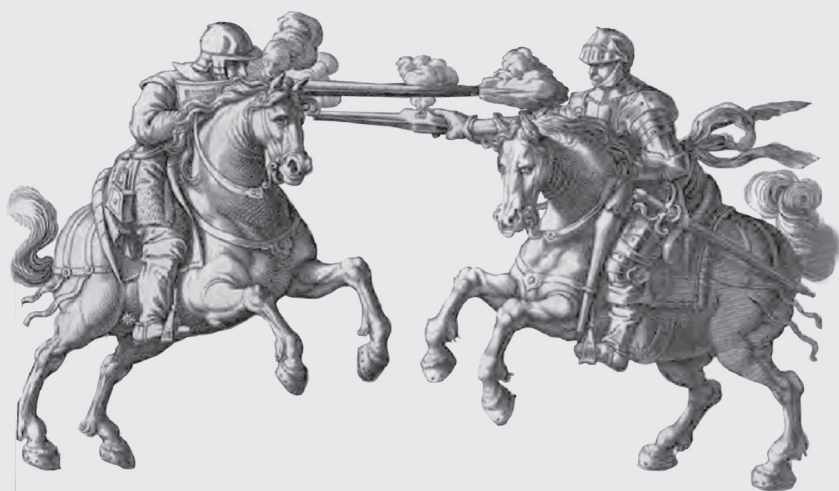


NUOVA **ANTOLOGIA** 
MILITARE
RIVISTA INTERDISCIPLINARE DELLA SOCIETÀ ITALIANA DI STORIA MILITARE

N. 1
2020

Fascicolo 1. Febbraio 2020
Cartografia militare



Società Italiana di Storia Militare

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Nuova Antologia Militare

Rivista interdisciplinare della Società Italiana di Storia Militare
Periodico telematico open-access annuale (www.nam-sism.org)
Registrazione del Tribunale Ordinario di Roma n. 06 del 30 Gennaio 2020



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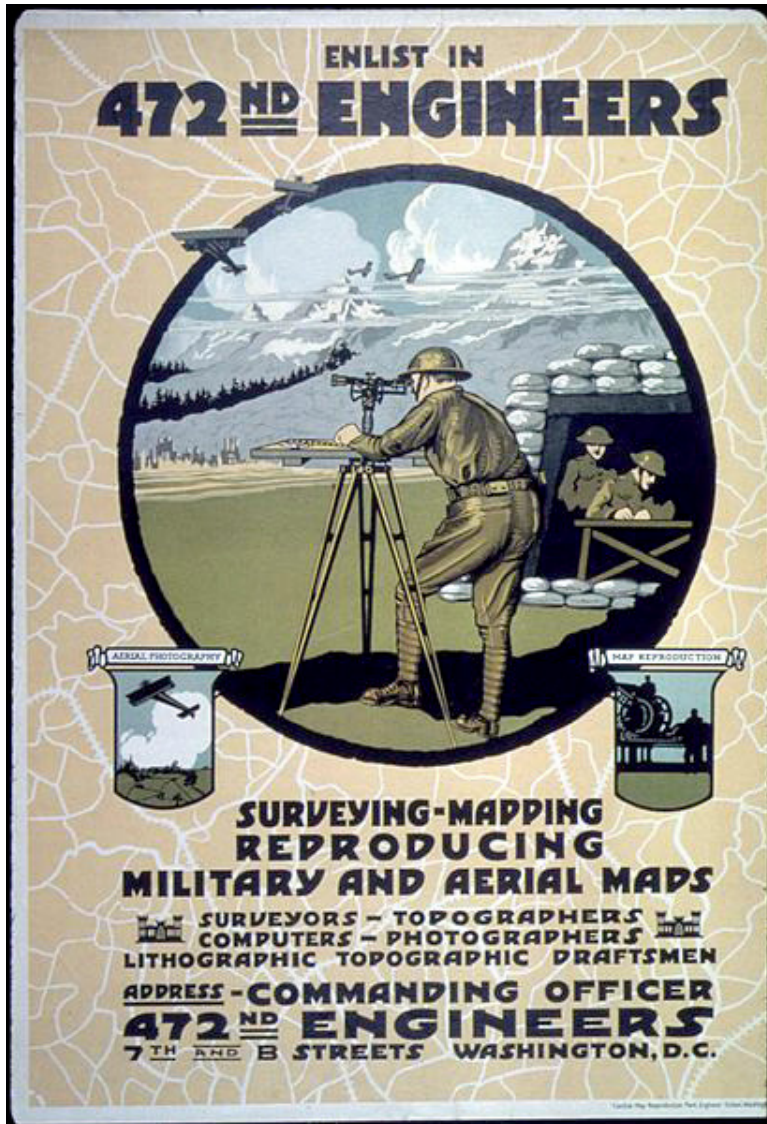
Gruppo Editoriale Tab Srl - Lungotevere degli Anguillara, 11 - 00153 Roma
www.tabedizioni.it

ISSN: 2704-9795

ISBN Fascicolo 1: 978-88-31352-36-9

Cartografia Militare
Cartography and War





U.S. Food Administration. Educational Division. Advertising Section. (01/15/1918 - 01/1919) *Enlist in 472nd Engineers. Surveying, mapping reproducing military and aerial maps. Surveyor- Topographers- Computers- Photographers lithographic- Topograding- Draftsmen. Address commanding Officer, 472nd Engineers, 7th and B Street, Washington, D.C* [National Archives at College Park, Still Picture Records Section, Special Media Archives Services Division (NWCS-S). NAIL Control Number: NWDNS-4-P-51. The National Archives and Records Administration provides images depicting American and global history which are public domain or licensed under a free license]

War and Cartography

by JEREMY MARTIN BLACK

ABSTRACT: For most combat, we have no maps. Thereafter mental mapping was the key; fitness is dependent on the need for mapping as well as the opportunities that exist. Not all places were equal in coverage and significance: sites to be fortified attracted mapping attention, and, more particularly, in order to plan how best to defend them. The precise location of the target, and an understanding of the routes there, are both crucial. The development of military cartography is conditioned by geographic theaters and operational capabilities. The essay illustrates the differences between the maps produced by the two world wars and between the British, American and Soviet, as well as the impact of airpower, developing three-dimensional mapping, radio navigation and geo-localization systems.

KEYWORDS: MILITARY CARTOGRAPHY. MILITARY PLANNING. SEAPOWER. AIRPOWER, SURVEYING.

War inherently takes place in a spatial context. It is an activity that can only be conducted in that fashion. As a result, mental mapping is central to conflict, and at every level, from the tactical to the strategic. Combatants order themselves in space and have to maintain that sense whatever the strains of combat. Doing so orientates them in terms of goal, means, and both colleagues and opponents. This sense of space is important to point-of-contact engagement however contested: whether hand-to-hand or by missiles weapons at any range.

For most combat, we have no maps. Instead, mental mapping was the key, as, indeed, overwhelmingly remains the case today. That point is not one found in discussion of the subject, but any emphasis on mental mapping leads to the conclusion that the standard approach to war and cartography is teleological, in that it adopts a progressivist account, one predicated on the assumption that mapping war is the desirable outcome and a necessary means.

Instead, the suggestion here is that a needs-based assessment is appropriate, one that considers idea of fitness for purpose in terms both of the maps and of their usage.

Such an approach, moreover, valuably complements that of considering the survival of artefacts, not least by asking what purpose is served. For maps in this context, there is the question not only of why they were retained, but, in particular, their potential value on a recurrent and/or long-term basis. That adds a further dimension to fitness for purpose.

So also with the issue of accuracy. That is not a fixed quantity but again a relative one in which fitness is dependent on the need for mapping as well as the opportunities that exist. Such an approach provides the theoretical background to a consideration of the specifics of the subject.

First, and most obviously, not all places were equal in coverage and significance. Indeed, that is a major difference between the mapping of the world, in whole or part, and the use of such maps for war, and, in contrast, more specific and detailed mapping for particular military purposes. The latter further demonstrates the point that is integrated to mapping about places not being equal, both in terms of which places are mapped and to what detail.

Linked to that issue comes that of purpose and timing, in particular maps produced prior to the period of immediate need and those arising from the latter. Indeed, in the second case, there is a collapsing of the distinction between map and photograph, with the photograph now serving as a form of map, and for immediate tactical purposes. This point underlines the difficulty of defining a map, but also, as a related point, the question of means versus ends in mapping. Thus, the trench maps of World War One were based on photographs.

Returning to the point that not all places are equal, it was especially the case that sites to be fortified attracted mapping attention, and, more particularly, in order to plan how best to defend them. In this case, there was again an overlap with other forms of illustration, notably in the shape of diagrams and pictures. That contrast, however, was not as clear as might be presumed, as maps included pictograms as devices. Moreover, some maps were simultaneously diagrammatic and pictorial. This, indeed, is an element that remained significant into the twentieth century.

The importance of maps for fortification was to be enhanced in the twentieth century as fortification spread into comprehensive front-wide systems with World War One. In that conflict, trench warfare, to a degree, swallowed the strategic and operational dimensions of war in tactical problems, but that process also encouraged the mapping of the systems.

In World War Two, the fighting was less static, but location remained a key issue, not least due to the continual importance of artillery. Indeed, that was a powerful driver for mapping at the tactical level. The understanding of ballistics demanded a fixing of target location in order that the algorithms that determined aiming could apply.

This account of mapping provides a clear linkage with capability, and the related requirement for maps for bombing was in effect another form of ballistics. The precise location of the target, and an understanding of the routes there, were both crucial. That meant that mapping for air warfare remained in effect two-dimensional, rather than focusing on the three dimensions that aerial conflict required. Instead, the latter for long remained a matter of the visual identification of targets. That changed greatly, however, when radar became more significant, not least because it allowed effective night-fighting.

Visibility was very differently a factor in submarine and anti-submarine warfare, but both affected the parameters of conflict at sea. So also did the deployment of aircraft. To focus hereafter in this account on the example of World War Two, mapping for the tactical level of warfare, as well as the operational level, but even more so, depended on the use (and updating) of existing map information and also, conversely, on the creation of totally new material. The range of the existing information varied greatly across the world. This was on an established pattern. Thus, there were no effective maps of Libya prior to the Italian conquest, but it was then rapidly mapped by the Istituto Geografico Militare of the army. So also for Ethiopia after its conquest in 1936.

The Pacific War posed major issues. Facing, from the unexpected Japanese attack in December 1941, the need to operate in the poorly-mapped Pacific, much of which had been in British or Japanese hands prior to the conflict, the Americans made extensive use of photo-reconnaissance, not least for mapping invasion beaches. The American landing force on the Japanese-occupied

island of Guadalcanal in the Solomon Islands in the south-western Pacific in 1942 lacked adequate maps, including landing maps, a problem that indicated the need for special amphibious landing maps. Moreover, the American naval raid in October 1943 on Wake Island, which before the war had been an American possession, faced the problem of inadequate charts for the surrounding waters. So also for the Australians with northern Australia, New Guinea, and the Solomon Islands.

In contrast, the Philippines, an American colony prior to the war, had been surveyed by the Coast and Geodetic Survey, a civilian agency under the Department of Commerce, and their data and charts were used for the successful American invasion of the Philippines in 1944-5. The Australian Navy Hydrographic Service, surveyed New Guinea from the summer of 1942, pressing on to produce surveys for elsewhere in the South Pacific, in part using material from the U.S. Coast and Geodetic Survey mapping, notably of the Philippines. More generally, there was a widespread use of fathometers for inshore navigation.

In the final year of the war, the U.S. Naval Hydrographic Office printed more than forty million charts. Some survey ships were equipped with presses that could print 2,000 sheets an hour. This was an aspect of the cumulative experience and capability that were important to American operations. That the Americans could plan where they wanted to operate and where to mount an invasion, increased the demand for maps, as did the inherently fluid style of their operations.

The British also markedly stepped up the production of hydrographic charts, notably in support of the 1944 invasion of Normandy. The danger of German bombing, abundantly seen with the bombing of the Ordnance Survey in Southampton, had led to the Hydrographic Office being moved from London to more distant Bath in 1939, and then to new buildings in distant Taunton in 1941. The supply of, and need for, charts was more problematic for Britain than in World War One due to the greater range and speed of operations, and the resulting number of tactical possibilities. This situation led to increased demand, which, in part, was met by the use of rotary offset printing machines. In the final run-up to the invasion of Normandy in 1944, the Hydrographic Office provided documents to thousands of vessels.

In the Soviet Union, there was a particular need for marine navigational-artillery charts for the Baltic and Black Seas which were designed to help warships bombard targets inland in support of ground forces. Detailed inland information and a kilometre grid were supplied accordingly. This task very much matched the general doctrines and practice for the use of Soviet warships.

There were also new technological requirements. Radar was a reflection of the novel nature of the three-dimensional character of mapping that stemmed from the role of submarines at sea and from the addition of aircraft to the vertical space already represented by terrain. The likely significance of air power and submarine attacks made this a major factor as a defensive capability. As with the use of mapping for artillery, radar was a response to the need to fix position accurately. However, unlike artillery, which generally fired from a stationary position, aircraft and submarines posed an inherently dynamic character in location and, thus, the depiction of location. Radar, thereby, looked ahead to what was to become a key element in the depiction of the battle-space, that of the GPS (Global Positioning System). At the same time, in using radar, it was necessary to develop systems and practices for signal processing, for example to distinguish aircraft from atmospheric features.

Radio navigation systems, such as the German *knickebein* system, were developed for aircraft. With OBOE, a targeting system first used in December 1941, and Gee-H, a radio navigation device introduced in 1942, the British developed accurate radio navigation systems which ensured that weather, darkness, and smog were less of an obstacle to bombing. Separately, Allied operations against submarines benefited greatly at the tactical level from sonar. This complemented the use of signals interception to fix the general area of submarine presence.

Maps were more extensively used for ground operations than in World War One. In part, this was because of the greater mobility of units and movement of operations, not least on the Western and Eastern Fronts in Europe, but also in the Mediterranean, for example in the war in Italy in 1943-5. The comparison between the movement in the war there in 1915-18 and that in 1943-5 is instructive. At the same time, a more mobile war did not prevent static operations akin to trench warfare.

Terrain evaluation maps were important for both infantry and for vehicles operating off-road, both military and logistical. Such maps were major additions to topographical maps. German terrain evaluation maps were impressive and effective. They covered a range of needs, both offensive and defensive, and regions, including the Libyan Sahara, and appeared at a number of scales. Colour was a key aspect in helping make the maps readily accessible. Aerial photography was important, but alongside ground information such as bridge weight limits. The material offered in German terrain evaluation maps included not just ground suitability, but also forest composition (type of tree) and density, slope gradients unsuitable for armoured vehicles, and important viewpoints with their field of view. In addition, German officers and NCOs were taught map drawing, and at a good level.

The British established the Inter-Service Topographical Division in the autumn of 1940, and it carried out terrain analysis to supplement topographical maps. This led to the printing of information on maps in order to make them more useful for troop movements, for example with the notation 'Irrigation ditches.' Tactical needs led the British to develop what were termed Goings maps, which were designed to display the nature of the terrain. Goings maps used colour to provide readily-grasped analysis. In addition to the terrain, metalled roads were presented differently depending on their width.

The Americans created the Military Geology Unit in June 1942, and it produced material for operations, notably Operation Husky, the successful invasion of Sicily in 1943. The value of this material in turn led to an increase in the unit's work, and its geographical expansion also to cover Pacific operations. American terrain appreciation maps covered a range of topics including not only the impact of the terrain on troop and vehicle maps, but also additional material on slope, soil, vegetation, climate and geological features. 'Trafficability,' the suitability of the terrain for cross-country movement, was the key element, and the Americans became adept at producing such material rapidly, as in January 1945 in preparation for the successful invasion of Germany. The material was made more valuable by being accompanied by charts showing, per month, the expected number of days of 'trafficable ground.'

Reliable maps and mapping still encouraged planning to reach a specific point on a map at a certain time, planning already seen in World War One; but

that crucial planning goal was now linked to greater mobility. In addition, the use of maps within the military was more widely extended. Whereas ordinary soldiers (unlike officers and senior non-commissioned officers) did not use maps extensively during World War One, they did so in World War Two and developed spatial awareness accordingly.

Mobility carried with it the risk of being obliged to defend areas of interest against attack to a greater depth than in the previous war. This factor interacted with the extension of the war due to the Allies fighting Italy from June 1940 and Japan from December 1941. Thus, in 1940, the British mapped the border areas of Kenya in preparation for campaigning against Italian East Africa (Ethiopia and Somalia). The threat of a Japanese invasion of Australia in early 1942 led to the production of large-scale maps for coastal areas of Australia, notably of Queensland, New South Wales, and Victoria, and near the cities of Adelaide, Darwin and Perth. These maps were linked to the location of artillery, for example to protect the naval base of Freemantle and the sea approaches to Melbourne.

A key element in mapping indeed was provided by the need to locate fortifications and to do so for strategic and operational ends and as part of integrated defence systems. Fortifications had to be planned with reference to each other and to possible attack routes, and they had to be fitted into the terrain. The war is not generally considered in terms of fortifications, in part because the emphasis is on mobility and notably, for ground combat, on tanks. This however, can lead to a serious failure to appreciate their significance.

The role of fortified positions in the war helped ensure that there were parallels with the mapping of opposing positions in the trench warfare of World War One. Aerial reconnaissance again proved significant, as did the planning of artillery bombardments, for example by the British at El Alamein in Egypt in late 1942. Greater tactical and operational mobility in World War Two were factors, but the similarities between the world wars can be instructive.

There were also maps for more specific purposes. Escape maps were used notably by shot down aircraft crew, first in Britain, where they were initially printed on silk by John Bartholomew and Son as part of its business for the War Office; and then in Germany and the United States. The British produced over 1 $\frac{3}{4}$ million copies of about 250 separate escape maps.

The relationship between resources and, on the other hand, the strategic, operational and tactical levels of war were clearly seen in the development of Allied mapping capability and its usage. Whereas Germany, Italy and Japan did not carry out systematic mapping, and generally simply overprinted, copied or enlarged existing maps, the Allies, and notably the Western Allies, carried out much new mapping. Topographic maps were very important both for ground operations and for air offensives. New material was inputted to fighting outcomes, with the British using maps based on new aerial photography in North Africa from 1941. There was much new mapping for subsequent Allied operations in North Africa, Europe, and the Pacific. The scale and sophistication of aerial photography was such that there would have been adequate American mapping for the large-scale invasion of Japan planned for late 1945. In contrast, other commitments, and the loss of the air war, ensured that the Axis powers progressively suffered from a lack of adequate up-to-date aerial photography in order to help land and air operations.

Very differently but, again, capturing the element of reconnaissance and mapping, conflict at sea was increasingly about location. This situation reflected the extent to which surface ships engaged at beyond visual range, as well as the growing role of aircraft carriers and submarines. Aerial reconnaissance and radar were each of great importance. The latter included the use of radar-controlled fire, as on 14 November 1942, off Guadalcanal in the Solomon Islands when the radar-controlled fire of the American battleships *Washington* and *South Dakota* hit hard the Japanese battleship *Kirishima*. It capsized on 15 November. Japanese battleships lacked radar-controlled fire. This night engagement was crucial to the American success in fighting on land on the island in January 1943. Until reliable, all-weather, day-and-night, reconnaissance and strike aircraft were available, which was really only in the 1950s, surface ships provided the prime means of fighting at night, although the highly-successful British carrier attack on Italian warships in the harbour at Taranto in 1940 was mounted at night. Moreover, some carrier aircraft carried radar.

On 24 May 1941, a British squadron sent to intercept the battleship *Bismarck*, the leading surface ship in the German navy, as it tried to enter the North Atlantic in order to attack trans-Atlantic shipping routes, was helped by radar in shadowing it off Iceland, only to suffer serious loss in the subse-

quent gunnery exchange, notably with the sinking of the battlecruiser *Hood*. The *Bismarck* was eventually sunk on 27 May by a far larger British fleet and thanks to both aircraft and gunnery.

Alongside the use of intelligence, mostly from interceptions, air power played a key role in resisting the German submarine assault, notably by identifying the target and rapidly attacking it. Nevertheless, accurate navigation over water proved a problem for the RAF, with many missions ending as ‘Convoy Not Found.’

In 1942, in contrast, there were marked improvements in British anti-submarine naval capability, including the increased use of shipborne radar and better sonar detection equipment. This very local locational information powerfully supplemented that from signals intelligence, which was less specific. In turn, enhanced weaponry, notably effective ahead-throwing, depth-charge launchers and more powerful depth-charges, as well as accumulated experience, gave effect to this information and capability.

Similarly with anti-submarine air resources. Again, very local target-finding was important, including ASV MK II radar and better searchlights. As a reminder that locational identification was part of a struggle between applied technologies, this radar lost its potency when the Germans were able to introduce listening receivers on U-boats. In turn, in March 1943, the MK III radar, which could not be detected by these receivers, proved a crucial addition. Radar sets small enough to be carried by aircraft, a key feature of applied capability, and yet capable of picking up submarine periscopes at five miles, were a crucial tool.

Precision locational and navigational information, including on the weather, was necessary for air as well as naval warfare. This information became more significant as the scale of each type of warfare increased. This was particularly the case to the end of the war with air warfare. Target identification on air raids was not easy, while there were also serious problems with accuracy. The British wished to destroy industrial targets in Germany, but the Butt Report on night raids in June-July 1941 showed that they were not doing so. Accuracy was difficult with night-time freefall bombing, and, also, despite American bombsights, with daytime bombing, for there was no electronic navigation or target identification, and the Allies did not have guided

bombs. Instead, concerned about the daytime vulnerability of their bombers, the British focused, from March 1942, on night-time area bombing. Cities were ranked on their economic importance as targets. The capacity of bombers increased thanks to the use of four-engined aircraft. However, although the American B-17 'Flying Fortress' was a steady platform that could carry a large bomb load, precision bombing was not easy. Indeed, with bombs with lethal radii measured in only a few tens of feet, a bombing tactic that involved bombardment squadrons all dropping simultaneously could not be accurately described as precision. Locational information, the instant mapping of a raid as it proceeded by navigators working with precise maps, was important. However, there were problems for the Allies with identifying the target, even in daylight and without anti-aircraft guns or enemy fighters, and accuracy remained heavily dependent on the skill of the pathfinder aircraft that preceded the bombers in order to identify targets.

Mapping was crucial for defence against air attack, as well as for attack. This was more than simply about technical developments. Mapping is a product and aspect of information systems, a creation of them, and a means to their success. This was clearly shown with the Battle of Britain in 1940. Germany had radar, but it was not yet available to help the *Luftwaffe*. In a serious intelligence failure, the Germans underrated the size, sophistication, and strength of the British defence and, in particular, failed to understand the role of British radar and radar stations, and their place in the integrated air-defence system, a system of information, analysis, and response. This control system, with its plotters of opposing moves and its telephone lines, was an early instance of the network-enabled capability seen in the 2000s with its plasma screens and secure data links. In each case, the targeting, sensors, and shooters, were linked through a network that included the decision-maker. In 1940, able command decisions and good intelligence were thus linked through a system that was effective for analysis and response.

In turn, in response to the Allied air offensive, and helped by the depth given by their conquests in 1940, the Germans developed a complex and wide-ranging system of radar warning, with long-range, early-warning radars, as well as short-range radars that guided night fighters (which also had their own radars) toward the bombers. This helped cause heavy Allied losses. Radar-defence systems could be wrecked by the British use of 'window': strips

of aluminium foil that appeared like bombers on the radar screens. However, in the autumn of 1943, the Germans adapted their radar to circumvent this. In turn, that November, the British began to fly electronic countermeasures aircraft.

The German ability to ‘map’ a raid as it was proceeding was not matched by Japan, which, with a bigger space to defend, totally lacked the integrated nature of the German defence system. Moreover, Japanese airfields were without protective radar, which ensured that Allied aircraft were able to mount successful raids, for example, crucially, on the New Guinea airfield at Wewak in August 1943; after which Allied ground operations in New Guinea were rarely threatened by Japanese aircraft.

The more general need to adapt tactics in order to use information more effectively was seen in the American air attack on Japan. Initially, from November 1944, the American raids were long-distance (from bases on the recently-conquered island of Saipan) and unsupported by fighter cover, as fighter range was less than that of bombers. This led to American attacks from a high altitude, which, however, reduced their effectiveness. The raids that were launched were also hindered by poor weather, especially cloudy conditions; by strong tailwinds; and by difficulties with the B-29’s reliability; as well as the general problems of precision bombing given the technology of the period. From February 1945, there was a switch to low-altitude night-time area-bombing of Japanese cities, which, from April, were supported by fighters from the newly-captured island of Iwo Jima. The value of the maps of Japanese cities thus depended heavily on the broader strategic situation and its consequences for the resources that could be applied.

The increased volume of ground-support by Allied aircraft also relied on information systems that included maps. The effectiveness of Allied ground support over Normandy in 1944 owed much to the long-term process of gaining air superiority over the *Luftwaffe*, but there had also been improvements in doctrine and organisation, including the use of air liaison teams with ground forces, as well as improvements in radio communication. Both attacks on specific targets and ‘carpet bombing’ relied on mapping. The latter was important to the American breakout from Normandy. Despite failures in coordination that led to ‘friendly-fire’ casualties, notably in the breakout from the Cotentin,

the Allies had become far more skilled at integrating their forces.

Separately to maps, the use of reconnaissance to prepare models as aids to the planning of attacks and bombardment was frequent. Relief models were used by both the Allies and the Axis. They helped prepare air attacks, for example on Pearl Harbor (1941) and the German dams successfully attacked by the British Dambusters (1943). Models were also used to help ground forces, whether attacking defended coastlines, as with Anglo-American forces invading Sicily (1943) and Normandy (1944), or advancing overland, as with the Soviet attacks on Finnish defences in 1940 and on Berlin in 1945.

Maps were also important in propaganda, which served military as well as civilian morale. For example, large maps were placed in the centres of the most important Italian cities, a practice begun with the conquest of Ethiopia in 1935-6. The practice was resumed in 1940, ending in 1943. Maps were a significant weapon on the Home Front of all the combatants. Their purpose, practicality and value therefore were multifaceted.



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by JEREMY MARTIN BLACK

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