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Operation Research and 21 Army Group

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During the Second World War a new branch of applied science referred to as Operational Research (OR) emerged as a reasonably distinct discipline. The origins of this development may be found in two separate but related activities. Within the British armed services Sir Henry Tizard's Committee for the Scientific Survey of Air Defences, established in 1936, presided over the development of "an effective system for the operational use of radar"[1] which went well beyond purely technical questions. Tizard was determined to apply scientific methods to the entire range of military activities and his influence was crucial in establishing operational research in the Royal Air Force.[2]

The second source of pressure for the employment of scientists in the solution of strategic and tactical problems came from a loosely knit group of academics determined to play a larger role in the conduct of the war. As Solly Zuckerman has related in his autobiography *From Apes to Warlords:*

> From the time of the Munich Crisis of 1938 there had been all manner of talk about how scientists were going to be put on some kind of register and that, given a war, all we would have to do was wait until told what our battle stations were. Nothing happened.[3]

Zuckerman and other leading lights among the young scientists wrote a "manifesto" entitled *Science in War.* Issued by Penguin in July 1940, the book asserted that:

> In the actual business of war, science has been used up to now almost exclusively on the technical side. . . .It has hardly been used, at least by us, on the more general and more vitally important questions of strategy and tactics. . . .The waging of warfare represents a series of human operations carried out for more or less definite ends. Seeing whether these operations actually yield the results expected from them should be a matter of direct scientific analysis. The ultimate answer is provided by victory or defeat, but failure to understand the factors contributing to that victory or defeat, and the degree to which each contributes, removes any secure ground for organizing further success … It is possible to reduce many of the factors in military operations to numerical values. Doing so provides problems capable of definite solution. This has, indeed, been done to a certain extent with the tactical problems of naval and air fighting but it could be extended to many more. The scientific staffs of the Services need to play a much larger part than they seem to do in the formulation and solution of strategical and tactical problems.[4]

The publication of *Science in War* coincided with the defeat of France and Churchill's efforts to energize the British war effort. By the end of 1940 there was employment for all of the Zuckerman group though few had the opportunity to work in the kind of roles that the manifesto had envisaged. Zuckerman himself became involved in studies of the effects of explosions on humans and it was several years before his views in bombing policy were sought by the air force.

The British army was more than willing to employ scientists on technical matters. General Frederick Pile, Commander-in-Chief of Anti-Aircraft Command, enlisted Professor P.M.S. Blackett as his Scientific Advisor in September of 1940.[5] They recruited a group of young scientific generalists, known as "Blackett's Circus," to work on improving the accuracy of the anti-aircraft defences. In March of 1941 Blackett left Anti-Aircraft Command for RAF Coastal Command where he was able to apply operational research techniques to a wide range of tactical as well as technical questions. Work on the optimum size of convoys, the effect of colour on the visibility of aircraft and the marginal value of aircraft cover over convoys reshaped Allied strategy.[6]

With Blackett's departure the future of OR in the army was uncertain. His research group continued to examine the problems of anti-aircraft gunnery, but there was no suggestion of any mandate for expanding the scope of operational research work. In May of 1941 the Chief of the Imperial General Staff did authorize the appointment of a Scientific Advisor to the Army Council and Sir Charles Darwin,[7] a distinguished physicist and grandson of Charles Darwin, accepted the position. Darwin, and his deputy Charles Ellis,[8] were offered broad terms of reference including the right to suggest "from the scientific standpoint methods of waging war."[9] The Directors of the various branches of the army, who served on the Army Council, were, however, quite opposed to interference in operational matters.

Darwin organized an Army Operational Research Group (AORG) to examine a wide variety of questions, but the AORG was placed under the Air Defence Research and Development Establishment, part of the Ministry of Supply.[10] This ensured that they would have very little direct connection with the army. Darwin selected Basil Schonland,[11] a South African physicist who had helped to pioneer methods of intercepting enemy communication on the western front in World War I, as Superintendent of AORG.[12]

Darwin and Schonland were determined to expand the scope of operational research and they established contact with officers in the various training establishments. At Lulworth, the Royal Armoured Corps' school, a Canadian scientist, Omond Solandt, had established a physiological lab to study tank design in relation to crew efficiency and fatigue. Solandt, a bright, inquisitive, and aggressive young man, quickly developed questions about all aspects of tank design and development. In June 1943 his research team was integrated into AORG.[13]

Schonland organized a signal corps OR section on his own initiative. The unit investigated a wide range of questions, including the problems created by squeezing all army communications into the narrow high frequency band. Efforts to persuade the army to use very high frequency (VHF) for shorter ranges were only partially successful due to the low priority assigned to equipping the army.[14]

A fifth section was established at the airborne school. Schonland had worked with Major-General "Boy" Browning during the planning of the Bruneval raid and Browning was quick to co-operate. Michael Swann, a

Major Michael Swann, REME

Royal Electrical and Mechanical Engineer (REME) captain with an abbreviated Cambridge degree in Zoology and a crash course in radar, started work on training methods for night operations.[15] He was joined by David Bailey Pike, a former schoolmaster recruited into OR by C.P. Snow. Pike was instrumental in the development of methods for optimizing the performance of the Rebecca-Eureka system of radar beacons which airborne Pathfinder forces would use on D-Day.[16]

Swann, promoted to Major, moved on to the Infantry school at Barnard Castle in Yorkshire. The infantry section, AORS6, became one of the most important units of AORG. Significant work was accomplished on all the key infantry weapons, and tactical problems were systematically analyzed in a series of influential reports.[17]

Four other sections were created in 1943. AORS7 examined the effectiveness of artillery. AORS8 split into three specialized sub-units; "Mines and Obstacles," "Special Optical Aids" and "Flamethrowers." The basic work on the employment of "Wasp" and "Crocodile" flamethrowers was carried out by Schonland's team of scientists. AORS9 began work on time and motion studies, while a tenth section, "Battle Analysis," was created to establish methods of studying large scale military operations.[18]

The experimental work of the AORG sections would be carried out in England, but Darwin also wanted to establish operational research overseas. An OR section had been sent to the Middle East in the summer of 1942 but it was simply attached to General Headquarters in Cairo. A proposed study of the effectiveness of anti-tank guns was met with the statement that this "could only be studied in the battle area . . . and no officer from GHQ, except the Commander-in Chief, could visit the battle area."[19]

Throughout the fall of 1942 Darwin tried to overcome resistance to the expansion of operational research onto the battlefield. As one of his colleagues put it:

> It was not easy to make headway: operational research was a new baby in a family which was already over large . . . the extra member was not popular and but for the determination of the Scientific Advisor might well 'have been starved out of existence in its early life.[20]

Authorization to form OR sections for overseas theatres was granted in November of 1942 and David Hill, one of the original members of Blackett's Circus, was sent to North Africa to join 1st British Army. Hill was unable to accomplish very much and he returned to the U.K.[21] Darwin persisted and in June 1943 No. 1 ORS (Italy) was established.

Eighth Army in Italy was no more hospitable to operational research than it had been in North Africa. Of the fifteen reports prepared by the section,[22] twelve dealt with questions related to the accuracy and effectiveness of artillery fire, an issue of some importance. There was, however, no mechanism for impressing the results of these studies on local commanders. As one anonymous researcher explained:

> A new type of unit has great difficulty in making good headway unless it is lucky enough to have a powerful sponsor. In No. 1 ORS' case there was no such person and work was undertaken in a somewhat haphazard manner.[23]

Two Canadian officers served with the section, Captain H.H. Clayton, Royal Canadian Artillery and Lieutenant-Colonel A.B. Dove, Royal Canadian Engineers. Like their British counterparts they found the work frustrating though Clayton finally won the attention of Eighth Army Headquarters by a study of the drying rates of soils in the Po Valley.

No.2 ORS, formed in July of 1943 to serve with 21 Army Group, was headed for a similar fate when Darwin's successor, Charles Ellis, intervened to try and establish a firm basis for operational research in North-West Europe. In the run-up to D-Day the section had worked chiefly as a liaison group between army staff officers and technical specialists

in the AORG. Important work on the control of communications in the bridgehead, where radio and radar sets of every conceivable kind would be operating in close proximity, was underway. Equally vital work on A. A. defences for the beaches and Mulberries was also in progress,[24] but Army OR had not begun to deal with the kind of complex battlefield questions that Ellis knew operational research should address.

Ellis advocated a three-tiered system for 21 Army Group. First he wanted a Scientific Advisor appointed as senior officer with ready access to the Chief of Staff. Second, an OR section with its own establishment including sufficient vehicles and clerical staff. The third tier would be the AORG in England, especially AORS10, the Battle Analysis group.[25] Late in 1943 Ellis wrote to the newly-appointed commander of 21 Army Group, General Bernard Montgomery, asking if he, Montgomery, would "like a small team of scientists to observe his battles." Monty's full reaction to this enquiry from an unknown civilian can only be imagined but he was said to have replied with a five word message, "I observe my own battles."[26]

Montgomery did not, however, veto Ellis' plan. The formal link with AORG in England was quite impossible, as Monty would not allow "outsiders" access to operational information, but he raised no objection to the addition of a Scientific Advisor to his staff, nor to the expansion of the OR Section. Ellis' choice for the position, Basil Schonland, had a military background, great common sense and considerable presence. When approached he was hard at work on the decoy attack on the Pas de Calais and other aspects of electronic warfare. Schonland had long been "unhappy about the highly technical turn the Operational Research Section had taken." He accepted the position on the condition that this could be changed and the promise that Ellis would make available "... any member of AORG whom I wanted, in uniform and at short notice."[27] Omond Solandt was to take charge in Schonland's absence and this young Canadian became Superintendent of AORG for the balance of the war.

Schonland was given the rank of Brigadier which, at least theoretically, placed him on an equal footing with the heads of Monty's Intelligence and Operations sections. He found that "Freddie," Lieutenant-General Frederic de Guingand, Montgomery's Chief of Staff, was "kind, courteous and accessible."[28] His fellow Brigadiers had been told that he was there "to solve difficult problems for them" and they seemed quite willing to try him out. In a 1951 *Memoir*,[29] Schonland noted that the "solving of conundrums" was an important subsidiary function of the Scientific Advisor. Most of the puzzles were deadly serious and technically complex. Others, put up by Intelligence, were similar to the query as to whether the enemy could "electrify the sea" by running leads from local power stations into the ocean at the landing beaches.[30]

For Schonland the principal function of the Scientific Advisor was to promote the application of operational research to the battlefield and to ensure that the recommendations of the OR teams were acted upon. As a first step, Schonland and Solandt selected "the best men available" to strengthen No.2 ORS. Patrick Johnson,[31] an Oxford Physics Don who had served with the OR group in the Middle East, was retained as CO. of the section but three new men who were "to turn the section on to real operational research" were added. The foremost of these was Michael Swann who put his experience at the infantry school to good use.

The second addition, H.A. Sargeaunt[32] had been working with Omond Solandt on problems related to tank gunnery, armour, and mobility. Sargeaunt had developed a detailed knowledge of the armoured corps while working with a tank brigade over a period of several months.[33] Schonland hoped to use his experience in addressing broad operational issues in armoured warfare.

The third new appointment was a Canadian artillery officer, John F. Fairlie, a RMC and University of Toronto graduate in mechanical engineering. After brief service in an artillery field regiment, Far lie was posted to the AORG gunnery section in December of

1943.[34] His work on the accuracy of field artillery along with his prewar experience convinced Schonland that Fairlie could approach the study of artillery doctrine in the desired manner.[35] Schonland soon added a signals expert, and an administrative officer to the team. He also recalled David Hill from his attachment to Tactical Air Force operational research. Hill became Schonland's assistant on air matters, an area of great sensitivity. In his 1951 memoir Schonland emphasized the importance of an army commander having his own advisors on air matters and explained that this was the one area of OR work which had to be personally directed by the Scientific Advisor.[36]

From March 1944 to late May, Schonland and No.2 ORS remained occupied with a wide variety of familiar technical matters. The commanding officer Lieutenant-Colonel Johnson was acting as Radar Advisor to the assault Anti-Aircraft Brigade.[37] John Fairlie was also detached from the section to organize a Special Observer Party, formed at the last minute to study the effectiveness of attacks on the coastal defences.[38]

Fairlie prepared the first two OR reports of the North-west European campaign on the basis of these investigations. Report No.l, "Self-Propelled Artillery in the Assault on the Beaches, 3 Cdn. Inf. Div. Sector,"[39] produced some startling revelations. Although the Self-Propelled Artillery regiments performed in

Major John Fairlie, Royal Canadian Artillery.

Resistance nestfaced by Canadians in St. Aubin. Fire from this gun was suppressed by close range fire, but the reinforced concrete position remained intact. (U. S. Air Force photo 72640 AC)

accordance with doctrine, it was evident that "no serious damage was done to any of the defences by S.P. fire." In an overall review of the battle for the Atlantic Wall, Fairlie wrote:

> The defences were overcome by D. D. Tanks, engineer and infantry assault. The degree of neutralization (by the Bombardment) actually achieved is difficult to assess because of the (German) method of siting guns to enfilade the beach area only. As few guns could fire to seaward it is difficult to say whether the delay of the enemy in opening fire was due to neutralization or to the fact that guns would not bear. In any event the defences were substantially intact when the infantry touched down and the enemy were able to deliver lethal fire in great quantity against our troops.[40]

This was not what the navy, air force or the Royal Artillery expected or wished to hear, but it was of vital importance in the planning of future attempts to storm fortified positions.

Fairlie's second report examined the "Employment of Royal Marine Artillery During Operation Neptune."[41] This was written under great pressure as the Brigadier (Staff Duties)[42] at 21 Army Group Headquarters was anxious to learn about their role in the D-Day landings. The Royal Marine Artillery had come ashore on the three Anglo-Canadian beaches equipped with Centaur Armoured Fighting Vehicles mounting 95-mm guns. These were intended to provide close support to the infantry especially in reducing or neutralizing concrete gun positions. Fairlie found that the Centaurs had provided "very useful close support"[43] at both Sword and Juno beaches suggesting the enormous value of aimed fire from a heavily gunned tank in infantry assaults against fortified positions.

In late June Fairlie and Johnson rejoined the OR team which had arrived in Normandy on June 24th. The section messed with the Weapons Technical staff "underneath an avenue of firs, which led down to the Chateau on the edge of Creully, round which Main Headquarters of Second British Army was scattered."[44] But no one at Second Army was interested in OR and Schonland was still with 21 Army Group Main H.Q. back in England. It was up to the members of the OR team to find work for themselves. As Michael Swann recalled it:

> In those days the bridgehead was so small and Second Army Headquarters so near the front, that 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 problem before us.
>
> By degrees our ideas crystallized, and a number of projects stood out as being worth some concentrated effort. Of the many that we turned over, the chief were, the location of enemy mortars, which were causing appalling casualties and proving almost impossible to deal with; the distribution of hits and penetrations in our own and the enemy's tank casualties, and the influence of this on tactics; the performance and the best method of use of the PIAT; the problem of dust on the roads, and particularly on airstrips (the dust in Normandy was extraordinary, and was wearing out certain types of aero engines at an alarming rate); and lastly the problem of mud, which in the rainy spells was causing great difficulties in the little lanes and tracks that had to be used as supply routes. The blessing of Second Army on these grandiose schemes was obtained, but in the end only the first two projects were completed. Dust was taken over by the Air Forces; mud, after looking hopeful, fell through because it became apparent that the ways of the Army were too rough and ready and liable to change in those hectic early days, to allow of any intricate planning of where roads should go; and the performance of the PIAT, which though it was often fired, seldom actually hit an enemy tank, turned into a series of planned trials which were run by the Weapons Technical Staff.
>
> Two projects however remained: the Mortar location and the Tank Casualty surveys. It is significant that neither were purely technical problems; nor on the other hand were they analyses of the whole or a large part of the battle. They were indeed midway between the technical and the operational; it was possible to isolate them, although the conditions of the battle were all-important.[45]

A PIAT and crew.

(IWMB6185)

These important endeavours were interrupted by the bombing of Caen on the night of July 7th. The awe-inspiring sight of Bomber Command's massive effort affected everyone in the bridgehead. But the battle of July 8th was as tough, costly and limited as any previous battle. Swann and Sargeaunt set out to study the effect of the bombing on their own initiative, quite unaware that many others would be engaged in the same task.[46] Their report contained some diplomatic language about "the disorganization and morale effects"[47] the attack may have produced but it also demonstrated how slight the impact of the bombing had been on the battle.

Schonland was now in France and he was able to bring the report to the attention of de Guingand. No. 2 ORS was ordered to study all subsequent heavy bomber operations so that the army would have its own independent assessment of such action.[48] The OR group looked at the bombing in support of Operations "Goodwood" (July 18), "Bluecoat" (July 30th) and "Totalize" (August 7th/8th). Each of these reports provided 21st Army Group with important information which permitted army planners to develop a much more sophisticated approach to the use of heavy bombers on the battlefield.[49]

A further report, "Heavy Bombing in Support of the Army" provided a summary of what the OR team had learned about the subject in the summer of 1944. Bombing, they insisted, should be examined under three distinct categories, "obstruction, destruction and demoralization." Obstruction involved the blocking of enemy movement, particularly in the context of Normandy, enemy withdrawals. The report noted that "the pattern on the ground of an attack by British

bombers is much the same size (1000 yards diameter) whatever the weight of the attack." It was the fact that the centre of the pattern was "often wrongly placed," not the individual crew's wide shots, that presented a safety problem to friendly troops. Given the wide dispersion throughout a 1000 yard circle (quite apart from incorrect aiming points) heavy bombing should, they wrote, "be confined to genuine area targets."[50]

brief time "no bombing attack with demoralization as its primary object should be arranged unless it can in fact be readily followed up." Here were the elements of a new doctrine for the use of the heavy bombers in support of the land battle. Unfortunately at the end of August General Eisenhower lost control of the strategic air forces which returned to their preferred task of bombing targets in Germany.

A Typhoon takes off on a mission carrying its potent load of eight 3-inch rockets.
(CFPU PL 42738)

There were real possibilities in using the heavies to obstruct German withdrawals and the OR team provided specific guidance on the number of bombs required for various types of localities. Howeyer, the destructive effect of bombs, that is the actual destruction of enemy troops and equipment, was so small that it "was the moral effect which must be utilized if heavy bombing is to prove really useful." Since morale was only affected for a

If the work on heavy bomber targets could not be immediately applied it nevertheless provided a foundation for other studies of the battlefield. Schonland had long been anxious to know something concrete about the effectiveness of fighter and fighter-bomber close support. This was an issue which was causing much difficulty between the army and air force and 21 Army Group badly wanted to know what was going on.

Major D.F.B. Pike, who had been a research officer at the Air Branch of 21 Army Group, was attached to the OR section to help with this work.[51]

On August 8th word came that the team was to proceed to the town of Mortain in the American zone. Here, the RAF proclaimed, the tactical air force had been "a decisive battle winning factor" in stopping the German counterattack to cut off the American troops south of Avranches. According to Air Marshal Coningham, the commander of Second Tactical Air Force (2nd TAF), rocket-firing Typhoons claimed to have destroyed 89 tanks, probably destroyed another 56 tracked vehicles, set on fire 104 motor vehicles and saw 47 motor vehicles smoking. These claims do not include 56 enemy tanks damaged and 81 motor vehicles damaged.[52] It had been, the air force insisted, "The Day of the Typhoon."

The army OR section was not the only group headed for Mortain. When Second Tactical Air Force was formed in 1943 it acquired operational research staff from Fighter and Army Co-operation Commands. Fighter Command had a good deal of experience with OR work and had amassed considerable information about attacks on ground targets. For example, in early 1943 a full scale model of a German artillery division with 48 mock guns and 558 dummy soldiers was created. "Every effort was made to aid the fighters and fighter-bombers in their attack task, but neither Mustangs strafing, nor Typhoons firing their new rockets with 60 lb. warheads were able to inflict more than negligible damage on the position."[53] A second experiment with a mock-up troop of medium artillery produced equally dismal results.

A carefully controlled study of the ability of pilots to find specific positions on the ground produced even more startling information. Tactical Memorandum No.30, dated March 1943, reported that:

> fighters, given a six-figure map reference were unable to spot well camouflaged guns even when the guns were actually firing . . . attacks on gun positions give negligible results for a high wastage and should only be ordered in an emergency.[54]

After 2nd TAF was established, OR studies continued to show that there were very real problems in attacking the kind of targets which were of interest to the army. Operations against a variety of targets were carefully examined in the pre-D-Day period. Typhoon rockets were found to hit a viaduct 500 yards long and 8 yards wide, one in fifteen times. Bombs dropped from fighter-bombers scored hits one in eighty-two times. Rocket Projectile (RP) attacks on gun positions produced results varying from 110 rockets fired at a casement in Courseulles-sur-Mer with zero hits to two hits out of 127 at Fontenay. Second TAF found all this disappointing, particularly since none of the targets had been "well-defended."[55]

The Allied Expeditionary Air Force (AEAF) established a school for training fighter pilots in close support during 1944. Results were not encouraging, for while strafing was "outstandingly successful" in damaging or destroying soft-skin vehicles, bombs and rockets could not be delivered accurately by average pilots. Near misses, it was found, did little damage. Even worse, accurate target location and identification of friendly troops proved to be an art which was readily mastered by very few pilots.[56]

The AEAF concluded that the probability of pilot error and the likely inaccuracy of rocket and bombing attacks meant that close support of army operations should only be ordered in an emergency. Interdiction well beyond the battlefield, armed reconnaissance and the search for targets of opportunity would be the normal role of the fighter-bombers. Nothing in the first two months of the campaign had altered this view, but if the Typhoons had really stopped the German armour at Mortain, the whole question of close support needed to be reopened.

The two rival OR groups began work at Mortain as soon as the German retreat cleared the area. For eight days, August 12th to August 20th, a not entirely friendly competition to locate and examine German

tanks, self-propelled guns and other vehicles was underway along the roads and lanes of the hilly countryside. Descriptive accounts of the battle, as well as air force claims, had prepared the scientists for scenes of devastation. A Panzer division, it was said, had been caught in a traffic jam caused by the crash of an allied aircraft onto the lead tank in the column. Scores of panzers had been destroyed near St. Barthelmus and this was just one among many stories that everyone had heard.

What the researchers saw was very different. Despite the most systematic search, very few wrecked tanks could be located. The army team borrowed an Auster aircraft to conduct a survey, but not a single additional vehicle was seen. In the end only 33 Panthers, 10 Mark IVs and 3 self-propelled guns were uncovered. If armoured troop carriers, armoured cars and tank recovery vehicles were added, the total for all armour left behind in the area was seventy-eight. Nor was it possible to find many of the motor vehicles which the air force had claimed to have destroyed. Only thirty German trucks were available to investigate.[57] This was difficult enough to account for, but the results of the individual examination of vehicles was even harder to explain. Nineteen of the forty-three tanks had definitely been destroyed by U.S. Army units. Only seven tanks showed signs of being struck by rocket projectiles. Two had been disabled by U.S. Air Force bombing, seven had been abandoned without a mark on them, and four had been destroyed by their crews. The fate of just three tanks was judged to be from unknown causes.[58]

The Army OR group was quite prepared to accept the argument that air power might be credited for some of the abandoned and crew-destroyed tanks. Their report, however, noted that these tanks could not be taken **into** consideration When comparing pilots' claims of having destroyed or damaged vehicles.[59] Major Pike's dispassionate analysis of the evidence angered the RAF and provoked outrage at 2nd TAF headquarters.

The Army OR group agreed that the Allied Air Forces had a "considerable effect" on the German attack at Mortain. But nothing remotely resembling the air force claims could be justified. Indeed, in many areas of the battlefield, no signs of the characteristic RP crater could be found. The RAF ought to have accepted this view for it knew from its own recent research that there were serious aiming problems with RP (and bomb-equipped) Typhoons.

A study on the "accuracy of attacks ..." had been completed in June 1944. It showed that under the most favourable conditions, average pilots were lucky to concentrate their rockets in a circle 150 yards in diameter. The report stated:

> In order to hit a small target with R.P. the pilot must be at the right height and dive angle, have the correct speed, have his sight on the target and the right angular depression on his sight, make the correct wind allowances and be free from skid or 'g'. . . .All of these factors are important but it is very difficult for a pilot to have them all right at the same time. . . .[60]

The report raised the question of what really happened in combat when the pilot was also being harassed by anti-aircraft fire. It concluded that previous views of the accuracy of RP attacks and of dive bombing (which was even more subject to aiming error) were wrong. Such ideas must have been based on "the performance of a few very keen and experienced pilots who can hit small objects, such as tanks, with R.P.'s." Such men might be grouped into a "corps d'élite" capable of attacking special targets but only continual training and practice could improve the accuracy of most of the TAF pilots.[61]

The rival OR teams now raced north to examine the battlefield around Falaise and the roads leading to the Seine crossings. Here there were thousands of wrecked vehicles to investigate and a new round of argument over the role of air power to be waged. The army investigators would once again report that their three-week investigation established beyond dispute that the devastation of the German forces in the area known as "the Shambles" was not primarily due to direct air

A British 5.5-inch gun in action.

(NACPA 112364)

attack. Only 11 of 171 armoured fighting vehicles examined had been hit by bombs or rockets. No doubt the air force had assisted in destroying German morale — strafing had accounted for a third of all soft-skinned vehicle losses — but, in the words of the OR report, the destruction of the German army had been achieved by "land action."[62]

The investigation of the Mortain battle continued to produce sparks. After one particularly nasty exchange, Brigadier Schonland suggested that "unless there were fairies in Normandy who could remove a large formation of tanks from the Mortain area,"[63] it was time to accept the evidence and act on the basis of fact, not fiction. But in the summer of 1944, 2nd TAF was in no mood to discuss the issues raised by Army OR. In an official "Addenda" to the Army's *Report* the Air Force insisted that:

> It would be wrong to regard the data provided in this report as yielding information on which to make recommendations for changes in weapons, tactics or operational doctrine, although the factual side of the report can itself be accepted.[64]

If it was not permissible to use accepted data as the basis for recommendations about "changes in weapons, tactics or operational doctrine" then there was little point to further investigation of tactical air power. However 21 Army Group was not about to give up its

attempts to influence tactical air doctrine. A formal agreement was negotiated between Schonland and 2nd TAF which provided for joint investigations of air operations against ground targets.

Air Force and Army OR researchers prepared four Joint Reports in the fall and winter of 1944-45.[65] Again there was no disagreement about the evidence. For example in Joint Report No.3 titled "Rocket Firing Typhoons in Close Support of Military Operations" it was found that 350 rockets, involving 44 sorties, would have to be fired at a small gun position to obtain a fifty percent chance of a hit.[66] If Typhoons were to be employed in a close support role they were best used to reduce enemy morale and raise the morale of allied infantry. Both doctrine and the manner of planning operations needed to be revised to take account of this.

Extensive research was also undertaken on artillery methods. John Fairlie had to be hospitalized in England in September 1944 and was not able to return to the section. He was replaced by Major J.G. Wallace and Captain G. Mathieson, two Royal Artillery officers with AORG experience. Their first investigation, which looked at the accuracy of a large predicted shoot in the Canadian attempt to clear the Breskins Pocket, "proved nothing short of a bombshell." The report "showed the grossest of inaccuracies in many of the concentrations, far greater than ever had been suspected."[67] Fortunately the senior artillery officer at First Canadian Army Headquarters, R.A. Brownfield, was anxious to make use of operational research and the OR team worked closely with First Canadian Army until the end of the war.

When the section was disbanded in July 1945, it had completed more than forty reports. Michael Swann, reflecting on what had been accomplished, was convinced that Operational Research had much to contribute to clearing up the uncertainties of war, yet he was equally convinced 'that the team's work had not been sufficiently appreciated. Schonland, who was in a better position to judge, disagreed. He insisted that OR had influenced many aspects of 21 Army Group operations.

> . . . the great things that the ORS did was to show that . . . operational research section[s] have as their first duty the rapid application of lessons learned from operations and they are able to derive such lessons in a form which will carry conviction. Every C-in-C and his Chief of Staff in a future campaign should be given a copy of *Operational Research in Northwest Europe* . . .

Whether future C-in-Cs read the report or not, Schonland was right about the success of OR. A new discipline had been created and henceforth no modern military force would attempt to function without the aid of an operational research team. Scientists had earned the right to bring their methodologies to bear on the art of war.[68]

NOTES

1. Stephen Brooks, "An Introduction to the Papers of Sir Henry Tizard" *Imperial War Museum Review,* 1988, p.51.
2. United Kingdom Air Ministry, *The Origins and Development of Operational Research in the Royal Air Force* (London: HMSO, 1963).
3. Solly Zuckerman, *From Apes* to *Warlords* (London, 1978), p. 178.
4. Cited in C.H. Waddington, *O.R. in World War 2: Operational Research Against the U-Boat* (London, 1973), pp.2-3.
5. L.E. Baylis, "The Origins of Operational Research in the Army" AORG Memorandum No.615, Oct. 1945. Ivor Evans Papers, Imperial War Museum (IWM).
6. See Waddington and P.M.S. Blackett, *Studies of War* (London, 1962), Part II Operational Research. See also J.G. Crowther and R. Waddington *Science at War,* (London: HMSO, 1947), Chapter II.
7. Sir Charles Galton Darwin 1887-1962. Physicist, associated with Ernest Rutherford at Manchester University 1910-1914. Officer, Royal Engineers WWI, specializing in detection of enemy guns by sound ranging. He held various scientific positions, 1914-1938 when he was appointed Director of the National Physical Laboratory. "He successfully reorganized the NPL for urgent war work and in 1941 was seconded to

Washington for a year as first director of the British Office set up to improve Anglo-American scientific war co-operation . . . Involved in liaison over the Atomic Bomb . . . On returning to Britain he became Scientific Advisor to the War Office." He returned to the NPL in 1943 and was instrumental in the development of the first electronic digital computer available in Britain. He retired in 1947. *Dictionary of National Biography 1961-1970,* p.272.

8. Sir Charles Drummond Ellis 1895-1980, Physicist. Graduate of the Royal Military Academy, Woolwich. He was interned in Germany 1914-1919 but was allowed to carry out scientific experiments. Graduated, Trinity College Cambridge 1920. Cavendish Laboratory 1920-36. Chair of Physics, King's College 1936-40. Deputy, then Scientific Advisor to the War Office 1940-45. Scientific Member National Coal Board 1945-1955. *Dictionary of National Biography 1971-1980,* p.281.
9. "Operational Research in the Army" Typescript 22 pages, no author, no date. Public Record Office (PRO) WO 291/1301 p.1.
10. *Ibid.,* p.1.
11. Sir Basil Ferdinand Jamieson Schonland, Physicist. (1896-1972) Graduated Rhodes University College (1914) Cambridge (1919). Served Royal Engineers 1915-1918. Cavendish Laboratory 1919-22. University of Cape Town 1922-1937. Director Institute for Geophysical Research, Witwaterstrand University 1937-1940. Internationally known specialist in the nature of lightning. Officer Commanding South African Army Radio Direction Finding Unit with General Wavell 1940. Joined Anti-Aircraft Command 1941 and transferred to AORG as Superintendent in that year. Scientific Advisor to C-in-C, 21 Army Group March - November 1944. Returned to South Africa in 1945 *to* establish the South African Council for Scientific and Industrial Research. In 1958 he was appointed Director of the Atomic Energy Research Establishment at Harwell in the United Kingdom. *Dictionary of National Biography 1970-1981,* p.761.
12. The Schonland Papers, Imperial War Museum contain several reports written by Schonland on the interception of German signals.
13. Omond M. Solandt (1909-93) B.A. and M.D., U of T. 1936. Research in physiology U of T and University of Cambridge. Lecturer, University of Cambridge 1939. Established and directed Medical Research Council (U.K.) Physiology Lab, Armoured Fighting Vehicle School, Lulworth, England. Armoured Fighting Vehicle Section AORG 1943. Deputy Superintendent AORG 1943-44. Superintendent AORG, 1944-45, Colonel CanadianArmy 1944-45, Chairman, Defence Research Board, 1947-56. Who's *Who in Canada 1988,* and interviews Terry Copp with Omond Solandt.
14. AORG. "Outline of Work Done by Army Operational Research Sections" Typescript lOpagesn.d. Ivor Evans Papers, IWM.
15. Interview T. Copp with Lord Swann, October 1989.
16. Interview T. Copp with D.B. Pike, May 1990.
17. See for example AORS6 Reports 162, 164, 167, PRO WO 291.
18. AORG "Outline of Work Done by Army Operation Research Section," Typescript 10 pages, n.d. Ivor Evans Papers, IWM.
19. "Operational Research in the Army," p. 12.
20. *Ibid.,* p.3.
21. Interview Terry Copp with D.K. Hill, 9 October **1990.**
22. Reports 1209-1225 PRO WO 291.
23. "Operational Research in the Army," p. 14.
24. B.F.J. Schonland, "Some Recollections of MyTime with 21 Army Group" typescript 2 pages, Schonland Papers, IWM.
25. Evans, p.2.
26. Quoted in Schonland "Some Recollections . . ."
27. B.F.J. Schonland, "Operational Research with the 21 st Army Group, British Liberation Army before and after the invasion of the Continent, June 6th, 1944," handwritten draft 6 pages, Schonland Papers, p.4.
28. *Ibid.,* p.4.
29. B.F.J. Schonland, "On Being a Scientific Advisor to a Commander-in-Chief," Typescript 18 pages, Montgomery Papers, BLM 140/6 IWM.
30. *Ibid.,* p. 12.
31. Patrick Johnson, b. 1904 was a Physics Don at Magdelen College, Oxford both before and after the war. He became Director of Studies, RAF College Cranwell, in 1947. Johnson did not show Schonland's enthusiasm for the application of OR to battlefield studies. Presumably he was left in command to front for the youngsters who made up the bulk of the OR team. Information on Johnson, though not the inferences, is from a letter Lord Swann to the author June 1987, Letter O.M. Solandt to B.J. Schonland 7 May 1945 Schonland Papers and letter Patrick Johnson to B.J. Schonland, 14 May 1945, Schonland Papers. See *Who's Who 1949,* p. 1473.
32. H.A. Sargeaunt served in the post-war AORG organization and later became a professor lecturing and writing on operations research. Interview Terry Copp with H.A. Sargeaunt, 1987.
33. Schonland, "Operational Research . . ." p.3.
34. Personnel File, John F. Fairlie, National Archives of Canada, National Personnel Records Centre, and letter, Mrs. John F. Fairlie to author, March 1988. Fairlie's appointment to AORG may have been due to the efforts of Dr. J. Tuzo Wilson, who was serving as a Scientific Liaison Officer at Canadian Army Headquar-

ters (London, England) in 1943. Wilson "was instrumental in encouraging the attachment of Canadian scientists and technical officers in uniform to research and technical establishments in the U.K. especially the AORG." J.W. Mayne, *The Origins of and Deployment of Operational Research in Canada* (Ottawa: DND, 1980), Vol.11, Appendix 8. Wilson returned to Canada to become Director of Operational Research in the Canadian Army Operational Research Group established in 1944. *Ibid.,* Appendix 4.

35. Fairlie had won a number of prizes as a writer including the 1942 Canadian Club Contest for the best essay on "Canada in the Post War World" open to any amateur or professional writer in Canada. Personnel File, *op cit* Schonland may well have been influenced by the clarity of Fairlie's reports.
36. Schonland "Operational Research . . ." p.5
37. M.M. Swann, éd., *Operational Research in Northwest Europe: The Work of No. 2 Operational Research Section with21 Army Group June 1944-July 1945.* AORG 1945, 217pages. PRO WO 291/1331. A copy may be found in NAC RG24 VOL. 10,438. There is no indication of editor or authors in the document. Swann wrote the introduction, the authors of individual reports are identified directly or indirectly in the report or other OR documents. Letter, Lord Swann to the author, April 6, 1986. Handwritten draft of introduction Swann Papers.
38. Swann, *Operational Research,* "Introduction," p.i.
39. *Ibid.,* Report No.l, p.187.
40. *Ibid.,* p. 192.
41. *Ibid.,* Report No.2, p. 193.
42. The Brigadier (SD) was responsible for reinforcements, establishments, the provision of equipment of every kind, and in addition controlled he Weapons Technical Staff and the OR group except on matters related to air questions. Schonland, "Operational Research . . ." p.6.
43. Swann, *Operational Research,* Report No.2, p. 195.
44. *Ibid.,* p.ii.
45. *Ibid.*
46. See Zuckerman, p. 272 for an account of the high-level investigation of the bombing in which Zuckerman, as Scientific Advisor to the Allied Expeditionary Air Force, took part. See also David A. Barnhill, *RAF Bomber Command and Tactical Air Support - Normandy 1944* M.A. Cognate Essay, Wilfrid Laurier University, 1988.
47. Swann, *Operational Research,* "Report No.5", p.36.
48. *Ibid.,* "Introduction," p.iv.
49. *Ibid.,* Reports No.6, 7, 8 & 14. Report No. 14 "Heavy Bombing in Support of the Army" is a synthesis of knowledge obtained in July-August 1944.
50. The quotations in this and the following paragraph are from Swann, *Operational Research,* Report No. 14.
51. *Ibid.,* "Introduction," p.v.
52. Air Marshal Sir Arthur Coningham, *Report Concerning Operations Carried out by Second Tactical Air Force between June 6 1944 and May 9, 1945.* p. 11. PRO Air 37/876.
53. Fighter Command Tactical Memorandum #30, March 1943, Director General History, 79/32.
54. *Ibid.*
55. Operational Research Section, Allied Expeditionary Force Report No. 16, Director General History, 181.003 (D342).
56. ORS, Allied Expeditionary Air Force (AEAF), "The Accuracy of Attacks on Small Targets by Fighter Bombers and R.P. Fighters," PRO AIR 37/653.
57. Swann, *Operational Research,* Report No.4.
58. *Ibid.,* p.65.
59. *Ibid.,* p.65.
60. ORS (AEAF) "The Accuracy . . ." p.2.
61. *Ibid.,* p.5.
62. Swann, *Operational Research,* Report No. 15, p.88.
63. B.S.J. Schonland to G.C. Oxborrow, 28 Oct. 1944, PRO WO 205/556.
64. Swann, *Operational Research,* p.88.
65. *Ibid.,* Chapter 4, 5.
66. *Ibid.,* Joint Report No.3.
67. Swann, *Operational Research,* pp.x&xi.
68. Schonland, "Operational Research . . ." p.6.

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