Marconi – 50 years on

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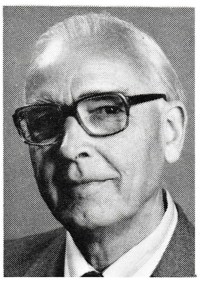


G.D. Speake graduated in physics at Cambridge University in 1941, and served in the RAF radar branch until 1946. He joined Marconi in 1950, and was appointed Chief of Research in 1963, Director of Research in 1965 and General Manager, communications and broadcasting, in 1968. In 1969, he became Technical Director for GEC Marconi, and since 1982 he has been Deputy Director of Research for GEC.

On July 20, 1937, Guglielmo Marconi died after a series of heart attacks, none of which had diverted him from the process of experimental research, aimed at practical application, which had characterized the whole of his adult life. In the same year, the laboratories which now bear his name (The Marconi Research Centre) came into being. During the intervening years the size of the establishment and the scale of activities have increased dramatically, but the general objective is consistent with that which Marconi set for his own research effort at the beginning of the century. Together with the other laboratories of GEC Research Ltd, the Centre aims to establish, by theoretical study and practical experiment, the foundations of new business opportunities and thereby to serve the needs of the operating companies.

This paper considers some of the areas currently being studied and draws parallels between the work in progress and that carried out by Marconi and his contemporaries over 50 years ago.

Origin of the Centre

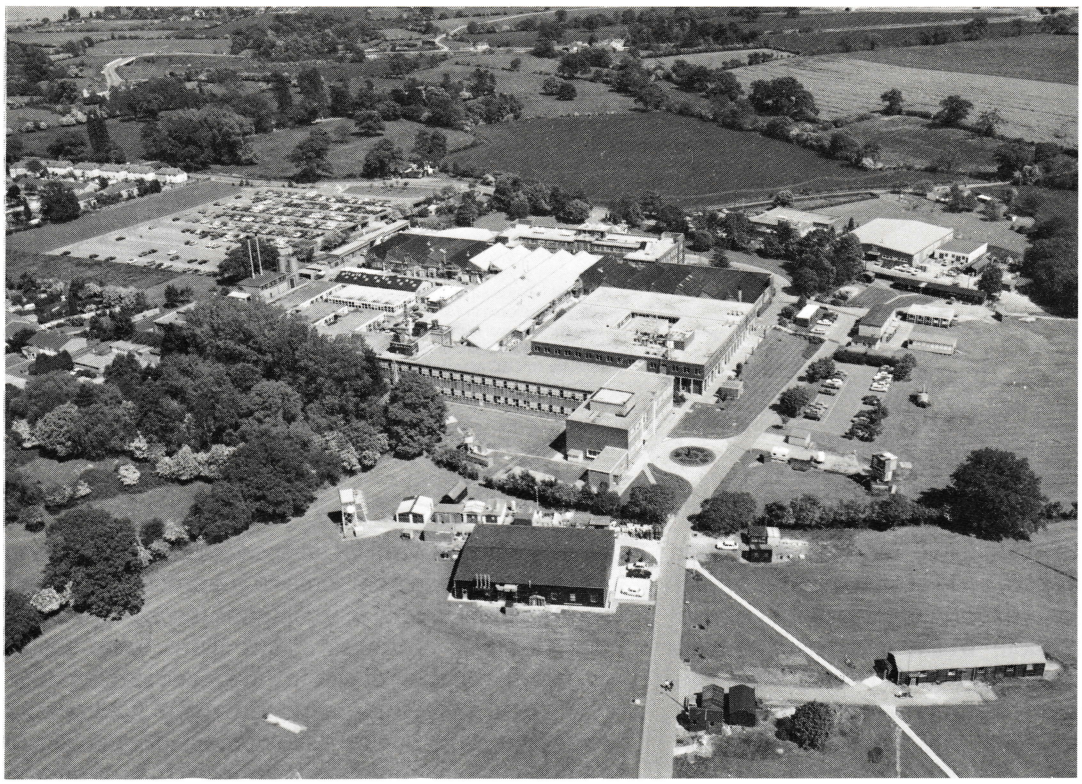
Although Marconi had done most of his early work from his base in Chelmsford, where the Company's and the world's first "wireless factory" was set up in 1898, the last years of his life were spent in his native Italy, where he became eminent as a member of the Italian Senate, while continuing his career as inventor and innovator. It was therefore a Board, led by H.A. White, the then Managing Director of Marconi's Wireless Telegraph Company Ltd, which decided to acquire the site at Great Baddow in order to bring together, under a single director, a number of research units previously scattered throughout the Chelmsford area.

They chose Baddow because of its relative isolation from potential sources of electronic interference and its suitability, therefore, for experimental work at low signal levels. The research groups were then, as now, closely allied to product units and the technologies in use had emerged from some 40 years of research and development in what Marconi and his contemporaries described as "wireless". Thus there were teams engaged in studies of electro-magnetic propagation, low noise receivers, radio direction finding and television, and in the development of specialized components such as quartz crystals and gas discharge devices. (There was also a telephone laboratory which, while not strictly qualifying for inclusion in the wireless category, used the same basic technologies.)

Information Technology

A visitor to the Marconi Research Centre now (fig. 1), if asked to give his view on what is a common theme throughout much of its activity, might well say "information technology". He would mean that a substantial proportion of the resources of the Research Centre is devoted to research into the generation, transmission and processing of data of all kinds. This is but a reflection of our modern society. The gathering of data from a range of sensors in an aircraft, and its processing into a state suitable and convenient for assimilation by a pilot or aircraft controller, are as much "information technology" as the connection of a "smart card", at a point-of-sale, to a customer's account in a remotely situated bank.

However, while the term is new, the concept is not; a visitor from a previous generation visiting Marconi and his fellow researchers at the beginning of the century might have found the same description apposite. The existence of electro-magnetic waves had been predicted by Maxwell and demonstrated by Hertz and others well before Marconi began his experiments. What he set out to do was to show that it was possible, and practicable, to convey useful information from point-to-point by such means. He recognized that the safety of ships at sea, and their effectiveness in time of war, would be vastly improved if they were able to communicate with one another and



1 *The Marconi Research Centre today.*

with land bases. His experimental approach was essentially a simple one; to increase the distance between transmitter and receiver progressively and to observe the results, not being unduly influenced by theoretical predictions of others even when their academic reputations far exceeded his own. Thus as early as 1899 he observed that signals transmitted from Wimereux near Boulogne, and intended for reception on the south coast of England, were being received strongly at Chelmsford, over 130 kilometres away and therefore well beyond the optical horizon. This led on to the celebrated adventure in 1901, when he and his colleague Kemp heard signals transmitted from Poldhu in Cornwall in the earphones of a receiver in Newfoundland. Even with our current knowledge of the behaviour of the ionosphere, (which was unknown to Marconi and his contemporaries in 1901), and the sophisticated analysis techniques which exist in the Propagation Group at Marconi Research Centre, we cannot satisfactorily explain how it was possible for the signals to be detectable by the relatively crude antennas and receivers available at that time. However, Marconi was not deterred by the poor quality and intermittent nature of the reception and, if he had any doubts that he and Kemp might in their enthusiasm have deluded themselves, he was able in the following year to reassure himself and the world at large by recording signals on the yacht Philadelphia at a range of 3000 km from the transmitter.

Marine Communications

With the formation of the Marconi International Marine Communication Company (MIMCO) in 1900, Marconi set out to provide a total communication service, i.e., shore- and ship-based equipment and operating staff, to the merchant navy. (MIMCO still provides such a service.) The first commercial installation was to the German liner Kaiser Wilhelm der Grosse in 1900; by the end of 1902, seventy ships were fitted and twenty-five land stations were installed, some on the east coast of North America. The Company was thereby already engaged on the development of information technology, although it did not have at its disposal modern techniques for processing data in such a way as to make human interpretation easier and more reliable. The benefit of having assistance at the human interface may be illustrated by a well-recorded incident from the Company's history.

On April 14, 1912, the liner *Titanic* struck an iceberg. The liner's wireless operator had received a warning that icebergs were present, from several ships in the area and one even reported that it was surrounded by ice and had stopped. However, the danger of the situation was clearly not appreciated on the bridge of the ship, which continued to steam on at high speed until the collision occured. The senior wireless operator on board began immediately to

send out distress signals, but they were not received by the nearest ship, the *California*, because its wireless operator had retired to his bunk after continuous duty of some sixteen hours. Other, more distant, ships did respond to the call and it was recognized by the public at large that the casualty list would have been even larger had the ships not been equipped with wireless communication, but there is no doubt that more effective aids at the human interface could have saved many of the 1517 people lost that night.

As is often the case, the *Titanic* disaster led to improvements in techniques and procedures. Marconi proposed an auto-alarm system, on which he had already experimented, by means of which an alarm bell would ring whenever a distress call was received on an unattended receiver. Such a system was finally introduced after World War I. There was also to be a much more rigid control of transmissions in future, with an allocation of particular wavebands for specific purposes.

With the invention of the transistor, and the many information processing devices which have developed from it, the introduction of much more sophisticated aids became practicable and economic. Much of the work of the Marconi Research Centre in 1987 is in the exploitation of semi-conductor devices to enable a human operator to perform more efficiently. Research is aimed at a wide range of potential applications in the civil and defence fields, ranging from the diagnosis of human illness to the control of sophisticated manufacturing plant or of complex military systems.

The work requires an equally wide spectrum of technical expertise, from the design of processing hardware to the development of expert systems and artificial intelligence concepts. In principle it seems to be far removed from the relatively crude techniques available to Marconi and his colleagues but there are other parallels which can be drawn.

Inter-Continental Communications

As early as 1910, the Marconi Company put forward a proposal to the Government for a scheme to link Britain, South Africa, India and Australia by wireless. It proposed to use high power long wave transmitters, with lower powered transmitters feeding into the system at appropriate points.

The outbreak of war prevented progress on this, and on many other non-military projects, but in the early 1920s elements of the proposed system were installed by the company under contracts placed by UK, South African and Australian authorities. In the meantime prolonged discussion took place on political issues, including the question of who should own and operate the system. In 1924 the UK Government announced its decision; that a scheme should be implemented, but that it would not be based on long waves. Instead it would employ the short-wave beam system, on which a Marconi team led by C.S. Franklin had been working for some years.

Responsibility for its UK operation was assigned to the Post Office, while the Dominion stations were operated by local companies, in which the Marconi Company usually had substantial interests.

In gaining acceptance of the scheme, Marconi completed the first phase of his ambition to create a worldwide communication system based on wireless. It is interesting that the natural area for the initiation of the system was at that time the British dominions, throughout which commercial and social connections were strongly established. The Marconi Research Centre, and GEC Companies with communications interests, have for the past year been involved in studies of another projected network of communication, but this time based on Europe and the Common Market, which has in recent years become the natural environment for UK developments. The RACE programme which is endorsed by the European PTTs and supported by the European Commission, is intended to lead to a broadband network serving the whole of the Community in the 1990s. The first project definition phase has been completed and continuation into a main programme via the Community's Framework Programme in R & D is planned.

ESPRIT and Alvey

The concept of a European broadband network is consistent with a worldwide trend to make better use of information technology. The ESPRIT and Alvey initiatives are designed to exploit this trend to the benefit of the European Community and of the UK respectively. GEC Research, via both Marconi and Hirst Research Centres, is playing a major role in both.

ESPRIT and Alvey were conceived as 10-year, but initially approved as 5-year, programmes. Both are now beyond the half way stage and are the subject of continuation proposals. Both include a substantial content of semi-conductor materials and devices research work, and a section on software engineering, none of which could have been practised by engineers of the Marconi generation, but all of which are highly relevant to the use of information in the modern context. A distinct and important feature of the ESPRIT work on which MRC is engaged relates to the use of the computer in a factory environment, both for the efficient transfer of information needed by the manufacturing process and for control of the machines on which it depends. The inclusion of research work on computer integrated manufacture in a European programme is a recognition of the fact that, in order to compete successfully in today's world, companies

must not only innovate but must also produce their products to reliable standards and on a scale which permits manufacture to be effected at minimum cost. In the Alvey programme the human interface is specially targetted for research work.

Industry/University Collaboration

These aspects of information technology arise by way of changes which have taken place largely in the post-war period and Marconi and his colleagues may not even have foreseen them. However, there is one feature of both Alvey and ESPRIT programmes which he would not have found strange. Both involve collaboration between a group of industrial companies, and between companies and research workers in Universities. As far back as 1919, the Marconi Company was collaborating with GEC to the extent of merging the interests in thermionic valves of both companies in the Marconi-Osram Valve Company. In 1923, Marconi, GEC, Metropolitan Vickers, BTH, The Radio Communication Co. and the Western Electric Co. collaborated to form the British Broadcasting Company. (Looking at this list of names now it seems probable that, had not the Government decided in 1926 to create a new Corporation with the same initials and a Royal Charter, the BBC would be a GEC operating company!) Collaboration between the Company and Universities also goes back a long way. In July 1900, Dr. J.A. (later Sir Ambrose) Fleming became the Marconi Company's Scientific Adviser, while retaining his chair as Professor of Electrical Technology in University College, London. The association was to prove a very fruitful one, not least because of Fleming's invention of the thermionic valve in 1904, and it continued almost up to the time of his death in 1945. The Alvey Directorate and the Science and Engineering Research Council, by encouraging university staff to join in industrial programmes directly aimed at the regeneration of UK industry, and ESPRIT, which has a similar aim in Europe, are continuing in the same tradition.

Radar Techniques

Other parallels can be drawn between the research activities of the widely separated generations. In 1935, after he had already suffered several heart attacks, Marconi carried out some experiments at a small Italian naval station at Torre Chiaruccia. He and a colleague Solari directed a beam from a transmitter operating in the 600 MHz frequency band across a road and detected a hiss in their receiver as a car was driven past. It was one of the early experiments in what later became known as radar and Marconi had moved on to studies of aircraft returns when his premature death cut short his work. In the post-war period, work in the 600 MHz band at Baddow led to a generation of widely-sold radars for air traffic control, and measurements on reflections from cars, albeit at a higher operating frequency, to a traffic speed monitor for the police! The MRC programme now includes studies of new radar techniques taking full advantage of the technology developments in both hardware and software which have taken place in recent years. Amongst these are included the production and processing of all-weather pictures, obtained from an aircraft or satellite, by synthetic aperture radar techniques, i.e., by a radar in which an effective aperture much larger than the physical dimension of the airborne antenna is created by storage of data generated as the aircraft (or satellite) moves along its path (fig. 2).

Satellites

One might ask "What connection could the processing of satellite radar data possibly have with Marconi and his associates since satellites had not been conceived at the time, radar was in its birth struggles and aircraft had very few electronic aids?" There are in fact two connections. In 1930 or thereabouts, Franklin was carrying out some experiments in the centimetric and millimetric wavebands and his notes visualized the production of a picture "analogous to that obtained by a camera". It is not clear how he thought that might be done but one answer now lies in the use of synthetic aperture radar techniques.

As far back as 1905, Marconi, in a lecture to the Royal Institution in London, referred to a statement by Lord Kelvin that it might eventually be possible to send messages to the other side of the globe. He then went on to say "For example, if transmissions to the Antipodes were possible, the energy ought to go over and travel round all parts of the globe from one station to the other, and perhaps concentrate on the Antipodes; and in this way it might be possible for messages to be sent to such distant lands by means of a very small amount of electrical energy and therefore at a correspondingly small expense".

Exactly what Marconi had in mind is not clear but if he had substituted "a satellite" for "the Antipodes" and "be amplified by" instead of "concentrate on", he would have had a fair description of modern satellite communication (fig. 3).

Summary

Fifty years ago, Marconi died and the Marconi Research Centre at Great Baddow was born. The path which he and his contemporaries trod was largely unexplored, often rough (the Company was beset by financial problems frequently and by legal ones from

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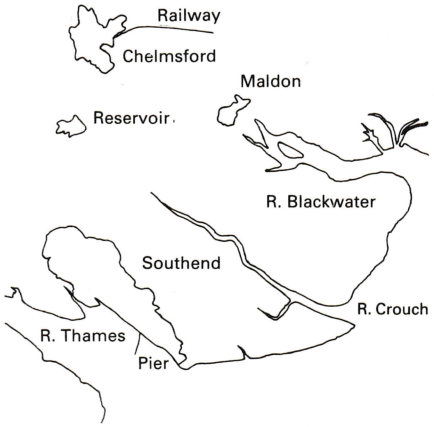
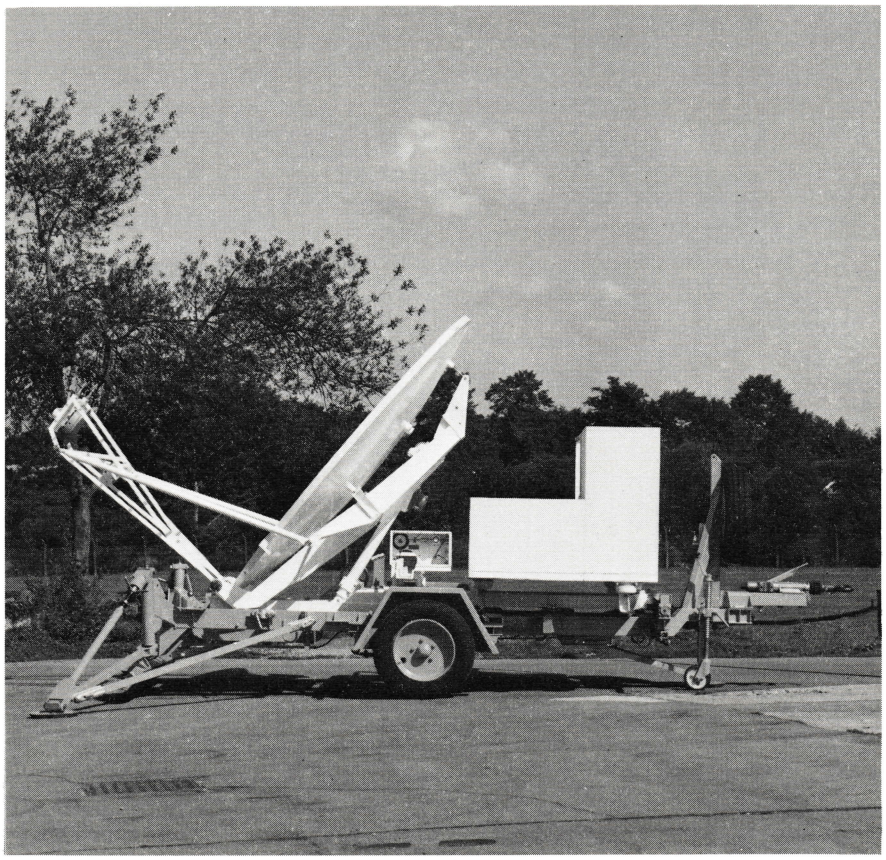


b)

2 *a) A synthetic aperture radar image of S.E. Essex, taken from a satellite. b) A half-scale map to show the main features of a). Photo by courtesy of NRSC, Farnborough.*



3 *The 2.5m diameter transportable satellite communication antenna for use at 20–30GHz for the ESA Olympus satellite.*

time to time) but relatively narrow. Their successors in the Research Centre (and in the other laboratories of GEC Research Ltd) operate on a broader highway, relatively well lit and endowed with many aids to progress but beset by other hazards, including the threat of equally well-equipped researchers from competitor countries and companies to overtake, or even to push them off the road. They could do worse than ponder on Franklin's summary of Marconi after his death: "Marconi may not have been a great scientist but he was a great man, and to deny that is to deny the facts. Without his steadfast faith, drive and courage, success would not have been possible".

Acknowledgements

I have verified a number of the dates in this article by reference to W.J. Baker's book, "A History of the Marconi Company", published by Methuen (1970). Readers wishing to know more about the early work of Marconi and the development of the company from its inception until the mid 1960s may refer to that volume or to "Marconi" by W.P. Jolley (Constable 1972).