J. D. NORTH, CBE, HonDSc, *Honorary Fellow*

1893 - 1968

JOHN DUDLEY NORTH was born on 2nd January, 1893. He died on 11th January, 1968. During those 75 years, I think that his mind was absorbing, questioning, theorising and creating, except perhaps when he was asleep. He was one of the most remarkable people I have known. He had a truly serious mind. That is not to say that he took his pleasures sadly—far from it—but in his lightest moments there was always an intense intellectual activity.

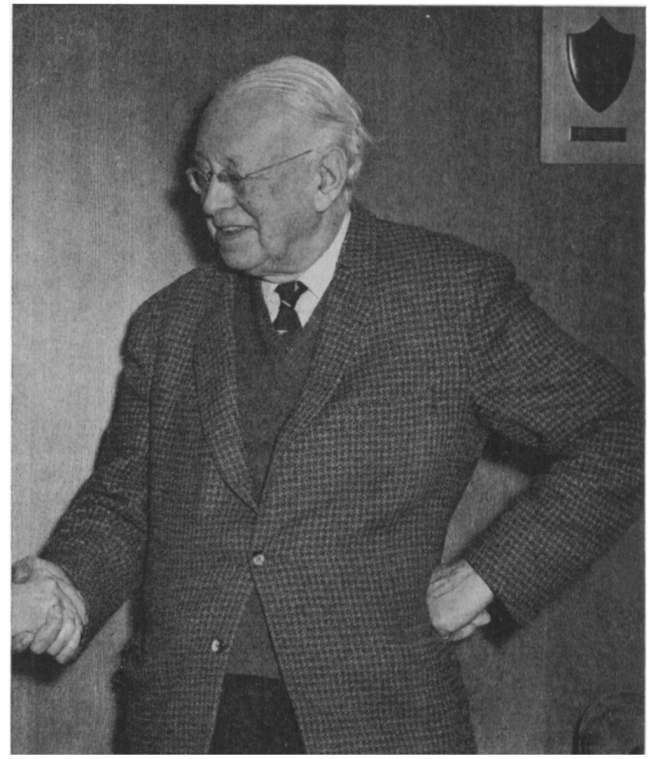
One is tempted, as was Dr. Watson in the case of that other remarkable character Sherlock Holmes, to make a list of the many areas in which he was especially knowledgeable. But while there were perhaps one or two, such as that of the modern novel or of the post-impressionist painters, in which he shone no more than the average, such areas were so few that the length of the list becomes oppressive. Outside his work one of his major interests, to which I feel I must refer, but on which I cannot comment in any critical sense, was plants and gardens, and particularly Alpine flora. His knowledge was equally impressive, to a poor gardener such as myself and to the experts.

I think it is true to say that North was the finest example I have known of the applied scientist. He absorbed scientific fact in an extraordinary way and he applied his knowledge to the creation of new things with unerring logic and usually with success; and when the total of relevant scientific fact, or the theory behind a particular design, was insufficient, he sought the missing data; he created the missing theory.

North was educated at Bedford School where he learned the foundation of the mathematics which remained a tool in his skilful hands to the end of his days. He did not go to university; he became an apprentice in marine engineering. While still an apprentice he won two competitions in *The Aeroplane*, edited at that time by another remarkable man, C. G. Grey. It was through Grey's advice that his apprenticeship was transferred to the Aeronautical Syndicate and, after that remarkable venture ended, he joined the Grahame-White company. It was not long before he became its Chief Engineer. Between 1912 and 1915 he designed and supervised the construction of a number of machines, one of which was the first British aeroplane to loop the loop. The best remembered product of this period of extraordinary precocity was the Grahame-White Char-à-banc which in 1913, piloted by Louis Noël, took nine passengers, including the youthful designer, into the air (Fig. 1).

In 1915, still only 22, he joined the Austin Motor Company as superintendent of their aeroplane division. In this post he was not responsible for design but for constructing the huge numbers of RE.7 and RE.8 aircraft which the company produced for the Royal Flying Corps.

At the end of 1917 he joined Boulton & Paul of Norwich. This company, through the aircraft production work it had taken up during the war, had decided to start a design department and put North in charge of it. The first machine he designed was the Bobolink, a fighter. It was followed by the Bourges, a bomber-reconnaissance aircraft of attractive design (Fig. 2) and remarkable performance. This aeroplane, of which there were several marks, was the first of a series of high performance bombers. It was followed by the Bolton and the Bugle and, in 1927, by probably the most famous of North's aeroplanes, the Sidestrand (Fig. 3). Towards the end of the 1920's there followed two single-seater fighters, one the Partridge, which was a single-engine biplane, and the Bittern, a twin-engine monoplane with a number of original features. The Air Ministry appeared to decide,



J. D. North.

however, that Boulton & Paul's forte was the bomber, and the next to be selected for service was the Overstrand (Fig. 4). For those who are interested in the remarkable series of aeroplanes for which North was responsible with Boulton & Paul, and its successor in the aircraft field, Boulton Paul Aircraft Ltd., there is an admirable article in *Flight International* for the 7th October, 1965 by H. F. King. This is, I think, exhaustive and is a remarkable testimony to North's fertility in invention and skill in engineering. Towards the end of the series came that remarkable turret-fighter, the Defiant (Fig. 5), which scored so heavily in the early days of the last war. The last aircraft production run, which came after the war ended, was on the Balliol, an advanced trainer for the RAF and Fleet Air Arm. Thereafter the only aircraft of note were the P.111 and the P.120 delta research aircraft, the first to use Boulton Paul power controls.

North was one of the first to move away from the wood and fabric of the First World War to the tubular and monocoque constructions of the later years. He was always close to the latest development in metal and plastic materials. His particular genius for design in metal was given a remarkable opportunity in 1924 when Boulton & Paul became intimately associated with the design and construction of the great airship R.101. The unhappy fate of that remarkable airship must never be allowed to obscure the ingenuity and skill of its structural design. In a design unlike that of any other airship, the main loads were carried in great transverse rings which were connected longitudinally by girders of triangular section, the whole being braced by steel wires. The overall geometry was the work of the design team at Cardington headed by Lt. Col. V. C. Richmond, a team of which I count it one of the great privileges of my life to have been a member. The individual girders composing this structure were designed, under the direction of North, to the end loads,

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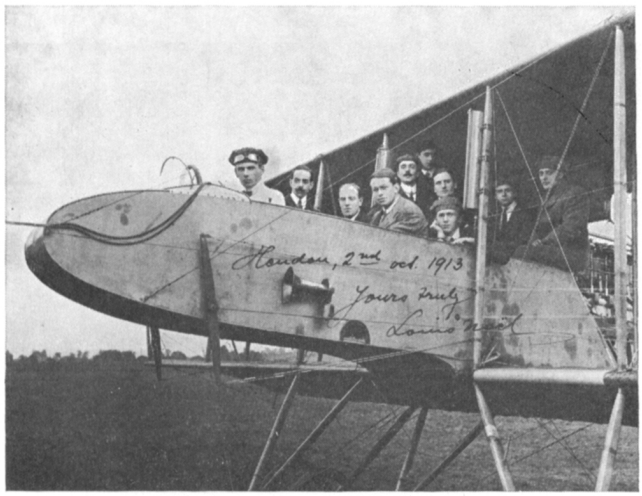

Figure 1. The Grahame-White Char-à-banc, which set up a world passenger record in 1913. Pilot Louis Noël. J. D. North is the fourth from the left.

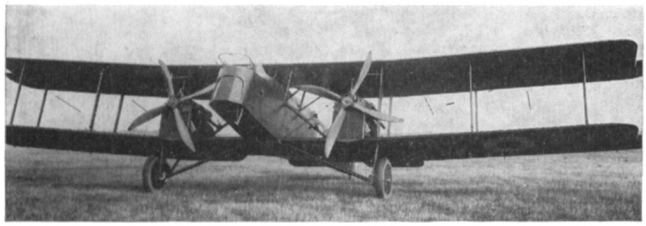

Figure 2. Boulton & Paul Bourges IIIA Bomber-Reconnaissance aircraft.

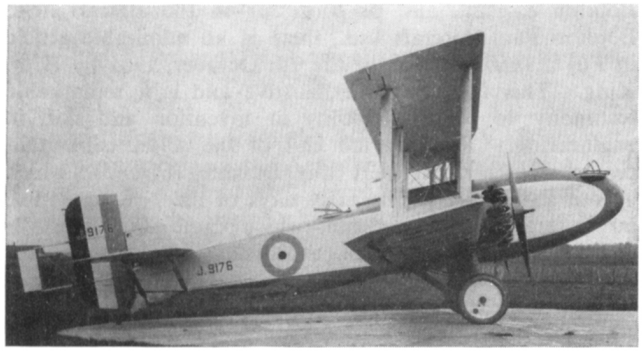

Figure 3. Boulton & Paul Sidestrand, 1927.

Figure 4. Boulton & Paul Overstrand.

shears and bending moments supplied by Cardington. This work was done with great skill and expedition, and the collaboration between the teams at Norwich and Cardington was splendid.

The main hull of the R.101 had fifteen sides, but in the region of the fins it was necessary, for reasons of symmetry, to have sixteen sides, and so in the 13th bay it was necessary for the fifteen sides to be developed into sixteen sides. This was done by incorporating a Y-shaped girder at the top of the bay and to have slowly twisting girders elsewhere. It is possible to criticise a design which required an elaborate feature of this kind, but it is not possible to have anything but admiration for those who were responsible for the geometry of this remarkable structure at Norwich. Designing twisting triangular girders for a tapering bay required the most clear-headed application of the principles of three-dimensional geometry. This is what the problem received and the structure went together without a hitch. The man responsible under North was A. H. Adkin.

This exercise was something very different from aeroplane design. It was indeed North's one departure in the 1920's from the aeroplane theme. In the 1930's a departure which had a more permanent effect began. That was the development of the gun turret. This feature, characteristic of the Overstrand, increasingly became the special expertise of Boulton Paul. More and more the firm became famous for powered gun turrets for a variety of aircraft, and although after the war the Balliol contract was secured, its work moved progressively away from complete aeroplanes to parts thereof. In his latter days North concentrated increasingly on power operated devices, particularly power controls, which spread beyond aeronautics into the marine and automobile worlds.

It was the development of North's ideas on control which led to his deep interest in control mathematics and cybernetics. I can remember many years ago reading an article by him in, I think, *The Aeroplane*, in which he discussed the operation of controls as the extensions of the human anatomy to perform the elaborate functions required in controlling the aeroplane. From this simple start developed his wide-ranging knowledge of operational research, ergonomics and statistics.

After the war he felt that various *ad hoc* experiments with aircraft turrets should be based on some wider, unified theory. In 1948, in a confidential report to the Air Ministry, he formulated his ideas; the title of the report was "The Probability Approach to Manual Tracking". It was from his conversations with Cambridge psychologists that North got the idea that a model of the human operator should be discrete since the operator's responses are in reality discontinuous. He also realised that the

Figure 5. Boulton Paul Defiant.

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difference equations describing the operator's behaviour could not be treated as deterministic but that, both in the assessment of the situation and in the execution of his task, the operator was committing errors, and that a stochastic model was called for.

Here North encountered difficulties since his general approach led to stochastic difference equations of the fourth order and at that time the only existing booklet, by M. G. Kendall, treated such equations up to the second order only. He decided to get some assistance from the National Physical Laboratory. The late E. C. Fieller used to recall the shock he got when one day the tall, imposing figure of North appeared in his office: he did not expect the Chairman and Managing Director of an aircraft company to discuss the autoregressive processes of higher orders without any preamble. He plunged into the problem and produced a detailed treatment of autoregressive processes of the third and fourth order.

In 1954 at a Conference on the Human Operator in Control Systems at the Royal Military Academy of Science in Shrivenham, North presented a paper in which he tried to convey to the audience that the human control of the machine could not be discussed solely by considering the properties of the machine and what it could do, but that it was necessary to borrow heavily from other fields of research such as stochastic processes, information theory, theory of games and decision theory. He called the paper "The Rational Behaviour of Mechanically Extended Man", a title which I am sure he enjoyed and which provoked humourous comment among his audience. The fun ended in the title—the paper is a very serious work indeed.

At the Third London Symposium on Information Theory in 1955, North produced a paper on the "Application of Communication Theory to the Human Operator". It was an attempt to sketch the ways in which the assumption of the constant information rate may assist the deductive theory of human controlled systems. The results of tracking experiments were discussed by him in two papers in *Ergonomics* in 1958 and 1961, written jointly with the members of his mathematics department; the experiments were performed on a specially built apparatus, the Human Operator Response Analyser (HORA).

In 1962 the US Office of Naval Research organised a meeting on "Complex Vehicular Control" in Farnborough. North headed the European list and presented a paper on "Manual Control as a Stochastic Process" which was published in *Ergonomics* in 1963; apart from discussing his model the paper attempts to verify the theory by experimental results obtained with the aid of HORA.

Now, after almost twenty years, North's ideas start to find their way into text-books and monographs, not always with complete understanding. They represent labours of which many—probably most—of his aeronautical acquaintances are unaware. That is why I have referred to them in some detail in this memoir.

North was one of the few founder members of the Operational Research Club, which was the fore-runner of the Operational Research Society. In 1948 he was asked by the Air Ministry to investigate the reliability of military aircraft. Today we would call it an extensive OR investigation. The work took five years (1948-1953) and was presented in 13 volumes under the title "Design for Reliability". The findings were regarded as secret since they concerned military aircraft and of course were not widely known. It is a pity, because the methodology expounded there was new in many respects and can be applied not only to military aircraft but to the study of reliability of civil aircraft and, with some modification, to investigating reliability in other machines.

In parallel with North's work as the head of Boulton Paul was his work for the SBAC, the ARB and the College of Aeronautics at Cranfield

He was a member of the Council of the SBAC from 1931 to 1962, Vice-President (Aircraft) from 1941 to 1943 and Chairman of the Society's Technical Board in 1944/45 and 1947/48. It was as the SBAC nominee that he joined the Council of the ARB and the Governors of Cranfield.

He was a member of the Council of the ARB from 1942-1960. He took his responsibilities very seriously and thought deeply about safety problems. Perhaps he would have done this anyway, but the ARB benefited from his unconventional approach in much of its work. I remember being in the chair at a meeting of the Royal Aeronautical Society as long ago as 1949 when he read his paper "Some Aspects of the Relationship between Airworthiness and Safety". And as recently as 1964 he read in Athens at a NATO conference a paper on a closely associated subject which he called "How to Succeed in Improving Reliability by Actually Trying"! He was chairman of the Design and Construction Panel of the ARB from 1943 to 1960, and his influence on the requirements of the Board was probably greater than that of any other single member. He could indeed logically be regarded as the inspirer of the policies on which the British Civil Airworthiness Requirements were built. In addition, he scrutinised in detail every paragraph to ensure the precision which he knew such requirements must have.

He did his duties as a Cranfield governor in the same dedicated spirit which animated his ARB work. Right at the outset, in 1946, he introduced in a paper to the Cranfield staff his views on the teaching of aircraft economics. He was indeed in this paper anticipating what we now call value engineering. He remained a valued Cranfield governor until 1960 and never lost his interest in the College's progress.

As engineer, as designer, as applied mathematician, J. D. North was a great professional. As horticulturist, cricketer, gastronome, he was a great amateur—an amateur in the cricketing sense in which he could keep his end up with the pros. In his professional life he was so outstanding that one must wonder why honours did not fall more thickly on him. He was, of course, an Honorary Fellow of the Royal Aeronautical Society. Last year he became an honorary Doctor of Science of the University of Birmingham. He was indeed a Companion of the Order of the British Empire. But far lesser men have been awarded more. He seemed utterly indifferent to fame and his course was never determined except by logic. His integrity was complete. In things that mattered he could not compromise. Perhaps this is the kind of man whose worth is honoured last. Certainly he did not scorn recognition and when he was honoured he was greatly pleased. When his years of service to the ARB were appreciated by a modest presentation he was deeply touched. Perhaps, in his great modesty, he never felt neglected, but in the memories of those who knew him best he will always stand out mightily among his fellows, a person of unforgettable distinction whose merit in his lifetime was comprehended by too few.

In this short memoir I have been greatly helped by Mr. Lomnicki, who for the last fifteen years of North's life worked closely with him in his mathematical investigations.

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