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Terry Copp

The campaign in Northwest Europe has been the subject of thousands of books and articles, including a number based on careful documentary research. But even the best accounts pay insufficient attention to the German weapons systems that inflicted the majority of Allied casualties. The mortar and the Nebelwerfer were chiefly responsible for the Wehrmacht's temporary success in stabilizing the front in Normandy, and for the balance of the war they played a major role in demoralizing and reducing the strength of Allied infantry units. The Allies did not foresee the central role these weapons would play in Northwest Europe and all three armies left counter-mortar operations to the initiative of individual divisional commanders.

This paper focuses on the work of 21 Army Group's No. 2 Operational Research Section (ORS) in developing a systematic and ultimately successful system of neutralizing enemy mortar and Nebelwerfer fire. Other attempts to deal with the problem were undertaken concurrently in the Mediterranean theatre and in First American Army but they are not examined here.

The British Army became involved in operational research in 1940 when P. M .S. Blackett was appointed scientific advisor to Anti-Aircraft Command. Blackett's "Circus," as the army's first OR group was called, developed into two quite separate sections, one dealing with radar equipment, and the other with problems of operating that equipment effectively with the available personnel. Blackett instructed a group of very young and very bright scientific generalists to figure out what to do with the first Gun Laying radar, the GL Mark I. It consisted of a small hut with an aerial attached to it. The entire hut could be rotated by a pair of bicycle pedals at the top of a column. The levelness of the immediate area, the soil type, the weather, and the proximity of trees and huts distorted the signal. Each set had to be "screened" with chicken wire, and individually calibrated. Even then there was little chance of hitting anything because minor human errors compounded the problems of a rudimentary fire control apparatus. This was an ideal problem for OR investigation involving the interface of men and complex equipment. During the course of the war technical developments in radar were paralleled by improvements in training and operational procedures developed by the OR section. In 1944 Anti-Aircraft command played a major role in the destruction of the VI Flying Bomb.[1]

After Blackett left the Army to establish an OR section with RAF Coastal Command, a South African physicist, Lieutenant-Colonel, later Brigadier, B.F.G. Schonland became the Superintendent of the Army Operational Research Group (AORG). Schonland had served in the First World War with the Royal Engineers. He was twice mentioned-in-dispatches and ended the war as a Chief Instructor in Wireless Communications. In the interwar period he established an international scientific reputation for his studies of lightning, and he was an early experimenter with cathode ray tubes. Schonland's military and scientific credentials were important, but it was his personality that won him influence with military officers.

In the spring of 1944 Montgomery agreed to a proposal to appoint Schonland as Scientific Advisor, 21 Army Group, a position which gave Schonland immediate access to the intelligence, planning, and operations staffs of the Anglo-Canadian Army Group.[2]

Schonland was determined to prevent operational research from being restricted to narrow technical functions. He, like Blackett, was convinced that scientists should be attached to operational commands, with direct access to the real operational data. This had already been accomplished with A.A. command and in 1941 an Army Operational Research Section worked closely with the Royal Navy to establish procedures for using the first centrimetric coastal radar sets designed to detect a German invasion fleet. This naturally led to studies of the use of radar in coastal artillery fire which had proven much less accurate than the gunners had supposed. Schonland urged the Royal Artillery to investigate the employment of radar as a way of improving the accuracy of field and medium artillery, but senior officers at Larkhill, the artillery school, were not impressed with the experimental evidence of radar echoes from ground bursts or with suggestions that their methods of employing predicted fire were subject to serious error. Information that mortar bombs could be seen in the early part of their trajectories by the new (1943) GL Mark IIIB radars was also ignored prior to the invasion of Northwest Europe,[3] presumably because existing counter-battery methods had proved adequate for dealing with mortars in North Africa.

A crew from Les Fusiliers Mont-Royal training with the 3 -inch mortar, February 1943.

Schonland continued to press for the extension of OR into all areas of army activity and by mid-1943 operational research sections were established at the army schools for airborne forces, artillery, armour and infantry. The first scientist assigned to the school of infantry at Barnard Castle in Yorkshire was Captain Michael Swann, a twenty-three year old REME officer with an abbreviated war-time degree in Zoology. Swann had taken the army radar course and spent a winter in Iceland helping to optimize local air and coastal defence practices. On his return to the U.K. Schonland assigned him to First Airborne Division where he worked on aids for night operations and the radar beacon system for paratroops known as Rebecca-Eureka.[4]

Swann shared many of Schonland's personality characteristics, including strong intellectual curiosity and an easy manner in dealing with officers of higher rank and greater age. In Yorkshire the infantry instructors discovered that Swann would devise and implement systems for testing the efficacy of both weapons and doctrines. His work on the use of the Bren light machine gun, the PIAT (a spring-loaded infantry anti-tank projector) and the 2-inch and 3-inch infantry mortars was instrumental in establishing guidelines for their use.[5]

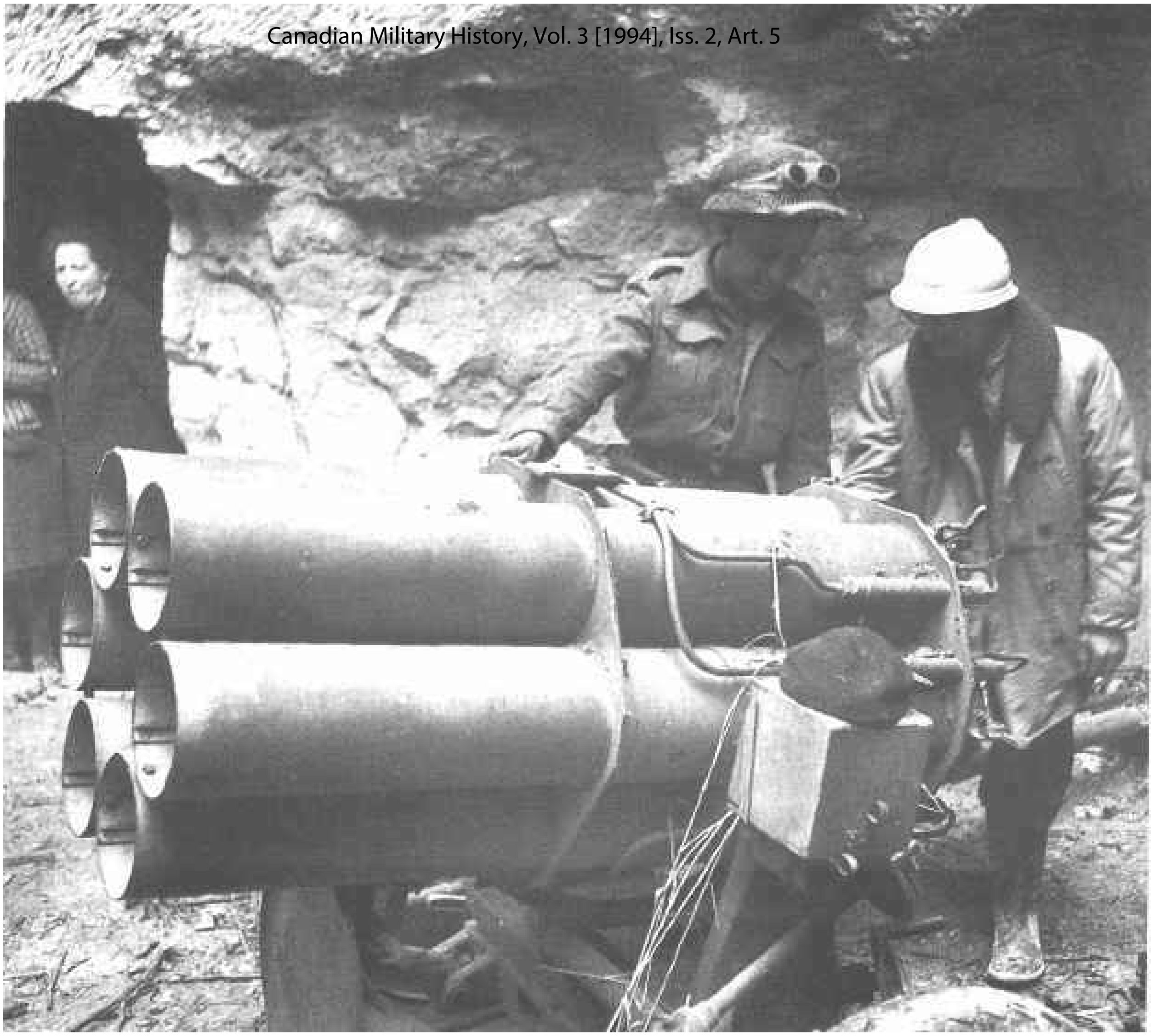
Swann paid particular attention to mortars and supervised elaborate tests of the "new" stepped-up British 3-inch mortar, comparing it to the German 81 mm mortar.[6] By the end of 1943 Swann knew a great deal about Allied and enemy mortars but he had not been asked to tackle the problem of mortar location. At this stage of the war hostile mortar location was still part of the basic duties of field and medium regimental counter-battery officers who employed sound ranging, flash spotting, crater analysis and other techniques to locate enemy artillery.

In the spring of 1944 Schonland selected a team of OR scientists to serve in the field with Montgomery's 21 Army Group. They were all generalists who had developed insight and skills working with a specific branch of the army. Michael Swann, despite the fact that he was the youngest of the group, became second-in-command and the effective leader of No. 2 Operational Research Section.

During the preparations for and the immediate aftermath of D-Day, the officers of No. 2 ORS were assigned to a variety of high priority tasks connected to radar or battlefield investigation. It was not until D+17, June 24, that the section was in a position to undertake new research. They began to visit the forward area "to gain ideas of what fighting looked like and to find out for ourselves where our particular way of doing things fitted in."[7] Swann, who got caught up in the defence of a newly-captured village during a German counterattack, recalled that "in those days the bridgehead was so small we could easily drive down to the battle area in half an hour, spend a day there and come back in the evening, to bathe in the meandering River Seulles, search for Calvados liqueur in Creully and discuss at length the great problems before us."

One of the chief problems was "the location of enemy mortars, which were causing appalling casualties and proving almost impossible to deal with." This was a classic OR challenge, a problem "midway between the technical and the operational." The first thing to do was to establish the operational facts and the section devoted as much time as it could to gathering the necessary information. The section's report began with a statement of "The Extent of the Problem""

> The German army uses mortars and Nebelwerfers in large numbers. These weapons are small and difficult to detect from the air; their trajectories make it possible to conceal them completely from ground observation, particularly in close country. The small noise of discharge of the mortar and the ripple fire of the Nebelwerfer make sound ranging difficult, while the flash and smoke from the mortar is slight and hard to spot. In defence the casualties from mortars and nebelwerfers may be considerable, while the strain of holding a position and being mortared for days on end is intense. In attack the casualties in forming up areas and on the objective may be very heavy indeed, and are often decisive in throwingback an attack. In either attack or defences, mortars can make movement in forward areas difficult.



A private from Le Régiment de Maisonneuve and a French civilian examine a captured German Nebelwerfer.
Photo by Lt. George Cooper, NAC PA 129127

> So much has long be realized. In the present campaign, however, casualties from mortars have been particularly heavy and have contributed as much as anything else to making advances slow and costly. The enemy's mortars are as much a weapon to be defeated as his tanks. This will continue as long as fighting goes on in undulating and cultivated country. Even on the plains of Picardy and Flanders, there is enough cover to conceal mortars, and although their importance may decline, they are still likely to prove a great source of trouble.[8]

Swarm interviewed battalion medical officers from four different mortar divisions and found that all agreed in placing the proportion of mortar casualties at above 70% of total casualties. He found that divisional Counter-Mortar staffs tended to underestimate the number of mortars and Nebelwerfers opposite them, noting that a German infantry division possessed as many as fifty-seven 81 mm mortars and between 12 and 20 of the 120 mm type. Panzer divisions were equipped with about half these numbers. In Normandy, the German army had also provided a regiment composed of 54 six-barrel Nebelwerfers on the scale of one per division. Swann estimated that to bring the problem under control divisions might need to obtain between 60 and 80 hostile mortar locations.

He noted that "at present no official organization for counter-mortar work" existed in the British Army and each division went its own way. All the divisions surveyed had appointed a Counter-Mortar Officer and allotted signals capacity to allow for communication to the plotting centre, but arrangements were ad hoc and no one was sure what worked best. Swann analyzed the

Hostile Mortar Lists compiled by four divisions. Each used sound bearings extensively, but there was no system for ensuring the rapid reporting of all instances of enemy mortaring and only one division had established separate observation posts with the responsibility for mortar location. Air photographs were widely used in conjunction with sound bearings and had proved particularly effective in locating Nebelwerfers which were sometimes concentrated in batteries. Observation aircraft were generally unable to spot mortars though the flash and smoke of the Nebelwerfer rockets were occasionally seen. Flash spotting, either from the ground or from sixty-foot towers, which had worked so well in the desert, was of little use in Normandy where the Germans almost always fired from reverse slope positions. The microphones of the Counter-Battery sound-ranging bases, deployed 4,000 to 5,000 yards behind the Forward Defence Line, occasionally picked up mortar locations but only one division had seriously exploited this resource.

Four-pen recorders, a miniature (1,500 yards) sound-ranging base of four posts connected to a recording machine in which four pens recorded the vibrations from the four microphones and deduced the location of the hostile mortar,[9] were in use but there were only three sets available in all of 21 Army Group. When in working condition the four-pen recorder produced good results, but the gunners and infantrymen assigned to maintain and operate them had not been properly trained nor had an OR team been employed to study the man-machine interface. Crater examination, a favoured method of determining the bearing of hostile batteries at the School of Artillery, was of little use in battle conditions where probing about in a recent mortar crater could not be realistically recommended.

This left radar. The OR section was told that a GL MK III had been tried out in the early days of the invasion after it was reported that mortar trajectories showed up on A.A. battery radar sets. Indeed mortar bombs had been detected at ranges of 7,000 yards and Nebelwerfer clusters at 11,000 yards. Field trials had met with mixed success and had not been followed up. Schonland and Swann believed that the OR section could help the army to greatly increase the effectiveness of radar. If further GL MK III and 4-pen recorders were made available, and the work co-ordinated with properly trained counter-

A German Nebelwerfer battery prepares Jor action. Each German division in Normandy had at its disposal one Nebelwerfer regiment composed of 54 six-barrelled launcher. The 15 cm Nebelwerfer could ripple off six shells in 10 seconds or three salvoes of six shells injive minutes to a maximum distance of 6900 metres. The peculiar noise made by the Nebelwerfer led Allied troops to name it "Moaning Minnie. "

A German 80 mm mortar crew in action. This weapon could throw a 3.5 kg high explosive or smoke shell to a minimum distance of 60 metres or a maximum of 2400 metres at a rate of 15-25 shells per minute. The difficulty of spotting a well-emplaced mortar crew is evident from these photos.

mortar staffs, the goal of 60 to 80 locations a day could be reached on static fronts.[10] Swann cautioned that even with such changes, existing radar and four-pen recorders were useful only on static fronts and could not assist where improved counter-mortar methods were most needed, in advance and consolidation.

No. 2 ORS's *Report on the Location of Enemy Mortars* was delayed by orders that the section give priority to a study of the effectiveness of heavy bombers in the land battle, so it did not reach the Counter-Mortar Committee of Second British Army until early August.[11] Brigadier Schonland was present to argue the case Swann had made and to add his own views about the role of radar on the battlefield. He noted that the American SCR 584 was vastly preferable to the British or Canadian GL Ills but none were available. The new British 10 cm equipment, the F.A.3 which was mounted on a half-track, was well-suited for employment in the field but the first three would not be delivered until mid-October. In the meantime it was important to organize counter-mortar units with a staff at divisional H.Q. and an officer with a small staff at each brigade. The Canadians had already added personnel to man specific counter-mortar listening posts and this system was adopted in British Second Army. The Corps Survey Regiment was to receive extra personnel and equipment to operate additional Four-Pen Recorder teams across the front. The Committee also decided to recommend the creation of a "Radar Battery" for each army "organized into 3 sections of 3 GL Ills plus 1 spare." It was agreed that "in view of the extreme urgency of the problem there must be no lengthy haggling over details."[12]

By late September both 1 Canadian Radar Battery and 100 British Radar Battery were organized and a ten day training course "in the theory and drill of locating mortars" was underway. At the divisional level, organizational changes were implemented in time to assist the British in the Arnhem Salient and the Canadians in the battle of the Scheldt, but the two Radar Batteries were not ready for an operational role until January 1945.

The Canadian Radar Battery was deployed in the Nijmegen area in support of British and Canadian units of First Canadian Army. A scheme, Operation "Trojan," was devised to draw enemy fire and the radar sections pinpointed 19 locations in a three hour period. Three weeks later they played an important role in Operation "Elephant," an attack on a small but well-defended German position at Kapelsche Veer. Two GL Ills were deployed to cover the area across the River Maas and almost complete success was obtained in locating and relocating enemy mortars.[13]

The enemy quickly reacted to these and other examples of improved mortar location techniques by waiting for long intervals between rounds, or firing a few rounds before moving some distance away. Both of these counter-measures "worked" in the sense that locations were more difficult to obtain, but escaping detection is not the main task assigned to mortar crews.[14]

The real test of the new counter-mortar methods came in Operation "Veritable," the Anglo-Canadian attack down the west bank of the Rhine. Both the Canadian and British Radar Batteries were deployed to provide counter-mortar information and near complete success was obtained. The attacking infantry reached their initial objectives, consolidated and moved forward to the next phase without any interference from enemy mortars.[15] As the troops advanced south they moved out of range and the radar sets had to be moved forward quickly. One section working with 2nd Canadian Division came under heavy shellfire and two men were killed, though the set was not damaged and continued to report hostile mortar locations.

The Germans used enormous quantities of artillery, Nebelwerfer and mortar fire in resisting the Allied advance and there was constant pressure on all the radar detachments until the battle ended in early March. Ten-ton radar sets proved to be of limited mobility in the flooded Rhineland landscape but they were relocated in forward areas and made a significant contribution to reducing casualties and speeding the advance.

The relative success of post-Normandy counter-mortar techniques inevitably raises the question of why such a system was not in place earlier. All of the equipment actually used in 1945 was available in 1943 but the Army Operational Research Group was unable to persuade the Royal Artillery that the available radar equipment should be employed in land battle. The Mk III Gun Laying sets were in short supply and most of the available ones went to Anti-Aircraft Command and the Anti-Aircraft batteries for the defence of the Allied bridgehead in Normandy.

There were other reasons for the slow recognition of the part radar might play in artillery support of land operations. When scientists of the Army Operational Research Group began to investigate the accuracy of predicted artillery fire they found that the gunners, who saw themselves as the scientists of the battlefield, had developed their techniques using a set of assumptions which rarely turned out to be as accurate as battle conditions demanded. The OR group fought a struggle, parallel to the one described here, to persuade the gunners to examine the results of predicted fire and to make use of radar in a number of ways including checking the RAF's "Meteor" messages which provided the essential information on air pressure, wind strength, and direction. Members of No.2 ORS played a major role in converting the artillery to an operational research approach to gunnery but they could not accomplish this until the gunners themselves recognized the problem. Before the end of the battle of Normandy artillery officers were convinced that operational research was of great value and that Schonland's advice should be followed. This was a bit late for the soldiers who fought in Normandy, but two months is a relatively short period for most humans or most organizations to learn new ways of dealing with their problems.

NOTES

1. Terry Copp, "Scientists and the Art of War: Operational Research in 21 Army Group." *Journal of the Royal United Services Institute* (Winter 1991).
2. B.F.G. Schonland, "On Being a Scientific Advisor to a Commander in Chief." 1951.
3. "AORG Radar Section" 1945, R.W. Shephard, *Readings on Early Military Operational Research,* Royal Military College of Science, 1984.
4. Interviews, Terry Copp with Lord Swann, 1988, 1989. See J.W.S. Pringle, "The Work of TRE in the Invasion of Europe," *IEE Proceedings,* October 1985.
5. The working papers for these studies are in the Swann Papers. Copies in possession of the author.
6. M.M. Swann, "A Comparison of the British & German 3" Mortars" December 1943, Swann Papers.
7. *Operational Research in Northwest Europe: The Work qfNo.2 ORS,* Mimeographed Report, 1945, ii.
8. *Ibid,* p.224.
9. G.W.L. Nicholson, *The Gunners of Canada,* Vol. II, p.385.
10. *Operational Research in...,* p.225.
11. "Counter-Mortar" Minutes of Second Meeting, 21 August 1944, National Archives of Canada (NAC) RG 24 Vol. 10,464.
12. *Ibid.*
13. War Diary, *1st Canadian Radar Battery,* p. 12.
14. *Ibid,* p. 14.
15. *Ibid,* p.17.

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