slessor's comments, on 1 April Bottomley submitted a lengthy memo to the COS Committee in response to a minute of 27 March asking for analysis of the means required 'to attack the German capital ships at present in Bogen Fiord (Narvik)'. After consulting Coastal Command, Bottomley believed that a squadron of 20 aircraft would be needed, but if the further idea of attacking Italian warships were pursued, a second Highball squadron should be planned. He held that the last week in June was the earliest date for an attack on *Tirpitz*. The following day, his ad hoc committee produced its second report, which held that 16 modified Mosquitoes would be operational by 8 May, the remaining 14 be ready at approximately four per week. This would allow 20 for *Tirpitz*, 10 for *Graf Zeppelin*. Yet another 'progress' meeting at the MAP on Saturday 3 April learnt that the first modified Mosquito would still leave Vickers-Armstrongs on 8 April, VHF be fitted on arrival at the operational unit and up to 500 Highballs, for inert and live use were now being considered.²⁶

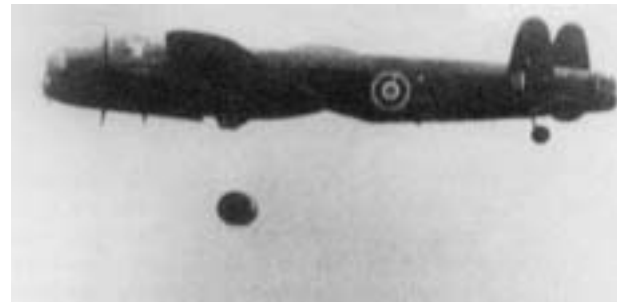
The Chiefs of Staff agreed on 7 April that Trondheim would be the most northerly location at which Highball could be used, and five days afterwards the Air Ministry sent the RAF delegation (RAF DEL) in Washington outline details of 'Weapon A' (Highball) and 'Weapon B' (Upkeep) with a warning that in 'personally' informing each member of the American Joint Chiefs of Staff 'the absolute need for security' be emphasised. Highball was 960 lb in weight including a 600 lb charge, with a 35in-diameter. If dropped from 100 ft at 300 mph, the range would be 1,250 yds and its 'primary purpose' was to attack capital ships. 'The bomb is suspended in the bomb bay and given a backward spin of about 500 revs per minute before dropping. This initial spin lengthens initial flight before impact on water, increases the angle of incidence of ricochet and serves to counter the action of the water drag and the tendency of the sphere to roll under water. Investigations so far show that the spherical bomb will not be checked by booms carrying protective torpedo netting'.²⁷

A progress meeting at the MAP on 14 April received more details about delivery by Air Transport Auxiliary pilots of Mosquitoes, for which additional wing tanks were on order. Next day, RAF DEL reported that General HH Arnold, Commanding-General of the US Army Air Forces, had displayed great interest in Highball and that it was 'very important that we get the plans for this device to the United States at the earliest possible date'. On 17 April, Bottomley's committee issued its third report, concentrating on the task of securing suitable drop tanks for the Mosquito to stretch its range by 200 miles 'under normal operational conditions'. The fourth report on 30 April confirmed that suitable, extra 42-gallon drop tanks had been made available and would be fitted to five aircraft a week. Ahead of schedule, 20 Mosquitoes were expected to be delivered by 15 May. Worryingly, though, that day Coastal Command recorded Vickers-Armstrong's observation that the Mosquito tended 'to sag' with an extra fuselage tank.²⁸

HIGHBALL TRIALS



Highball trials at Reculver Bay



In fact, Highball dropping trials did not go well once a more specialised series, quite distinct from Upkeep, commenced in April. On 20 February 1943, Lockspeiser had warned Wallis of discussions between the MAP and Admiralty about 'the question of trials which will be necessary with the smaller version of your little toy to bring it into operational use as quickly as possible'. The final set of trials at Chesil Beach

took place 8-9 March, but these exclusively concerned Upkeep. Although similar trials with a 46in-sphere were planned for eight days later, on 13 March the range was declared 'inadequate'. Due to lowering of the water level in spring and summer, even in ideal weather the Chesil Beach range would now be suitable on only three days a fortnight. Other locations were examined, including Shoeburyness, Orfordness and Port Madoc, but on 20 March the bombing range north of Reculver on the Kent coast was chosen and arrangements made to carry out separate Upkeep and Highball trials there from RAF Manston. It was, the MAP concluded, 'the best bet ... for security purposes'. On 18 March, Bottomley's committee noted that the first Mosquito would soon be ready to commence the

following programme: 'Trials to confirm the trajectory, range and dropping height will be undertaken immediately on delivery, these being followed by others against a target ship'. Next day, 19 March, ACAS (Ops) agreed that the first Reculver trial would be on 10 April, though during a meeting at the Air Ministry on 25 March this was put back to 11 April. The training and testing schedule now became clearer. 'Technical trials' would be at Reculver, and some operational crews would be trained there too in tandem with others at RAF Skitten in Scotland. The operational station for the special Mosquito squadron destined to attack *Tirpitz* would be RAF Sumburgh.²⁹

By arrangement with Renouf, the former French warship Courbet would become the static target in a Scottish loch, and Mosquitoes practising against her would be based at RAF Turnberry. A meeting on 9 April recorded that inert-filled Highballs were to go to Turnberry, where Vickers-Armstrong would provide mechanics for aircraft maintenance. The previous day, a programme for Highball trials at Reculver was drawn up, aiming 'to determine the optimum range and trajectory of the 35in-sphere'. To establish the 'highest possible speed' commensurate with safety, the aircraft would dive up to 400 mph 'and parallel trials should be carried out at the maximum ground level speed without diving'. The sphere would be spun at different speeds up to 1,000 rpm, and modifications would be made to the sphere in the light of results.³⁰

Static tests were conducted at Manston on 11 and 12 April, the inert filling being 'a compost of synthetic resin and sawdust'. On Tuesday 13 April Sqn Ldr C F Rose flying west to east dropped two Highballs at 0717 and 0720, both from 100 ft at 360 mph. One spun at 700, the other 1,000 rpm. As at Chesil Beach, the trials were filmed from a camera on shore, but for later ones at Reculver a second camera was positioned ahead on a spit of land below the old Norman church. Wallis recorded the outcome of Rose's efforts. 'In both cases the wood casing broke up on impact, but in the second run about 3/4 of the casing remained intact and gradually separated from the cylinder the latter apparently coming out axially. Casing and cylinder then continued flight together for a short distance, the casing striking the water and making a slight bounce. During the whole of this period, the undamaged portion of casing maintained its correct size and shape, so far as can be seen from the film'. On 16 April, three more Highballs (two from a Mosquito, one the Wellington) were dropped with similar results. Following the first failure, the metal bands restraining the outer wooden casing had been tightened. More drops on Sunday 18 April were unsuccessful, though: 'The cylinder also failed to run due to a section (or slice) of the wooden casing being cut off on impact'. Further adjustments were then put in hand with an 18in-wide metal band being fitted over the wooden casing. However, on 20 April, Air Marshal RHM Saundby at Bomber Command pronounced the trials so far 'disappointing'. Three days later, privately Wallis admitted that, although the tests at Porton had been 'successful', those from Manston were 'inconclusive'.³¹

The fourth trial at Reculver commenced on Wednesday 28 April, watched by Wallis and Renouf. At 7.30pm, flying parallel to the coast, Rose dropped the first steel-cased ('armoured with steel plates $\frac{5}{32}$ in-thick') Highball, spinning at 700 rpm, from 130 ft at 350 mph into a 15 mph head wind. Wallis recorded, despite a rough sea, 'a very successful drop, the store running well', '4-5 bounces' over 'about 1,000 yds'. The Highball was empty and therefore floated, but was 'slightly damaged'. The following morning Rose released a second, empty steel-cased Highball, spinning at 920 rpm, from 60 ft at 370 mph into a 5mph head wind. Again it bounced '4-5' times and travelled '1-2,000 yds'. 'Very successful. Casing quite undamaged', Wallis wrote. On 30 April, in flat calm Rose dropped two Highballs encased in wood (ash) not steel, spinning at 700 rpm from 60 ft at 360 mph. The first travelled 1,600 yds and bounced 12 times. Wallis professed only 'academic interest' in the performance, seeking merely to gain information about 'impact forces'. He had still not decided on the final composition of Highball, proposing to repeat the trial with steel plates. If successful, he would 'put on order' $\frac{5}{32}$ in-thickness plates for the remainder. He also considered 'plastic

mould casings' instead of wood. In its fourth report, issued on 30 April, Bottomley's committee noted that the two drops on 28 and 29 April, with a 'metal sheet over the wooden casing', had been 'successful'.³²

Rose dropped two steel-cased Highballs on Sunday 2 May at 1230 in rough seas from 60 ft, one at 370 mph and 700 rpm, the other 380 mph and 520 rpm. In spite of an 'excellent performance' in terms of distance travelled, on recovery both were dented. Nevertheless, Wallis now opted for steel covering of the wooden casing. In a meeting at Manston on 2 May, chaired by Air Cdre B McEntegart, Wallis explained that 30 sets of steel bands had been ordered by Vickers-Armstrong from Messrs Sankeys, four of which had been delivered to Crayford on 1 May, thus revealing that Wallis's decision had been taken (and presumably officially approved) after the 29 April trial. The 'bands' were to be fitted to inert-filled Highballs by Vickers-Armstrongs and then sent to RAF Turnberry for trials against *Courbet*. Other inert-filled stores would be modified at Crayford and despatched to Manston for use at Reculver. The meeting, however, agreed that modifications to the full number of 250 Highballs would be postponed till after the anti-ship trials. As to those already delivered to RAF stations, 'all that would be required of the Service to modify existing stores would be to tighten up the bands, screw on steel plates provided and treat these plates and the exposed woodwork with a good quality paint'. They could then be kept in the open under a tarpaulin.³³

Simultaneous operations against Tirpitz and the German dams remained theoretically feasible

Unlike Upkeep which had been stripped to its bare, internal cylinder, Highball now comprised a central cylinder for an HE charge or inert filling, and packing outside of that held in position by wooden slats. In turn, the slats were surrounded by metal bands (like a rainwater butt) and further encased by two, 18in-wide, ⁵/₃₂ in-thick steel plates. On 6 May, a meeting at the Air Ministry concluded that security problems would be 'reduced', with Upkeep now being cylindrical, Highball spherical with flattened poles. Meanwhile, on 5 May, another meeting at the MAP had reviewed the Reculver trials, considered the failure of the wood-covered Highball, looked at the option of a moulded plastic replacement and confirmed the Manston decision of 2 May in favour of steel plates. Highballs, modified in this way, should be ready for balancing at Turnberry on 9 May. Trials from there would aim to secure information about the ability to withstand impact with a target and, administratively, would be conducted by the Marine Aircraft Experimental Establishment (MAEE) at RAF Helensburgh. Two Mosquitoes would go to Turnberry for the preliminary trials.³⁴

Simultaneous operations against *Tirpitz* and the German dams remained theoretically feasible. This article is concluded in the next issue.



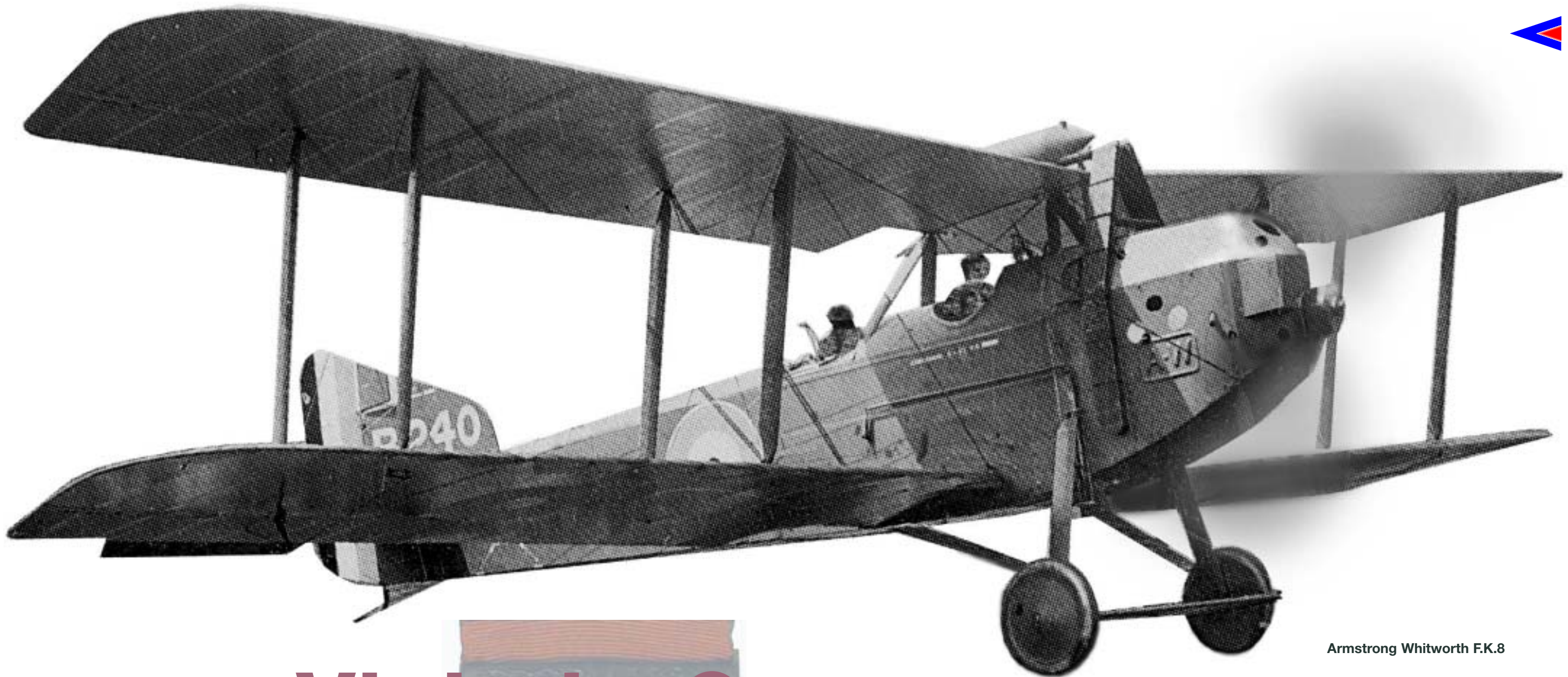
Explanation. Sir Barnes Wallis's papers contain a wide range of personal and official correspondence as well as copies of the minutes of meetings connected with his various projects, including Highball. When consulted at his residence in Effingham, the papers were not catalogued. They have since been dispersed mainly to the Science Museum, RAF Museum Hendon and Churchill College Cambridge. Some remain with the family, a few are in the possession of the Barnes Wallis Memorial Trust at the Yorkshire Air Museum, Elvington. Reference to the 'Wallis Papers' is made, therefore, only to identify the source of information and quotations.

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3. *A Note on a Method of Attacking the Axis Powers*, 1940, Wallis Papers.
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5. Wallis Papers.
6. Wallis Papers; 19 May & 30 June 1942, PRO AVIA 15/3933.
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12. 1 Oct & 21 Nov 1942, PRO AVIA 15/3934; 23 & 26 Nov 1942, PRO AVIA 15/3933.
13. PRO AVIA 15/3933.
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18. PRO AVIA 15/3933.
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20. 16 Feb 1943, Winterbotham to Inglis, Winterbotham Papers, RAF Hendon, AC 72/23/2; 22 & 26 Feb, Wallis Papers; 27 Feb, PRO AVIA 15/3933.
21. PRO Air 8/1234.
22. 3 Mar 1943, PRO AVIA 15/3933; 8 & 10 Mar, PRO Air 8/1234; Bottomley comment, Wallis Papers.
23. 9 Mar 1943, PRO AVIA 15/3933; 13 & 16 Mar, PRO AVIA 15/3934; 17 March, PRO Air 20/2617.
24. 18 Mar 1943, PRO Air 8/1237 & PRO Air 14/840; 20, 21 & 24 March, PRO Air 8/1234.
25. Bottomley Committee, PRO Air 14/840; Slessor, PRO Air 15/442.
26. Bottomley, PRO Air 209/2617 & PRO Air 8/1237; MAP meeting, PRO Air 14/840.
27. PRO Air 8/1834.
28. MAP meeting, PRO Air 14/840; Bottomley Committee, PRO Air 8/1237; Coastal Command, PRO Air 15/442.
29. Lockspeiser to Wallis, Wallis Papers; trials details, PRO AVIA 15/3934; Bottomley Committee, PRO Air 14/840 & PRO Air 20/2619; 19 March 1943, Air 8/1234; 25 March, PRO Air 14/840.
30. Wallis Papers.

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32. Fourth trial, Wallis Papers; Bottomley, PRO Air 8/1237.
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34. Wallis Papers; MAP meeting, PRO Air 15/442.





Armstrong Whitworth F.K.8

Victoria Cross Hero

This story was originally published in *TEE EMM* (Training Memoranda) in May 1941, issued by the then Air Member for Training, Air Ministry, London



On 1 May 1918, the name of 2nd Lieutenant A A McLeod of the Royal Air Force appeared in the *London Gazette* as having been awarded the Victoria Cross. Only three Canadian aviators received this decoration during the last Great War, and he was the youngest, being not then 19. As a matter of further interest he was not a fighter pilot, to whom, as a rule, fate sent more opportunities for winning the VC; he was one of the very few airmen to win it in a heavy bomber. As a record of successful achievement, dogged endurance and high courage, the story of the fight that gave McLeod his decoration is worth re-telling.

LOST IN THE FOG

With Lieutenant A W Hammond as observer, he was flying an Armstrong-Whitworth one morning on a bombing raid against German troop concentrations near Bray. They were flying in company with six other planes, but soon lost them in fog and had to come down at another squadron's aerodrome. Owing to slight damage on landing they did not take off again till afternoon, but in spite of the weather and disregarding the fact that Richthofen's famous circus was known to have been operating in the neighbourhood, they determined to finish the job they had started out to do.

Reaching the Bray area, with clouds now at about 3,000 ft, they started to look for a target. Soon they spotted a German battery in action and were just getting into position to bomb when suddenly a German triplane appeared only 200 yards away.

The enemy was one of the fast new Fokkers for which the heavily-loaded Armstrong-Whitworth was hardly a match, but without hesitation they attacked. By skilful manoeuvring McLeod put Hammond in position, and after three short bursts of fire the German machine went over on its back, then into a spin and crashed to the ground.

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Lieutenant A A McLeod, a young Canadian aviator who received the Victoria Cross



German aircraft fired from all directions

The German aircraft swarmed around them, firing from all directions, but Hammond and McLeod made good use of their guns, firing just enough to keep the enemy at bay and at the same time conserving their ammunition

OUT OF THE BLUE

McLeod and Hammond were waving congratulations to each other over their unexpected success, when all at once the clouds broke and they saw blue sky. At the same moment another Fokker triplane dived at them, followed by six others. (It is quite clear from Richthofen's reports for the day that these machines were his and were therefore flown by some of the finest German pilots.) The German aircraft swarmed around them, firing from all directions, but Hammond and McLeod made good use of their guns, firing just enough to keep the enemy at bay and at the same time conserving their ammunition. Presently, by very skilful handling of the Armstrong-Whitworth, McLeod again gave Hammond the chance for a good burst, this time at a plane which had dived so close that he was only a few feet away when Hammond opened fire. The force of the bullets hitting the German aircraft was so great that the body of the triplane broke off at the pilot's seat and the wreckage immediately burst into flames.

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Even though one of his arms was completely useless and that he had been hit in several places, Hammond once more manned his gun and shot the German machine down in flames

At the same time another triplane dived from behind and zoomed up underneath the British machine, raking it with fire, hitting both McLeod and Hammond and igniting the tank. At last the fight had come to its almost inevitable end. They were still about 2,000 ft up, and McLeod put the machine into an easy dive in an effort to reach the ground. Before long, the floor of the machine fell away, carrying with it the revolving stool on which the observer sat.

In spite of his wounds, Hammond managed to climb up and sit on the ledge surrounding the top of the observer's cockpit. It now looked as though death was certain, but McLeod climbed out on the left lower wing and controlled the plane from there, putting it into a steep sideslip so that the flames blew clear of himself and his observer. One of the Germans, evidently thinking that the British aircraft was hopelessly out of action, dived so close that Hammond could see the features of the pilot.

Even though one of his arms was completely useless and that he had been hit in several places, Hammond once more manned his gun and shot the German machine down in flames. The remaining Fokker again opened fire, and finally jammed Hammond's gun. He was then able to follow them safely almost to the ground, hitting them time and time again. McLeod still kept the Armstrong-Whitworth in a steep sideslip and finally succeeded in flattening it out just before it hit the ground, where it crashed into a shell-hole. Before it did so, Hammond had climbed on to the upper wing and both were thrown clear of the wreckage.

CRASH LANDING

As it crashed the plane began to blaze fiercely, and as there were eight heavy bombs and more than 1,000 rounds of ammunition still in it, the two airmen, who had escaped death most miraculously, were once more threatened. Hammond, who had been wounded six times, was now quite helpless, and McLeod, although he himself received five wounds, began to drag him to safety. The machine-gun bullets from the plane were going off all around, and soon the bombs also exploded and blew parts of the aircraft about the pair, but without further injuring either of them.

When they had come down, neither had known where they were, until heavy machine-gun fire told them that they were between the two front lines. McLeod dragged Hammond toward the British trenches and was again wounded. However, before collapsing from loss of blood, he had dragged his companion by sheer dogged courage to within a few yards of the trenches where some men from the South African Scottish rushed out and carried them into the trench.

Then came perhaps the worst experience of all. They were in the very midst of the battle area, and at this particular point there were no communication trenches through which they could be carried back to safety. Their rescuers could only wait for darkness, and all afternoon they lay in terrible pain, expecting at any time to be attacked.

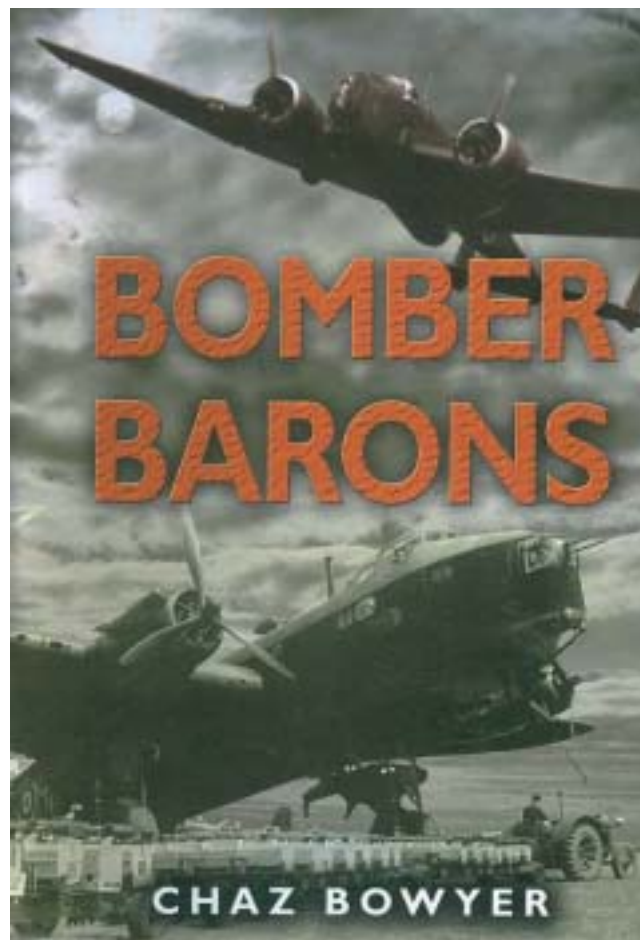
Their rescuers could only wait for darkness, and all afternoon they lay in terrible pain, expecting at any time to be attacked

About eight o'clock that night they reached the reserve trenches where their wounds were dressed and the pain relieved by morphine. Then they were taken by stretcher bearers to a dressing station, on by ambulance to the Casualty Clearing Station and thence to hospital at Etaples. Two nights later both were safely back in England.

For this epic fight Hammond received a bar to his Military Cross, while McLeod was awarded a well-earned Victoria Cross.

BOMBER BARONS

Chaz Bowyer



By the end of the Second World War, a grim total of 55,000 air crew of Bomber Command had lost their lives. This figure comprised no less than seventy per cent of RAF fatalities. Yet, unlike their more glamorous fighter pilot colleagues, very few bomber pilots or crewmen were familiar household names to the general public. However, within the ranks of the RAF itself, some individuals stood out gaining high reputations for their courage and leadership, a respect achieved regardless of the decorations they had won or the number of sorties flown. These were the **Bomber Barons**.

In this authoritative book, aviation historian Chaz Bowyer chooses a selection of these men. Some like Leonard Cheshire, Guy Gibson and Hughie Edwards are today well known, but others such as Nick Knilans, Syd Clayton and Jo

Lancaster, are familiar only to those known 'in the know'. For each, the author details their careers and relates episodes that reflect the qualities that made them outstanding.

At the same time, the reader learns of the unfolding dramatic development of Bomber Command from the comparatively uncoordinated, non-cohesive raids of the early part of the war to the highly-trained and deadly offensive weapon it became under Sir Arthur Harris, from 1942 AOC-in-C of Bomber Command, and the Greatest Baron of them all.

B A 'Jimmy' James

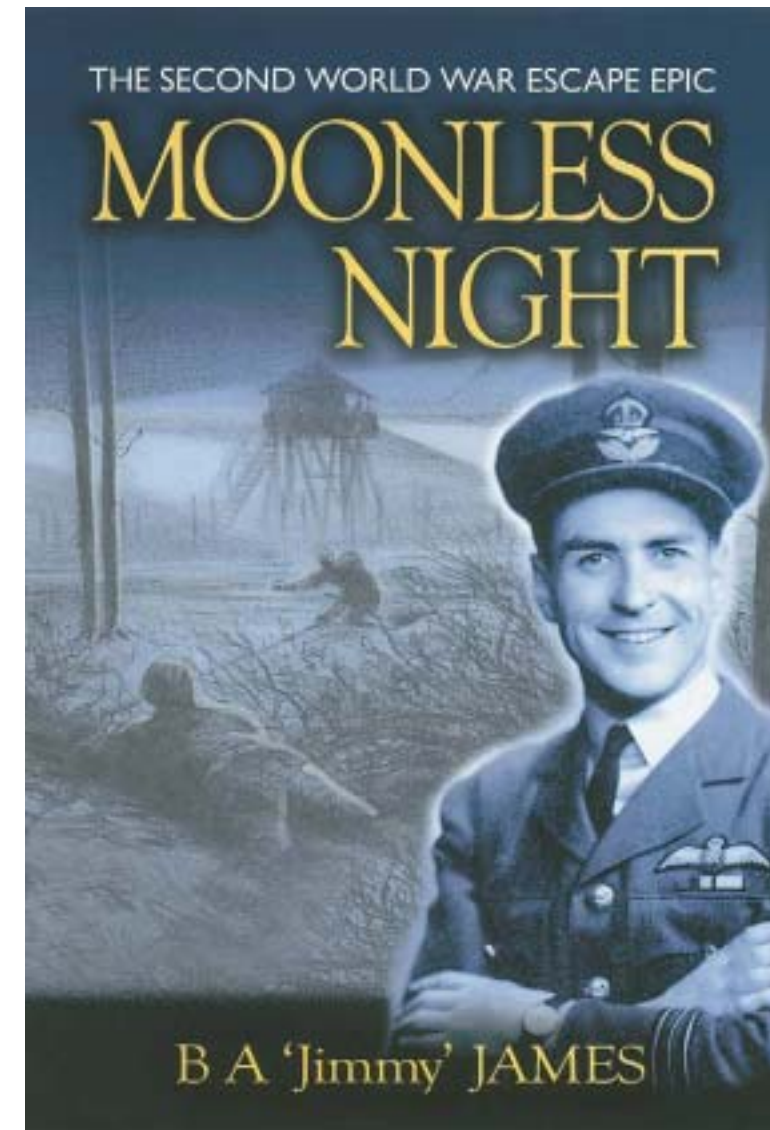
Any prisoner-of-war deep inside the Nazi Third Reich who attempted to escape deserves the highest praise for courage and determination.

Remarkably Jimmy James took part in no less than twelve attempts including the Great Escape, which so angered Hitler that fifty of the seventy-six POWs involved were callously murdered.

In ***Moonless Night*** he describes in the most graphic and gripping terms not only on his own experiences and emotions, both in captivity and on-the-run, but also the achievements of his fellow prisoners-of-war.

The author's style is so disarmingly modest that readers may find themselves almost taking for granted the extreme risks involved. After capture, following the Great Escape, he and a small group of colleagues experienced appalling conditions at the notorious Sachsenhausen Concentration Camp. Yet they utterly refused to accept captivity even when recapture carried the real prospect of execution. Indeed they were sentenced to death by Himmler after a further unsuccessful escape but this was commuted to five months solitary confinement in the Death Cells. In the closing stages of the war, Jimmy James passed through Flossenbug and Dachau.

In the front rank of World War Two escape stories, ***Moonless Night*** is an inspiring, exciting book which demands reading.





TATTOO HOME-COMING

The Royal International Air Tattoo (RIAT) 2002 will take off from RAF Fairford in Gloucestershire on Saturday and Sunday 20th and 21st July. Major airfield renovations at the air base, home to the tattoo since 1985, led to Europe's biggest airshow being staged at RAF Cottesmore, Rutland, in 2000 and 2001.

In a high-flying celebration of Queen Elizabeth II's Golden Jubilee, the Red Arrows will perform a special Royal Routine, and the flying display will open with a unique flypast of Hunter, Harrier, Nimrod, Tornado and Eurofighter aircraft representing each decade of Her Majesty's reign. RIAT 2002 will also stage a Salute to Bomber Crews on the 60th anniversary of the 'Mighty Eighth', formed by the US Army Air Force to fly from English bases during World War II, and *Global Ability* will give airshow spectators an insight into world-wide expeditionary air force operations.

RIAT Director, Paul Bowen, says "It is a great pleasure to be back at RAF Fairford and RIAT 2002 promises to be one of the best ever, attended by 200,000 airshow fans. As the world's biggest military airshow, we are set to attract some 450 aircraft from at least 35 countries for a spectacular mini-united nations of aviation." The Royal International Air Tattoo is held in support of the RAF Benevolent Fund.

Information:

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MILITARY AIRSHOW TO STAGE 2003 NATIONAL DEFENCE EVENT

The Royal Air Force has nominated The Royal International Air Tattoo (RIAT) taking place on 20th and 21st July 2002 at RAF Fairford, Gloucestershire, to host a three-day *Defence 2003* event from 18th – 20th July 2003, when the RAF will take the tri-Service lead in ‘Taking Defence to the Nation’. The Defence 2000 series of events replaces the Royal Tournament at Earl’s Court, following a Ministry of Defence decision that called for a more extensive public forum to display the complexity and capability of the UK’s modern Armed Forces.

Air Chief Marshal Sir Peter Squire, Chief of The Air Staff, says “The *Defence 2000* series is an exciting development in the presentation of Britain’s Armed Services to the nation, and in 2003 the RAF will be proud to act as host for this high-profile occasion. I am also delighted that The Royal International Air Tattoo, for three decades the world’s largest and most prestigious military airshow, will provide the venue for *Defence 2003*.”

2003 also marks 100 years of powered flight and this momentous anniversary will be celebrated alongside British Forces demonstrating their main role today, expeditionary operations. A fictional trouble spot somewhere in the world will be created on the airfield at RAF Fairford. Spectators will see

the planning, equipment and mission expertise of all three Services in a realistic environment, enhanced by big screen coverage of all the action as it unfolds. A century of aviation, and the achievements of aircraft designers and test pilots, will see a living history of period set pieces highlighting aircraft that have pushed back the frontiers of flight.

RIAT Director Paul Bowen says “Most breakthroughs in aeronautical technology can be traced to defence needs, and it could not be more appropriate to link 100 Years of Aviation with *Defence 2003*. We are working closely with the RAF and a special tri-Service team to stage next year’s most spectacular national event.”

Around RIAT and *Defence 2003*, the RAF will be hosting the bi-annual Armed Forces Careers Convention and the Chief of The Air Staff will head a conference of Air Force Commanders from round the world. Finally, it is intended that up to 20,000 young people will attend the RIAT/Defence 2003 preview day on Friday 18th July 2003.

For more information contact:

Group Captain Chris Morris (RAF Defence 2003 Project Leader) 01285 713300 (x5601)
Patti Heady (RIAT PRO) 01285 713300 (x5341)



DUXFORD COMMEMORATES FALKLANDS WAR IN NEW EXHIBITION

To commemorate the 20th anniversary of the Falklands War, the Imperial War Museum Duxford is opening a special exhibition that will tell the story of the conflict and the men and machines that took part. Combat aircraft, helicopters, artillery and military vehicles feature in the first Falklands exhibition of its kind in the UK.

Exhibits will include a Royal Air Force Harrier that flew many missions from *HMS Hermes* during the conflict, and former adversary a rare captured Pucara ground attack aircraft used by the Argentine Air Force and feared by troops and pilots alike. *The Falklands War lasted just 72 days but claimed nearly 1,000 casualties and was instrumental in restoring democracy in Argentina.* Complemented by life-like figures in uniform, the exhibition opened at Duxford on Monday 25th March and is expected to run until the end of the year.

In addition to the exhibits featured in this exhibition, Duxford also displays many of the types of aircraft used in the Falklands campaign such as the Victor, Canberra and Vulcan.

The Falklands War saw one of the biggest task forces ever assembled and began on the 26th of March 1982 with the invasion of the islands by the Argentine military junta. Britain responded by sending a huge task force of nearly one hundred ships, including the aircraft carriers *HMS Hermes* and *HMS Invincible*, and two infantry brigades. 252 British servicemen were to lose their lives in the ensuing conflict.

Duxford is at junction 10 on the M11 and is open daily from 10.00am. The Museum's free courtesy bus operates throughout the day from Cambridge City Centre and railway station. Normal admission is £8.00 for adults, £6.00 for senior citizens and £4.00 for concessions (though please note that special rates apply on Air Show days).

CHILDREN UNDER 16 ARE GRANTED FREE

ADMISSION. For more information about Duxford, visit the Imperial War Museum website – www.iwm.org.uk.

If you would like further information, please contact Tracey Woods, Marketing Manager, on 01223 499320.

DUXFORD AIR SHOWS 2002

Listed below are the dates and brief information for all Air Shows at the Imperial War Museum Duxford in 2002.

Flying Legends Air Show Saturday 13 and Sunday 14 July

Established as *the* warbird show in Europe, Flying Legends brings together an unparalleled selection of classic American and European fighting aircraft including Spitfires, Hurricanes, Corsairs, B17s and Mustangs. Both days culminate in a mass flypast. This year will be the first of Duxford's Shows to commemorate the 60th anniversary of the arrival of the USAAF in the UK.

Duxford 2002 Air Show Saturday 7 and Sunday 8 September

Stunning action for the whole family, Duxford 2002 marks the anniversary of US 8th Air Force's arrival in the UK. Fighters and bombers, transport aircraft and modern combat aircraft take to the skies for a truly memorable show. The Show is expected

to feature second World War aircraft including a B17, Mustangs, Harvards, Spitfires, Hurricanes, a Stearman, P-47 Thunderbolt, Blenheim and Hellcat. There will also be classic jets from the 1950s and examples from today's frontline USAF and RAF combat aircraft.

Autumn Air Show Sunday 13 October

The perfect chance to see your favourites before winter, the Autumn Air show focuses on spies and spy planes, as well as marking the anniversary of the battle of El Alamein. Aircraft taking part will include Spitfires, a Lysander, Canberra, Nimrod and OV-10A.

For further information about these events please see the Duxford website at www.iwm.org.uk or contact the Marketing Manager Tracey Woods on 01223 499320.

ROYAL AIR FORCE HISTORICAL SOCIETY

- Formed in July 1986
- Studies the history of Air Power
- Examines the creation of Military Air Power and studies various topics including:
 - The strategic bomber offensive
 - Berlin Air Lift
 - The V Force
 - The RAF in the Far Eastern War
 - Falklands
 - Contemporary Air Power
 - Lectures, Seminars, Discussions and Journal
 - Self Financing, £15 membership per annum
- Information and Application Form from:
 - Dr Jack Dunham
 - Silverhill House
 - Coombe
 - Wotton-u-Edge
 - Glos GL12 7ND
 - Tel: 01453 843362
- The central objective of the Society is to bring together those involved in Royal Air Force activities in the past and those concerned today so that we can learn more about its history.



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 08.30 am – 4.30 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.