研究会記録

Why the Allies Won the Air War, 1939-1945

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For nearly three decades, first in Queens' College Cambridge and then in King's College London, I shared a college with Richard Overy, one of the most eminent historians of World War Two. The title of this paper melds the titles of two of Overy's most well-known books – *The Air War, 1939-1945* from 1980, and *Why the Allies Won* from 1995.[1] My aim is to review his arguments after a generation of further scholarship, and to see whether his insights retain their validity today.[2]

Two fundamental and inter-related scholarly debates may be identified with regard to the overall issue of Allied victory in World War Two. One concerns whether (as Paul Kennedy and John Ellis have suggested) Axis defeat was all but inevitable because of the overwhelming economic and industrial advantages of the Allies, or whether, as Overy himself argued strongly in *Why the Allies Won*, 'There was nothing preordained about Allied success' and 'Materially rich, but divided, demoralised, and poorly led, the Allied coalition would have lost the war'.[3] The second, related, debate concerns which aspect of this massive struggle was the most decisive. Norman Davies argued in 2006 that the devastating and bloody land war between the Axis powers and their totalitarian rivals in the USSR was the key to Axis defeat, and that the efforts of the Western democracies (especially in Europe) were little more than a sideshow in comparison.[4] Phillips O'Brien, by contrast, argued in 2015 that the war was decided primarily by production, technology and economics rather than by blood-letting among massed armies, and that this made the air and sea contest in which the Western powers achieved growing dominance the most decisive aspect of the struggle, to the point that

[1] R J Overy, *The Air War, 1939-1945*, (paperback edition, London: 1987), and *Why the Allies Won*, (London: 1995).
[2] An earlier version of this paper appeared in chapter 9 of Chris Szejnmann (ed.), *Rethinking History, Dictatorships and War: New Approaches and Interpretations*, (London: 2009).
[3] P Kennedy, *The Rise and Fall of the Great Powers*, (London: 1988), chs. 6-7; J Ellis, *Brute Force*, (London: 1990); Overy (1995), pp. 1 & 325.
[4] N Davies, *Europe at War, 1939-1945: No Simple Victory* (London: 2006).

the West would likely have prevailed in the end even had the USSR collapsed as Russia did in 1917-18.[5]

My own focus in this paper is on why the Allies won the air war rather than the war as a whole, and this narrower question resolves itself into two main sub-questions. First, why could the Axis states not translate their undoubted early advantages in air power into decisive strategic gains which would offset their obvious shortcomings in a prolonged contest of aerial production and attrition? Second, why could the Axis powers not exploit the considerable strategic depth offered by their initial conquests to protect their heartlands from air attack even after Allied production superiority shifted the numerical odds increasingly in Allied favour? Answering these two key sub-questions offers important insights into the broader issues of the balance of determinants underlying Allied victory as a whole, and of how close-run that victory was.

World War Two quickly became a truly global contest, but it is in Europe rather than the Pacific where Allied aerial victory seems to have been most in the balance. Japan's strategic situation in terms of industrial capacity, technology, natural resources and geography was even more disadvantageous relative to its multiple adversaries than that of Nazi Germany, making its eventual aerial defeat even more of a foregone conclusion. Hence, in the following discussion I will pay closest attention to the eclipse of the Luftwaffe, before a necessarily much briefer analysis of similarities and differences in the eclipse of Japanese air power. I will tackle the two sub-questions which I identified earlier through three generic sections – first, Axis efforts to use air power to achieve decisive strategic gains against targets inaccessible by land; second, the employment of Axis air power in conjunction with land campaigns; and finally, Axis efforts to defend their heartlands against inexorably growing Allied air power.

AXIS AIR OFFENSIVES

Had Britain fallen to the German onslaught in 1940-41, the strategic consequences for the Allied cause would have been catastrophic. Not only would the further reduction in Allied resource potential have surpassed even that already lost, but the Mediterranean and Middle East would almost certainly have been conquered in quick

[5] P P O'Brien, *How the War was Won* (Cambridge: 2015).

succession, and there would have been no remaining land base for an American air or amphibious counteroffensive. Germany's failure against Britain was hence decisive for the outcome of the entire war, and the dominant role of the Luftwaffe in this campaign makes it of central importance for my current enquiry.

The popular image of the Battle of Britain in the English-speaking world, as embodied in Harry Saltzman's oft-repeated 1969 film, is of a triumph 'against the odds' in which 'The Few' saw off overwhelming numbers through sheer British pluck.[6] This image is not just a product of Churchillian 'Finest Hour' propaganda, but has a measure of scholarly support. Williamson Murray, for example, argued in 1990 that the main reason for the Luftwaffe's failure was blundering overconfidence.[7] Instances such as the delay in the initial German air onslaught, and the premature discontinuation of attacks on radar stations and airfields, have passed into legend.[8] However, most scholars today take a broader view, and argue that the real strategic situation was much more in the RAF's favour than legend admits.[9] Even if it had been better handled operationally, the Luftwaffe would have been very hard pressed to achieve anything like the objectives required.

For one thing, the overall balance of forces between the two sides was actually fairly even. Richard Overy points out that Fighter Command had slightly *more* single-engined fighters than the Luftwaffe, and he describes the idea of the few against the many as 'one of the most enduring myths of the Battle'.[10] Unlike in the earlier campaigns, the defending aircraft were not outclassed technologically, now that Fighter Command had been almost entirely re-equipped with fast monoplane Spitfires and Hurricanes. The German numerical advantage lay in bombers and twin-engined fighters, but these were no better than their RAF counterparts – the Bf 110 and Ju-87 proved terribly vulnerable to British fighters, and the He-111, Do-17 and Ju-88 carried insufficient bombloads to inflict enduring damage in the face of active air defences.[11] The problem was compounded by poor target intelligence and by the limited

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[6] H Saltzman, *Battle of Britain*, (MGM, 1969); L Mosley, *The Battle of Britain: the making of a film*, (London: 1969); P Addison & J A Crang (eds.), *The Burning Blue*, (London: 2000), Part 5.
[7] W Murray, 'The Battle of Britain: How did "The Few" Win?', *Military History Quarterly*, Summer 1990, pp. 8-21.
[8] See, for instance, P Townsend, *Duel of Eagles*, (London: 1970), especially p. 393.
[9] See, for example, S Bungay, *The Most Dangerous Enemy*, (London: 2001), ch.31; Addison & Crang (2000), Parts 1 & 2.
[10] R J Overy, *The Battle*, (London: 2000), p. 35.
[11] W Green, *Aircraft of the Battle of Britain*, (London: 1969); D Wood & D Dempster, *The Narrow Margin*, (London: 1961), Appendix 1.

vulnerability of the targets themselves – as Alfred Price points out, radar stations and fighter control centres were difficult, pin-point targets, and even if concrete runways were cratered, the summer weather allowed defending fighters to operate off makeshift grass strips, just like those in use in France by the Luftwaffe itself.[12] Dispersion and radar warning meant that only around 44 Spitfires and Hurricanes were destroyed or badly damaged on the ground by German attack during the Battle.[13]

The second important consideration is that, despite the enduring stress in air doctrine on the idea that 'attack is the best form of defence', [14] there was in fact a substantial 'home advantage' for the defending air force in this period. I have analysed this phenomenon myself using the naval concept of 'force gradients', according to which the effectiveness of a force gradually diminishes, the further it tries to operate from its land base.[15] In 1940-41, the RAF obviously benefited from its radar and Observer Corps network and from its greater ability to recover downed aircraft and pilots, while the Luftwaffe suffered from anti-aircraft fire, poor intelligence on what was happening in the enemy's backyard, and the limited range of its aircraft, especially the Bf 109.[16] In the initial clashes over the Channel in June and July, the situation was much more even, but when the locus of fighting shifted inland to London in September, the RAF's 'force gradient' advantage became pronounced, and the kill ratio swung to 2:1 in the British favour.[17] The Luftwaffe had already paid heavily for its offensive stance in previous campaigns, with around 560 aircraft written off in Poland, 240 in Norway, and 1,900 in France and the Low Countries, and these losses obviously reduced further the threat it could pose to the UK.[18]

The impact of force gradients may be offset by the attacker's ability to seize the initiative and to concentrate superior forces at a point of his choosing. The Luftwaffe certainly did enjoy local numerical superiority over 11 Group in the South East, and this could have been decisive had Lanchester been right when he theorised in 1916 that fighting power in air engagements would increase in proportion to the square of the

[12] A Price, *Battle of Britain: The Hardest Day, 18 August 1940*, (London: 1979), ch. 7.
[13] T C G James, *The Battle of Britain*, (London: 2000), Appendix 34.
[14] See P S Meilinger (ed.), *The Paths of Heaven: The Evolution of Airpower Theory*, (Maxwell AL: 1997).
[15] P A G Sabin, 'The Counter-Air Contest', in A Lambert & A C Williamson (eds.), *The Dynamics of Air Power*, (Bracknell: 1996), pp. 18-39.
[16] R Hough & D Richards, *The Battle of Britain*, (London: 1990).
[17] Bungay (2001), p.371; F K Mason, *Battle over Britain*, (London: 1969), chs. 6-8.
[18] Overy (1987), pp.28-9; C Becker, *The Luftwaffe War Diaries*, (London: 1967), Appendix 2; W Murray, *Strategy for Defeat: The Luftwaffe, 1933-1945*, (Maxwell AL: 1983), p. 40.

friendly numbers engaged.[19] Fortunately for the RAF, Lanchester was wrong, for several reasons including the way in which large numbers of aircraft got in one another's way and made it harder to identify the less numerous adversaries. This had already been clearly demonstrated on the Western Front in World War One, when the German Air Service capitalised on its defensive stance to achieve kill ratios of up to 3:1, despite being outnumbered by roughly the same ratio.[20] It was demonstrated again in 1941-42 when the remnants of the Luftwaffe left in the West inflicted more losses than they suffered during hit and run interceptions of the massive RAF 'circuses' over France.[21] Hence, although the 'Big Wings' favoured by Bader and Leigh-Mallory in 1940 could certainly give German bomber formations a bloody nose if they got the chance, Park's individual squadrons also did well, even when heavily outnumbered.[22]

A further nail in the Luftwaffe's coffin was that Germany (unlike Britain) was hardly producing enough aircraft to replace its losses in a continuing attritional struggle. From July to September 1940, Germany had around 1,000 fighters and nearly 1,200 bombers destroyed or severely damaged, while its new production came to only around 920 fighters and 1,130 bombers.[23] Britain, by contrast, had around 1,000 Hurricanes and Spitfires destroyed or seriously damaged but it produced 1,250 and repaired many others in that same three month period.[24] A key problem was that German intelligence consistently underestimated enemy air strength and production capacity, so that Germany's own aircraft production and repair efforts were not given a sufficiently high priority.[25] The RAF did run shorter of skilled pilots than it did of airframes, but the Luftwaffe faced similar aircrew shortages as the Battle continued.[26] Hence, there was no prospect of Germany being able to grind Britain's air defences down in a contest of attrition and exhaustion, since (as Alfred Price put it), 'in trying to smash Fighter Command, the Luftwaffe was likely to smash itself also'.[27]

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[19] F W Lanchester, *Aircraft in Warfare*, (London: 1916), chs.V-VI.
[20] See J Morrow, *The Great War in the Air*, (Shrewsbury, 1993), especially pp. 215-6 & 302-4.
[21] M Spick, *Fighter Pilot Tactics*, (Cambridge, 1983), pp. 73-7.
[22] J Ray, *The Battle of Britain: New Perspectives*, (London, 1994); J F Turner, *The Bader Wing*, (Shrewsbury, 1999); Bungay (2001), chs.25-30.
[23] Murray (1983), p.53; F A Vadja & P Dancey, *German Aircraft Industry and Production, 1933-1945*, (Shrewsbury, 1998), p. 145.
[24] Mason (1969), p.598; Wood & Dempster (1961), Appendix 6.
[25] Overy (1987), pp.22-3 & 32-3; K A Maier, H Rohde, B Stegemann & H Umbreit, *Germany and the Second World War*, Vol II, (Oxford, 1991), pp. 39-59 & 380-405.
[26] Overy (2000), pp. 124-5 & 162; Bungay (2001), pp. 369-74.
[27] Price (1979), p. 168.

When the Luftwaffe belatedly followed the RAF's own example and shifted its bombers to night attacks on British cities, German loss rates tumbled because of the very primitive nature of night air defence techniques. In 1941, RAF night fighters became much more adept at making contact, but the bombers were still usually able to escape by taking evasive action in the gloom, and losses to enemy action averaged only around 1% of sorties.[28] However, accidents in the darkness claimed at least as many aircraft, and bombing accuracy also suffered severely, especially as British scientists countered German navigational radio beams in the 'Wizard War'.[29] Although considerable damage was caused (especially in Coventry on November 15th/16th and London on May 10th/11th), the Blitz was nothing like as destructive as that later visited on Germany itself, and so was even less likely to coerce the country into coming to terms.[30]

This highlights the biggest single obstacle to the success of Germany's air offensive against Britain, namely that, unlike in all the previous campaigns in which the Luftwaffe had assailed enemy forces and civilians (as at Warsaw and Rotterdam), the English Channel precluded the usual accompaniment of an irresistible ground advance by the Wehrmacht. Even had it been possible for Goering to win air superiority in the very limited time before winter weather rendered a cross-Channel invasion unthinkable, the twin handicaps of British naval dominance and a total lack of dedicated amphibious shipping made Operation Sealion an essentially suicidal endeavour.[31] It was probably lucky for the Germans that their frustration in the air saved them from having the cream of the Wehrmacht sunk or repulsed at sea (as happened to the invasion convoys bound for Crete in May 1941, despite complete German air superiority) or penned on a hostile shore and cut off from resupply or retreat (as happened to the Axis forces in Tunisia two years later).[32]

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[28] K Delve, *Nightfighter*, (London: 2000), chs. 3-4; B Gunston, *Night Fighters*, (Cambridge, 1976), ch. 4; E R Hooton, *Eagle in Flames*, (London: 1999), pp. 31-8.
[29] Murray (1983), pp. 54-5; R V Jones, *Most Secret War*, (London: 1978), chs. 11-24.
[30] J Ray, *The Night Blitz, 1940-1941*, (London: 1996); A Price, *Blitz on Britain, 1939-1945*, (London, 1977), pp. 89-125; B.Collier, *The Defence of the United Kingdom*, (London: 1957), chs. XVI-XVII.
[31] E Kiesler, *Hitler on the Doorstep*, (London: 1997); P Schenk, *Invasion of England 1940*, (London: 1990); D Robinson, *Invasion, 1940*, (London: 2005).
[32] D A Thomas, *Crete 1941: The Battle at Sea*, (London: 1972), chs. 8-11; D Rolf, *The Bloody Road to Tunis*, (London: 2001). In 1975, a Sandhurst wargame involving commanders of the time such as Galland and Ruge resulted in the latter outcome – see J.Bloom, 'Britain Invaded...Again', *Moves* 81, Jul-Aug 1994, pp. 29-38.

Richard Overy summarised the result of the Battle of Britain with the downbeat conclusion that, 'Neither side was defeated in any technical sense.... Losses on both sides were soon made good. The outcome was technically a stalemate'.[33] Stephen Bungay was less equivocal in hailing a British victory, and he wrote that, 'Fighter Command was the best prepared fighter force in the world, by a considerable margin. In 1940 it was given the opportunity of fighting almost precisely the battle it had planned for... It did not need to improvise, there was very little muddle, and it all worked out much as expected'.[34] Although it is not perhaps inconceivable that a significantly better German performance might have spooked Britain into entering Vichy-style peace talks (after all, Norway, France and Crete all fell to the Germans in this period in defiance of conventional military wisdom),[35] the Luftwaffe's failure to achieve any meaningful success against the RAF in fact seems to have been over-determined by a multiplicity of strategic obstacles, and was not just a result of Goering's poor leadership. The idea that the Battle was a near-run thing seems to have stemmed originally from persistent German underestimation and British overestimation of enemy capabilities.[36] With the benefit of hindsight, it is hard to see how the outcome could have been all that different from what actually occurred.

The Pacific counterpart to the Battle of Britain lay in the Japanese carrier attacks on Pearl Harbour and Midway in 1941-42. Midway showed that carrier duels are highly chancy affairs, and had the Dauntlesses from *Enterprise* missed *Arashi*'s fatal return dash to Nagumo's task force, one may easily imagine much more even losses for the contending fleets (as at Coral Sea). It is also entirely plausible that the US carriers might have been caught earlier at Pearl Harbour as planned, giving Japan a significant advantage in the early naval air war. However, luck cuts both ways, and it is equally conceivable that Operation Z might have been compromised or that the Japanese carriers at Midway would have been hit by the many waves of air attacks which preceded McClusky's famous dive. Even in 1942, the USA enjoyed crucial advantages in logistics, intelligence (as shown by the Midway ambush), and above all in production, and even had the Japanese been lucky enough to do a little better overall in the initial

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[33] Overy (2000), p. 128.
[34] Bungay (2001), p. 391.
[35] F Kersaudy, *Norway 1940*, (London: 1990); E R May, *Strange Victory*, (London, 2000); A Beevor, *Crete*, (London, 1991).
[36] Overy (1987), pp. 22-5; F H Hinsley, *British Intelligence in the Second World War*, Vol.1, (London, 1979), pp. 60-61 & 159-90.

air raids and island battles, there was no remotely attainable territorial objective whose loss would hinder the Americans for long in their determination to avenge the 'infamy' of their early losses, as a British capitulation might have done in Europe.[37]

AIR-LAND CAMPAIGNS

The Luftwaffe played a key role in the Wehrmacht's rapid conquest of Poland, Norway, the Low Countries, France and the Balkans in 1939-41, as well as in Rommel's advances in North Africa in 1941-42.[38] However, the acid test came with Operation Barbarossa and the massive air-land campaign against the USSR.[39] Had the Axis succeeded in triggering a Soviet collapse, the impact on the balance of the war would have been just as profound as that of Britain being brought to terms in 1940.

The Luftwaffe was grossly outnumbered, even by its own optimistic estimates, when it took part in Operation Barbarossa in June 1941. Continuing low production levels, combined with commitments elsewhere and the strain of recent operations against Britain and in the Balkans, meant that only around 2,800 German aircraft took part in the onslaught – less than had attacked France just over a year earlier.[40] David Glantz suggests that the USSR had around 15,600 combat aircraft, over 7,000 of which were in the Western military districts.[41] However, unlike the RAF in 1940, the Red Air Force was tactically and technologically inferior, and was caught completely by surprise. On the first day alone, the Germans claimed the destruction of 1,811 aircraft (mostly on the ground) for the loss of just a few dozen of their own, and even the Soviet official history admits that around 1,200 planes were destroyed.[42] In Alfred Price's words, 'the Soviet Air Force losses represented by far the greatest number of aircraft ever destroyed in a single day's fighting. It was also the most comprehensive defeat to be inflicted by one air force on another, in the long history of air warfare'.[43]

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[37] J Lundstrom, *The First Team: Pacific Naval Air Combat from Pearl Harbor to Midway* (Annapolis: 1990); J Parshall & A Tully, *Shattered Sword: The Untold Story of the Battle of Midway* (Washington DC: 2005).
[38] See E R Hooton, *Phoenix Triumphant*, (London: 1994).
[39] R Muller, *The German Air War in Russia*, (Baltimore, 1992).
[40] Air Ministry, *The Rise and Fall of the German Air Force, 1933-1945*, (Kew: 2001), pp. 66 & 165-6; Murray (1983), pp. 80-81; A Brookes, *Air War over Russia*, (Hersham, 2003), pp. 37-8; R J Overy, *Russia's War*, (London: 1997), p. 89.
[41] D M Glantz, *Stumbling Colossus*, (Lawrence KA: 1998), pp.187 & 204. *Cf.* E Mawdsley, *Thunder in the East*, (London: 2005), pp. 42-3.
[42] Brookes (2003), p. 26; L Fetzer, *The Soviet Air Force in World War II*, (London: 1974), p. 35.
[43] A Price, *Sky Battles, Sky Warriors*, (London, 1998), Part 2, p. 51.

Opinions differ over the real impact of this initial blow, and of the further carnage which the remnants of the Red Air Force suffered in the succeeding days and weeks as they were shot out of the sky and as their airfields were overrun by marauding panzers. E R Hooton suggests that Russian air power did not recover until late in 1942, whereas Richard Overy argued that, 'The bulk of the very many Russian aircraft destroyed in June 1941 were...already obsolete, the Luftwaffe simply completing a job that was already being carried out by the Red Air Force itself'.[44] What is not in dispute is that the Luftwaffe paid a very heavy price for its intensive sorties in the ensuing months to support the Wehrmacht's continued advances across such a wide front. As in previous offensives, several hundred aircraft per month were destroyed or damaged on operations, and the serviceability of the remaining planes declined catastrophically as equipment wore out, supply lines stretched beyond the breaking point, and mud and snow made the improvised airfields unusable.[45] By early September, only around 1,000 Luftwaffe aircraft were still serviceable, and by the time of the Soviet counteroffensive in December, German air power in the east had become a shadow of its former self, and the Red Air Force regained temporary superiority by default.[46]

Although Soviet air power never again suffered the rate of loss that it had in 1941, attrition remained very high due to the Luftwaffe's recovery with time and better weather, and due to the increasingly offensive stance of the Red Air Force itself.[47] Evan Mawdsley puts Soviet combat aircraft losses in combat alone at 10,300 in 1941, 7,800 in 1942, 11,200 in 1943, 9,700 in 1944, and 4,100 in early 1945, and these numbers increase very substantially if accidents are included.[48] What saved the USSR was its even higher levels of aircraft production. Output had already exceeded 10,000 aircraft per year in 1939 and 1940 (twice what the Germans believed), and thanks to the evacuation of factories to the Urals to escape the Wehrmacht's advance, it rose to around 15,000 in 1941, 25,000 in 1942, 35,000 in 1943, and 40,000 in 1944.[49] Lend-Lease aid

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[44] Hooton (1999), pp. 95-6; Overy (1987), p. 49.
[45] The Wehrmacht 'victored itself to death' in a similar way – see R J Kershaw, *War Without Garlands*, (Shepperton, 2004).
[46] Murray (1983), pp. 88-97; Hooton (1999), pp.95-104; Overy (1987), pp.49-54; V Hardesty, *Red Phoenix*, (London: 1982), ch. 3.
[47] J S A Hayward, *Stopped at Stalingrad*, (Lawrence KA: 1998).
[48] Mawdsley (2005), pp. 58-9 & 201-3.
[49] Overy (1987), pp. 48-9; A Boyd, *The Soviet Air Force since 1918*, (London: 1977), ch. 12; Overy (1997), p. 155; J Ellis, *The World War II Databook*, (London: 1995), pp. 278-9.

provided another 18,000 or so aircraft, as well as vital aluminium and aviation fuel.[50] Not only were the new aircraft much more of a technological match for the Luftwaffe, but they allowed the expansion of the Red Air Force's front-line strength to over 13,000 planes by June 1944, fully half of which were concentrated in Belorussia to support the Bagration offensive on the third anniversary of Barbarossa.[51]

Meanwhile, Luftwaffe strength in the East was gradually declining from its initial (already inadequate) level, because German aircraft production remained low at first despite the failure to smash the USSR as quickly as had been hoped, and because the production increases which began in 1942 and accelerated in 1943 and 1944 were offset by the growing need to divert resources to other theatres.[52] Total German aircraft output for all fronts was around 12,000 in 1941, 15,000 in 1942, 29,000 in 1943, and 40,000 in 1944, so it was always outstripped by the USSR alone.[53] The one bright spot for the declining proportion of the Luftwaffe in the east was that attrition seems to have been lower than elsewhere. Williamson Murray puts Luftwaffe losses in the East from June 1942 to November 1943 (including those suffered at Stalingrad and Kursk) at around 6,160 aircraft, compared to 10,710 German planes lost on other fronts over the same period.[54] The clear implication is that flying in the East was not as dangerous for German pilots as it was in the West, and that far more Soviet than German aircraft were downed throughout the campaign.

Is this impression at all plausible, given the overwhelming numerical preponderance of the Red Air Force? I have already argued that simple Lanchestrian rules do not apply, and that there are plenty of instances of outnumbered but tactically proficient air arms giving significantly better than they got when on the operational defensive. Even when the Germans attacked, as at Kursk, they remained capable of achieving a very favourable exchange ratio. Soviet writers admitted that they lost nearly 1,000 planes while defending at Kursk in July 1943, but most scholars reject their equally high kill claims, and instead go with the German records which show only around 200 Luftwaffe aircraft lost during the 10 days of the offensive.[55] It was primarily

[50] A Seaton, *The Russo-German War, 1941-1945*, (New York, 1971), Appendix A; Fetzer (1974), Appendix 2; and Mawdsley (2005), pp. 200-2.
[51] Hardesty (1982), pp. 189-96; and D M Glantz & H S Orenstein (eds.), *Belorussia 1944*, (London: 2001).
[52] On the fatal delay in increasing production, see Murray (1983), pp. 96-107.
[53] Vadja & Dancey (1998), pp. 138-9; Overy (1997), p. 155.
[54] Murray (1983), pp.114 & 148.
[55] N Zetterling & A Frankson, *Kursk 1943: A Statistical Analysis*, (London: 2000), ch. 5.

on the Eastern front where German fighter aces famously racked up kill claims in the hundreds (all after October 1942 for the leading ace, Erich Hartmann, with his 352 claims).[56] There are obvious suspicions of exaggeration given the difficulty of verification in this theatre, but there are also plenty of reports of Soviet aircraft effectively being sitting ducks – entirely understandable when one considers the constant need for new and inexperienced pilots to offset the high attrition rates.[57] Soviet fighter tactics and technology did undoubtedly improve a great deal over time,[58] but this was not all that mattered. Von Hardesty makes some very interesting points about the Red Air Force's focus on direct ground support rather than counter-air operations *per se*:

> There was never a clear-cut, one-on-one air struggle between the VVS and the Luftwaffe. Rather than attempting to destroy the Luftwaffe as a fighting force, the VVS stayed close to the cutting edge of Soviet offensives. This fact allowed the Luftwaffe a curious reprieve in the east, the ability to maintain diverse air operations until the final weeks of the war. There were occasions after 1943 when a concentration of German air power, properly applied, could still assert temporary local air superiority.[59]

So where does all this leave us with regard to the USSR's contribution to winning the air war, and beyond that the European war as a whole? Norman Davies and Phillips O'Brien take such different views on this issue because Davies emphasises land fighting and manpower casualties, whereas O'Brien stresses equipment and argues that 'the Second World War in Europe was, economically speaking, an air war' since over 40% of German munitions production (in terms of man hours) was devoted to making aircraft.[60] Both writers seem to be guilty of a significant degree of special pleading, and it is no surprise that most scholars take an intermediate view.[61] The Eastern Front with its enormous tracts of land was very different from the Western and Mediterranean fronts, where water obstacles hindered ground operations and privileged air and naval power. It is therefore quite understandable that both Germany and the USSR adopted what Richard Overy termed a 'limited' air strategy focused on tactical cooperation with

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[56] Mawdsley (2005), p. 202; R F Toliver & T J Constable, *Horrido!*, (London: 1968) and *The Blond Knight of Germany*, (New York: 1970).
[57] H Morgan & J Seibel, *Combat Kill*, (Sparkford: 1997), chs. 2 & 6; M Spick, *Luftwaffe Fighter Aces*, (London, 1996), chs. 3 & 10; N Hanning, *Luftwaffe Fighter Ace*, (London: 2004), chs.3 & 5.
[58] B Gunston, *Combat Aircraft of World War II*, (London: 1978), pp. 174-97; Hardesty (1982), pp. 25-30, 83-8, 126, & 139-47.
[59] Hardesty (1982), p. 219.
[60] Davies (2006), pp. 20-42; P P O'Brien, 'East versus West in the Defeat of Nazi Germany', *Journal of Strategic Studies* 23/2, June 2000, especially pp. 92-4.
[61] O'Brien (2000), pp. 89-92.

the army, since it was the army's role in defending and seizing resource centres which ultimately decided the war in the East.[62] The Red Air Force took this focus on army support even further than the Luftwaffe, and it is fascinating to see how it triumphed in the end through sheer omnipresent mass, whereas the German superiority in counter-air combat proved nugatory after a while because of chronic overstretch.

Richard Overy argued that the German invasion of the USSR 'gave the western allies a long breathing-space in the west to build up large air forces and deploy them more or less at will. From this perspective the Russian armed forces gave greater help in the execution of western strategy than the west gave in return'.[63] The second half of this statement seems rather harsh, since the drawing off of an increasing proportion of the Luftwaffe, and the greater attritional losses which it suffered in the West, do appear to have been key ingredients in the Red Air Force's growing ability to win air superiority by default. However, the most important element by far in the Red Air Force's triumph was surely the continuous mass production of new aircraft and aircrew, without which the constant and heavy attrition of Soviet air assets would soon have proved fatal. If there ever was an air war which was won primarily in the factories and training schools, this was it.[64]

As in the German *blitzkrieg* campaigns, the Japanese Army's initial sweeping conquests in South East Asia were aided by initially dominant Japanese air power, but Japan had its own massive and enduring land campaign in China and Burma in which the sheer scale, intractability and strategic depth of the theatre combined with logistic challenges and bitter resistance to stymie the Axis forces as in the USSR. Just as Soviet factories had been withdrawn to safety behind the Urals, so the Allied war effort in China and Burma relied on production and training facilities in distant regions and in other countries out of reach of the Japanese, precluding strategically decisive Axis attacks. As American and British air power flowed into the theatre, the air balance gradually swung against the Japanese, from the early days of the outnumbered 'Flying Tigers' to the later campaigns when Allied air transport was crucial for supplying isolated detachments like the Chindits and the garrisons at Kohima and Imphal.

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[62] Overy (1987), pp. 82-4 & 203-5; D M Glantz & J M House, *When Titans Clashed*, (Lawrence KA: 1995).
[63] Overy (1987), p. 82.
[64] B F Cooling (ed.), *Case Studies in the Achievement of Air Superiority*, (Washington DC: 1994), pp. 193-213.

Unlike the Germans at Leningrad and Moscow, the Japanese land forces were never at the gates of key cities whose loss might have triggered a political collapse and so headed off the inexorable worsening of the air balance as overwhelming Allied industrial superiority made itself felt.[65]

HOMELAND DEFENCE

In *Why the Allies Won*, Richard Overy gave rather short shrift to the air superiority contest which was fought in 1944-45. He wrote that, although 'the conflict was poised on a knife-edge in the middle years of the war', Allied numerical superiority thereafter became overwhelming (especially in the air).[66] In his words, 'However many new aircraft were produced in 1944 – and some 40 per cent of Axis aircraft output was produced in that year – it was in effect reducing the odds from 4:1 to 3:1, and under either of those circumstances defeat was unavoidable'.[67] The figures seem to support this point of view, since American and British aircraft production rose from over 70,000 in 1942 to more than 110,000 in 1943 and more than 120,000 in 1944, compared to less than 40,000 for Germany and less than 30,000 for Japan at their 1944 peak.[68] By the end of 1943, the crowded airbases in England and Southern Italy held more aircraft than the entire Red Air Force, giving the Western Allies the same numerical superiority over the Luftwaffe as the USSR had so painfully amassed.[69] Goering was driven to rely on the supposed qualitative superiority of German personnel, when he admitted in November 1943 that:

In terms of numbers I cannot measure up to Russia and to the United States, which are working quite undisturbed... nor is it necessary to. We did not do so in the last world war... With us it is always the man that counts.[70]

However, the Luftwaffe did still have some more solid advantages to offset its numerical inferiority. In particular, Germany's territorial holdings in France, the Low

[65] R Mitter, *China's War with Japan, 1937-1945* (London: 2013); S Kleiner, *The Flying* Tigers (New York: 2018); C Shores, *Bloody Shambles* (2 vols., London: 1992-3) and *Air War for Burma* (London: 2005).
[66] Overy (1997), p. 325.
[67] Overy (1987), p. 184.
[68] Ellis (1995), pp. 278-9.
[69] H Wynn & S Young, *Prelude to Overlord*, (Shrewsbury: 1983), pp. 15-18; A Brookes, *Air War over Italy*, (Shepperton, 2000), ch. 6.
[70] H Boog, G Krebs & D Vogel, *Germany and the Second World War*, Vol.VII, (Oxford: 2006), pp. 267-9.

Countries Italy, the Balkans and Eastern Europe gave it significant strategic depth, which meant that air attacks on the Nazi heartland suffered from even more severe force gradient penalties than those which the Luftwaffe itself had encountered against Britain in 1940. Only the largest Allied aircraft had the range even to reach German targets, and the few hundred unescorted US bombers attacking Schweinfurt in August and October 1943 suffered crippling attrition.[71] RAF Bomber Command used its greater numbers and larger bomb loads to inflict severe damage on the Ruhr and Hamburg in mid-1943, but when it turned against the more distant target of Berlin in the winter of 1943/44, tactical and technological improvements in the German night defences inflicted a clear defeat, despite the cloak of darkness.[72] Hence, although the increasing diversion of Luftwaffe resources to defend the Reich served to bolster Allied air superiority at the fighting fronts, control of the air over Germany itself, and with it the ability to shield or assail the belatedly burgeoning German war economy, remained very much in doubt.[73]

So what happened in 1944 to change this situation, such that the Luftwaffe was decisively beaten even over its own homeland? At entirely the opposite extreme from the idea that the Germans were simply overwhelmed by superior numbers, popular explanations tend to focus on the impact of particular 'decisive weapons'.[74] The American P-51 Mustang is credited with solving the fighter range problem and outclassing the Luftwaffe interceptors, while the belated introduction of the jet-powered Me-262 is seen as a classic 'lost opportunity' which could have turned the tide of the air war in Germany's favour had it happened earlier.[75] Anecdotes by Adolf Galland about being chased by Mustangs all the way to Berlin and about Hitler's disastrous insistence on equipping the Me-262 as a bomber are quoted endlessly in support of these simplistic interpretations.[76] Some writers focus instead on the impact of specific clashes, especially those during the US 'Big Week' raids in late February 1944.[77] However, modern scholars have addressed this topic in considerable depth, and they have generally

[71] R A Freeman, *The Mighty Eighth*, (London: 1970); M Middlebrook, *The Schweinfurt-Regensburg Mission*, (London: 1983); T M Coffey, *Decision over Schweinfurt*, (New York: 1977).
[72] G Aders, *History of the German Night Fighter Force, 1917*-1945, (London: 1979), chs. 5-6; A Cooper, *Air Battle of the Ruhr*, (Shrewsbury: 2000) and *Bombers over Berlin*, (London: 1985); M Middlebrook, *The Battle of Hamburg*, (London: 1980), and *The Berlin Raids*, (London: 1988).
[73] A Price, *Battle over the Reich*, (Shepperton, 1973), chs.3-5; Boog *et al* (2006), pp. 9-102 & 159-274.
[74] M Davidson & A Levy, *Decisive Weapons*, (London: 1996), ch. 4.
[75] J E Johnson, *The Story of Air Fighting*, (London: 1985), chs. 21 & 23.
[76] A Galland, *The First and the Last*, (Glasgow, 1970), pp. 203-4 & 258-73. See also A Speer, *Inside the Third Reich*, (London: 1970), pp. 362-4.
[77] J Holland, *Big Week*, (London: Bantam, 2018); C Shores, *Duel for the Sky*, (London, 1985), ch. 9.

developed much more nuanced and multi-faceted explanations for the turning of the aerial tide over Germany as 1944 progressed.[78]

The advent of fighter escorts which could accompany US daylight bombers all the way to their targets was certainly a key development, but this was not simply a result of the introduction of the Mustang. P-51s only became the dominant American escort fighter in the second half of 1944, and they equipped just 2 or 3 out of over 20 US fighter groups during the major air battles in February and March.[79] More important was the employment of increasingly large drop tanks, which doubled the range of the existing P-47s and P-38s and allowed them to make up the bulk of the relay of escorts which accompanied each inbound and outbound raid, with the P-51s taking up the burden only near the target itself.[80] This continuous wave of fighter escorts allowed air combat to become an integral element of US strategy. As John Ellis put it, 'In 1944...one of the daylight bombers' main roles was to lure up the German fighters so that the long-range escorts could shoot them down'.[81] There is actually a direct parallel in this regard between the deliberately provocative US attacks on Berlin in March 1944 and the Luftwaffe's daylight raids on London in September 1940, with the difference that in 1940 it was the attackers who found themselves unable to sustain the resulting aerial attrition.[82]

The contrast stemmed not just from relative production rates, but also from significant strategic and tactical differences between the two cases. In 1940, the short range of the Bf 109 meant that German attacks were concentrated on the fairly compact target of South East England, whereas in 1944, the Luftwaffe defenders were stretched much thinner to cover a far wider array of targets. The Allied airbases established in Southern Italy at the end of 1943 played a key role in this enforced dispersion, since they completely avoided the usual ingress routes over the Low Countries, and threatened a wide arc of targets from Southern Germany to Rumania.[83] There were also important differences in tactical doctrine. Goering focused throughout on bombers as

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[78] Boog *et al* (2006), Part I; Levine (1992), ch. 7; S L Mcfarland & W P Newton, *To Command the Sky*, (Washington DC: 1991).
[79] Shores (1985), p. 178; J L Ethell & A Price, *Target Berlin*, (London: 1981), pp. 9-13; K Delve, *The Mustang Story*, (London: 1999), p .96.
[80] Boog *et al* (2006), pp. 86-8; Ethell & Price (1981), pp. 30-31; R A Freeman, *The Mighty Eighth War Manual*, (London: 2001), pp. 218-21.
[81] Ellis (1990), p. 200.
[82] Ethell & Price (1981); McFarland & Newton (1991), ch. 6; A Price, *Battle of Britain Day*, (London: 1990).
[83] Shores (1985), ch. 9; K C Rust, *Fifteenth Air Force Story*, (Temple City CA: 1976).

the key element, constraining his fighters in 1940 to use close escort tactics, and insisting in 1944 that they focus on downing enemy bombers, prompting one Luftwaffe commander to complain that 'the safest flying that was ever possible was that of an American fighter over Germany'.[84] By contrast, when General Doolittle took command of the US 8th Air Force in January 1944, he de-emphasised direct bomber protection and urged his fighters to range more widely and aggressively and to seek out the Luftwaffe, even strafing them on the ground despite the resultant losses from flak.[85] The result was that the German fighter force (which in 1943 had emphasised heavy armament rather than aircraft performance when engaging unescorted bombers) suffered crippling attrition, losing an average of 44% of its strength each month in the first half of 1944, not even counting damaged aircraft.[86]

Although the losses in *materiel* were offset by the significant rise in German aircraft production, the real shortage was in skilled fighter pilots, to replace the 2,260 lost in the first five months of 1944 alone.[87] Whereas Allied pilots received up to 400 hours of training and were actually in over-supply thanks to the manpower resources and secure global hinterland which the Allies enjoyed, Luftwaffe training time fell from around 260 hours in the early years of the war to only some 110 hours by mid-1944.[88] This shortfall created a very damaging vicious circle. For one thing, it exposed the Luftwaffe in the West to the same asymmetric combat losses which it had long benefited from on the Eastern Front. Moreover, it contributed to an increasing rate of accidents (which accounted for over half of the 17,500 or so Luftwaffe losses in early 1944), thereby further worsening the vicious downward spiral.[89] The US Strategic Bombing Survey concluded that 'the deterioration of quality of German pilots appears to be the most important single cause of the defeat of the German Air Force'.[90]

The direct contribution of bombing to the defeat of the Luftwaffe through attacks on aircraft production seems to have been limited. Although the 'Big Week' raids on aircraft factories did cause output to drop in February 1944, it soon rose to an even

[84] Galland (1970), pp. 38-9 & 211-12; Air Ministry (2001), p. 296.
[85] S L McFarland, 'The Evolution of the American Strategic Fighter in Europe, 1942-44', *Journal of Strategic Studies* 10/2, June 1987, pp. 189-208.
[86] Boog *et al* (2006), pp. 125-9; Murray (1983), ch. VI.
[87] Vadja & Dancey (1998), pp. 140-41; Murray (1983), p. 240.
[88] Overy (1987), pp. 138-45; Ellis (1990), pp. 200-207; Boog *et al* (2006), pp. 126-8.
[89] Boog *et al* (2006), pp. 128-9.
[90] Ellis (1990), pp. 203-7. See also McFarland & Newton (1991).

higher level, peaking at over 4,200 aircraft in July.[91] However, bombing made a much bigger impact on the air war through attacks on oil production, which was always the Achilles' Heel of the German war effort.[92] Raids from Italy on the Rumanian oil complex at Ploesti reduced German imports from 565,000 tons in the first 3 months of 1944 to 292,000 tons in the remaining time before the site was captured by the Red Army in August.[93] Attacks on synthetic oil plants in the Reich itself had an even more dramatic impact, with fuel production for the Luftwaffe falling from 889,000 tons in the first half of 1944 to just 146,000 tons in the rest of the year.[94] This obviously crippled both training and operational flying, and hindered any recovery from the traumas in the spring. The progressive destruction of Germany's transport infrastructure by the bomber fleets further undermined the Luftwaffe's ability to make actual use of its increasingly dispersed aircraft production, creating a widening gulf between paper strength and real combat potential.[95]

German night defences against RAF Bomber Command suffered a similar decline, after reaching their apogee in the disastrous raid on Nuremberg in March 1944.[96] The growing pervasiveness of US fighters in German skies eroded Luftwaffe capabilities, especially since night fighters were sometimes used in desperation against American daylight raids despite being deeply unsuited for such a role.[97] The RAF also regained the advantage in the intricate measure-countermeasure contest of electronic warfare, particularly after a stroke of good fortune when one of the latest German night fighters lost its bearings and landed in Britain by mistake in July 1944 with all of its 'black boxes' intact.[98] In addition, there was a night-time counterpart to the role of the US escort fighters in the form of the Mosquito squadrons fielded by 100 Group, which downed numerous German night fighters and caused others to crash as they blundered through the darkness at low level to escape detection.[99] Increasing fuel shortages and the impossibility of replacing experienced night aces meant (in Gebhard Aders' words)

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[91] Boog *et al* (2006), pp. 114-9; Galland (1970), pp. 209-12.
[92] R C Cooke & R C Nesbit, *Target: Hitler's Oil*, (London: 1985).
[93] Boog *et al* (2006), pp. 144-5; C Webster & N Frankland, *The Strategic Air Offensive against Germany, 1939-1945*, Vol.IV, (London: 1961), p. 516.
[94] Webster & Frankland (1961), p. 517.
[95] Ellis (1990), pp. 206-10; A Price, *The Last Year of the Luftwaffe*, (London: 1991); A C Mierzejewski, *The Collapse of the German War Economy, 1944-1945*, (London: 1988).
[96] M Middlebrook, *The Nuremberg Raid*, (London: 1973).
[97] Ethell & Price (1981), pp. 61-2, 71, 89-90 & 105-8.
[98] A Price, *Instruments of Darkness*, (London: 1977), chs. 8 & 10.
[99] M Streetly, *Confound & Destroy*, (London: 1978).

that, 'By the end of 1944 only a few leading crews could still fly operationally, while the majority of crews sat around doing nothing for weeks on end'.[100] In December 1944, the Luftwaffe's night fighters achieved just 66 kills for the loss of 114 of their own aircraft, not even counting those destroyed on the ground.[101]

This vicious downward spiral in the day and night defence of the Reich could perhaps have been postponed for a while had the resources devoted to bombers and V-weapons been used instead for fighters.[102] However, fighters already made up around 44% of total German aircraft output in 1943 and 62% in 1944, and (as I have shown), aircraft production was not the key choke point in any case.[103] Only a very small proportion of the 1,400 Me-262s built ever went into action, and they destroyed no more than 150 Allied aircraft, for the loss of around 100 of the jets in air combat alone.[104] Despite the wishful thinking of Galland and others about the earlier introduction of the Me-262, modern historians agree that it could not have been produced sooner, because of problems with the turbines.[105] My own simulation modelling highlights how hard it was for novice Me-262 pilots to use energy tactics against Allied fighters or to avoid ambushes around their scarce airfields.[106] There was, in any case, a larger problem with the idea of ruthless concentration on the air defence of the Reich, namely that this was not the only strategic threat which Germany faced in 1944. The Allied advances on land from both East and West posed an even more inexorable challenge, and the liberation of France and Belgium in the late summer of 1944 further undermined the air defence of Germany itself. Luftwaffe losses in the West in 1944 were almost as high as those in the air battles over the Reich, and hundreds more German fighters and their precious pilots were lost in the ill-judged attack on Allied airfields on New Year's Day 1945, but had the Luftwaffe abandoned the fighting fronts entirely, then the pressure on the beleaguered Wehrmacht would have been even more overwhelming than it already was.[107]

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[100] Aders (1979), p. 167.
[101] *Ibid*, p. 205.
[102] Boog *et al* (2006), pp. 257-91 & 357-458; R Irons, *Hitler's Terror Weapons*, (London: 2002).
[103] Vadja & Dancey (1998), pp. 133, 138-9 & 146-7.
[104] J Ethell & A Price, *World War II Fighting Jets*, (Shrewsbury: 1994), p. 50.
[105] Boog *et al* (2006), pp. 338-46; Price (1998), Part 1, ch. 12.
[106] See my talk on May 15th 2019 at the Royal Aeronautical Society, London, on 'The Me 262 and "Lost Opportunities" in the Air Superiority Contest'.
[107] Hooton (1999), pp. 282-5; Price (1991); N Franks, *The Battle of the Airfields*, (London: 1994).

The Allied aerial victory over Germany in 1944 was not won without tremendous cost. Around 1,550 RAF and 1,730 8th Air Force heavy bombers were lost in the first half of 1944, and these losses still stood at 750 and 1,370 respectively in the second half of the year, and 480 and 820 even in 1945.[108] The significant decline in loss rates per sortie owed at least as much to the inexorable increase in the number of attacking aircraft as it did to the falling effectiveness of the Luftwaffe, for all its many travails. As John Ellis put it, 'Because they could now put so many planes in the air at any one time, the German home defences simply could not destroy enough of them, allowing American *percentage* casualties to fall to perfectly acceptable levels. In relative terms, therefore, the Germans were becoming increasingly weak... Such are the mathematics of attrition and such the ineluctable logic of brute force'.[109] As I have shown, the contest was not quite so brutally simple, and factors such as the advent of long-range fighters, the tactical choices of the two sides, the electronic duels in the ether and the vulnerability of German oil supplies all played a very significant role, but in the end, it was the greater Allied ability to replace their losses in aircraft and trained aircrew which most underpinned their victory, as it had in 1940.

Thanks to its wide ranging conquests in the Pacific, Japan benefited from an even wider defence perimeter than Germany to keep US bombers at bay. However, the magnificent quality and training standards of Japanese pilots in 1941-42 eroded even faster than in the Luftwaffe as attrition took its toll, creating a similarly vicious downward spiral in pilot skill which was famously evidenced in the 'Marianas Turkey Shoot' in June 1944 as novice replacement aircrew tried to protect this extended defence perimeter.[110] Japan also suffered increasingly crippling oil shortages as tanker shipments from conquered South East Asia were inexorably strangled by American air and submarine interdiction.[111] Long range B-29 bombers began to bombard Japan from the captured Marianas, and although the latest Japanese fighters were able to inflict some losses, the B-29s simply switched to night incendiary attacks at low level, exploiting the Japanese weakness in electronic warfare and the flammability of their cities. Desperate *kamikaze* raids on the US fleet only strengthened American determination to bomb Japan into surrender, with the atomic bombing of Hiroshima

[108] Ellis (1990), Table 43.
[109] *Ibid*, p. 200.
[110] Shores (1985), ch. 10; Price (1998), Part 2, ch. 7.
[111] C Blair: *Silent Victory: The US Submarine Victory against Japan* (Annapolis: 2001).

and Nagasaki providing the ultimate demonstration of US technological and industrial supremacy.[112]

CONCLUSION

Richard Overy ascribed the Allied victory in the air war to two factors above all – Allied resource superiority, and the adoption by the British and Americans of a 'general air strategy' as opposed to the limited air strategy pursued by the Axis powers (and the USSR). He defined 'general air strategy' as involving greater autonomy for air forces, the diversion of massive economic resources to the air effort, and the simultaneous pursuit of air defence, strategic bombing, aero-naval co-operation and air support for ground troops.[113] The three aspects of the air war on which I have focused in this paper cast some interesting light on Overy's claims. Britain would surely have been defeated in short order in 1940 had the Channel not blocked the Wehrmacht's advance, but as it was, the limited and short range power of the Luftwaffe alone proved woefully insufficient to cripple British fighting ability. On the Eastern Front, cooperation between the Luftwaffe and the Wehrmacht was far more effective in 1941-42, and it was only the enormous strategic depth and production resources of the USSR which allowed it to endure the onslaught and to build up overwhelming ground and air forces despite continuing tactical weakness. In the West, the long range air attacks by Britain and the US did eventually win real air superiority and pave the way for the cross-Channel invasion and the crippling of the German war economy, but only after a bitter struggle and through the application of massively greater resources. In the Pacific, Japan had similar initial opportunities and strategic resilience to Nazi Germany, but was even more outclassed by the USA and even less capable of attaining either quick victory or an enduring stalemate.

Was the Allied air victory a foregone conclusion? The one lesson which all three of my sub-sections highlight is that aerial victory in this era required both the will and the ability to endure and to replace dreadful attritional losses. The Allies in West and East had the ability to do this thanks to their global hinterland, and they also demonstrated

[112] Cooling (1994) ch. 8; K Werrell, *Blankets of Fire* (Washington DC: 1996); R Reilly, *Kamikaze Attacks of World War II* (New York: 2012).
[113] Overy (1987), pp. 204-5.

the necessary will and determination to pay the very heavy price required. Germany and Japan proved in 1944 that they were capable of similar mobilisation for total war, but earlier they gambled on winning quick victories through individual battles, while neglecting long war preparations such as ensuring the availability of a continuing flow of well trained replacement pilots. Systemic Axis disadvantages in access to resources such as oil would probably have doomed them regardless in the end, but poor intelligence and under-estimation of enemy resilience and commitment led them to focus unduly on their short war gambles, which proved to be blind alleys leading them only to inexorable catastrophe.[114]

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[114] R Higham & S J Harris (eds.), *Why Air Forces Fail: The Anatomy of Defeat*, (Kentucky: Kentucky University Press, 2006), chs. 5-7.