Gabriel's Map: Cartography and Corpography in Modern War

4

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As the balloon calmed, the major looked down once more at the Belgian soil they had recently vacated…
Foot by foot, yard by yard, the war was heaving into view…
"Believe you me, Major, this is the only way you can make sense of what's down there. Once you are in the trenches, you keep your head down and the world shrinks…"

Robert Ryan, *Dead Man's Land*

I Would Rather Be in France . . .

In the winter of 1980–1981 William Boyd was researching his second novel in the Bodleian Library's collections at Rhodes House. *An Ice-Cream War* opens in June 1914, but Boyd was at Rhodes House because his eyes were fixed not on the killing fields of the Western Front—these would appear in later novels—but on a little known colonial conflict in British East Africa and German East Africa. This was one of the most remote theaters of World War I and, as Boyd said himself, in many ways the very opposite of the war in Europe: a war of movement, of skirmish and pursuit through desperately difficult bush country "on a scale unimaginable to soldiers on

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the Western Front—two armies pursuing each other for 4 years over territory five times the size of Germany." Boyd found it difficult to get its measure too—which is why 25 years later he welcomed a new history (Boyd, 2007)—and made the most of one of its better documented and most dramatic episodes: the Battle of Tanga.

The battle took place in the first few days of November 1914 in and around the small German-held port of Tanga. It was an epic disaster for a British expeditionary force that had sailed from India with orders "to bring the whole of German East Africa under British authority" (for detailed accounts, see Anderson, 2001; Godefroy, 2000). The officers in command made a series of miscalculations that allowed the much smaller opposing force to seize the advantage and ultimately to draw out the campaign for another 4 years. Many of them revolved around inadequate planning and incomplete intelligence, and in *An Ice-cream War* Boyd renders this fatal combination in vividly cartographic terms.[1] A young subaltern, Gabriel, joins a group of officers on board a lighter from the troop ship, "all peering at copies of the map by the light of torches" (Boyd, 1982, p. 144).

> "What's this mark?" someone asked. "It's a railway cutting," Major Santoras replied. "Between the landing beaches and the town." He went on less confidently: "There'll be bridges over it, I think . . . Should be, anyway." (p. 144)

The morning of the next day the men plunge ashore and climb the low, scrub-covered cliffs before advancing on the town:

> Gabriel tried to visualise the advance as if from a bird's-eye view—3,000 men moving on Tanga—but found it impossible. (p. 158)

> He wondered if they'd wandered off course in the coconut plantation. But what lay beyond the maize field? Gabriel waved his men down into a crouch and got out his map. It made no sense at all. (p. 160)

As the fighting continues, and the British are forced into an ignominious retreat, Gabriel has the epiphany that provides me with my title:

> "It's all gone wrong," Bilderbeck said . . . He took out his map from his pocket and smoothed it on the ground. *Gabriel thought maps should be banned. They gave the world an order and reasonableness it didn't possess*. (p. 169; my emphasis)

The contrast between what Clausewitz called more generally "paper war" and "real war" bedevils all conflicts, but the lack of what today would be called geospatial intelligence proved to be catastrophic for the East Africa campaign (Lohman, 2012, p. 21). It was a peculiarly brutal affair, described by one official historian as "a war of attrition and extermination which [was] without parallel in modern times"

[1] What I have described as "cartographic anxiety" (Gregory, 1994) is advertised in Boyd's epigraph to *An Ice-Cream War*, which comes from Rudyard Kipling's (1910) *The Brushwood Boy*:

"He hurried desperately, and islands slipped and slid under his feet, the straits yawned and widened, till he found himself utterly lost in the world's fourth dimension with no hope of return. Yet only a little distance away he could see the old world with the rivers and mountain chains marked according to the Sandhurst rules of map-making."

Those "Sandhurst rules of map-making" were unbuttoned in the war in East Africa and, as I will show, were simultaneously enforced and confounded in the war in Europe.

(Sandes, 1933, p. 498, cited in Paice, 2007, p. 3). In his more recent history Paice (2007) sharpens the point with an extraordinary vignette:

> In 1914 Lieutenant Lewis had witnessed the slaughter of every single man in his half-battalion on the Western Front and had experienced all the horrors of trench warfare. Yet sixteen months later, in a letter sent to his mother from the East African "front," Lewis wrote "I would rather be in France than here." (p. 7)

In this essay I turn back to British experience on the Western Front in 1914–1918 and, for all the distance and difference from East Africa, re-locate Gabriel's despair at the ordered geometry of the map in the no less surreal and slippery landscapes of war-torn Belgium and France. In contrast to the East African campaign, war here was fought with increasingly sophisticated, highly detailed geospatial intelligence. In the next sections I describe a combination of mapping and sketching, aerial reconnaissance and sound ranging that transformed the battlefield into a highly regulated, quasi-mathematical space: the abstract space of a military Reason whose material instruments were aircraft, artillery, and machine-guns. In the sections that follow I counterpose this cartography and its intrinsically optical-visual logic to the muddy, mutilated and shell-torn slimescapes in which the infantry were immersed month after month. I call the radically different knowledges that the war-weary soldiers improvised as a matter of sheer survival a corpography: a way of apprehending the battle space through the body as an acutely physical field in which the senses of sound, smell and touch were increasingly privileged in the construction of a profoundly haptic or somatic geography.[2] I conclude with some reflections on the shadows cast by this analysis over war in our own troubled present.

The Optical War and Cartographic Vision

It has become commonplace to identify World War I with a crisis of perception that was, through its intimate connections with modernist experimentation, also a crisis of representation (Kern, 1983; see also Eksteins, 1989).[3] And yet—or rather, in consequence—it was also what Saint-Amour (2003, p. 354) calls "the most optical war yet" that depended on a rapidly improvised and then swiftly professionalized techno-military assemblage whose political technology of vision not only brought the war into view but also ordered its conduct through a distinctive scopic regime whose parameters I must now sketch out.[4]

[2] I thought I had made the word up—I discuss its filiations below—but I have since discovered that Pugliese (2013) uses "geocorpographies" to designate "the violent enmeshment of the flesh and blood of the body within the geopolitics of war and empire"(p. 86). My intention is to use the term more directly to confront the optical privileges of cartography through an appeal to the corporeal (and to the corpses of those who were killed in the names of war and empire).

[3] More specifically, Jay (1994) describes this as a crisis of *ocularcentrism* (pp. 192–217).

[4] Saint-Amour (2003, p. 354) describes this as a "technological matrix" but I use "assemblage" to emphasize both its heterogeneity and its materiality.

When the British Expeditionary Force set sail in August 1914 it was assumed that tried and tested methods of geospatial intelligence would suffice.[5] In the War Office's collective view, existing maps of the combat zone would be perfectly adequate, and the Ordnance Survey was instructed to provide General Headquarters (GHQ) with copies of two medium-scale topographic maps of Belgium and northeastern France (1:100,000) and of France (1:80,000). Any updates would be made by traditional means, and in July General Douglas Haig made it clear that the only useful reconnaissance would be conducted by the cavalry: "I hope none of you gentlemen is so foolish as to think that aeroplanes will be usefully employed for reconnaissance purposes in war" (Sykes, 1942, p. 105).[6] Neither assumption survived the first encounters with enemy forces. During the chaotic retreat from Mons in the last week of August one subaltern recalled that "maps were non-existent. We had been issued with maps for an advance, and we soon walked off those!" (Lt. B. K. Young, in Barton, Doyle, & Vandewalle, 2010, p. 19). For many days he and his fellows relied on a road map confiscated from a fleeing motorist.

Confronted with a cascade of unforeseen events, GHQ demanded regular updates for its (as it turned out, wholly inadequate) maps, and turned to the fledgling Royal Flying Corps for reconnaissance. The first results were not encouraging; the pilots flew without observers and the official historian admits that "the machines lost their way and lost each other" (Raleigh, 1922, p. 300). The officers had no training for these missions, and during the first Battle of Ypres in October observers from No. 6 Squadron "mistook long patches of tar on macadamized roads for troops on the move, and the shadows cast by gravestones in a churchyard for a military bivouac" (Raleigh, p. 304). But a system was already beginning to emerge. Reports were made in narrative-tabular form, under three standard headings—Time, Place, Observation—and as soon as the aircraft landed the pilot and observer would report to GHQ where they were debriefed and the base maps updated and annotated (Sykes, 1922).

After the battles in Flanders in October the Western Front stabilized and the conflict turned into a war of attrition with the armies, in William Brodrick's (2008) splendidly evocative phrase, "scratching behind the skirting boards of France and Belgium" (p. 27). The first (1:50,000) British trench maps showing the position of the German lines had been produced in great haste for the first battle of the Aisne in September, but it was now clear that many more and still larger scale maps would be required—the sooner the better—and that they would need to be regularly updated and overprinted with the latest, fine-grained tactical intelligence.[7] A small

[5] For details of the various offensives, see Hart (2013). My own account is largely confined to the British experience, but Hart restores the French to the prominent place from which they have been evicted in too many English-language accounts of the war.

[6] Sykes served as Chief of Staff for the Royal Flying Corps in 1914–1915.

[7] My discussion of military cartography and its ancillary practices has two principal limitations. First, it is confined largely to the practice of the British Army, though this may not be as restrictive as it appears. Chasseaud (2002) shows that, for all the differences between them, "in almost every aspect of war survey and mapping" the British, French, and German armies "developed remarkably similar organisations and methods, suggesting that problems were clear and solutions obvious"

Ranging and Survey section of military surveyors arrived in France in November 1914, and by March 1915 their field sheets had been submitted to the Ordnance Survey for the production of a new series of 1:20,000 maps. These improved the accuracy of artillery fire, but their very success generated demands for even more detailed maps.[8] By the end of November a new series of 1:10,000 trench maps had been distributed by the Ordnance Survey from its printing house in Southampton.

The presses rolled through the night, sometimes printing as many as 20,000 sheets in a day, and by the end of the war 34 million sheets had been supplied to Britain's armed forces. The sheets were shipped to Le Havre and then taken by train to forward distribution points from which Ordnance Survey "map cars" would eventually make daily runs to General, Corps, and Divisional Headquarters.

This was a formidable feat of production and distribution that required the military to overcome two major challenges. The first was to map occupied territory that lay beyond the scope of field survey, while the second was to update the database in line with a fluid battle space. In fact, for all the apparent authority of the printed map, it was always provisional; it always belonged to a past that was rapidly receding. In 1915 it took 2 weeks to produce a finished map at Southampton, and by 1916 this had doubled, so that by the time the map arrived at the Front it was already out of date (Chasseaud, 1999, p. 87).[9] In these difficult circumstances four techniques were used to consolidate and refine cartographic vision. Aerial photography and field sketching apprehended the battlefield as a space of objects, locating trenches and troop dispositions, while aerial observation and sound ranging animated the battlefield as a space of events, tracking troops advancing and guns firing (Table 4.1).

First (and foremost), aerial photography proved to be indispensable for what was, by the standards of day, near real-time mapping.[10] In the view of one observer, the camera was "a means for recording, with relentless precision, the multitudinous

(p. 201). Second, it is primarily concerned with the production of topographic maps and their trench overlays. As the conflict developed other geo-technical maps were required, based on the topographic series. Supplying water for troops, horses, and mules was a major problem—some estimates put the daily requirement at 45 liters per man or animal—and from 1915 water supply maps at various scales were used to identify likely sources and plan new boreholes. The development of tunneling and mining relied on geological maps and the production of meticulous mine plans (see Barton, Doyle, & Vandewalle, 2010; Doyle & Bennett, 1997; Rose & Rosenbaum, 1993). Towards the end of the war enterprising intelligence officers prepared terrain maps indicating the suitability (or otherwise) of the ground for tanks, but these "goings" maps were not always appreciated by staff officers. Haig's Chief of Intelligence intercepted one of them, which showed how limited the safe ("white") areas were, and returned it to its author with the curt instruction: "Pray do not send me any more of these ridiculous maps" (Macdonald, 1993, p. 116).

[8] The canonical account of British military cartography is Chasseaud (1999, 2013); see also Murray (1988) and Forty (2013).

[9] This increased the urgency for printing in theater, and by 1917 every Field Service Company was provided with powered printing presses for limited distribution, time-critical ("hasty") runs. By then, fears of attacks on Channel shipping had also prompted the Ordnance Survey to open an Overseas Branch in a disused factory in northern France.

[10] The definitive account is Finnegan (2011), but see also Slater's (n.d.) highly informative series on "British Aaerial photography and photographic interpretation on the Western Front" at http://tim-slater.blogspot.ca

Table 4.1 Cartographic vision and the battlefield

	Space of objects	Space of events
Air	Aerial photography	Aerial observation
Ground	Field sketching	Sound ranging

changes that take place within the restless area of an army at war" (H. A. Jones, 1928, p. 87). It was that capacity to track changes—to set the printed map in motion—that gave aerial photography its power. "Every day there are hundreds of photographs to be taken," one pilot explained, "so that the British map-makers can trace each detail of the German trench positions and can check up on any changes in the enemy zone" (Bishop, 1918, p. 22.). Still, it had a slow start; the Royal Flying Corps took only one official camera to France in 1914, and the first plates were unimpressive. But by January 1915 one enterprising observer had on his own initiative assembled a photomosaic that sufficiently impressed the General Staff for it to establish an experimental photographic section whose first sorties took place in early March.[11] The reconnaissance flights photographed the German lines to a depth of 700–1,500 yards, and the plates were used to overprint the existing 1:50,000 maps with an outline of the enemy trench system. This was the first trench map to be augmented by aerial photographs, and Haig used it to plan the first large-scale offensive by the British Army, the Battle of Neuve Chapelle, which took place a week or so later between 10 and 13 March 1915 (Fig. 4.1).[12]

Reconnaissance flights soon became so routine that one pilot compared them with "going to the office daily, the aeroplane being substituted for the suburban train" (H. A. Jones, 1928, p. 82), although once the power of aerial reconnaissance was recognized the commute became much more dangerous and often deadly. The reference to the relentless rhythm of the workaday world became ever more appropriate as the interval between reconnaissance and reproduction decreased. In the summer of 1916, in preparation for the Battle of the Somme, the Royal Flying Corps (RFC) conducted a series of "speed tests" in which less than an hour—and sometimes as little as 30 minutes—elapsed between taking a photograph and delivering the print to Corps HQ.[13] The tempo of reconnaissance increased too, particu-

[11] The first "A" camera was handheld and required the observer to perform 11 separate operations "in thick gloves or with numbed fingers" to expose the first plate; its limitations were obvious, and by the summer a semi-automated "C" camera was fixed to the aircraft (Slater, n.d., Part 8; H. A. Jones, 1928, pp. 89–90).

[12] Finnegan (2011, p. 55) calls this "the first imagery-planned battle" but the newly detailed map was not sufficient to turn aerial photography from a novelty into a necessity. Slater (n.d., part 10) argues that it was the critical shortage of ammunition for the artillery—which Sir John French also blamed for the military failure at Neuve Chapelle—that drove the search for more accurate and efficient methods of targeting that aerial photography promised to provide.

[13] Slater (n.d.) claims that it was the Battle of the Somme that marked aerial photography's admission to the very center of operational planning; for a vivid account of the RFC's wider role

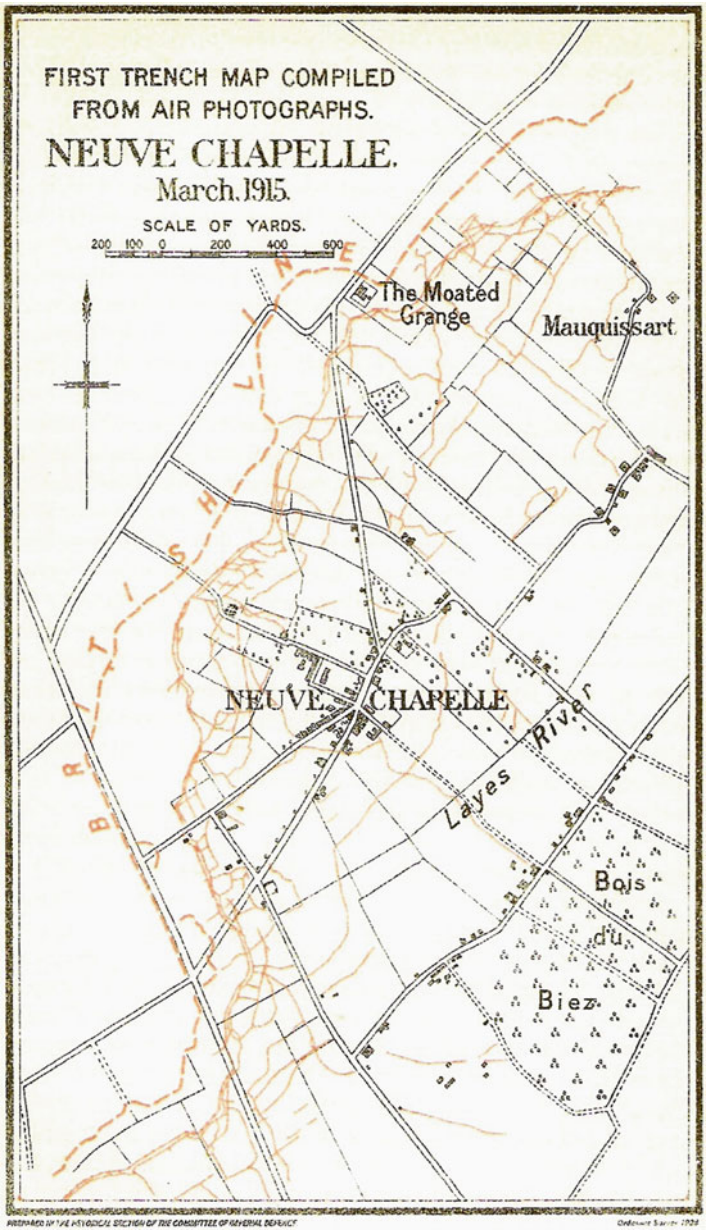

Fig. 4.1 First trench map compiled from air photography. Neuve Chapelle, 1915 (From *The War in the Air*, (Vol. 2, p. 91), by H. A. Jones, 1928, Oxford, UK: Clarendon Press. Reprinted with permission)

larly during a major offensive. In 1916 the RFC planned to photograph the German lines to a depth of 3,000 yards every five days and the counter-battery area to the rear every ten days, but during the preparatory barrage for the Battle of Messines in July 1917 the German lines were being photographed every day. The production of photographic prints, like so much else on the Front, was becoming thoroughly industrialized. In 1915 the standard British production cycle had called for photographic plates to arrive at 2130 in the evening and for 100 copies to be ready for distribution to headquarters down the line by 0600 the following morning (Finnegan, 2011, p. 56). But this system was rapidly overtaken by events; photographic sections were decentralized to meet the growing demand for near real-time prints so that imagery also flowed up the command hierarchy. The stream of images rapidly accelerated, and was given a further boost once the United States entered the war in April 1917. What Sekula (1975, p. 27) called the "instrumental collage" of aircraft, camera, and artillery was central to modern, industrialized war, and the middle term was crucial. By November *Scientific American* could describe the camera as "a deadly instrument" that was "many times deadlier than its equivalent weight of high explosive" ("The Camera at the Front," 1917, p. 389). Its payload was most effectively delivered through assembly-line production. Sekula (1975) again:

> The establishment of this method of production grew out of demands for resolution, volume, and immediacy. No method of reproduction but direct printing from the original negative would hold the detail necessary for reconnaissance purposes. Large numbers of prints from a single negative had to be made for distribution throughout the hierarchy of command. In addition, the information in prints dated very rapidly. Under these circumstances, efficiency depended on a thorough-going division of labor and a virtually continuous speedup of the work process. Printers worked in unventilated, makeshift darkrooms; 20 workers might produce as many as 1,500 prints in an hour, working 16-hour shifts.[14] (p. 28)

Like the economic model from which it derived, the system was the product of a synergy between industrial innovation and scientific advance. As soon as semi-automation made it possible for pilots to produce series of overlapping photographs the analysis of stereoscopic pairs made the art of photo-interpretation equally scientific. Some staff officers no doubt still believed that the raw photograph spoke for itself, but careful interpretation was essential to *make* the image speak. "Reconnaissance images are highly encoded," Amad (2012) insists, "non-literal, non-transparent and opaque documents" (p. 83; see also Saint-Amour, 2011).[15] Reading them was an exacting business, and their capacity to disclose the battlefield was complicated as militaries not only integrated aerial reconnaissance into their

in that offensive, see Hart (2012).

[14] One of the principal managers of these production methods was Edward Steichen, who commanded the photographic division of the American Expeditionary Forces. He organized the 55 officers and 1,111 men under his command into what Virilio (1989) described as "a factory-style output of war information" that "fitted perfectly with the statistical tendencies of this first great military-industrial conflict" (p. 201).

[15] Hüppauf (1993) emphasizes how the photograph worked to project order onto a disordered landscape "by reducing the abundance of detail to restricted patterns of surface texture." In his view, "the morphology of the landscape of destruction, photographed from a plane, is the visual order of an abstract pattern" (p. 57).

operations but also sought to confound its use by their adversaries. There were two developments of particular significance. Most—or perhaps least—obviously, the refinement of aerial photography stimulated the development of the counter-science of camouflage. By 1916 the British had developed a sort of "net work warfare," using specially designed scrimmed netting throughout their section to subvert the enemy's photographic gaze. This required the *camoufleurs* to "see like a camera," and Shell (2012) suggests that the netting effectively "seeded itself into the emulsive space both within and between the photographic frames," so that the viewed became "active agents, operating to conceal themselves within regulated and serially photographed time" (p. 77; see also Forsyth, 2013).[16] This in turn required the photo-interpreters to see like a sort of reverse camera, and to peel away the deceptive layers of the frames. The problems were not only on the surface, however, because once the trenches had more or less stabilized part of the battlefield they disappeared deep underground. Both sides dug tunnels beneath the opposing lines to detonate enormous explosions (mines), and these too relied on detailed mapping for their success. Although the excavations were not visible from the air—the point was to take the enemy by surprise—the spoil was highly vulnerable to aerial reconnaissance. In consequence, large numbers of troops were employed at night to remove and distribute the spoil far from the mine head, and it was no simple task to detect traces of these operations on the photographic plates in time for countermeasures to be taken (Barton et al., 2010, p. 94; S. Jones, 2010).

All the way down the distribution chain aerial photographs were scrutinized, annotated, and used to construct makeshift maps modified from the printed sheets. But on the front lines direct observation from the ground was also indispensable and here a second, heterogeneous set of techniques came into its own: sketching of both maps and terrain. Thus Edmund Blunden was ordered "to produce an enlargement of the trench map showing our front line and the German front line at a chosen point" (in preparation for a raid), and later crawled along a disused sap towards a suspected German observation post, all the while "pretty certain that German topographers were crawling from their end in like fashion" (Blunden, 1928/2000, p. 39). The knowledge obtained from these sorts of expedition was typically recorded on annotated sketch maps (Fig. 4.2).

These were supplemented by formal field sketching carried out by military draftsmen. This was artisan rather than factory production, art more than science, but it maintained significant connections with both cartography and photography: some draftsmen revised their initial drawings with the aid of aerial photographs, and while the perspective of the field sketch was horizontal—unlike the vertical frame

[16] Even this could be undone by the violence of war. One artillery officer at Ypres in 1917 worried that "the ground was so devastated and wrecked that the usual camouflage netting might give you away. So we would make the [battery] position look as untidy as the surroundings. . . . We were told to do this by the RFC pilots. They said, 'For God's sake don't have any kind of order'" (Arthur, 2002, p. 214).

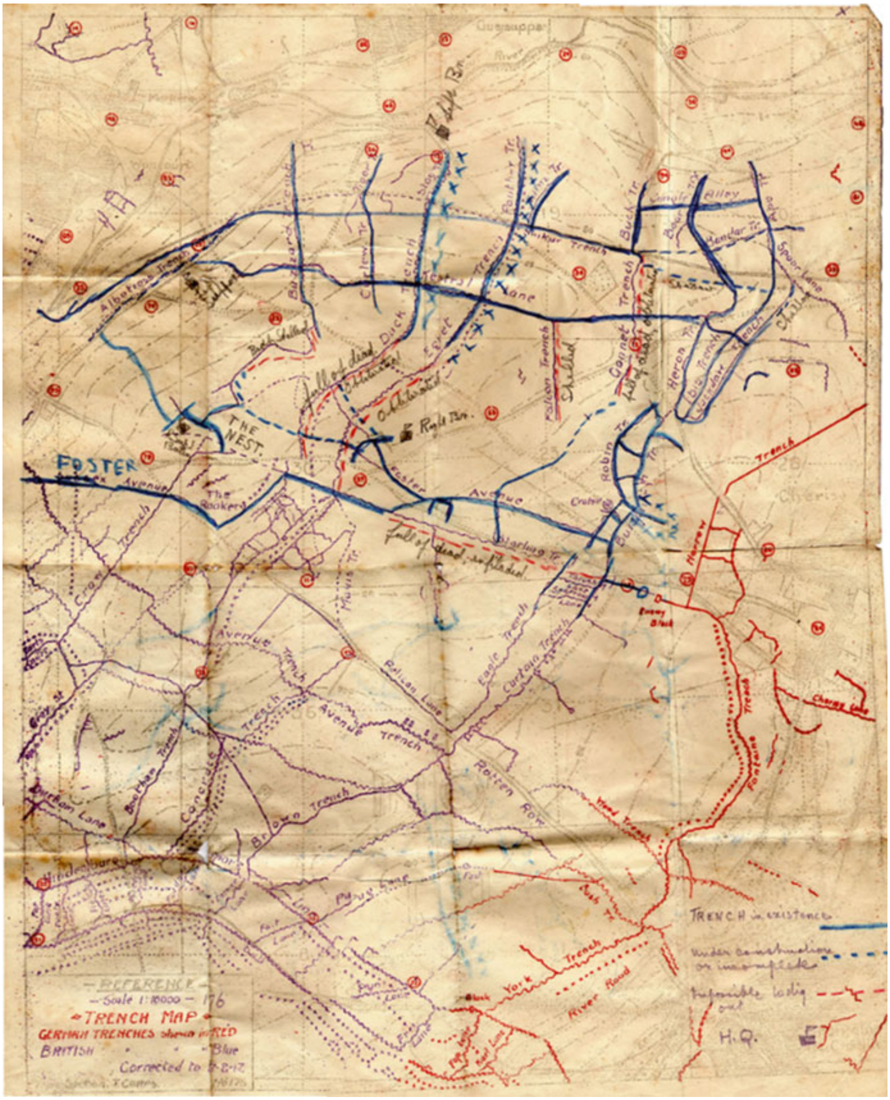

Fig. 4.2 Annotated trench map (Source: http://britishtrenchmaps.co.uk/pdfs/Trench%20maps%20A4%20leaflet.pdf. Copyright unknown)

of the map or the photograph—Gough (1998, 2009, p. 244) has demonstrated that field sketches were almost always "heavily dressed in the idiom of map-making."[17]

The demand for field sketches increased throughout the war, and Gough (2009) claims that the panorama became "a surrogate view for the distant artillery" (p. 238). That was probably more important in the first phase of the war, when gun batteries

[17] See also Mattison's discussion of the work of British-Canadian military topographer Walter Draycot(t) in "Representations of war as autobiographical media" at http://www.walterdraycot.com

relied on direct fire; since this made them highly vulnerable to counterattack—because the line of sight could readily be reversed—indirect fire from concealed positions against unseen targets soon became the norm, and then other means had to be used to register the locations of enemy batteries. A third set of techniques thus relied on direct observation from the air, and in his history of the air war Raleigh (1922) insisted that

> Reconnaissance, or observation, can never be superseded; knowledge comes before power; and the air is first of all a place to see from. It is also a place to strike from, but, speaking historically, offensive action in the air, on any large scale, began, as had been anticipated, in the effort of the conflicting forces to deprive each other of the opportunity and means of vision. (p. 446)

Bombing played its role in the war, both on and off the battlefield, but much of the time the most vital vector of military violence was the artillery, and although its shells flew high into the air the ground—its ground—remained "the place to strike from".[18] Raleigh's sharp point was that effective artillery fire depended on air-to-ground coordination. The use of balloons and aircraft for direct observation and ranging allowed near real-time communication with gun batteries, and overrode the delay between reconnaissance, reproduction, and dissemination that remained no matter how fast a Steichen could spin the aerial photography cycle.

Unlike other belligerents, the British Expeditionary Force arrived without a single observation balloon, and the first British Kite Balloon Section was not deployed until May 1915. Its balloons were set 12–15 miles apart, usually 3 miles behind the front line trenches so that they were beyond the range of small arms and artillery fire, and tethered to a truck-mounted winch. They could rise to a height of 3,000–4,000 ft, which provided a field of view (see Fig. 4.3) that could extend 15 miles or so beyond the enemy's front line, and although they were static they had significant advantages over reconnaissance aircraft.

The balloons provided more or less persistent presence since, apart from changing observers, they could remain aloft all day and all night so long as they were not attacked by enemy aircraft; in ideal conditions the motion of the basket suspended beneath the balloon was so slight that observers could use high-magnification field glasses to conduct detailed surveillance; and the telephone line incorporated into the cable gave them two-way voice communication with the ground (H. A. Jones, 1928, p. 115; Kennett, 1991, p. 25).

Still, most historians seem to agree that balloons were much better for providing general situational awareness, and while at first the artillery was reluctant to have its guns "run by the Flying Corps" (Hart, 2012, p. 36) aircraft soon became the preferred platform for ranging guns on to specified targets.[19] An aircraft was assigned to work with a particular battery, but the first communications were hit-or-miss

[18] On some estimates artillery fire accounted for 58 % of all combat deaths during the war. On the role of artillery see Marble (2008) and Strong and Marble (2011).

[19] Batteries were not wholly reliant on aircraft, but also used forward observers, flash spotting, and sound ranging.

Fig. 4.3 Balloon view of bombardment, Roclincourt, 23 September 1915. Imperial War Museum, photograph Q42236 (Retrieved from http://www.gutenberg-e.org/mas01/images/mas03a.html. Also listed at http://www.iwm.org.uk/collections/item/object/205276700 as ©IWM)

affairs, involving written messages dropped to the ground ("You hit them—We must go home—No petrol"), very lights, and signaling lamps. Wireless communication was soon introduced, and in short order "a wireless aeroplane was as popular as an opera-singer" (Raleigh, 1922, p. 340) . But it had its own shortcomings: the equipment was so heavy that aircraft could only carry a transmitter and not a receiver, reception was often scrambled and disrupted by weather conditions, and there were teething problems when different aircraft used the same wavelength (Raleigh, 1922, p. 343). The first transmissions were verbal, as in this wireless communication on 24 September 1914:

4.02 p.m. A very little short. Fire. Fire.
4.04 p.m. Fire again. Fire again.
4.12 p.m. A little short; line O.K.
4.15 p.m. Short. Over, over and a little left.
4.20 p.m. You were just between two batteries. Search 200 yards each side of your last shot. Range O.K.
4.22 p.m. You have them.
4.26 p.m. Hit. Hit. Hit.

In early 1915 this impressionistic system was replaced by a standard clock-code: a clock face was superimposed over a target identified on an aerial photograph, with 12 indicating north; radial distances were lettered from Y and Z (10 and 25 yards) out to E and F (400 and 500 yards), and the aircraft transmitted the location of each salvo (Y4, say) to the battery in Morse code. "With a good battery," one pilot reckoned, "you should get them right on target at about the third salvo" (Hart, 2012, p. 35; see also pp. 107–108).[20] The next year zone calls were introduced, in which guns were ranged on to quartered grid squares ("zones") on a 1:40,000 map (the "Artillery Board"). These refinements were moments in the abstraction of the battle space. As one reporter noted,

> The affair is not like shooting at anything. A polished missile is shoved into the gun. A horrid bang—the missile has disappeared, has simply gone. Where it has gone, what it has done, nobody in the hut seems to care. There is a telephone close by, but only numbers and formulae—and perhaps an occasional rebuke—come out of the telephone, in response to which the perspiring men make minute adjustments in the gun or in the next missile.
>
> Of the target I am absolutely ignorant, and so are the perspiring men. (Bennett, 1915, p. 97)

The same can be said of a fourth set of techniques known as sound ranging, which Liddle (1998) hailed as "the 'Manhattan Project' of the 1914–18 war" (p. 120). This involved locating an enemy battery by calculating its distance and direction from the sound-wave generated by its shell. The usual configuration had six low-frequency microphones stationed at carefully surveyed intervals along an arc 4,000 yards behind the front line with two observation posts in front of them, all linked to a recording station in the rear. When the forward observers saw a gun flash or heard its boom they sent a signal that activated an oscillograph and film recorder in the recording station (MacLeod, 2000).[21] The British established their first sound-ranging section in October 1915, following the French example, and by the end of the year they could locate an enemy gun within 500 yards. In the course of 1916 another seven sections were established, each plotting battery positions on printed Ordnance Survey sheets. In ideal conditions (which were rare) the operation could be completed for a single battery within 3 minutes and with an accuracy of 25–100 yards. Tom McCarthy's (2010) novel *C* provides a vivid reconstruction of the process:

> This [hut]'s wall has a large-scale map taped to it; stuck in the map in a neat semi-circle are six pins. Two men are going through a pile of torn-off, line-streaked film-strips, measuring the gaps between the kicks with lengths of string; then, moving the string over to the map slowly, careful to preserve the intervals, they transfer the latter onto its surface by fixing one end of the string to the pin and holding a pencil to the other, swinging it from side to side to mark a broad arc on the map. "Each pin's a microphone," the slender-fingered man explains. "Where the arcs intersect, the gun site must be." "So the strings are time, or space?" Serge asks. "You could say either," the man answers with a smile. "The film-strip knows no

[20] There is an imaginative description of artillery ranging from the pilot's point of view in McCarthy (2010, pp. 177–178).

[21] For a more informal account that describes the everyday routine of the sound rangers, see Innes (1935).

> difference. The mathematical answer to your question, though, is that the strings represent the asymptote of the hyperbola on which the gun lies." (p. 195)

We might draw three conclusions from all this. First, the war was—in this register and in this place at least—a profoundly visual-optical affair. Even sound ranging relied on "filming sound," as McCarthy's protagonist realizes, and he inhabits a world of arcs and parabolas and gridded space. "I don't think of it as mathematics," he says at one point, "I just see space: surfaces and lines" (McCarthy, 2010, p. 152). Second, that space was in constant motion. In fact, the seeming stasis of trench warfare was Janus-faced, produced by myriad movements—advances and retreats, raids and repulses—whose effectiveness depended not on the fixity of the map or the photograph but on their more or less constant updating. This capacity is not the unique achievement of twenty-first century digital navigation, and Chasseaud (2002) is not exaggerating when he describes the results of the entanglements between aerial reconnaissance, photography, and cartography on the Western Front as the production of "a new geographical information system" that provided "a sophisticated three-dimensional fire-control database or matrix of the battlefield." "In effect," he claims, "the battlefield had been digitized" (p. 172). Third, this matrix was performative, producing the quick-fire succession of events that it represented. McCarthy captures this to great effect in his account of a pilot working with a gun battery:

> Serge feels an almost sacred tingling, as though he himself had become godlike, elevated by machinery and signal code to a higher post within the overall structure of things, a vantage point from which the vectors and control lines linking earth and heaven . . . have become visible, tangible even, all concentrated at a spot just underneath the index finger of his right hand which is tapping out, right now, the sequence C3E MX12 G . . .
>
> Almost immediately, a white rip appears amidst the wood's green cover on the English side. A small jet of smoke spills up into the air from this like cushion stuffing; out of it, a shell rises. It arcs above the trench-meshes and track-marked open ground, then dips and falls into the copse beneath Serge, blossoming there in vibrant red and yellow flame. A second follows it, then a third. The same is happening in the two-mile strip between Battery I and its target, and Battery M and its one, right on down the line: whole swathes of space becoming animated by the plumed trajectories of plans and orders metamorphosed into steel and cordite, speed and noise. Everything seems connected: disparate locations twitch and burst into activity like limbs reacting to impulses sent from elsewhere in the body, booms and jibs obeying levers at the far end of a complex set of ropes and cogs and relays. (p. 177)

Serge is using the clock code to range the guns on to their target, but the passage is remarkable for McCarthy's imagery of "machinery and signal code" and "ropes and cogs and relays." Some of those who survived the war used the same mechanical imagery, perhaps nobody more effectively than Ernst Jünger (1920/2003):

> The modern battlefield is like a huge, sleeping machine with innumerable eyes and ears and arms, lying hidden and inactive, ambushed for the one moment on which all depends. Then from some hole in the ground a single red light ascends in fiery prelude. A thousand guns

> roar out on the instant, and at a touch, driven by innumerable levers, the work of annihilation goes pounding on its way.[22] (p. 107)

What distinguishes McCarthy (2010), I think, is his realization that more is happening than lights setting levers in motion. Later he has Serge recognize that he is the messenger of death but insists that

> He doesn't think doesn't think of what he's doing as a deadening. Quite the opposite: it's a quickening, a bringing to life. He feels this viscerally, not just intellectually, every time his tapping finger draws shells up into their arcs, or sends instructions buzzing through the woods to kick-start piano wires for whirring cameras, or causes the ground's scars and wrinkles to shift and contort from one photo to another: it's an awakening, a setting into motion. (p. 200)

When "the ground's scars and wrinkles . . . shift and contort from one photo to another" the cycle is complete: the image becomes the ground which becomes the image. A clockwork war is set in motion through the changing contours of the map.

"Clockwork War" and the Mathematics of the Battlefield

The new face of industrialized warfare with its intricate co-ordination of military forces along the Front required time and space to be choreographed with unprecedented precision. Various methods were used to synchronize time, but the wristwatch (or trench watch) was the indispensable mechanism, as the *Stars and Stripes* made plain in 1918 in an essay entitled "The Wrist Watch Speaks." The wristwatch was "at the heart of every move in this man's war."

> On the wrist of every line officer in the front line trenches, I point to the hour, minute and second at which the waiting men spring from the trenches to the attack. I . . . am the final arbiter as to when the barrage shall be laid down, when it shall be advanced, when it shall case, when it shall resume. I need but point with my tiny hands and the signal is given that means life or death to thousands upon thousands.

Synchronizing watches was a two-step process. Time-signals were transmitted from the Observatoire de Paris to the French military's radio-telegraphic station at the Eiffel Tower and broadcast twice a day in three bursts in the morning and again in the evening. Signals Officers or orderlies would be summoned to Brigade Headquarters to receive the official time and set their rated watch to Eiffel Tower Time, and they would then redistribute the synchronized watches to the officers.[23]

[22] The book was first published in German in 1920 but this passage was omitted by Jünger in subsequent revisions (which continued until 1961), and so does not appear in the (superior) English translation of the 1961 edition by Michael Hofmann (London, UK: Penguin, 2003). Unless otherwise noted, all subsequent references are to the Hofmann translation.

[23] Hence, for example, this "synchronisation instruction" contained in Operation Order (no 233) from the 112th Infantry Brigade on 10 October 1918: "O.C. No.2 Section, 41st Divisional Signal Company, will arrange for EIFFEL TOWER Time to be taken at 11.49 on 'J' minus one day ['J' was

By these means, as Stephen Kern (1983) has it, "the war imposed homogeneous time" (p. 288)—or at any rate attempted to do so.[24]

The relentless timetabling of the war was partly a product of the scale of the conflict, the sheer numbers of men and machines that had to be maneuvered across the battlefield, but it was also necessitated by the difficulty of real-time communication between infantry, artillery and aircraft. It also required a no less rigid mathematization of the battlespace. "We are to go over from tapes laid by the Engineers," wrote A. M. Burrage (1930). "The whole thing must be done *with mathematical precision*, for we are to follow a creeping barrage which is to play for 4 min only a hundred yards in front of the first 'ripple' of our first 'wave'." (p. 127). The artillery timetable had been introduced at Neuve Chapelle in March 1915, followed by the stepped barrage at Loos in September and the creeping barrage by the time of the Somme offensive in 1916 (Becke, 1931; Marble 2008, Chap. 6). The Tactical Note from Fourth Army HQ in May 1916 explained the principle:

> The ideal is for the artillery to keep their fire immediately in front of the infantry as the latter advances, battering down all opposition with a hurricane of projectiles. The difficulties of observation, especially in view of dust and smoke . . . the probable interruption of telephone communications between infantry and artillery . . . renders this idea very difficult to obtain.
>
> Experience has shown that the only safe method of artillery support during an advance, is *a fixed timetable of lifts to which both the infantry and artillery must rigidly conform*.
>
> This timetable must be regulated by the rate at which it is calculated the infantry can reach their successive objectives. (Macdonald, 1983, p. 46)

The Plan of Operations issued by XXI Corps repeated the same injunction:

> The advance of the infantry will be covered by a heavy barrage from all natures of guns and mortars. The heavy artillery barrage will lift direct from one line onto the next. The field artillery barrage will creep back by short lifts. Both will work *strictly according to time-table*. The lifts have been timed so as to allow the infantry plenty of time for the advance from one objective to the next . . . (Becke, 1931, Appendix 40)

These strictures were superimposed over model landscapes derived from air photographs. Some of them were scale models, a sort of topographical bas-relief. Blunden (1928/2000) described "an enormous model of the German systems" being "open for inspection, whether from the ground or from step-ladders raised beside, and this was popular, though whether from its charm as a model or value as a military aid is uncertain." (p. 150) (Fig. 4.4). Others were 1:1 simulacra—"we dug the trenches exactly as they were in the photographs" (Private William Holbrook,

---

the day of the attack] and afterwards will synchronise watches throughout the Brigade Group by a 'rated watch.'" Edmund Blunden (1928/2000) describes the practice: "Watches were synchronized and reconsigned to the officers" (p. 91); and again: "A runner came round distributing our watches, which had been synchronized at Bilge Street ['battle headquarters']" (p. 254). Wristwatches were originally worn by women and pocket watches carried by men, but wristwatches became favored by soldiers and airmen because they required a "hands-free" way of telling the time.

[24] That is surely something of an overstatement: just as the "optical war" was supplemented, subverted, and even resisted by quite other, intimately sensuous geographies so, too, must the impositions and regimentations of Walter Benjamin's (1940/2006) "homogeneous, empty time" have been registered and on occasion even refused in the persistence of other, more intimate temporalities.

Fig. 4.4 Trench model of Messines Ridge (Retrieved from http://www.expressandstar.com/wpmvc/wp/wp-content/uploads/2013/09/32047939.jpg. Copyright unknown)

4th Battalion, Royal Fusiliers, in Levine, 2009, p. 87)—built at considerable effort so that troops could practice their drills:

> Three weeks before the Big Push of July 1st [1916]—as the Battle of the Somme has been called—started, exact duplicates of the German trenches were dug about 30 kilos behind our lines. The layout of the trenches were [sic] taken from aeroplane photographs submitted by the Royal Flying Corps. The trenches were correct to the foot; they showed dugouts, saps, barbed wire defences, and danger spots.
> Battalions that were to go over in the first waves were sent back for three days to study these trenches, engage in practice attacks, and have night maneuvers. Each man was required to make a map of the trenches and familiarize himself with the names and location of the parts his battalion was to attack.[25] (Empey, 1917, p. 236)

[25] The models that were derived from aerial reconnaissance were also vulnerable to aerial reconnaissance: "These imitation trenches, or trench models, were well guarded from observation by numerous allied planes which constantly circled above them. No German aeroplane could approach within observing distance. A restricted area was maintained and no civilian was allowed within three miles . . ." But, Empey adds, "When we took over the front line we received an awful shock. The Germans displayed signboards over the top of their trench showing the names that we had called their trenches. The signs read 'Fair,' 'Fact,' 'Fate,' and 'Fancy' and so on, according to the code names on our map. Then to rub it in, they hoisted some more signs which read, 'When are you coming over?' or 'Come on, we are ready, stupid English'" (Empey, 1917, pp. 237–238).

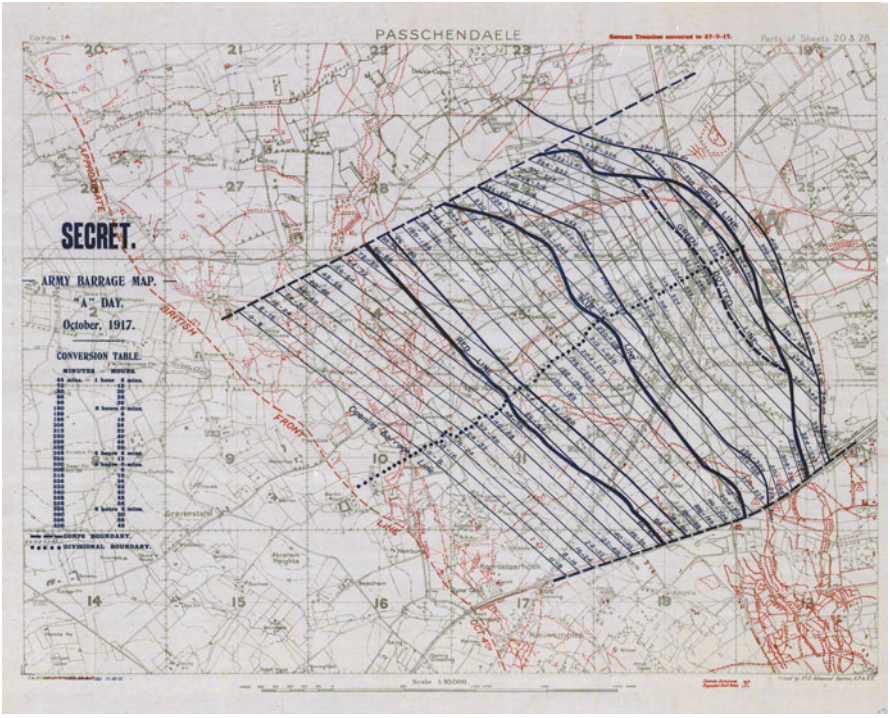

Fig. 4.5 Army barrage map, Passchendaele (Retrieved from http://upload.wikimedia.org/wikipedia/commons/f/f3/First_Battle_of_Passchendaele_-_barrage_map_%28colour_balance%29.jpg. Copyright by Wikipedia Commons)

Staff officers watched the rehearsals and re-calibrated the details of each paper offensive. "The plan for the attack has now come out," one artillery officer recorded in his diary, "about 100 pages of typed foolscap which had to be read through, digested and from which the battery programme had to be extracted and the calculations made" (Major Roderick Macleod, Royal Field Artillery, in Steel & Hart, 2000, p. 87). The (re)calibrations were projected onto a map whose timelines marched across the geometricized space in perfect military order (Fig. 4.5). Troops were to move in the same linear progression, their columns animated by the imperative future—and never conditional—tense of the typed orders:

> The left column will cross trenches 5, 6 and 7 by gangways; it will seize trenches D and E, drive out the defenders and occupy the communication trenches. . . . A detachment previously detailed for the purpose will face west; another similarly detailed will face east, and will enfilade trench B with a machine gun. As soon as the left column has reached the hostile trenches, the right column will debouch by trenches 8 and 9, and advance through the interval between them against trenches M and W. (*Trench Warfare*, 1915)

Nowhere was that attempt to order the future plainer than in the official British decree that the disordered space of "No Man's Land" did not exist: Allied territory extended all the way to the German front line (Deer, 2009, p. 23).

It did not take a Borges or a Korzybski to unpick the sutures between map, model, and territory: as one young private explained, once you were over the top and advancing behind the artillery curtain "there was barbed wire and artillery fire, and it wasn't like the practices" (Private Tom Bracey, 9th Battalion, Royal Fusiliers, in Levine, 2009, p. 87). Neither was it like the map. But from the air—the perspective from which the maps and models had been made—there was a disconcerting sense that the map had *preceded* the territory:

> The waves of attacking infantry as they came out of their trenches and trudged forward behind the curtain of shells laid down by the artillery had been an amazing sight. The men seemed to wander across No Mans Land and into the enemy trenches, as if the battle was a great bore to them. From the air it looked as though they did not realise they were at war and were taking it all entirely too easy. That is the way with clock-work warfare. These troops had been drilled to move forward at a given pace. They had been timed over and over again in marching a certain distance and from this timing the "creeping" or rolling barrage had been mathematically worked out. . . .
>
> I could not get the idea out of my head that it was just a game they were playing at; it all seemed so unreal. Nor could I believe that the little brown figures moving about below me were really men going to the glory of victory or the glory of death. I could not make myself realise the full truth or meaning of it all. It seemed that I was in an entirely different world, looking down from another sphere on this strange, uncanny puppet-show. (Bishop, 1918, pp. 97–98, 99)[26]

Yet those who had set these marionettes in motion were unable to watch the show. A dense web of telephone and telegraph lines ran from GHQ through division, brigade, and battalion headquarters to the front-line trenches but, as Keegan (2004) noted, it had "one disabling shortcoming: it stopped at the edge of no-man's-land. Once the troops left their trenches . . . they passed beyond the carry of their signals system into the unknown" (p. 260).[27] One subaltern saw troops running across a field towards Gommecourt Wood:

> Then they vanished into the smoke. And then there was nothing left but noise. And after this we saw nothing and we knew nothing. And we lived in a world of noise, simply noise.[28]

I want to follow those troops into the smoke and the noise, but before I do I want to pause to stake two claims. First, I do not mean to repeat the conventional (and casual) critique of GHQ and its staff officers. In March 1916 they had moved their departments from St. Omer to Montreuil, a small town even more distant from the

[26] Bishop had started his military career as a cavalry officer, and claimed that "It was the mud, I think, that made me take to flying" (1918, p. 17). Yet even those down in the mud used the same imagery. In Fredric Manning's (1929) semi-autobiographical novel *The Middle Parts of Fortune: Somme and Ancre, 1916* the troops are seen "moving forward in a way that seemed commonplace, mechanical, as though at some moment of ordinary routine . . . They had seemed so toy-like . . . they had moved forward mechanically" (p. 10).

[27] Keegan (2004, p. 260) continues: "The army had provided them with some makeshifts to indicate their position: rockets, tin triangles sewn to the backs of their packs as air recognition symbols, lamps and flags, and some one-way signaling expedients, Morse shutters, semaphore flags and carrier pigeons . . ."

[28] Captain Charles Carrington, in Arthur (2002, pp. 157–158).

Front, and there was an *experiential* break between the two worlds.[29] Keegan (2004) suggests that from the middle of the nineteenth century it had been accepted that "the main work of the general . . . had now to be done in his office and before the battle began," (p. 261) and, as Strachan (2006, pp. 171–172) reminds us, the combination of mass armies and massive firepower ensured that modern warfare would become ever more managerial. Staff officers were tied to their desks because, logistically and strategically, war on such a scale could only be administered through the telephone, the telegraph, and the wireless (see also Hall, 2009, 2012). Second, both contemporaries and critics have railed against the experiential detachment of the general staff from the front lines—I have no doubt this was true: none of them visited the Front in 1916 or 1917—but it was also an *epistemic* rupture. They were creatures as well as creators of an administrative apparatus that dictated the terms through which they apprehended the battle space. "If the work of a general occurs in the space of an office," Booth (1996) explains, "the space of a battlefield—physically expansive, perceptually elusive—must necessarily be shrunken and flattened to the plane of a map" (p. 88). The space of the map was supplemented by the space of the photograph, and together these were the optical-visual devices of a supremely abstract order. "If the emblematic figure for the collapse of vision was No Man's Land," so Deer (2009) argues, "it was the strategist's map that came to represent the struggle to recapture oversight, to survey and order the mud, chaos and horror of battle" (p. 24; see also Brantz, 2009).[30] This was, of course, precisely what Boyd's Gabriel had realized—and rejected—thousands of miles away on the coast of East Africa. In this struggle to reassert a cartographic order the battle *space* was mathematized and the simultaneous equations of clockwork war were solved, at least on paper, by bracketing the messiness and materiality of the battle *field*: it was as though "only mathematical space emptied of human experience but structured in abstract detail [could] provide the smooth sphere for the "pure" war of technology" (Hüppauf, 1993, p. 74). And yet, if this transformed time and space into what Hüppauf calls "predictable, calculable operations" at several removes from another, radically "impure" space—"the space of experience"—"constituted by fighting, suffering and dying soldiers," the fact remained that each co-produced the other (pp. 74–75).[31] The maps and the photographs, which were themselves a materializa-

[29] The same was true for the German High Command, and Jünger (1920) wryly describes "episodes [that] prove the futility of the system of higher command with its headquarters far in the rear" (p. 243) and operations that "had been ordered from the rear and by the map, for it could not have occurred to anyone who had seen the lay of the land to give such orders" (p. 261)—and of the occasional runner "who carried the paper war even into this secluded spot" (p. 254)—but quickly adds "though of course I do not question the necessity" (p. 243).

[30] "To many commanders, battlefields continued to be transposed onto maps" so that military strategies became "increasingly abstract" (Brantz, 2009, p. 74). Vismann (1997) draws a distinction between "the homogeneous space of geography" and "the specific space of the soil" (p. 47).

[31] It is not difficult to hear echoes of Lefebvre (1974/1991) in these formulations, who identifies the aggressive production of an abstract space with the violent triumph of a visual-geometric-phallocentric space that "entails a series of substitutions and displacements by means of which it overwhelms the whole body and usurps its role."

tion not only of techno-scientific Reason but also of corporeal investment, were instrumental in the formation of what the soldier-poet Wilfred Owen described as "the topography of Golgotha."[32] It is now time to descend into that inferno.

The Corpography of the Slimescape

In this clockwork war, Erich Remarque (1929/2013) wrote in *All quiet on the Western Front*, "the earth is the background of this restless, gloomy world of automatons" (p. 87). But it was surely more than that: the earth was also the medium in which and through which the war was conducted.[33] For many soldiers, the earth was transformed into a mud of such cloying stickiness that it threatened to bring the war to a juddering halt (Fig. 4.6).

Marc Bloch (1980) famously described his experience on the Aisne in 1914–1915 as "the age of mud" (p. 152), and Arthur Empey (1917) complained that "the men slept in mud, washed in mud, ate mud and dreamed mud" (p. 60). "At present," wrote one artillery major from Passchendaele in the summer of 1917, "I am more likely to die from drowning than hostile fire. It has rained solidly for 3 days and the place is knee deep in mud."[34] The weather was extraordinary for August—another artillery officer there confirmed that "it rained absolutely continuously, one was as afraid of getting drowned as of getting hit by shells"[35]—but, ironically, the quagmire was also produced by artillery shells piercing the clay layer and forcing water to the surface under pressure. In any event, the fear of drowning was real enough. "Deep devouring mud spread deadly traps in all directions," recalled one British guardsman: "We splashed and slithered, and dragged our feet from the pull of an invisible enemy determined to suck us into its depth. Every few steps someone would slide and stumble and, weighed down by rifle and equipment, rapidly sink into the squelching mess."[36] Those who fell into one of the myriad waterlogged shell-holes found themselves up to their waist in liquid, cloying mud and often had to wait for hours, even days before they were rescued; many never made it out. One subaltern described laying the wounded at Passchendaele on duckboards because they had run out of stretchers and then, during a lull in the shelling, "we heard this terrible kind of gurgling noise. It was the wounded, lying there sinking, and this

[32] "For 14 hours yesterday, I was at work—teaching Christ to lift his cross by numbers. . . and with maps I make him familiar with the topography of Golgotha": Wilfred Owen, letter to Osbert Sitwell, 4 July 1918. (The Topography of Golgotha, 1918). http://pw20c.mcmaster.ca/case-study/topography-golgotha-mapping-trenches-first-world-war

[33] This is capable of generalization; I have explored the mud of the Western Front in the First World War, the Western Desert in World War II, and the jungles of the Vietnam War in "The Natures of War", *Antipode* (in press).

[34] Major Roderick Macleod, in Steel and Hart (2000), p. 138.

[35] Major Richard Talbot Kelly, in Arthur (2002, p. 218).

[36] Private Norman Cliff, in Hart (2013, p. 365).

Fig. 4.6 Mud at the Western front. Pilckem Ridge 1917 (Retrieved from http://upload.wikimedia.org/wikipedia/commons/6/6f/Q_005935PilckemRidge1August1917StretcherBearersBoesinghe.jpg. See also Brooke J W (Lt) © IWM (Q 5935). http://www.iwmprints.org.uk/image/743595/brooke-j-w-lt-a-team-of-stretcher-bearers-struggle-through-deep-mud-to-carry-a-wounded-man-to-safety-near-boesinghe-on-1-august-1917-during-the-third-battle-of-ypres)

liquid mud burying them alive, running over their faces, into their mouth and nose."[37] "We live in a world of Somme mud," reported Edward Lynch (2008):

> We sleep in it, work in it, fight in it, wade in it and many of us die in it. We see it, feel it, eat it and curse it, but we can't escape it, not even by dying. (p. 147)

Not surprisingly perhaps, some began to see the mud as possessing a diabolical agency through which it possessed them:

> At night, crouching in a shell-hole and filling it, the mud watches, like an enormous octopus. The victim arrives. It throws its poisonous slobber out at him, blinds him, closes round him, buries him. One more *disparu*, one more gone. . . . For men die of mud, as they do from bullets, but more horribly."[38]

It was, still more horrifically, much more than mud: military operations commingled with the earth and the water to produce a cyborg nature in which mud

[37] Lt. James Annan, 1st/9th Bn Royal Scots Regiment, in Macdonald (1993, p. 126).

[38] *Le Bochofage: organe anticafardeux*, *Kaisericide et embuscophobe*, 26 March 1917, in Audoin-Rouzeau (1992, p. 38). *Le Bochofage* was a French trench journal.

mixed with barbed wire, shells and iron scraps, and with organic wastes, dead animals, and decomposing bodies, to form what Ernst Jünger described as "a garden full of strange plants" (see Huyssen, 1993, p. 15).[39] This "slimescape," as Das (2008, p. 37) calls it, had two effects on the neat and ordered lines of the battle space envisioned on the staff officers' maps and plans.

First, the slimescape multiplied scepticism at the order and reasonableness of the map a thousand times or more. The paper war was confounded at every turn. One of the artillery officers at Passchendaele watched through his binoculars as the infantry struggled to keep pace with the creeping barrage, which had been slowed down in an attempt to compensate for the terrain: "They were up to their knees in mud, and by the time they got half-way across it was virtually impossible for them to move either forward or back" (Macleod, quoted in Macdonald, 1993, p. 149). Even his own ordnance made little headway; his fellow artillery officer said that "the extraordinary quagmire nature of the Passchendaele battle masked much of the effect of the shells, which sank so deeply into the mud that the splinter and blast effect was to a large extent nullified" (Major Richard Talbot Kelly, in Arthur, 2002, p. 218). Horses, mules, artillery limbers strained to make it through the mud (Fig. 4.7), and it became desperately difficult to rescue the wounded:

> In normal conditions, even under fire, two men could carry a casualty from the line to the dressing-station. Now it took four, even six, men to haul a stretcher case to safety, and a journey of as little as 200 yards could take 2 hours of struggle through the lashing rain and the sucking mud. (Macdonald, 1993, p. 123)

Modern warfare seemed to be waged against the very earth itself. "Its new technology generated a capacity for destruction that no longer focused just on the killing of individual soldiers," Brantz (2009) suggests: "Now warfare also included the obliteration of entire landscapes" (p. 74). Hynes (1977) says much the same. In his view, the war "turns landscape into *anti-landscape*, and everything in that landscape into grotesque, broken, useless rubbish" (p. 8). Landscape is above all a visual construction—even a visual ideology[40]—and the power and significance of Hynes's insight resides in its implication that through the production of this anti-landscape the privileges accorded to vision in the constitution of "optical war" were challenged and even withdrawn by the soldiers most intimately involved in its execution.

Second, surviving the slimescape required a "re-mapping," what I call a corpography, in which other senses had to be heightened in order to apprehend and navigate the field of battle. Sight was no longer the master sense for those on the front line, especially the infantry, because the terrain had been pulverized—a European rural landscape that was so familiar to so many (but by no means all) of those who fought over it had been made strange—and its contours were successively reworked by each barrage and offensive that it became ever more unrecognizable. In a vivid anticipation of

[39] Huyssen (1993) sees Jünger directing his "entomological gaze" on this "garden" through an "armored eye".

[40] This *aperçu* was developed with most acuity by Cosgrove (1985).

Fig. 4.7 Ypres, 1917. Australian War Memorial, photograph E00963 (Retrieved from http://www.awm.gov.au/collection/E00963/ In the public domain)

Gabriel's despair at the orderliness of the map, one subaltern explained that "though we had studied the map so thoroughly beforehand, it was impossible to recognize anything in this chaos . . ."[41] His experience was a common one; here is another lieutenant:

> We sent out four runners to get to Battalion Headquarters at Minty's Farm, and every time, after an hour, the Adjutant rang up—because somehow or other we got a line laid—to ask, "When is your runner coming up to take the relief out?" That happened four times, and still he was on the blower, kicking up hell and asking where the runners were. Well, we weren't too happy about it either! So I said, "Well, the only thing I can do is have a go myself and see if I can get there." I walked right to it and there were no landmarks at all. You couldn't say, well, I know that tree, or I can see half a house there, or anything like that. There was nothing. Just one morass of mud as far as the horizon. The runners had simply got lost, and I didn't blame them at all.[42]

The battlefield was constantly shifting, not only as each advance swept forward and back, as trench lines were taken, lost and taken again, but as each wave of destruction broke over the land so its shapes and elements became ever more transitory. This meant that it was not only maps that became unreliable as the terrain became unreadable; memory became all but useless too. "I had to go round my sector once a night with the sergeant-major," another subaltern remarked. "And

[41] 2nd Lt. Thomas Hope Floyd, 2/5 Lancashire Fusiliers, 31 July 1917 in Barton (2007, p. 166).

[42] Lt. J. Annan, 1/9 Bn., Royal Scots Regiment, in Macdonald (1993, p. 133).

when we left one shell-hole we'd have to ask which way to go next, because each night the ground would have absolutely shifted."[43] Soldiers had to look for new markers—material or corporeal did not matter very much: "Left by the coil of wire, right by the French legs" (Brantz, 2009, p. 77)—but they were all increasingly impermanent. One runner returning to Brigade Headquarters across the Ypres Salient "by a quicker but more exposed route" looked for objects to help guide him. "I see a foot and it keeps me for the next time but it is not there long."[44]

The sense of radical instability is vital. Weir (2007) is right to insist that "wrinkles in the texture of destruction [became] coordinates which allow[ed] the striation of smooth space," that the destruction of the battlefield required and became "the starting-point for a new re-gridding" (p. 45): but there was nothing permanent about those makeshift griddings, which were fluid, improvisational processes rather than fixed cartographies. The stream of maps and photographs could not keep pace with these intimately local changes, and the gap between their representations—which remained crucial for the general staff and the artillery—and the stocks of local knowledge developed and mobilized by the infantry grew wider. Jünger (2003) describes being criticized by a staff officer, jabbing his finger at a map after the failure of a trench raid to take prisoners late in 1917: "I realised that the kind of confusion where notions like right and left just go out of the window was quite outside his experience. For him the whole thing had been a plan; for us an intensely experiential reality" (p. 189). It certainly was a matter of experience but it was also a matter of epistemology: of what counted as useful knowledge. In his classic account of *No Man's Land*, Leed (1981) explained the gulf between the infantry and the staff officers like this:

> Trench war is an environment that can never be known abstractly or from the outside. Onlookers could never understand a reality that must be crawled through and lived in. This life, in turn, equips the inhabitant with a knowledge that is difficult to generalize or explain. (p. 79)

The reason for that, Leed (1981, p. 74) argued, was that what he called "the knowledge gained in war"—he meant not the intelligence used by planners to ordain a future anterior through "the safe distance of the gaze" but an intensely practical, densely particular local knowledge used by, even inhabited by the infantry—resided in and derived from the "clumsy immediacy" of the combatant's body.

This is what Das (2008) variously calls a "phenomenological geography" through which the trenches and No Man's Land were known not in terms of the abstract, cognitive apparatus of "maps, places and names" but apprehended—*re*-cognized—as "sensuous states of experience," and also a "haptic geography" (p. 73):

> [T]he visual topography of the everyday world . . . was replaced by the haptic geography of the trenches and mud was a prime agent in this change. In an atmosphere of darkness, danger and uncertainty, sights, sounds and even smells are encountered as material presences against the flesh. (p. 23)

[43] Lt. Ulrich Burke, 2 Bn., Devonshire Regiment, in Arthur (2002, p. 241).

[44] Private Aston, in Weir (2007, p. 42).

These are both useful terms, but I prefer to call this a corpography: although it is a made-up word, it simultaneously speaks to cartography and undoes it through its own muffled corporeality, an almost subterranean acknowledgement of its implication in what Lynch (2008) called "the land of rotting men" (p. 357).[45]

There were three other senses that had to be heightened—three other sources of knowledge that had to be developed—if the soldiers were to survive. The first, of almost overwhelming importance, was sound. During an offensive the soldiers were thrust into a world of noise: not the sound detected by tunnelers as they listened through their stethoscopes and microphones for traces of the enemy digging towards them nor the arcs traced by the sound rangers on their oscilloscopes and filmstrips but a 'flat, unceasing noise' that was intensely corporeal: "You could feel the vibrations coming up through the earth, through your limbs, through your body. You were all of a tremor, just by artillery fire only." Or again: "We lie on the shuddering ground, rocking to the vibrations, under a shower of solid noise we feel we could reach out and touch."[46] Because the link between sight, space and danger was broken all along the Front, Das (2008) suggests there was an "exaggerated investment in sound" (p. 81). To capitalize on this, it became essential to learn to detect signals in the noise, to order the roaring soundscape, and A. M. Burrage (1930) captures this as well as anyone:

> We know by the singing of a shell when it is going to drop near us, when it is politic to duck and when one may treat the sound with contempt. We are becoming soldiers. We know the calibres of the shells which are sent over in search of us. The brute that explodes with a crash like that of much crockery being broken, and afterwards makes a "cheering" noise like the distant echoes of a football match, is a five-point-nine. The very sudden brute that you don't hear until it has passed you, and rushes with the hiss of escaping steam, is a whizz-bang. . . . The funny little chap who goes tonk-phew-bong is a little high-velocity shell which doesn't do much harm. . . . The thing which, without warning, suddenly utters a hissing sneeze behind us is one of our own trench-mortars. The dull bump which follows, and comes from the middle distance out in front, tells us that the ammunition is "dud." The German shell which arrives with the sound of a woman with a hare-lip trying to whistle, and makes very little sound when it bursts, almost certainly contains gas.
>
> We know when to ignore machine-gun and rifle bullets and when to take an interest in them. A steady phew-phew-phew means that they are not dangerously near. When on the other hand we get a sensation of whips being slashed in our ears we know that it is time to seek the embrace of Mother Earth. (pp. 78–79)[47]

And here is Edward Lynch (2008):

> Talk gets on to the sounds made by shells, and the *minenwerfers* that we can run from if our luck's in, and about the spiteful little whizz-bang that it's generally too late to run from

[45] Booth (1996, p. 50) writes of the "corpsescapes" of trench warfare, which also evokes Blunden's (1928/2000) description: "The whole zone was a corpse, and the mud itself mortified" (p. 98).

[46] Henry Holdstock, in Levine (2009, p. 94); Lynch (2008, p. 144).

[47] As that last sentence suggests, this fostered a sort of geo-intimacy. "Sometimes you wish the earth would shrink," one private said, "so as to let you in" (Private Thomas McIndoe, in Levine, 2009, p. 38). And here is Remarque (1928/2013): "To no man does the earth mean so much as to the soldier. When he presses himself down upon her, long and powerfully, when he buries his face and his limbs deep in her from the fear of death by shell-fire, then she is his only friend, his brother, his mother; he stifles his terror and his cries in her silence and her security . . ."(p. 41).

> when it's heard. . . . More digging and the [machine-]gun fires again. Jacko makes to get down, but has a nasty shock when he sees that none of us has even bobbed. We explain that we knew by the sound of the gun that it was not firing in our direction. . . . Gas shells are sometimes hard to distinguish from duds. They land with a little putt-tt sort of sound. Just enough explosive in them to burst the case and release the gas without scattering it. (p. 95)

It was, in effect, a way of "seeing by listening" so that, as Brantz (2009) suggests, "trench life was, in many ways, a synesthetic experience" (p. 76).

The soldiers also inhabited an aggressive and intrusive smellscape compounded, as Ellis (1976) records, of a score of things: "the chloride of lime that was liberally scattered to minimise the risk of infection, the creosote that was sprayed around to get rid of the flies, the contents of the latrines, the smoke from the braziers and the sweat of the men" (pp. 58–59). Above all, it was the fetid odor of death, which Jünger (2003) described as "a persistent smell of carrion", or "Eau d'offensive" (p. 258). All smells are particulate, and there was something intensely, intimately physical about this apprehension of the killing fields. "I have not seen any dead," Wilfred Owen wrote after three weeks at the front, "I have done worse. In the dank air I have *perceived* it, and in the darkness *felt*" (Das, 2008, p. 7). It was commonplace yet never became a commonplace. "I never grew accustomed to the all-pervading stench of decayed and decaying flesh," one artillery officer said, "mingled with that of high explosive fumes that hung over miles and miles of what had been sweet countryside and now was one vast muck heap of murder."[48] But there were other smells that, if you knew them, could save your life. At Passchendaele, one corporal recalled, "the smells were very marked and very sweet. Very sweet indeed. The first smell one got going up the track was a very sweet smell which you only later found out was the smell of decaying bodies—men and mules." But then, he added,

> You got the smell of chlorine gas, which was like the sort of pear drops you'd known as a child. In fact the stronger and more attractive the pear-drop smell became, the more gas there was and the more dangerous it was. When you were walking up the track a shell dropping into the mud and stirring it all up would release a great burst of these smells.[49]

The third sense was touch. Trench diaries, journals and memoirs are saturated with the predatory touch of the slimescape, the mud that invaded the body, "clogged the fingers, filled the nails, smeared the face, ringed the mouth and clung to the stubbly beard and hair," and which could all too silently infect wounds and kill soldiers.[50] But they could also be saved by their sense of touch, and those same sources are no less full of men subsisting in dugouts and crawling through the trenches, emerging to worm their way through the barbed wire and the mud. "Creep, crawl, worm, burrow," Das (2008) reminds us, "were the usual modes of movement during a night patrol in no man's land or while rescuing war-wounded in order to avoid being detected" (p. 43) and each of them—there are others too: plunge,

[48] Lt. R. G. Dixon, Royal Garrison Artillery, in Steel and Hart (2000, p. 198).

[49] Corporal Jack Dillon, Second Bn, Tank Corps, in Arthur (2002, p. 233).

[50] Private N. M. Ingram, in Barton (2007, p. 309).

immerse, scrape—registers a shift from the visual to the tactile.[51] Sight in those circumstances was of limited purchase, but where it was invoked it too became haptic, a facility described by Frederic Manning (1929) in *The Middle Parts of Fortune*, a novel based on his own experience in the Somme:

> [E]very nerve was stretched to the limit of apprehension. Staring into the darkness, behind which menace lurked, equally vigilant and furtive, his consciousness had pushed out through it, to take possession, gradually, and foot by foot, of some forty or fifty yards of territory within which nothing moved or breathed without his knowledge of it. Beyond this was a more dubious obscurity, into which he could only grope without certainty. The effort of mere sense to exceed its normal function had ended for the moment . . . (p. 224)

Stretching, pushing out, taking possession, groping: these are the probing moments of a profoundly haptic apprehension of the battlefield.

Conclusion

Paul Virilio's (1989) account of *War and cinema*, and particularly his rendering of the logistics of perception during World War I, remains a landmark analysis. He made much of the connections between aviation and cinema, and his arguments have informed the opening sections of my own essay. In his eyes, aerial reconnaissance—which stood in the closest of associations to the cartographic—became successively "chronophotographic" and then cinematographic, as these new methods struggled both to keep pace with and to produce the new motility of a war that merely appeared to be static and fixed in place. But Virilio also advanced another, more problematic claim: "As sight lost its direct quality and reeled out of phase, the soldier had the feeling of being not so much destroyed as de-realized or de-materialized, any sensory point of reference suddenly vanishing in a surfeit of optical targets" (pp. 14–15). Here he continues to privilege the visual-optical register of cartography and fails to register the bodily habitus that, as I have shown in the closing sections, was profoundly implicated in the actions and affects of the ordinary infantryman. Virilio was not alone. A. M. Burrage (1930) wrote that

> [W]e are slowly realising that the job of the infantry isn't to kill. It is the artillery and the machine-gun corps who do the killing. We are merely there to be killed. We are the little flags which the General sticks on the war-map to show the position of the front line. (p. 82)

In sketching the outlines of a countervailing corpography established by those on that front line, I do not wish to privilege one mode of knowing over the other: each sutures knowledge to power in vital, significant but none the less different ways, and

[51] Das (2008, p. 86) cites Merleau-Ponty to sharpen the contrast between ocular vision and touch: "It is through my body that I go to the world, and tactile experience occurs 'ahead' of me." There were of course other registers in which touch was central, and Das also beautifully illuminates the homo-sociality of this subterranean world in which forms of intimacy with other men—not just "mother earth"—were no less vital in rendering this stunted life endurable and meaningful.

each both advances and repels military violence. But I do sympathize with Edmund Blunden's (1928/2000) agonized question:

> Was it nearer the soul of war to adjust armies in coloured inks on vast maps at Montreuil or Whitehall, to hear of or to project colossal shocks in a sort of mathematical symbol, than to rub knees with some poor jaw-dropping resting sentry, under the dripping rubber sheet, balancing on the greasy fire-step . . . ? (p. 141)

Of course, "a map is a weapon," as Lt.-Col. E. M. Jack ("Maps GHQ") insisted, and those "vast maps," together with the panoply of trench maps, sketch maps, and all the rest, were some of the deadliest weapons in the staff officers' armory; but they were hardly sufficient sources of knowledge. And so I understand, too, why Blunden (1928/2000) concluded that venturing into the killing fields armed with its pure, abstract, mathematical knowledge alone was sheer folly:

> [T]he new Colonel . . . sent forward from C Camp an officer fresh from England, and one or two men with him, to patrol the land over which our assault was intended, . . . This officer took with him his set of the maps, panoramas, photographs and assault programmes which had been served round with such generosity for this battle. He never returned . . . (pp. 151–152)

Coda

In this essay I have been concerned with World War I but, as we approach its centenary, it is worth reflecting on the ways in which modern warfare has changed—and those in which it has not. Through the constant circulation of military imagery and its ghosting in video games, many of us have come to think of contemporary warfare as optical war hypostatized: a war fought on screens and through digital images, in which full motion video feeds from Predators and Reapers allow for an unprecedented degree of remoteness from the killing fields. In consequence, perhaps, many of us are tempted to think of the wars waged by advanced militaries, in contrast to World War I, as "surgical," even body-less. These are wars without fronts, whose complex geometries have required new investments in cartography and satellite imagery, and there have been major advances in political technologies of vision and in the development of a host of other sensors that have dramatically increased the volume of geo-spatial intelligence on which the administration of later modern military violence relies. All of this has transformed but not replaced the cartographic imaginary.

And yet, for all of their liquid violence, these wars are still shaped and even confounded by the multiple, acutely material environments through which they are fought. In Sebastian Junger's (2011) remarkable dispatch from Afghanistan, he notes that for the United States and its allies "the war diverged from the textbooks because it was fought in such axle-breaking, helicopter-crashing, spirit-killing, mind-bending terrain that few military plans survive intact for even an hour" (p. 47). If that sounds familiar, then so too will MacLeish's (2013) cautionary observations about soldiers as both vectors and victims of military violence:

> The body's unruly matter is war's most necessary and most necessarily expendable raw material. While many analyses of US war violence have emphasized the technologically facilitated withdrawal of American bodies from combat zones in favour of air strikes, smart bombs, remotely piloted drones, and privately contracted fighting forces, the wars in Iraq and Afghanistan could not carry on without the physical presence of tens of thousands of such bodies. (p. 11)

In consequence, the troops have had to cultivate an intrinsically practical knowledge that, while its operating environment and technical armature are obviously different, still owes much to the tacit bodily awareness of the Tommy or the Poilu:

> In the combat zone there is a balance to be struck, a cultivated operational knowledge, that comes in large part from first-hand experience about what can hurt you and what can't . . . So you need not only knowledge of what the weapons and armor can do for you and to you but a kind of bodily habitus as well—an ability to take in the sensory indications of danger and act on them without having to think too hard about it first. When you hear a shot, is it passing close by? Is it accurate or random? Is it of sufficient caliber to penetrate your vest, the window of your Humvee or the side of your tank? (MacLeish, 2013, p. 76)

In the intricate nexus formed by knowledge, space, and military power, later modern war still relies on cartographic vision—and its agents still produce their own corpographies.

References

Amad, P. (2012). From God's-eye to camera-eye: Aerial photography's post-humanist and neo-humanist visions of the world. *History of Photography, 36*, 66–86.

Anderson, R. (2001). The Battle of Tanga, 2–5 November 1914. *War in History, 8*, 294–332.

Arthur, M. (2002). *Forgotten voices of the Great War: A new history*. London: Imperial War Museum.

Audoin-Rouzeau, S. (1992). *Men at war 1914–1918: National sentiment and trench journalism in France during the First World War*. Oxford, UK: Berg.

Barton, P. (2007). *Passchendaele*. London: Constable and Robinson.

Barton, P., Doyle, P., & Vandewalle, J. (2010). *Beneath flanders fields: The tunnellers' war, 1914–1918*. Stroud, UK: The History Press.

Becke, A. F. (1931). The coming of the creeping barrage. *Journal of the Royal Artillery, 58*(1), 19–31.

Benjamin, W. (2006). On the concept of history. *Selected writings: Vol. 4. 1938–1940* (pp. 389–400). Cambridge, MA: Harvard University Press. (Original work published 1940).

Bennett, A. (1915). *Over there: War scenes on the Western Front*. London: Methuen.

Bishop, W. A. (1918). *Winged warfare*. New York: George Doran.

Bloch, M. (1980). *Memoirs of war 1914–1915* (C. Fink, Trans.). Ithaca, NY: Cornell University Press.

Blunden, E. (2000). *Undertones of war*. London: Penguin (Original work published 1928).

Booth, A. (1996). *Postcards from the trenches: Negotiating the space between modernism and the First World War*. New York: Oxford University Press.

Boyd, W. (2007, January 21). A bizarre and surreal conflict. *Sunday Times*.

Boyd, W. (1982). *An ice-cream war*. London: Hamish Hamilton.

Brantz, D. (2009). Environments of death: Trench warfare on the Western Front, 1914–1918. In C. Closmann (Ed.), *War and the environment: Military destruction in the modern age* (pp. 68–91). College Station, TX: A & M University Press.

Brodrick, W. (2008). *A whispered name*. London: Little, Brown.

Burrage, A. M. (1930). *War is war*. London: Victor Gollancz.
Chasseaud, P. (1999). *Artillery's astrologers: A history of British survey and mapping on the Western Front, 1914–1918*. Lewes: Mapbooks.
Chasseaud, P. (2002). British, French and German mapping and survey on the Western Front in the First World War. In P. Doyle & M. Bennett (Eds.), *Fields of battle: Terrain in military history* (pp. 171–204). Dordrecht, The Netherlands: Kluwer.
Chasseaud, P. (2013). *Mapping the First World War: The Great War through maps*. London: Collins/Imperial War Museum.
Cosgrove, D. (1985). Prospect, perspective and the evolution of the landscape idea. *Transactions of the Institute of British Geographers, 10*, 45–62.
Das, S. (2008). *Touch and intimacy in First World War literature*. Cambridge, UK: Cambridge University Press.
Deer, P. (2009). *Culture in camouflage: War, empire and modern British literature*. Oxford, UK: Oxford University Press.
Doyle, P., & Bennett, M. (1997). Military geography: Terrain evaluation and the British Western Front, 1914–1918. *Geographical Journal, 163*, 1–24.
Eksteins, M. (1989). *The rites of spring: The Great War and the birth of the modern age*. New York: Houghton Mifflin.
Ellis, J. (1976). *Eye-deep in hell: Trench warfare in World War I*. Baltimore: Johns Hopkins.
Empey, A. (1917). *Over the top*. New York: G. P. Putnam.
Finnegan, T. J. (2011). *Shooting the front: Allied aerial reconnaissance in the First World War*. Stroud, UK: Spellmount, The History Press.
Forsyth, I. (2013). Subversive patterning: The surficial qualities of camouflage. *Environment and Planning A, 45*, 1037–1052.
Forty, S. (2013). *Mapping the First World War: Battlefields of the great conflict from above*. London: Conway.
Godefroy, M. (2000). The Battle of Tanga Bay. *The Army Doctrine and Training Bulletin, 3*(3), 35–42.
Gough, P. (1998). Dead lines: Codified drawing and scopic vision in a hostile space. *POINT, Art and Design Research Journal, 6*(Autumn/Winter), 34–41.
Gough, P. (2009). "Calculating the future": Panoramic sketching, reconnaissance drawing and the material trace of war. In N. Saunders & P. Cornish (Eds.), *Contested objects: Material memories of the Great War* (pp. 237–251). London: Routledge.
Gregory, D. (in press). The natures of war. *Antipode*.
Gregory, D. (1994). *Geographical imaginations*. Oxford, UK: Blackwell.
Hall, B. (2009). *The British Expeditionary Force and communications on the Western Front, 1914–1918* (Doctoral dissertation). University of Salford, UK.
Hall, B. (2012). The British Army and wireless communication. *War in History, 19*, 290–312.
Hart, P. (2012). *Somme success: The Royal Flying Corps and the battle of the Somme, 1916*. Barnsley, UK: Pen and Sword.
Hart, P. (2013). *The Great War: A combat history of the First World War*. New York: Oxford University Press.
Hüppauf, B. (1993). Experiences of modern warfare and the crisis of representation. *New German Critique, 59*, 41–76.
Huyssen, A. (1993). Fortifying the heart—totally: Ernst Jünger's armored texts. *New German Critique, 59*, 3–23.
Hynes, S. (1977). *The soldiers' tale: Bearing witness to modern war*. New York: Allen Lane.
Innes, J. (1935). *Flash spotters and sound rangers: How they lived, worked and fought in the Great War*. London: George Allen & Unwin.
Jay, M. (1994). *Downcast eyes: The denigration of vision in twentieth-century French thought*. Berkeley: University of California Press.
Jones, H. A. (1928). *The war in the air* (Vol. 2). Oxford, UK: Clarendon.
Jones, S. (2010). *Underground warfare, 1914–1918*. Barnsley, UK: Pen & Sword.

Jünger, E. (2003). *Storm of steel* (M. Hofmann, Trans.). New York/London: Doubleday/Penguin. (Original work published 1920)
Junger, S. (2011). *War*. New York: Hachette.
Keegan, J. (2004). *The face of battle*. London: Pimlico.
Kennett, L. (1991). *The first air war, 1914–1918*. New York: Simon and Schuster.
Kern, S. (1983). *The culture of time and space, 1880–1918*. Cambridge, MA: Harvard University Press.
Kipling, R. (1910). *The brushwood boy*. London: Macmillan.
Leed, E. (1981). *No man's land: Combat and identity in World War I*. Cambridge, UK: Cambridge University Press.
Lefebvre, H. (1991). *The production of space* (D. Nicholson-Smith, Trans.). Oxford, UK: Blackwell. (Original work published 1974)
Levine, J. (2009). *Forgotten voices of the Somme*. London: Ebury Press.
Liddle, P. (1998). *Passchendaele in perspective: The third Battle of Ypres*. Barnsley, UK: Pen & Sword.
Lohman, A. (2012). East Africa in World War I: A geographic analysis. *Journal of Military Geography, 1*, 15–33.
Lynch, E. (2008). *Somme Mud: The experiences of an infantryman in France, 1916–1919*. London: Doubleday.
Macdonald, L. (1983). *Somme*. London: M. Joseph.
Macdonald, L. (1993). *They called it Passchendaele: The story of the Battle of Ypres and of the men who fought in it*. London: Penguin.
MacLeish, K. (2013). *Making war at Fort Hood: Life and uncertainty in a military community*. Princeton, NJ: Princeton University Press.
MacLeod, R. (2000). Sight and sound on the Western Front: Surveyors, scientists and the "battlefield laboratory", 1915–1918. *War and Society, 1*, 23–46. doi:10.1179/072924700791201405.
Manning, F. (1929). *The middle parts of fortune: The Somme and Ancre, 1916*. London: Piazza Press and Peter Davies.
Marble, S. (2008). *The infantry cannot do with a gun less: The place of the artillery in the British Expeditionary Force, 1914–1918*. New York: Columbia University Press.
Mattison, J. (n.d.). *Representations of war as autobiographical media*. Retrieved from http://www.walterdraycot.com
McCarthy, T. (2010). *C*. New York: Knopf.
Murray, J. (1988). British-Canadian military cartography on the Western Front, 1914–1918. *Archivaria, 26*, 52–65.
Paice, E. (2007). *Tip and run: The untold tragedy of the Great War in Africa*. London: Weidenfeld and Nicolson.
Pugliese, J. (2013). *State violence and the execution of law*. New York: Routledge.
Raleigh, W. (1922). *The war in the air* (Vol. 1). Oxford, UK: Clarendon.
Remarque, E. M. (2013). *All quiet on the Western Front* (B. Murdoch, Trans.). London: Vintage. (Original edition published 1928)
Rose, E., & Rosenbaum, M. S. (1993). British military geologists: The formative years to the end of the First World War. *Proceedings of the Geological Association, 104*, 41–49.
Ryan, R. (2013). *Dead man's land*. London: Simon & Schuster.
Saint-Amour, P. (2003). Modernist reconnaissance. *Modernism/Modernity, 10*, 349–380.
Saint-Amour, P. (2011). Applied modernism: Military and civilian uses of the aerial photomosaic. *Theory, culture and society, 28*(7–8), 241–269.
Sekula, A. (1975). The instrumental image: Steichen at war. *Artforum, 14*(4), 26–35.
Shell, H. R. (2012). *Hide and seek: Camouflage, photography, and the media of reconnaissance*. New York: Zone Books.
Slater, T. (n.d.). *British aerial photography and photographic interpretation on the Western Front*. Retrieved from http://tim-slater.blogspot.ca
Steel, N., & Hart, P. (2000). *Passchendaele: The sacrificial ground*. London: Cassell.
Strachan, H. (2006). *The First World War: A new illustrated history*. London: Simon and Schuster.
Strong, P., & Marble, S. (2011). *Artillery in the Great War*. Barnsley, UK: Pen and Sword.
Sykes, F. (1922). *Aviation in peace and war*. London: Edward Arnold.

Sykes, F. (1942). *From many angles: An autobiography*. London: Harrap.
The Camera at the front. (1917). *Scientific American*, *117,* 380–381. doi:10.1038/scientificamerican11241917-380.
The Wrist watch speaks. (1918, February 15). *Stars and Stripes*, p. 2.
Trench warfare: Notes on attack and defence [Pamphlet]. (1915). Garvin Papers. London: British Library.
Virilio, P. (1989). *War and cinema: The logistics of perception* (P. Camiller, Trans.). London: Verso. (Original work published 1984)
Vismann, C. (1997). Starting from scratch: Concepts of order in no man's land. In B. Hüppauf (Ed.), *War, violence and the modern condition* (pp. 46–64). Berlin: Walter de Gruyter.
Weir, B. (2007). "Degrees in nothingness": Battlefield topography in the First World War. *Critical Quarterly, 49*(4), 40–55.