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**Item Description:** This is a draft manuscript of a lengthy report compiled by the RAF Bomber Command Operational Research Section, probably some time in 1945. The report was authored by Dr. Basil Dickins, a rising star in the field of physics who served as Section head during the war. Using a thematic approach it explores in excellent detail the challenges inherent in strategic bombing, making it a valuable source for both historians of air power and those studying Europe in the Second World War.

**Keywords:** Bomber Command; Operational Research; Operations; Technique; Bombing; Navigation

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R E S T R I C T E D

CHAPTER 1

ESTABLISHMENT AND GROWTH OF BOMBER COMMAND O.R.S.

Early Research in Bomber Command

The first scientific analysis of Bomber Command's operations in World War II was carried out in July 1940 by Mr. A.E. Woodward-Nutt of the department of the Director of Scientific Research, Ministry of Aircraft Production (M.A.P.) following a recommendation of the Committee for the Scientific Survey of Air Warfare. This investigation was directed towards the determination of the causes of bomber losses and a critical examination of the phenomena reported by aircrew during operations. It was hoped that the study would lead to suggestions for reducing our losses, while at the same time providing information which might be of help to our own fighter defences. This survey which was published under the title 'Interception of British Bombers at Night (May-June 1940)' was the first of its kind concerning Bomber Command's operations and was most valuable in presenting all the ascertainable facts; it was decided that a continuous review should be made on the same lines and from August 1940 Dr. B.G. Dickins of the Director of Scientific Research's department paid regular visits to Bomber Command for the purpose. These analyses were issued monthly in a series of reports entitled 'Phenomena connected with Enemy Night Tactics', and later called 'Report on Losses and Interceptions of Bomber Command aircraft' which was continued until the end of the war. The reports constitute a complete record of statistics relating to the interceptions and losses sustained by our bombers together with various conclusions which it was possible to draw from time to time.

The early reports in this series revealed certain facts regarding the efficiency of the bomber's armament which required further detailed study and the Command Armament Officer approached the Director of Scientific Research for the permanent attachment of a scientific officer for more detailed analysis of the problem. As a result of this request, Miss K.M.M. Goggin was posted to Bomber Command in August 1941.

In the meantime, consideration was being given to the provision of radar aids to Bomber Command and although it was to be many months before any equipment became available, <sup>Mr (later</sup> Sir Robert) Watson-Watt, the Scientific Adviser on Telecommunications to the Air Ministry, felt the need for a liason officer in the Command to represent him in the day-to-day deliberations which were going on and to study the operational problems involved. The desirability of such an officer was agreed by the Commander-in-Chief and in April 1941 Professor A.O. Rankine was appointed 'Radio Operational Research Officer'. He was succeeded in July 1941 by Mr. G.A. Roberts of the Telecommunications Research Establishment, who had previously been working in the Stanmore Research Section, Fighter Command. Apart from being concerned with future

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equipments, numerous other 'Signals' problems, in particular the reputed effect of I.P.F. (Identification Friend from Foe) on enemy searchlights, arose and Mr. J.A. Jukes and Miss H. Lang Brown were posted to Bomber Command to assist the Radio Operational Research Officer.

Formation of the Operational Research Section

The value of the work of the scientists attached to Fighter and Coastal Commands had been so amply demonstrated that in mid-1941 the Air Ministry gave consideration to the extension and rationalisation of the scheme. Previously the operational researchers were, with a few notable exceptions, members of the Telecommunications Research Establishment who were merely attached to the Command in which they served. The change agreed upon was to bring operational research more directly under the control of the Air Ministry, while making the groups of scientists now designated 'Operational Research Sections' directly responsible to the Commander-in-Chief of the Command concerned. The personnel concerned were transferred to the staff of the Director of Scientific Research, Ministry of Aircraft Production and seconded to the Air Ministry for attachment to the various Commands. While the Sections were completely independent formations, owing allegiance primarily to their Commands, the closest contact with the M.A.P. and its experimental establishments was essential and was maintained. Liaison with M.A.P. was a special concern of the Deputy Director of Scientific Research 3 (Mr. R.S. Capon) and his staff who throughout the war were of the greatest help to O.R.S's both on technical and numerous personnel matters including recruitment of staff which continually arose. Establishment questions which were the concern of the Air Ministry were handled through the Operational Research Centre (later Deputy Directorate of Science) which was set up under the Assistant Chief of Air Staff (Operations). This department also effected a measure of co-ordination between the various Sections and was responsible, inter alia, for the distribution of the reports prepared.

Thus, following a request by the Commander-in-Chief in August 1941, an Operational Research Section was set up in Bomber Command on 1 September 1941. In view of his long standing contact and consequent knowledge of the Command's operations, Dr. B.G. Dickins was appointed Officer-in-Charge, a position he held until after the cessation of hostilities in Europe. The various other scientists already working in the Command were brought in to form the nucleus of the section together with three additional officers provided by the M.A.P.

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Scope of Research

In asking the Air Ministry for the establishment of an O.R.S. the Commander-in-Chief outlined the scope of the researches which he considered should be undertaken. Broadly speaking, these covered the general study of operations with a view to determining how the efficiency of operations in terms of bombs on the target per aircraft lost could be increased. This objective remained the aim of the O.R.S. throughout the war, although in the later stages, following the example set by Coastal Command, it was extended to include research towards reducing the maintenance manpower required to sustain the effort and other related economic factors. At this stage nobody had any firm ideas on the desirable size of the Section. Some plan was, of course, necessary and it was decided to tackle the problems on a broad front. The first distribution of staff duties which was issued on 25 September 1941 was accordingly along the following lines:-

Dr. B.G. Dickins	Officer-in-Charge.
Dr. R.J. Sneed ) Miss K.M.M. Goggin )	Study of bomber losses.
Mr. G.W.H. Stevens	Study of success of bombing operations.
Mr. E.A. Lovell	Study of vulnerability of bombers.
Mr. G.A. Roberts ) Mr. J.A. Jukes )	Study of radar and radio problems.

While the available staff enabled research to get under way, it was abundantly clear from the beginning that a considerable staff would be required if the wide field was to be adequately covered. It was considered, however, that since most of any future staff likely to be obtained would have to be recruited from outside the Government service, the strength would have to be built up slowly. This was inevitable in view of the problems involved in absorbing and training inexperienced staff and was in any case forced on us by difficulties in accommodation. The continual expansion of the O.R.S. coincided with that of the Command and although increases were always anticipated the requirements for office accommodation were usually underestimated. This resulted primarily from the building restrictions imposed on the Command Headquarters as a whole and the long time taken to complete the work. Shortly after the first building had been completed in February 1942, the O.R.S. expansion and that of the Command made it necessary to move part of the staff to accommodation about half a mile away from the main headquarters. This led to considerable inconvenience and loss in efficiency. Plans were made for a new building but it was not until March 1943 that the whole branch came together again. Two extensions to this building were added later, but even so the O.R.S. suffered from over crowding during most of the war; a state of affairs which was not conducive to the best work.

The Establishment

As a result of a preliminary study of the problems requiring investigation it was proposed that the initial establishment of the Section should be:- one principal scientific officer, one senior scientific officer, two scientific officers and six junior scientific officers/~~laboratory~~ assistants grade III, together with a clerical staff of five clerks (General Duty), five clerks (Special Duty) and one tracer. A scientific establishment of 10 officers was approved by the Operational Research Centre in December 1941, and it was also authorised that over the following six months the establishment should be increased to 30 officers (one principal scientific officer, two senior scientific officers, five scientific officers and 22 junior scientific officers/~~laboratory~~ assistants grade III).

By mid-1942 it was realised that the staff agreed on was insufficient to meet the growing commitments of the section, and in September representations were made to the Air Ministry for an increase in establishment to 41 officers (two principal scientific officers, four senior scientific officers, 20 scientific officers/junior scientific officers and 15 ~~laboratory~~ assistants grade II/III). The increase was approved by the Operational Research Committee in October 1942. A further expansion to 51 officers was approved in April 1943, and the maximum of 55 was reached in August of that year. The variation in the strength of the branch is illustrated at Appendix 2 .

Laboratory Assistants

As a result of the growth in the size of the Command, the quantity of data which had to be sifted in any particular investigation became very considerable. The initial establishment of service clerks became in consequence inadequate and in view of the difficulty in obtaining service personnel for the routine extraction and compilation of data, an establishment of 10 civilian laboratory assistant posts was sought and approved in May 1943. Following on the increase in intensity in the Command's operations prior and subsequent to the landings in Europe this establishment was increased to 20 in May 1944. Some of the civilian posts were filled by service clerks but the majority were filled by local recruitment including a number of wives of the officers serving in the headquarters. Many of the laboratory assistants worked only part time, and while this caused some inconvenience, on the whole the scheme worked very well and they made a valuable contribution to the work of the branch. In view of the isolated nature of the headquarters, recruitment of laboratory assistants proved rather difficult and a sufficient number of them was never obtained.

/Clerical Staff

Clerical Staff

In accordance with agreed procedure the clerical assistance to the O.R.S. was provided by Command Headquarters. The initial establishment was five clerks (General Duty), five clerks (Special Duty) and one tracer. This was increased in June 1942 by one in each class and by a further five clerks (Special Duty) in June 1944, who were held against the laboratory assistant establishment. Finally when a number of junior officers were posted overseas in early 1945, the establishment was increased again by one flight sergeant and eight sergeant clerks (Special Duty) in order to replace them. The Service clerks proved very satisfactory on the whole and took a considerable interest and pride in their work. The typists, in particular, were extremely hard working and maintained a very high output throughout the war.

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The Scientific Personnel

Mention has been made of some of the original personnel in the Section and later, reference will be made to officers selected for specific appointments. It is neither practicable nor necessary to give details of the part played by every officer on the strength of the branch. A complete list of officers serving in the branch is, however, given in Appendix I together with the dates of arrival and departure, and an indication of the section to which they were attached. In passing, it must be said, however, that very few of the officers posted to the branch proved unsatisfactory or disliked the work, a state of affairs which was largely due to the care taken by the Ministry of Aircraft Production in selecting the staff.

Organisation of the Section

As explained above, the work of the section was initially divided into four main sections:-

- (a) Study of bomber losses.
- (b) Study of the success of bomber operations.
- (c) Study of vulnerability of bombers.
- (d) Study of radar and radio problems.

A fifth section for the study of day operations was added shortly after the branch was formed. This arrangement enabled the field available for research to be adequately explored and work on the main problems to be started. It soon became clear, however, that the study of radar problems was too closely linked to both the study of the success of bomber operations and that of bomber losses for it to be pursued in a separate section. The branch was accordingly re-organized in early 1942 into three sections in the following manner:-

Officer-in-charge O.R.S.	Dr. B.G. Dickins	Head of Branch.
O.R.S.1	Mr. G.A. Roberts	Research into success of Night Operations.
O.R.S.2	Dr. R.J. Sneed	Research in losses in Night Operations.
O.R.S.3	Mr. H.L. Beards	Research into Day Operations.

This proved a much more satisfactory arrangement, since all matters affecting one aspect of the Command's operations were in a single section. Co-ordination in matters impinging on both losses and successes was, of course, affected through the head of the branch. O.R.S.3 was disbanded in early 1943 when the Command ceased day operations and when these were resumed in mid-1944 the analyses were carried out by O.R.S.1.

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The analyses carried out by O.R.S.2 to determine the cause of bomber losses, the effect of different equipments on the loss rates and numerous other factors necessitated the maintenance of adequate statistics which were not available from normal sources or required by other branches in the Headquarters. The methods adopted are discussed in detail in Chapter 19 of this monograph. It is sufficient to state here that O.R.S.3 was reconstituted as the statistical section in early 1943. This section was run by an assistant (II) and Service clerks. An enormous quantity of essential data relating to each night sortie flown by Bomber Command from March 1944 onwards, was recorded on Hollerith cards.

Miscellaneous Section

As was to be expected, <sup>the</sup> O.R.S. was asked to undertake some functions which did not fit in with the organisation described above, or, alternatively, there were some researches which could be pursued without reference to the main problems. These considerations led to the setting up of O.R.S.4 in mid-1942. Each member of this section had a specific job to carry out and reported direct to the head of the branch. The main items covered were investigations into certain aspects of airfield control, research directed towards the use of air photography in the Command, certain training problems and various routine commitments. The research projects are dealt with in the appropriate parts of this monograph and only brief mention need be made here of the following two main routine commitments.

The Bomber Command Quarterly Review

In January 1942, Coastal Command O.R.S. produced a document called the Coastal Command Review. This was seen by the Commander-in-Chief Bomber Command, who immediately commissioned his O.R.S. to produce a similar publication. The desirability of diverting effort from research for this purpose was undoubtedly questionable, although there was no doubt that such a document would be of considerable value for propaganda purposes and could be a useful medium for bringing out some of the lessons learnt. As no suitable serving officer could be found at the time, the O.R.S. undertook to start it off with a view to handing it over <sup>to</sup> the Service at a later date. It so happened that Mr. B.R. Megaw, an archaeologist, had considerable experience of the right type and he was accordingly appointed editor of the 'Bomber Command Quarterly Review'. The first issue was for the period April-June 1942, and although several efforts were made to hand over the work to the Service, it was not until towards the end of the war that a large proportion of the work was taken over. While many of the articles, were, of course, prepared by other branches of the Headquarters, Mr. Megaw wrote a large part of the twelve volumes which were issued, as well as supervising their preparation and publication.

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It is well recognised that each major operation carried out by Bomber Command was a major battle and no two operations were identical. It was therefore essential for research purposes for each operation to be studied in detail, for conditions of the operation to be adequately recorded, the success achieved assessed and the causes of losses determined. This naturally required considerable effort and took a considerable time. The investigations generally showed that the only report of a raid, excluding the subsequent reconnaissance reports issued by the Central Interpretation Unit, which were restricted to a statement of the damage observed, <sup>and</sup> which was issued by the Intelligence Branch on the basis of pilots reports, did not represent a very accurate statement of results. These reports were ~~unreliable~~ the best that could be produced on the evidence available at their time of issue but a permanent and accurate statement was required. Since the O.R.S. had to collect for research purposes the necessary information they were asked to produce a report on each operation for general issue and record purposes. Accordingly as from February 1942, a series of reports known as the 'Bomber Command Night Raid Report' and 'Bomber Command Day Raid Reports' were issued. To start with, parts of these reports had to be written by various members of O.R.S.1 and O.R.S.2, but ultimately the M.A.P. were able to recruit a non-scientist Mr. M. Meyer, to undertake this work. A total of 838 reports on night operations and 328 on day operations were produced, the majority by Mr. Meyer who really tackled what must have become a very monotonous undertaking with much fortitude. With the increasing intensity of operations and only a laboratory assistant to help him, the task became a Herculean one and at one time he was at least three months in arrears. In February 1945, however, it was possible to call a halt and get the Intelligence Branch to take over this commitment for future raids.

The reports give the only complete picture available of each operation and include all relevant statistics and brief statements of the weather, route, success, damage and other relevant matters. Amplified statements of the damage inflicted are obtainable from the relevant C.I.U. Interpretation report and details of the tactics and interceptions are given in the 'Interceptions and Tactics' Report which was issued by the Intelligence Branch for each operation.

Radar Research

The increasing use of radar aids to navigation and bombing and the great importance of improving the accuracy and operational use of the various devices available to the Command made it necessary to reconsider the desirability of carrying out the general analysis of

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the success of operations and the detailed research into the performance of radar aids in O.R.S.1. Increase in accuracy could be achieved either by improvement in tactical planning or improvement in the performance and use of the equipment available or a combination of both. The tactical planning had reached a high degree of efficiency by mid-1942 and it was considered that a marked increase in the success of operations could only be achieved by increasing the accuracy of the radar devices available. It therefore seemed desirable that the most suitable officer available should devote all his time to this end. This officer was Mr. G.A. Roberts, who was in charge of O.R.S.1, and it was therefore decided to split O.R.S.1 into two parts, one dealing with the general tactical analysis and visual bombing problems and form under Mr. Roberts O.R.S.5 which dealt with navigational and radar research. Dr. B.G. Peters took charge of O.R.S.1. This arrangement proved completely satisfactory.

Manpower Research

While the major effort of the O.R.S. was directed towards improving accuracy and the continual struggle to reduce losses, some attention was paid to what is now known as administrative research. This type of research was started in O.R.S.6, a new section which formed for the purpose under Mr. K.A. Stott.

O.R.S. Detachments

While the great majority of the staff of the O.R.S. worked at Headquarters, paying visits to units for specific purposes as required, certain officers were detached to lower formations on a permanent basis. The first detachment of this kind occurred in 1942 when service trials of Gee were about to be undertaken by the Command. Following suggestions by the O.R.S., No. 1418 Flight was established to develop the operational use of the device and Mr. J.A. Jukes who had put forward some proposals on the subject, ~~was~~ <sup>was</sup> attached to the unit to assist in the execution of the trials and the analysis of the results. Later, when the Bombing Development Unit was re-formed, Mr. Jukes became the permanent O.R.S. representative at the unit. He was succeeded in January 1943 by Mr. <sup>J.K.</sup> Marshall. The value of scientific assistance in the planning execution and analysis of trials at the unit was amply demonstrated and in July 1943 this assistance strengthened by the addition of a more senior officer, Mr. N. Mowatt. Apart from providing general scientific assistance in a large proportion of the trials undertaken, some projects, notably those concerned with the development of Window, were largely the responsibility of the O.R.S. personnel. The experience in this and other Commands amply demonstrated that work at the R.A.F. Development Units should be a permanent feature of the O.R.S. organisation.

Representation .....

Representation at Groups

The analysis and development of target finding technique formed a large part of the functions of the O.R.S. throughout the war, and on the formation of the Pathfinder Force in July 1942 it was clear that while the general analysis would have to continue at Command Headquarters, more rapid analysis would be required at the Group Headquarters if the Pathfinder Force was to fulfil its function of developing target marking techniques. It was therefore felt essential to establish an O.R.S. representative within the group for the purpose of advising the Air Officer Commanding on day-to-day problems, assisting in the quick analysis of each operation and in the development of new techniques. The desirability of this proposal was agreed by the Air Officer Commanding, and in view of his past experience Mr. Jukes was selected for the appointment, which was arranged on a part-time basis until he was relieved of his duties at the Bombing Development Unit in January 1943.

Following a successful O.R.S. investigation into the effect of pilots' experience in the loss rate, the Air Officer Commanding No. 5 Group requested the attachment of an O.R.S. officer to carry out investigations into some of the problems facing the group, and in February 1943 Mr. J. Curry was detached from headquarters for the purpose. Mr. <sup>F.J.</sup> Lloyd was appointed to No. 4 Group in July 1943, Mr. L.F. Lammerton to No. 100 Group on its formation in December 1943, and Mr. A.W. Pratt and Dr. J.W. Hopkins to Nos. 1 and 6 Groups respectively in February 1944. Dr. J. Hopkins was one of the Canadian scientists sent over to this country for operational research duties.

In addition to general group representatives special damage inspectors were established in Nos. 3, 4 and 5 Groups during 1943, since the reports on aircraft damaged by enemy action required for O.R.S. vulnerability investigations could not be rendered in sufficient detail by the engineer officers in view of the pressure of their normal duties. The damage inspectors, <sup>equipped in the first place</sup> equipped with motor cycles and later with cars, toured their allotted stations after each operation and rendered most valuable reports on the damage sustained by the aircraft operating. Their reports formed the basis of the work described in Chapter ~~18~~ 19.

The establishment of group representatives proved a great success and all Air Officers Commanding <sup>spoke</sup> ~~very~~ very highly of the officers selected. The posts were of considerable responsibility and although the gain to the headquarters branch was not as great as was expected, all the officers performed extremely useful functions so far as the groups were concerned. They were undoubtedly over-worked and had staff permitted they would have been given assistants. This would have enabled the liaison with the headquarters branch to have been

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improved. The delay in establishing the posts was unfortunate but could not have been avoided in view of the general shortage of staff and the absolute necessity of providing experienced and first-class men for the posts.

Bomber Command Bombing Research Unit

Shortly after the Allies were successfully established on the Continent, the Bombing Analysis Unit (B.A.U.) was set up in the Allied Expeditionary Air Force to study the effects of the operations carried out in support of the landing. As Bomber Command had taken a large share in this offensive, the Commander-in-Chief Bomber Command directed that members of his O.R.S. should be associated with this Unit. A small party under the Officer-in-Charge O.R.S. went to France with the B.A.U. in August 1944. After working in the Normandy battle area the party became a self-contained team known as the Bomber Command Bombing Research Unit and examined targets in Germany which had been attacked by Bomber Command. An account of its activities will be found in Chapter 7. Mr H.L. Beards and Mr E.A. Lovell were largely responsible for these field investigations.

Administrative Officer

One further specialised duty in the O.R.S. must be mentioned and that is the establishment of the <sup>Section</sup> ~~Branch~~ Administrative Officer. With the ~~Branch~~ <sup>former</sup> assuming a substantial size, the Officer-in-Charge found it essential to have an officer to carry out the normal administrative duties in the branch such as leave, overtime claims, billeting arrangements, accommodation, staff returns, recruitment and payment of laboratory assistants, circulation of incoming reports and distribution of the O.R.S.'s own reports etc. Mr. H.W. Corbett, a school-master who did not possess any scientific qualifications, was selected for this purpose. In addition, he was responsible for maintaining certain routine statistics and records. The Administrative Officer

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the Officer-in-Charge of a great number of troublesome administrative matters as well as acting as his personal Assistant, and there is no question that such an officer is essential to the smooth running of a large branch. When Mr. Corbett left the Section after the cessation of hostilities, his place was taken by a W.A.A.F. Officer. It is doubtful if such an arrangement can be quite so satisfactory as the employment of a civilian.

The Final Organisation

It is now possible to set out the organisation of the Section which was finally adopted and which proved to be quite satisfactory. This is given below and includes the sub-sections into which the branch was divided. Most investigations fell within the subjects named and all required continual study in view of the constantly changing tactical situation.

Officer-in-Charge O.R.S.

Administrative Officer

- |                |   |             |  |
|----------------|---|-------------|--|
| <u>O.R.S.1</u> | Research into Success of Operations.                | O.R.S.1 (a) | General tactical success of operations.    |
|                |   | O.R.S.1 (b) | Bombing accuracy and weapon effectiveness. |
|                |   | O.R.S.1 (c) | Bombing training.                          |
| <u>O.R.S.2</u> | Research into Bomber Losses.                        | O.R.S.2 (a) | Bomber tactics.                            |
|                |   | O.R.S.2 (b) | Radio counter-measures.                    |
|                |   | O.R.S.2 (c) | Aircraft vulnerability.                    |
|                |   | O.R.S.2 (d) | Causes of bomber losses.                   |
| <u>O.R.S.3</u> | Statistical Section                                 |             |  |
| <u>O.R.S.4</u> | General Problems.                                   | O.R.S.4 (a) | Use of night photography.                  |
|                |   | O.R.S.4 (b) | Airfield Control.                          |
|                |   | O.R.S.4 (c) | Bomber Command Review.                     |
|                |   | O.R.S.4 (d) | Night and Day Raid Reports.                |
| <u>O.R.S.5</u> | Research into Radar Aids to Navigation and Bombing. | O.R.S.5 (a) | Use and accuracy of blind bombing aids.    |
|                |   | O.R.S.5 (b) | Use and accuracy of navigational aids.     |
| <u>O.R.S.6</u> | Research into Manpower Economy.                     |             |  |

- Detachments
- (a) Group Representatives Nos. 1, 3, 4, 5, 6, 100 and Pathfinder Force.
  - (b) Bombing Development Unit Representatives.
  - (c) Bomber Command Bombing Research Unit (Field Investigations).
  - (d) Group Damage Inspectors Nos. 1, 3, 4, 5 and 6 Groups).

The Position of the O.R.S. in the Command Organisation

The primary purpose of an operational research section is to make a scientific study of the operations of the Command concerned and to draw conclusions which will assist in improving the efficiency of the operations in progress and will ensure that those planned for the future achieve the maximum effect for the effort expended. With this objective in view it was necessary for the O.R.S. to study such subjects as tactics, use of and requirements for navigational and bombing aids, weapon effectiveness, training and aircraft maintenance etc., all of which were the responsibility of one or other of the Command branches. It was, therefore, essential for the O.R.S. to hold a special place in the Command organisation and to work in the closest collaboration with other branches. It was essential also for the O.R.S. to have access to all information relating to past operations and if the maximum use was to be made of their specialised knowledge for them to be consulted in the early stages of the planning of projected operations.

The importance of these requirements was well appreciated by the two Commanders-in-Chief who commanded Bomber Command during the period considered in this monograph and by Air-Vice-Marshal Sir Robert Saundby (Senior Air Staff Officer and later Deputy Commander-in-Chief). From its inception the Commander-in-Chief and the Deputy Commander-in-Chief gave the O.R.S. their fullest encouragement and did much to facilitate the conduct of its investigations. Frank expressions of opinion and advice offered, even though not previously asked for, were always welcomed. This attitude did much to establish in the eyes of the Command staff the correct position and functions of the O.R.S. Complete confidence in the O.R.S.'s ability to help was not, of course, established overnight but apart from a few minor exceptions the necessary collaboration and recognition was quickly forthcoming. The incursion of the scientist into the field of operations, was, after all, an innovation insofar as most of the service staff was concerned and in a large headquarters opposition in some quarters was to be expected. Most of it was short lived and the remainder removed by postings occurring in the normal course of events.

In the same way, as it was necessary for the serving officer to appreciate the place of the scientist in the functioning of the Command, so it was necessary for the scientist to acclimatise himself. Since the scientists were recruited primarily from outside the Government service, they not only had no experience of operations but no knowledge of either aircraft or equipment. And, although short courses were arranged at both the Royal Aircraft Establishment and the Telecommunications Research Establishment for some members of the staff, the knowledge gained was small compared with that of the Command technical staffs. Thus operational research on the equipment side, which was

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not only more difficult to pursue, was restricted by the limited amount of personnel with the necessary background and experience. The scientists had also to learn what was not practicable for both the aircrew and the bomber force as a whole to carry out and also to appreciate the various operational factors which had to be taken into account before conclusions could be drawn from accumulated statistics. That these lessons were well learned is reflected in the fact that no proposal made by the O.R.S. was ever turned down by the Command on the grounds of impracticability. It is, of course, most important for the scientists to attain the closest contact possible with actual operations and with aircrews. For this reason the Officer-in-Charge O.R.S. was normally present at the Commander-in-Chief's daily planning conference and arrangements <sup>were</sup> made for members of the branch to attend briefings and interrogations as required. The necessity for visits to stations arose, of course, in connection with many investigations. Such visits are an essential part of the practical education of an operational researcher and should be encouraged to the utmost. During the war pressure of work often prevented some members of the staff from visiting stations sufficiently frequently.

In view of its wide terms of reference, involving as it did investigations in the provinces of all branches in both the Air Staff and the administrative side of a Command, the proper place for the O.R.S. in the Command hierarchy is directly under the Commander-in-Chief. For various reasons such an arrangement is not really practicable and in Bomber Command the Commander-in-Chief placed the O.R.S. under the Senior Air Staff Officer (and later under the Deputy Commander-in-Chief when this post was created). At the same time the Officer-in-Charge O.R.S. had access to the Commander-in-Chief at all times. Thus the O.R.S. became a branch of the Air Staff. This position proved to be satisfactory and even at a later date when problems relating to the Air Officer Administrations branches were investigated no difficulty was experienced. On such problems the branch merely dealt with the Air Officer Administration instead of with the Senior Air Staff Officer. It was, however, generally understood that the O.R.S. was available to assist any branch of the Command in any problem, and was situated under the Air Staff primarily for convenience and because its problems were mainly operations. It has now been realised that the administrative problems are of great importance where questions of economy of effort are involved.

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In connection with the position of the O.R.S. in the Command, it is of interest to mention that since the O.R.S. was engaged largely on problems which might be said to be the concern of other branches, particularly in the case of equipment studies, it was often suggested that the scientists should be attached to the various service branches concerned and not be in a separate unit. Such an arrangement would have certain advantages but the majority of problems concerned more than one branch and there was a great advantage in having a single section covering all aspects of the activities of a Command. Further, an economy in manpower would be achieved since within limits the staff could be switched to the problems of greatest urgency at any time. There seems little doubt that a separate O.R.S. branch with the resultant freedom of action is the most efficient and satisfactory arrangement.

The Research Programme

When the O.R.S. was first formed the Commander-in-Chief gave the branch a broad programme of research covering the problems which he regarded as of the greatest importance. The precise items of research necessary to meet this general direction<sup>ive</sup> were left to the Officer-in-Charge O.R.S. to decide, and in consultation with the senior members of his staff the detailed programme was built up as the staff increased. From time to time the Commander-in-Chief, his Deputy, the Headquarters branches and external establishments would request specific investigations. These would be given priority but normally the items for research originated in the Section itself.

A detailed research programme was prepared occasionally and submitted to the Commander-in-Chief and Senior Air Staff Officer for approval and guidance as to priorities. It was also forwarded to the Air Ministry.

Issue of Reports

On the completion of an investigation, the results were normally written up in the form of a report together with conclusions and recommendations. It was first forwarded to the service branch or branches concerned for comments, which were then dealt with, and finally forwarded to the Senior Air Staff Officer or to the Commander-in-Chief through the Senior Air Staff Officer for approval and any subsequent action.

Those reports which were approved by the Command were automatically released for circulation. Two series of reports were issued. One, a general series with a wide circulation list dealing with

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matters of general interest, and ~~was~~ <sup>the other,</sup> designated 'S' Reports <sup>which</sup> were not circulated, ~~nor~~ <sup>except to those</sup> outside the Command immediately concerned. Some of the investigations were of a strictly domestic nature and the results of these, which sometimes criticised certain aspects of operations, were included in the 'B' series of reports which were not released for general publication. The reports in this series did not necessarily have the Command's approval, but represented <sup>the</sup> O.R.S.'s findings and views on the matter.

From time to time members of the staff produced reports which were not considered suitable for publication by the head of the section concerned, and for record purposes these were numbered and classified as 'M' Reports. They did not have the approval of the Officer-in-Charge and represent only the personal views of the author. Such reports, however, became available for consultation.

Thus the researches conducted by O.R.S. during the period September 1941 to June 1945 are recorded in the following series of reports.

- (a) General Series Nos. 1 to 141.
- (b) 'S' Series Nos. 1 to 243.
- (c) 'B' Series Nos. 101 to 237.
- (d) 'M' Series Nos. 1 to 160.

~~A list of titles in the four series is given in Appendix~~

#### External Contacts

The work of Bomber Command O.R.S. was closely related not only to that of other branches in the headquarters and in the Experimental Establishments of the Ministry of Aircraft Production, with whom close contact was maintained, but also with certain other research organisations. The most notable of these were the Air Warfare Analysis Section, Air Ministry; the R.E.8 (Research and Experiments) Division of the Ministry of Home Security; and <sup>(later Allied Central)</sup> 'N' Section of the ~~War~~ Central Interpretation Unit. All these organisations were carrying out, inter alia, operational research into certain aspects of bombing operations for which they were well suited. The A.W.A.S. was responsible for the preparation of charts associated with the various ground based navigational and bombing aids and the calculation of target co-ordinates, and were in consequence greatly interested in the accuracies of these systems, which was also a function of the O.R.S.; R.E.8 following their studies of the effect of enemy bombing of the U.K., turned their attention to the economic effects of the Allied offensive and were thus interested in the weight of bombs falling on the target. A determination of this, together with research into

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methods of improving it, was, of course a primary function of O.R.S. from the tactical and technical aspects. The O.R.S. therefore provided R.E.8 with much of their operational information, while they in return supplied the O.R.S. with bomb plots for analysis purposes. Bomb plots were also obtained from a section of the Allied Central Interpretation Unit, while 'N' Section, which specialised in the interpretation of night photographs taken at bomb release, developed many interesting methods of providing evidence of the activities of bombers in the target area and the distribution of bombs and markers etc, which were essential to the analysis of raids.

There would have been some advantage had the relevant work of these organisations been done within the O.R.S., but the manpower involved was considerable, and having regard to their other commitments and the accommodation question, it would have been impracticable. As it was a very close liaison was maintained and, on the whole, the arrangement worked smoothly. O.R.S., however, had no responsibility for advising on target selection or for the assessment of the effect of the bomber offensive. Their activities in this field were directed towards increasing the accuracy of attack on the targets selected.

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