# Scientific Intelligence



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*A lecture delivered in 1947 by the father of scientific intelligence, a classic of the literature, is reproduced here because it bears witness to the labors of the infant Hercules, contributes to the intelligence history of the war, and says some wise things about the nature of intelligence.*

Public statements regarding intelligence are very rare. One reason for this is security; you cannot say much about your own intelligence service-and particularly about its success-without disclosing something of value to a potential enemy. But this is equally true of any statement you may make about any aspect of your defence system, yet it has been found worth while for distinguished officers to outline publicly the principles of their strategy and armament. Our gain in having the views of successful commanders spread throughout our own country more than offsets the loss in security. I believe, therefore, that it is not entirely for reasons of security that intelligence is so rarely discussed in public: there is a deeper reason. Owing to the inadequate status which intelligence has hitherto been accorded in our defence system, it has rarely been able to command a staff of mental calibre commensurate with the difficulty of its problems. As a result, while much thought has been given to the principles of strategy and while penetrating treatises have been written on that subject, a coherent philosophy or doctrine of intelligence has until now failed to develop.

It is hardly surprising, therefore, that published opinion regarding intelligence is, on the whole, derogatory. Take, for example, Clausewitz. While he says that intelligence is the foundation of all a commander's ideas and actions, he goes on to state that "a great part of the information obtained in war is contradictory, a still greater part is false,

and by far the greatest part is of a doubtful character." Shakespeare's King John, having been let down by his spies, expressed himself rather tersely: "Oh where hath our Intelligence been drunk, where hath it slept?" And, knowing the two classic methods of intelligence, he might well ask!

Despite, however, the hard things that have been said about intelligence in the past, I believe that its development during the recent war was so vast that a coherent philosophy has now evolved. It is about this, in particular relation to my own branch, Scientific Intelligence, that I want to speak. My approach will be largely historical not only because, as Mr. Churchill has said, strict chronology is the secret of good narrative, but also because I know of no more convincing way to present the philosophy of intelligence to you than along the path of direct experience by which I travelled myself.

# Germination

Early in 1939, the Committee for the Scientific Study of Air Defence drew attention to our ignorance of new German weapons. It was therefore suggested that a scientist should be attached to the intelligence branches of the Air Staff to find out what was wrong and whether an improvement could be effected. I was the scientist selected but, owing to Treasury opposition to the general proposal, the war broke out before I took up my duties on 11th September, 1939.

Eight days later Hitler made his famous "secret weapon" speech-in which, in fact, he made no reference to a secret weapon. The subsequent alarm in this country was due to an error in translation, for it was clear from the BBC's record of his speech that Hitler was not referring to a specific weapon, or Wafe, but to the Luftwaffe as a whole. In the meantime it had become my task to search through all the intelligence files for possible new weapons, and while the material in the files was very nebulous, I was able to indicate that certain weapons would have to be taken seriously: these included (quoting from my first intelligence Report) gliding bombs, pilotless aircraft, long-range guns, and rockets. But my search through the files had also taught me how primitive was our intelligence service compared with what, from a

schoolboy onwards, I had imagined it to be.

At times of alarm, such as followed the outbreak of war and Hitler's speech, casual sources crop up in large numbers. These are mainly people who, under the stress of the situation, think that they have information of value to the country. Much of the information is useless, but in the days following Hitler's speech one casual source came up whose information was of remarkable interest. It happened in this way. Our naval attache in Oslo received an anonymous letter telling him that if we would like a report on German technical developments, all we need do was to alter the preamble on our German news broadcast on a certain evening, so as to say, "Hullo, hier ist London," instead of whatever we usually said. The writer would then know that we wanted the information and would send it to us.

We duly altered the preamble, and the information arrived. It told us that the Germans had two kinds of radar equipment, that large rockets were being developed, that there was an important experimental establishment at Peenemunde, and that rocket-driven glider bombs were being tried there. There was also other information-so much of it in fact that many people argued that it must have been a plant by the Germans, because no man could possibly have known of all the developments that the report described. But as the war progressed and one development after another actually appeared, it was obvious that the report was largely correct; and in the few dull moments of the war I used to look up the Oslo report to see what should be coming along next.[2]

That was at the beginning of November, 1939. A month later I drew up my first report on the organisation of scientific intelligence. I was subsequently to write several more, but they were rarely accepted. I asked then, as I have asked since, for a single scientific intelligence organisation working on behalf of the defence system as a whole. One reason for this is that many weapons are of interest to at least two services. A single scientific intelligence organisation, moreover, could probably have functioned with less staff than three separate organisations-an important consideration in a country where scientists are scarce, as they were in ours during the war. A further reason was that, for reasons which I shall explain later, I believe that scientific intelligence requires a single head to direct it.

But the importance of scientific intelligence was not yet generally

appreciated, and not merely did I fail to get an inter-service organisation, I failed to get any help at all, even a secretary. For myself, I had no doubt regarding the importance of the work. It seemed obvious to me that while scientific intelligence could not by itself contribute more than a fraction towards winning a war, a failure of scientific intelligence to detect the development of a new hostile weapon in time might well result in national disaster. This at all times was a somewhat terrifying thought, but it left no doubt about scientific intelligence being worth while. And while I even had to plead with my Director on several occasions to be allowed not to abandon scientific intelligence during the "phoney war" period, my own conviction regarding its value remained firm.

I conceived scientific intelligence, with its constant vigil for new applications of science to warfare by the enemy, as the, first watchdog of national defence; and to be a good watchdog it is not sufficient to detect the approach of danger-you must bark at the right time: not too early, for then your master becomes dulled to danger by too much barking, nor too late, for he may then be overtaken by disaster; and you must not bark at false alarms.

My failure to obtain help in the early days had one interesting result, the significance of which I hardly realized at the time, although it coincided with the philosophy that I was already building up. To explain its nature I must first describe how an intelligence organisation works.

# Functions and Organisation

An intelligence organisation-despite the Encyclopaedia Britannica dig about there being three kinds of intelligence, human, animal, and military-resembles in fact a human head very closely. The sources of intelligence correspond to the sense organs of the head; the detailed resemblance here is in some cases remarkable, with photographic reconnaissance as the eyes and the radio listening service as the ears. The senses pass observations to the brain, where they are correlated, and a particular sound is associated with a particular visual object. In intelligence; information from the sources is likewise fed to a collating centre, corresponding to the brain; and just as the brain, to be

successful, must have a good memory, an intelligence organisation must have a good memory built up of the individual memories of its staff and its filed records.

So far no machine has been found to perform these functions nearly so well as a good human mind, and the design of an intelligence organisation must be such as to make it resemble a single perfect human mind as closely as possible. It follows from this that the most successful intelligence organisation is likely to be that which employs the smallest number of individual minds each of the greatest possible ability. For only then can you get those vital correlations of, say, a shadow on an air photograph with a fragment of a decoded intercept, or with a report or a sketch from a secret agent.

It has for a long time been appreciated that there are two functions of an intelligence system, known as the "collection" and "collation" of information. These cover the functions of the human head as I have so far described them. They present an enormous difficulty in organisation in that, whereas information enters the intelligence machine by source, it has to leave it by subject: it is this changeover inside the machine that causes all the difficulty. In practice there are many subtle cases which almost defy classification as peculiarly collection or collation functions. It is not surprising that in an organisation which has to be expanded rapidly in wartime considerable confusion results.

Now for me, this problem did not immediately arise. Since there was only one of me to do everything, I could not split myself into two separate halves. Orthodox intelligence in this country is, however, fairly rigorously split, with service intelligence branches doing the collation duties and interservice sections doing the collection of information. This division of duties has drawbacks; notably there is insufficient contact between the service users of the information and the actual sources of that information, and also there is no direct responsibility on any one organisation to develop new sources. The collators cannot do it, because it is not within their terms of reference, while each collection organisation can only deal with the kind of source for which it was originally set up, Now I, with my enforced duty as maid-of-all-work, was unfettered by any of these restrictions; and I found it of such benefit to break through them that I framed my later organisation to take advantage of this fact.

Before proceeding with the narrative, I should like to say one thing more

about the functions of an intelligence system, the importance of which, unlike collection and collation, was not generally realized. With perfect collection and collation you may succeed in building up an accurate picture of what the enemy is going to do. But the test of good intelligence service in war is not merely that you were right; it is that you persuaded an operational or research star to take the correct countermeasures. To do this it is necessary first to build up a reputation for accuracy and timeliness, so that from experience they find that they can trust your pronouncements. And, as I said before, it is not good enough to bark at the slightest approach of danger, you must first learn enough about that danger to be able to tell the operational staff what it is, so that they can take definite action. Otherwise you merely distract them with something that may not materialize. I have seen operational reaction to a new enemy weapon entirely vitiated because the intelligence section concerned barked too early. On the other hand, if you are certain that you have correctly ascertained the nature of the danger you must spare no effort to ensure that the operational staff fully appreciates what is about to happen.

If you pursue the policy I have described you will undoubtedly from time to time make yourself unpopular. You will at times be accused of hoarding information, and at other times you will be called an alarmist and will be told that you have no business interfering with operational policy. But in the end you will be justified by events.

# Radio Beams

I may seem to have wandered a long way from my narrative, but most of these thoughts were growing in my mind during the "phoney war" period. I had already decided that, my first attempt at an organisation having been rejected, I would go on alone to see whether I could prove my beliefs by practical demonstration. That demonstration came even sooner than I had expected.

In June, 1940, I received the culminating information on a trail that I had been following for some months, which led me to the conclusion that Germans had developed a radio beam system for blind bombing known as Knickebein.[3] They had taken care to disguise the receiver in their

aircraft as being designed for blind landing, but we managed to unmask its true purpose. The importance of this development was great. The evacuation from Dunkirk had just occurred, our air defences, while excellent by day, were almost impotent by night, and the whole of the German bomber force could come over then and drop most of its bombs into the area of intersection of the beams, which were little more than half a mile wide over London. Thanks to the ready appreciation of Lord Cherwell and Mr. Churchill, who had recently become Prime Minister, steps were immediately taken to check whether I was right; and on the night of 21st June, 1940, a Royal Air Force search aircraft went up and detected the beams on the expected frequencies and in the expected place.

Even before we had finally found the beams we were starting countermeasures to jam them; this was the beginning of the radio war. When the beams came into serious use at the beginning of the night Blitz,[4] there were enough jammers to upset them, and many bombs intended for such a large target as London fell in open country. There is a story that during this period, which lasted over two months, nobody had the courage to tell Goering that his beams were jammed; for he had said, after his defeat by day, that he would change to night attack by means of the beams, which were unj amenable. The chase of Knickebein was the best fun I had ever hadbut it had its frights. It was here that I learned for the first time the danger of expert opinion in intelligence. For the same facts as I had had about Knickebein were also given to a scientist outside intelligence who was an acknowledged authority on the propagation of radio waves. He said that my solution of the problem must be wrong because it was impossible to make a shortwave beam which would bend sufficiently round the curve of the earth from Germany to enable it to be heard in a bomber over England. He proposed an alternative solution which was obviously unfeasible on the intelligence evidence, but which nearly led to the cancellation of the vital flight that confirmed my solution. It was only the fact of Mr. Churchill's personal order that finally forced the search to continue.

Our own experts proved so repeatedly wrong in their opinions about new German weapons throughout the war, despite the fact that in their own fields they more often than not proved superior to their German counterparts (and that is one of the reasons why we won the war) that there must have been some underlying factor in their errors. In mentioning this I have no desire to demonstrate that I was better at my own job than the experts who often tried to do it for me, except in so far

as it may make the path of my successors in scientific intelligence easier. What was not realized is that the expert in this country on a particular scientific development is not the best man to interpret the information received from intelligence sources. He is, in fact, not a collator-he is a source. He is that source who spies on the laws of nature in so far as they affect the weapon under consideration.

He is a valuable source, for the laws of nature acknowledge no political frontiers. But he is human and fallible, as are all sources of intelligence. If therefore his opinion conflicts with the intelligence picture as built up from the evidence of the other sources, it is certainly a case for going over this evidence again. And if it still appears reasonably conclusive, then you must go back and query the expert's evidence just as you have queried the other sources. For this reason, which the expert can rarely appreciate, the final word must not be with him: it must be with independent scientists well versed in the art of intelligence. It is on this argument that the case for an independent scientific intelligence organisation largely rests. All my experience in the war convinces me that it is sound.

Returning to the Blitz, we had a hard fight with the beams during the last two months of 1940, after the Germans realized the fact that Knickebein was jammed. The cause of the trouble was a new beam system of even greater accuracy, employing an equipment with the intriguing title of "X Apparatus." We soon found what the X Apparatus was, and how it worked.[5] It was used by only one formation, Kampfgruppe 100, which was intended to do precision bombing. But although we had discovered the correct frequencies on which to jam it, an unfortunate technical error rendered our jamming ineffective until almost the end of the year. In the meantime, the Germans switched Kampfgruppe 100 to dropping incendiaries and so marking the target for the rest of the deKnickebeined Luftwaffe. This was the beginning of pathfinding, which was later adopted also by Bomber Command. Coventry was the first target attacked by the new method, which caused a good deal of destruction until finally countered in January, 1941.[7] There persists a story, to which the British are extremely sensitive, that Coventry was not a deliberate German target but was mistakenly...

Then with X Apparatus now out of action the Germans tried their next trick with "Y Apparatus." This time, however, we were particularly successful, because we had it entirely worked out in advance. This was partly due to one or two lucky guesses, and partly to the Oslo report,

which I had decided to trust. Whereas the X system had depended on setting up crossing beams in the target area, the Y system used only one beam, down which the bomber flew. By a special new radio method its range along the beam from the transmitting station was found,[8] and when the bomber had reached the correct distance it was told to drop its bombs. What the Oslo report told us was that the Germans were experimenting with such a method of range-finding (curiously, the Oslo report had made no mention whatever of beams), and I guessed that the Y Apparatus would use this system. As a result we had several months' warning of what was coming, and on the very first occasion on which the Germans decided to rely on the Apparatus for pathfinding they found it jammed. Thereafter they were largely restricted to coastal targets where they did not need any beams, and the main danger was temporarily over.

All this had demonstrated what scientific intelligence could do-at least for the Air Staff; and I was permitted to have some assistance. The main reason for my first helper was simply that at one time a good deal of the information had to be carried in my head, and I might well have got knocked out in the Blitz. Not that I ever wanted a large staff. For the reasons that I have already indicated, I believe that intelligence is best done by a minimum number of men of the greatest possible ability; and the staff that I gradually acquired certainly conformed to both these requirements. There were never very many of us, and we proceeded, as I had started, by running both the collection and the collation in one section.

# Night Defence Radar

With the end of the Blitz we were able to turn our attention more to offensive intelligence; by this I mean the production of information concerning the enemy defences for the benefit of our own offensive. It proved a more difficult task, for in the Blitz we had had a steady stream of prisoners, equipment, and documents from crashed aircraft which would almost always, sooner or later, put us on the right track. In offensive intelligence, however, all these sources were denied to us; and as an item of intelligence I have had more regard for the work that we did in this direction than for that against the beams, although in many

ways the latter was more dramatic.

In turning to the offensive I had to decide where our limited effort could produce the greatest result. The decision did not take long. I knew that most of our own scientific effort was at that time going into radar development, and I knew also that our night defences depended very largely upon radar aids. As our bomber offensive, to which we were now committed, grew, it seemed very probable that the Germans would come to depend, as we had done, upon radar. In trying to find out about their radar we were therefore conducting a basic intelligence assault upon the German defence system.

As a limited objective, having regard to the slender means of intelligence at our disposal, we directed our main effort first against the chain of German radar stations on the Channel coast, for these were within range of our photographic reconnaissance aircraft, and also they might be picked up by radio while they were transmitting. This twin thrust achieved both results almost simultaneously, for the Photographic Reconnaissance Unit obtained the first low oblique of a German radar station almost at the same time as one of our officers first heard its transmissions in February, 1941. Having found the first one, it was much easier to find similar stations, and as the year progressed we gradually built up our knowledge of the coastal chain.

The coastal chain was not of course the main belt of German night defences; these had still to be detected. But this detection was going to be a good deal easier now that we knew the characteristics of at least one type of German radar equipment. We could then plan a wider effort. We could listen to the radiotelephony conversations of the German nightfighters, which were now beginning to appear on a serious scale. We could analyse this traffic, although it was naturally as disguised by code language as the Germans could make it, and see whether we could deduce anything about the methods of control which the Germans were using. We could also take bearings on the transmitters and so find the position of the night-fighter areas. As many of these were in occupied territory, we could then brief friendly agents in that territory to look for radar stations similar to those on the coast; and then from the pinpoints given us by the agents we could once again send out our photographic aircraft to obtain pictures, and special aircraft to listen for the radar transmissions. All our available sources could thus be swung into one big operation.

It is in the planning of operations such as this one that I believe we made our biggest advance. That they were possible is largely due to the new kinds of sources that were available to us and which we developed ourselves as the war proceeded. Given any new problem, we would survey our existing sources and see how they could be brought into the attack on it and what new sources could be developed specially for this attack. New weapons often inspired new sources; radar, for example, almost automatically invited the search aircraft equipped with a battery of listening receivers, and this soon developed into a regular source.[9]

# Some Collection Operations

The Bruneval raid was one of the thrusts in the intelligence assault on the German night defences. The Germans themselves afterwards called it "a violent technical reconnaissance by the English.[10] It depended on a photograph, and this is the story behind it. After a chase extending literally from the Black Sea to the English Channel, one of my staff found a small speck on a photograph, so small that we had to examine several photographs to prove that it was not a speck of dust. We had found this speck by a process of deduction. We knew that the Germans had a new kind of radar equipment known as the Wurzburg apparatus, and we suspected that this would be used in some form for controlling night-fighters. We also guessed that it might be small-too small to be found without some external help on air photographs. Nevertheless, it was a good bet that the Germans would put it alongside some of the larger equipment that we had already discovered, and we therefore searched all photographs showing the larger equipment to see whether there were any likely specks. We ultimately found the one near Bruneval.

The next stage was to get it photographed. But before we had time to put in an official request, our suspicions came to the notice of a photographic pilot-Squadron Leader Tony Hill, who promptly took off unofficially to have a look at it. He came back with the exciting news that it looked like what we had expected-a large electric bowl-fire; but his camera had failed to work. He was about to take off again the next day, again unofficially, when he was stopped because three aircraft from a rival squadron were officially scheduled to be taking photographs in the same area at the same time. He thereupon taxied his aircraft over to

the others and told them that if he found any of them within twenty miles of the target he would shoot them down. He went out and got his photographs unmolested. They were among the classics of the war, and they led directly to the Bruneval raid.

Tony Hill subsequently took nearly all the most dangerous obliques of the radar stations that we wanted, and we owed him a very great debt for his skill, courage and enterprise. Low oblique photography did not come easily to him; in fact he was originally rather slower than average, but by hours and hours of determined practice he made himself the greatest low oblique photographer of the war. It is one of the tragedies of intelligence that good work by its sources can rarely be publicly recognised, but none of these unnamed sources would, I am sure, begrudge Tony Hill this recognition. He died in a German hospital of wounds received while photographing Le Creusot on Trafalgar Day, 1942; it was a sortie so dangerous that he, as squadron commander, would allow none of his pilots to do it.

With Tony Hill there were many other fine pilots in the Photographic Reconnaissance Unit, many of whom did magnificent work for us. Facts are always better testimonials than adjectives, and I know ob no more remarkable contrast in the whole war than the fact that the Germans did not achieve a single photographic reconnaissance of London, only 50 miles inside our coastline, from 10th January, 1941, to 10th September, 1944, while our photographic pilots brought us back pictures consistently not only from Berlin but also, on occasions when we asked for them, from Poland and from Bruster Ort near Konigsberg, where the Germans thought that they were secure in doing their flying bomb training. That is a true testimony to the skill and courage of our pilots and to the excellence of their aircraft; it is also a testimony to Fighter Command.

The success of the Bruneval raid finally depended on a RAF radio mechanic-Flight Sergeant C. W. H. Cox, who had never previously been out of England, on the sea or in the air, but who volunteered for this dangerous operation and, after a short training, parachuted at Bruneval. In my final briefing to him I warned him of the danger of his being specially interrogated if taken prisoner, and above all to be careful of any German officer who was unexpectedly kind to him. He stood to attention, smiled, and said: "I can stand a lot of kindness, Sir." I am sure that it was only his coolness and skill in dismantling the Wurzburg apparatus, which he had never before seen, in the dark and under fire,

that made the Bruneval raid the outstanding success that it was. I mention this fact specifically, because a recent film, "School for Secrets," at least implies that it was all due to civilian scientists. It is true that a civilian scientist did go (and several others volunteered to go) on the seaborne part of the raid, but none of us would like to steal the credit for the Flight Sergeant's splendid performance.

While the Bruneval raid was spectacular, the work of some of our secret agents, notably the Belgians, was equally effective. Fired at by German sentries and unable to know whether their information was getting through or what we were doing with it, they nevertheless sent us information in enormous quantity. Of all the many gallant stories I can only select one about an agent whom I had asked to pinpoint some German searchlights for us. Instead of laboriously going round the countryside finding them, he broke into the hut of the German officer commanding searchlights over literally half of Belgium and secured his map showing the positions of every searchlight and radar station under his command. That was an enormous help. In fact it provided one of the most vital clues in the entire intelligence picture.

One more story. Towards the end of 1942, it became clear that the Germans were at last putting radar equipment into large numbers of their night-fighters. There were one or two facts concerning the actual transmissions from this equipment that we needed to confirm. Accordingly one of our special search aircraft was asked to trail its coat in front of a German night-fighter to see whether it could hear the transmission. It succeeded almost too well; it was attacked 11 times by a night-fighter and nearly all the crew were wounded. The operator on the listening receiver, Flying Officer Jordan, was hit in the head by a cannon shell, but continued to listen and to warn the pilot of the successive approaches of the night-fighter. Our aircraft then limped home. The crew pushed their most wounded member out by parachute over Canterbury with the vital log of observations, in case they should crash on landing. They then took their aircraft out over the coast again and came down in the sea, as it was in too bad condition to land. Fortunately they were all saved.

# Countermeasures

These stories are just a few of many that happened in the course of that offensive effort which culminated at the end of 1942 in a complete knowledge of the German defence system as it was. It was a very great privilege to have developed that effort with such a great company of sources. From then on, we could say exactly what countermeasures were required, and as the German system changed as a result of these countermeasures, we were always able to follow and at times to anticipate it. Once we had found the scientific principles and technical details employed in the equipment of the German night defences, all the other Intelligence, such as order of battle, deployment, and so forth, fell into place; and we were given the final responsibility for fitting it all together. This is one of the reasons for the importance of scientific intelligence, because the scientific principles and technical details underlying a particular kind of equipment determine its tactical limitations, and these in turn determine its strategic application. Once you have discovered the scientific principles of the enemy's equipment, it is therefore natural that the way he employs it, i.e., his tactics and strategy, can then be understood.

The path of intelligence, as usual, was not smooth. There were always people to challenge our interpretation of the evidence and to deny the danger of the German night-fighters. So serious did the situation become at times, when it appeared that only we in scientific intelligence could see the need of particular countermeasures, that I sometimes had to make vigorous appeals for countermeasures to be employed. It is a fact, for example, that Lord Portal of Hungerford, as Chief of the Air Staff, took me with him to the Prime Minister when the Air Ministry made its final fight to use "Window" in 1943.[11] We had, of course, been fighting to have it used for at least six months before, because we could clearly see the mounting powers of the German night-fighters; but we had a little difficulty in persuading Bomber Command that their losses were not mainly due to flak. And we had, moreover, found in December, 1942,[12] that the Germans knew about Window but were frightened to use it themselves, so that there was no case against our using it for fear of teaching the Germans about it.[13]

There were several reasons why I felt strongly about countermeasures. The first, of course, was that I did not want to see our bomber crews lost. It would have been invidious to avoid disfavour by acquiescing in the non-employment of Window when such an issue was at stake. A second reason was that I had a duty to the sources who had risked so

much to enable me to build up the picture of the German night defences. I was not going to see their work wasted by inaction. There is nothing more demoralising to a source than to see no action as the result of his work. On the other hand, to see direct action is often the only reward he can receive; but it is the best of all.

On the whole, our orthodox intelligence system has not realized this, its most important duty to its sources. I attribute this fact to the rigorous split between collectors and collators. It is the latter who have to present the intelligence case to the operational staff and, as they never have personal contact with the sources, they have not such a lively appreciation of their responsibilities in this direction. I think that this is one of the greatest drawbacks of our orthodox system; I never allowed it to occur in mine. To keep faith with his sources should be one of the first rules of an intelligence officer.

# The Long-Range Rocket

Fortunately for chronological accuracy, the back of the night defence problem was largely broken just as a new threat appeared. This was the long-range rocket. The intelligence story behind this might have been perfectly normal, because the rocket problem could have been solved, as finally it had to be, by the application of what were now becoming our standard methods of attack. But unfortunately another intelligence section, while correctly interpreting the early intelligence reports as indicating a long-range rocket, nevertheless caused unending trouble by barking too soon. As a result, an alarm was raised and it was widely believed in May, 1943, that London would within a few weeks be attacked by rockets weighing 80 tons with a 10-ton warhead. We, having the same facts, had raised no alarm at all, beyond telling a few senior officers that we were after the rocket at Peenemiinde, because we did not know enough, and certainly nobody else knew enough to take any countermeasures. The thing to do was not to raise an alarm but to seek fresh facts-a phrase which might well be incorporated into the intelligence officer's creed.

Once again we planned our attack on the new intelligence target, and we were delighted with the results, for by a very long shot we got right

into the heart of German long-range weapon development.[14] It is very doubtful whether we could possibly have taken such a long shot without our previous experience with the beams and the night defences. This incident convinced me more than anything in the whole war of the value of experience in intelligence.

But long shots take a long time to hit the target, and in the meantime we had to proceed by more direct means. Peenemunde was photographed from the air and secret agents were insinuated into the army of foreign workers at that place. One of the photographs showed what was unquestionably a large rocket, and this almost clinched the evidence. But since some of our own experts had hitherto thought such a large rocket impracticable, they argued that it was a hoax to distract our attention from more important developments.

Now if it were a hoax, and it succeeded, we should probably be led to bomb Peenemunde; the Germans would presumably only tempt us to do this if Peenemunde were not a genuine, serious experimental station. I finally managed to show that this was extremely unlikely from an apparently insignificant piece of evidence gathered in quite another field. This was a circular to various German Air Force experimental stations, signed by a petty clerk in the German Air Ministry, giving revised instructions for applying for petrol coupons. Now all the experimental stations were on the list of addresses, apparently in order of importance, and Peenemunde was shown on the list above some other stations of whose importance we were certain. The clerk, who could hardly have known that his little circular would come into our hands, was in fact an unconscious witness to the importance of Peenemunde. The petrol instructions, to my mind, finished the case. They showed that Peenemunde was as genuine as our own Farnborough, and whatever hard things may have been said about the latter establishment, few of us would actually have liked to see it bombed.

Following the intelligence build-up, Peenemunde was attacked by Bomber Command on the night of 17th August, 1943. I see from Air Chief Marshal Sir Arthur Harris's book, "Bomber Offensive," that there has been some controversy about the effect of this raid. Here are the facts. We killed their chief jet designer and we burned up all the production drawings for the large rocket just as they had been completed for issue to industry. The Germans, worried by the damage that we had done to their experimental factory at Peenemunde (and at Friedrichshafen,

which had already been bombed on our advice) decided to put their rocket production underground and to move their experimental work to Poland. The culminating effect of all this must have meant several valuable months delay: but for this the rocket might well have preceded the flying bomb. We should have been subjected to a longer attack at shorter range (the rockets were never fired, as intended, from France), and our defences would have been worried by two kinds of attack at the same time. There can be no doubt that the Peenemunde raid was worth while.

## The Flying Bomb

While we were investigating long-range missile development we found the flying bomb also being tried out at Peenemunde in competition with the rocket; it was a much more recent project, but was making rapid progress. Fortunately we obtained all the details of its performance before Christmas, 1943, and Bomber Command could take all the necessary neutralising action against the launching sites. We had sufficient detail to design fighter and A.A. defences, with the Americans specially making us some new predictors and fuses. The Americans told me that it was only possible to design these through the most detailed knowledge of the flying bomb's intended performance, and even with seven or eight months' warning they were barely ready in time, so great were the difficulties involved. But before the campaign ended they produced remarkable results. [15]

## The Normandy Invasion

Before the flying bomb came into operation we were to have a great deal to do with the return to the continent, or as I preferred to call it, the reopening of the First Front. We had been looking forward to it for some time, our anticipation taking the form of hunting out all German radar stations, because we believed that it would be necessary to put them out of action before a successful landing. This locating of German radar

stations was one of our hobbies, and in all Germanoccupied Europe we found about 740 of them, leaving not more than six to be discovered by our ground forces. Between Dunkirk and Guernsey-the invasion area-there were 120 pieces of major equipment; we found them all.

Our belief that it was important to put these stations out of action did not appear to be shared by the invasion planning staff until very shortly before D-Day. Fortunately, when the decision to attack them was finally made, we had the necessary target dossier ready; it could not have been ready had we waited for a directive from the operational staff. This was just another case where intelligence had to anticipate operational needs. Considering the haste with which the operation was undertaken, its success was remarkable, and due mainly to the skill and courage of the rocket Typhoons of Nos. 20 and 22 sectors, whose accuracy in delivering attacks against such small targets was amazing. Barely more than 10 per cent of the stations were able to operate as D-Day broke, and these were so shaken that they fell easily for a spoof diversion to make the Germans think that we were landing east of the Seine. It has rarely been mentioned, if ever, that all this effort was entirely British.

On D-Day plus 7, as we had anticipated, the Germans launched the delayed and much reduced flying bomb attack. Once again, knowing the nature of the weapon, we were able to fix its likely line of production and supply. This led us to the Volkswagen works at Fallersleben, which was knocked out by the American Army Air Force; it also led us to the main supply depots in France. These were mushroom caves, mainly in the Oise valley. They were attacked by Bomber Command and the Americans; in one attack alone 298 flying bombs were irretrievably buried. During this period I was asked to take over all the intelligence concerning Hitler's retaliation campaign, mainly because it was temporarily realized that, once you had the technical details of the weapon worked out, everything else was easy.

The rocket followed the flying bomb in September, 1944, but not before we had its performance completely evaluated; in no point, technical or logistic, were we more than 10 per cent out, and generally very much closer. We were rather pleased with this because, as opposed to our own rocket experts' estimate of 80 tons total weight with a 10-ton warhead, we had predicted 12 tons with a 1-ton warhead. We were not believed, but events soon proved our figures. That is one of the satisfactory things about intelligence in war; you soon know whether you or your critics are right.

# The Atomic Bomb

The atomic bomb was an interesting intelligence problem. In this we had to prove a negative case, one of the most difficult of intelligence exercises, for you have to make such a thorough search before you can confidently say that the enemy is doing nothing. True, we found the Germans doing something early on, which caused us to knock out the Norwegian heavy water production. This, in fact, as one of their experts told me, prevented them from doing the vital experiment which might have convinced them that the atomic bomb was possible. As it was, they decided that the bomb was not practicable and so finally did little about it.

# L'Envoi

By way of epilogue, I should like publicly to thank my sources. There were thousands of them: secret agents at Peenemtinde, in the German night-fighter control rooms, and on the flying bomb sites; photographic reconnaissance pilots travelling thousands of miles alone above Germany or diving down for a perilous oblique; girls in remote huts listening to German night-fighter radiotelephony; photographic interpreters ruining their eyesight through poring over photographs; aircrews in radio reconnaissance aircraft patrolling alone in the German night-fighter belt; technical officers sieving the earth around crashed German bombers trying to find the vital clue and trying to read the burnt documents; and many others. I, as their mouthpiece, had the limelight, but without them I could have done nothing. It is, as I said before, one of the tragedies that few of them get recognised, but we owe them much.

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1 First published in the Journal of the Royal United Services Institution, August 1947, pp. 352-60. This minimally edited version is annotated by T.

M. Odarenko, who worked in liaison with Dr. Jones during the war.

2 It may be possible in a future issue to tell the story behind this anonymous report.

3 Early in the year there had been obtained a German document that referred to a radio navigation system for blind bombing. In March German prisoners began to refer to the Knickebein-"Bentleg"-system by name. Dr. Jones' "culminating information" in June was an intercepted operational message which indicated that Fliegerkorps IV was equipped to use the Knickebein. Since the Fliegerkorps IV bombers were all HE III's, whose radio instrumentation was known, it could be concluded that the Knickebein beams were transmitted in the frequency range 28-35 megacycles.

4 23 August 1940.

5 The X-Gerat consisted of a guiding beam laid over the target and transverse beams laid across it sufficiently in advance of the target to permit the bombardier to work out automatically the correct bomb release point.

6 Incorrect measurements of the modulating frequency in intercepts of the beam. The error was discovered only after careful analytic work on the radio equipment of a Kampfgruppe 100 plane that crashed in England late in November.

7 There persists a story, to which the British are extremely sensitive, that Coventry was not a deliberate German target but was mistakenly marked as one by a Kqmpfgruppe 100 pathfinder who was confused by antibeam measures and thought himself over London.

8 In the Y-Gerat -a transponder/delay box in the aircraft retransmitted signals sent out by the ranging station on the ground. Range along the beam was determined by the time lag between original transmission and receipt of the response.

9 These "new kinds of sources" grew ultimately into what is known in the UK as "technical search" and in the United States as Elint.

10 We hope in a future issue to present the full story, from the scientific and technical officer's viewpoint, of this raid, a spectacular commando-type operation mounted solely to obtain a sample transmitter from a

new German flak-control radar. Its success contributed greatly to knowledge of the German night defenses.

11 "Window," a code name at the time, is still used as a generic term for decoy devices which produce false signals to confuse the radar operator and in particular for reflective chaff dropped for this purpose from an aircraft. After Churchill's favorable decision terminated the long and heated controversy over whether it should be used, it was so successful, in the Hamburg raid of 24-25 July 1943, that the Germans thereafter referred to the chaff as "Hamburg bodies."

12 Through an intercepted message.

13 The Germans were nervous about using it (they called it "Duppel") because they had conducted no large-scale operational trials and because they felt that in a Window war they would lose more than they would gain. After the Hamburg raid, however, they followed suit, and metallized paper dropped from their aircraft to jam radar stations in the UK on the night of 7/8 October 1943 caused considerable confusion and excitement. They made several other raids with Window that fall, concerning which the official British view was that it "was not seriously detrimental to the defence because it was not dropped in sufficient quantity, nor had the dropping technique been properly developed." But the following year, during the heaviest attack (28/29 January) of the "Little Blitz," the accompanying Window had a serious effect on the British GCI radar, and throughout the January-June period of the Little Blitz the defense felt its effects.

14 We have no information on the nature of this "long shot." It may be possible in a future issue to present the history of intelligence on the V-weapons in greater detail than Dr. Jones does here.

15 Two U.S. radars were used in the UK against the flying bombs. One was the Microwave Early Warning Set, which was particularly suitable for the purpose because of its high power (and therefore long range), high discrimination, and multicontrol facilities. It served not only for early warning, but also, in conjunction with a computer or "predictor," for fighter direction. Between 29 June and the end of August 1944, 142 flying bombs were destroyed by aircraft under its direction. The other U.S. device heavily involved in the anti-flying-bomb operation was SCR-584, a gun-laying radar, available at all important AA batteries in the UK. This automatictracking radar was associated with a computer which

integrated the radar data with other pertinent data on the AA guns, weather, etc., and provided the control or "prediction" data for the firing of the gun. SCR-584-equipped AA batteries brought down some 85 percent of all V-1's they engaged.



Posted: May 08, 2007 07:44 AM