A History of The Marconi Radar Company

Unpublished Draft

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Introduction

What follows is a highly personal view of the period 1960 to 1992; thirty-two continuous years of almost unalloyed, wonderfully exciting and absorbing working time. A quick look back at the title of this paper will show that it is not **'THE'** history but 'A history recounted by someone who came to the Company at a time just before Bill Baker had finished his own great book, 'The History of The Marconi Company'[1].

I joined Marconi Radar in May 1960 when it was a Division of Marconi Wireless Telegraph Company. After having spent 17 years with A. C. Cossor and seeing it gradually decline, following a fierce national credit 'squeeze' in the early fifties, I started to look around for other employment. Came the day when I discovered that their Plastic Injection Moulding shop was making lipsticks for Helena Rubenstein. This seemed to be a far cry from electronics.

It was time to get out.

I was interviewed by The Marconi Company and offered a job as Systems Engineer, the discipline I worked in at Cossor for several years after a long progression from research, development and field commissioning posts. I got a good feeling immediately upon joining the Marconi Company, since Systems Engineering Group worked from a large country house in Broomfield, some two or three miles from the Radar Division's HQ at New Street, Chelmsford. The Systems Group was managed by Peter Max, a large, impressive young man originally from South Africa. His second-in-command was Gerald Taylor, with whom I quickly became, and still remain, very good friends.

Before embarking on the main body of the text, a few words on the impact of the Company upon a newcomer at that time helps to give an idea of its moving spirit. In the late '50s the notion of 'image' began to filter down from its use by the advertising fraternity and gain everyday currency. When contemplating joining The Marconi Company, the image conjured up was one of great competency, vast endeavours, lasting quality, things built like brick outhouses enduring forever, probity, academic foundation and professional training. Its very seriousness was, for me, somewhat daunting.

Within days of joining the Company I came to there was a sense of belonging to a family of like-minded people for whom the Company image was expressed in terms of their attitudes to work and to co-workers: attitudes which would reflect credit upon the Company and enhance its reputation because they were 'the Company'. The Company's 'image' was, indeed, a true reflection of itself.

Bill Baker's excellent history of The Marconi Company had, of necessity, to be very brief on the emergence of Radar Division between 1945 and 1965. To understand the spirit and animus of the time, the following expansion of his description is given.

The Division's real springboard was the enormous work acquired and required in the ROTOR project[2]. This was to up-date the war-time defence radars and to plan for new equipments to meet the newly-perceived threat from our former ally, Russia and her satellite states. A larger staff had to be recruited swiftly and, naturally, those who had worked upon the equipments to be up-dated were prime candidates. Thus, a large intake of ex-Services (preponderantly RAF) personnel resulted in the Division being staffed largely by people who had shared a common service ethos, had a knowledge of what a hard life was and knowing the value of team-work. Most had served abroad and many had suffered during the war. This made for the sort of camaraderie that gets things done and, all in all, the easy running of a happy ship. The 'services' culture was exemplified by the appointment of Col. Elford as Divisional Manager.

As Bill Baker points out, not only was there this vast amount of UK MoD work to execute,other countries were also looking to their own defence requirements; added to which, civil aviation was growing to the point where radar was seen, in busy areas, as a vital tool for Air Traffic Control

(ATC). It was the ATC group of systems engineers that I had joined; however, since all the systems engineers - military, naval and civil - were in the same 'cheek-by-jowl' building and making use of a common pool of equipments, a great deal of cross-fertilization resulted; we got to know a lot about each other's work and problems.

The increased emphasis upon creating new equipments with state-of-the-art signal processing brought the formation of the Radar Development Group (RDG) at Broomfield, in Pottery Lane, under the direction of Hugh Wassell, who later was appointed Director of Engineering.

All this effort produced two series of radars of enormous importance.

Alongside these was to emerge the TAC (Transistorized Automatic computer). The upsurge of staffing level established a vast wealth of experienced talent and engineering skills; these four formed the corner stones of the self-standing Company that the Division was to become.

The Radars

Each of the two series of new radars mentioned above had a different operational role - military defence and civil ATC. The new transmitters & receivers formed the SR1000 series, the two military surveillance radars operating in the 10cm (S) and 23cm (L) bands, respectively. Their massive antennas could be operated either independently or mounted back-to-back as in the S247. In either configuration they made an awe-inspiring sight, mounted as they were on gigantic steel-girdered tripods some 30 ft (9m) high (see fig. 1). These two monsters had an equally formidable stable-mate - the S244 nodding height-finder. This was virtually, the 'S' band surveillance radar but with its antenna turned through 90°. Its elevation scan was executed by hydraulic rams and its cries of pain when doing this could be heard at great distances! It, too, was mounted upon a massive steel tripod underneath which a wide area of gravel would glisten with oil which, after several months, inevitably dripped down from the points of action (see fig. 2).

The second series (the S232, S264 and 264A) operated at around 600 MHz. The S232 had a 25 ft 'orange peel' antenna made from wire mesh with a radiating horn as a feeder arrangement. It was mounted close to the ground so that ground-reflected energy combined with directly radiated energy phase constructively at about two degrees

1 S247 back-to-back surveillance radars

2 S244 nodding height finder

elevation, forming a long, low lobe reaching far further than the radar's free-space range - it embraced maximum altitudes at which civil aircraft of those days would fly; the subsequent null formed at about four degrees elevation made little or no incursion into these height bands and so made it a very effective surveillance radar for civil use. The more so, because by its use of a wavelength of 50 cm, echoes from rain storms and clouds would be far less than for 10 and 23cm radars; a great boon for air traffic controllers. The relatively low frequency of 600 MHz also meant that the whole system could be self-coherent (the p.r.f. and all frequencies up to final transmission, could be crystal controlled) led to superior permanent echo cancellation. These properties and the fact that it was the only radar in the world to use this frequency ensured that it dominated the small but growing civil ATC market. Its success quickly led to

Note that the operating wavebands bear their old letter coding, both here and in the subsequent text.

3 S264A 50cm surveillance radar

the development of the system to higher performance levels. A new antenna with wider horizontal aperture of 50 ft reduced the beamwidth to a much more acceptable $2\tfrac{1}{2}^\circ$. The S264 was born and its higher-powered version (500kW peak power) S264A shown to the world in 1958 at the Farnborough Air Show that year (see fig. 3).

The Transistorized Automatic Computer - TAC

The equipments described above can be considered as arising by an evolutionary process through exercising the Company's traditional skills. The TAC, however, was totally different; it was revolutionary.

It was the brain-child of Sir (then Dr.) Eric Eastwood - so often to be found as an inspirational force, in the history of the Radar Company.

In the late '50s the Company managed to win a contract to supply the Swedish Air Board with an up-to-date radar processing system which would allow operation of several Sector Operations Centres (SOCs) by which a variety of defence weapons - fighters, SAMs, etc. - could be brought into action in a faster time than before. This meant high-speed computing. From primitive radar returns, tracks of aircraft which had been detected had to be formed and classified as 'hostile' or 'friendly'. Fast computing would allow intercept manoeuvres to be derived and passed to defending fighters in quicker time than before. Originally, this problem of increasing the processing speed was seen to rest in the use of two 'Deuce' machines, back-to-back. 'Doc E' was not content with this and sought a radical solution by using modern transistor technology. The seed of TAC was sown and after much discussion, the design basis of TAC was established. It was founded upon the wide use of what became known as the 'R' unit. This was a simple arrangement of discrete germanium transistors and diodes on a very small printed circuit board. They formed a 'NOR' gate. The tolerancing of the components was exhaustively tested to ensure the design worked over a wide environmental range without requiring component selection; reliability was the watchword. Over 100000 of these 'R' units were used in the system. They formed the basis of all the real-time digital processors. Remote radars piped their real-time signals into two Plot Reporting Centres located at the North and South of the country. From this data, plots were formed by manual operators positioning symbols over the radar 'blips', automatically sending the (r, θ) position information to the digital processing system. From this, TAC derived track data giving labelled target position, speed and heading. Subsidiary data allowed the targets to be categorized as 'friendly' or 'hostile`. The storage for the system was also virtually real time, the storage medium being acoustic delay lines of either glass or a magnetostrictive device. The TAC computer, which also used batteries of 'R' units, was not programmed in the general sense of today's meaning; it was all 'hard - wired' and real time.

So successful and reliable was this concept of the widespread use of identical modules that the system operated for decades - well into the era of microelectronics. Thus, Radar Division entered the world of digital engineering, from whence came the 'Myriad' - of which more later.

The 'family' feeling mentioned earlier was no accident. Not only was it natural, it was deliberately fostered as part of Company policy from the very highest management levels. It was not uncommon, from time to time, to find within the Marconi Company at large, three generations of a given family working within it. There was the annual Company Gala Day where all members of the Company and their children were welcomed. The Radar Division's annual dinner and dance would be eagerly anticipated and always well attended. It was generally recognized that a sense of belonging to a 'work family' was a valuable asset to a company and that to know one's fellow workers socially was beneficial. The advantages seem too obvious to dwell upon beyond observing its opposite; the sterile attitude of treating people merely as 'functionaries' - "for this job we need four Engineers, three Programmers and two Draughtsmen".

The attitude towards staff is exemplified by an episode at Church Green, the name of the place in which the Systems Engineering country house was situated. The staff there had formed a social group called, not unnaturally, The Church Green Association. All people who worked there were eligible to join for a trifling subscription. All kinds of social outings and functions were organized by its small committee. One such was a coach outing to see a pantomime in London. In the preceding weeks the Treasurer had gathered in the contributions from those wishing to go. On the very evening of the outing, it was discovered that, quite out of character, the Treasurer had de-camped with the money he'd collected! Of course, he was soon apprehended, charged and suffered a short jail sentence. On his release, he re-applied for his old job! Rather than dismiss it out of hand, Peter Max, our manager referred the matter to all those who had been embezzled. 'Yes', they said, 'provided he pays back all our money'. He was re-employed and, over a period of months, paid off all his debt. No more was heard of the matter.

These people, together with the three equipments described earlier, were the bed-rocks upon which the Radar Company was founded and raised the Division to become the largest European player in the world's radar market-place.

Success Breeds Success

Early successes with the S232 and S264 were accompanied by even greater success in selling the military radars in the SRI 000 series (see fig. 4). In pursuit of a very large NATO order, Radar Division mounted a huge demonstration of the military surveillance and nodding height-finder radars, plus display facilities at Rivenhall during the autumn of 1958. Special trains laid on from Liverpool Street in London to Witham, about six miles from Rivenhall, were filled with polyglot military of exalted rank. They were brought to Rivenhall by coaches. It was a mammoth exercise. It paid off, for by 1960, NATO had procured 17 of these S247 and S244 systems and later the next year, a large order from South Africa brought the order book to unprecedented levels.

4 S1023 L-band transmitter1receiver rack

Together with the radars mentioned above, display technology was also progressing. In 1958 the Radar Division had its new fixed-coil PPI display system on show at Farnborough, complete with the ability to exploit what was known then as 'interconsole marking'. In this, it was possible to generate symbols for display at any desired position on the screen. The symbol (a square, diamond, circle, asterisk, etc.) was steered across the screen by use of a joystick control - a novelty in those days. More importantly, it was possible to make the symbol appear upon other displays in a suite, by selection.

Thus, controllers of air traffic could hand over control of a given aircraft (indicated by an agreed symbol) to a colleague without the need for verbal interchange. Large screen situation displays had also been developed and supplied.

The Growing Role of Systems Engineering

The Company's role in the 'Vast' and 'Rotor' projects was largely one of modifying and up-dating existing equipments. But in the late '50s the Division had increasingly to take on responsibility for supply of equipment which was ancillary to the radar proper - buildings, ventilation systems, security and maintenance staff domestic facilities. This meant that Systems Engineers had to become skilled in writing specifications for their purchase and supply from other sources. This skill was to play a vital part in the Division's history in allowing the Company, with confidence, to offer prospective customers a complete 'turnkey' contract. In these, the Company would assume total responsibility for the provision of all goods and services required to meet the customer's specified needs.

Besides this wealth of military and civil ATC radar business, naval sales were also made. Export orders for the Chilean and Argentinian navies were obtained.

Until the end of the '50s, trading in the radar market was, for Marconi's, not very difficult - even quite developed countries' Authorities had not become sophisticated in specification writing. This, together with the Company's very wide network of associated companies and the post-colonial climate, gave the Company a head start against the competition. But, as time went on, and the radar art became more widely known and amenable to calculation, competition rapidly grew - life was fast becoming tougher.

Into the Sixties

The foregoing gives something of the flavour of the times and a fair picture of the Company I joined in May 1960 - and how it grew to such a stature. My difficulty from now on is what to leave out of the following story! Within a few days of my joining the Company, I was taken to Rivenhall, a disused airfield about 14 miles north of Chelmsford. The visit was arranged at this early date because, I was told, 'Rivenhall is closing down soon'; it is still in use by the Company today! There were examples of all the radars mentioned earlier, except the S232. I was shown the S264 first. Standing next to its whirling 50 ft aperture antenna and seeing its 1.5m³. turning gear I was deeply impressed by the sheer size of the things; I had never experienced engineering on this scale before. Being shown the transmitter cabinets and the gigantic modulator and transmitting tubes convinced me that my perceived image of the Company was a correct one. A few hundred yards away were the military radars - the back-to-back 'S' and 'L: band surveillance monsters and nearer the Display Room (one of a group of Nissen huts), the nodding height-finder. Gazing up at these from close quarters, one could only wonder how anybody could have the audacity to believe that such large structures could work - my word, they did - all over the world. I began to get the measure of the Company - as I returned to Church Green I modified, in my mind, the Company image. It now included the phrase 'the courage to think, and to do, big things.

A Testing Time

The following incident may help to underline the way in which the Company, at the working level, went about its business.

My first task was writing, ostensibly for later use in standard commercial documents, a unit-by-unit description of the S264. This, of course, ensured that I got a thorough understanding of the whole system.

A few weeks later I was taken on my first real site visit - to Warton, the English Electric base for its 'Lightning' aircraft testing. I figured out later that it was a test run to see what 'this fellow Cole' was like in action! The trip was timed to start from Chelmsford just after lunch on a Sunday afternoon. The late, great Leslie King, who looked after UK Civil business, was our driver. He was a big, bluff Falstaff of a man who I got to know and love well in later years. In 1972 he was elected Mayor of Chelmsford. Alan Carnell, Manager of ATC Sales, and Frank Martyr from Systems were the others of the 'examination' team. The first test came in the evening. I was introduced to Worthington 'E' on draught at the crumby hotel in Newcastle-under-Lyme where we stayed the night. Being in the north midlands, the beer was somewhat more powerful than we southern softies were used to. In the morning, all I wanted for breakfast was a lightly-boiled aspirin on toast! When we resumed our car journey to Warton, I was forced to request Les not to go so fast around the bends. We arrived about ten o'clock and we were taken to see the radar display. As usual in those days, it was in a darkened room. I studied the screen, holding on to the display's framework for fear of falling over - the rotating trace was doing unpleasant things to my sense of balance. The signals were there all right, but they looked all washed out, having no 'punch'. Yes, there did seem something wrong, as I had been told on the way up. I had been given to understand that the Marconi people on site were not able to find the trouble - that was the reason for my presence. I asked for the noise figure to be checked-all OK. Had someone set the display drive limiter at too low a level? No. Was the signal level at the display end of the remoting cable too low? No. I asked to be shown how the noise figure was measured and went up to the radar head. All seemed perfectly in order. I suddenly remembered that, in the low power version of the S264, as this was, the noise figure was measured after the signal had passed through a tuned cavity in the duplexer arrangement. If this was off-tune, the signals would be attenuated, but the noise figure would not appear to be affected. I asked for the tuning to be checked. Sure enough, the cavity was found to be off-tune and when this was rectified, the radar picture took on its accustomed 'sparkle' and all was well.

We went to lunch and I was 'examined' for 'customer inter-action'. I had the good fortune to sit next to Peter Twiss, the English Electric test pilot who once baled out at high altitude and still survived, despite his parachute not opening! I asked for, and got, permission to rub his back - in the hope that some of his luck would rub off on me. I presume I passed the 'examination', since I remained with the Company until 1992.

Engineering Style and the Rise of Systems Engineering

The engineering style adopted in the design of the new SR1000 series of radars had a direct and beneficial effect on the marketing process. Early on in their development history, decisions on standardization were taken. This was particularly helpful when it came to signal processing and displays - the areas where variations of facility to meet different customer requirements were mostly found. Practically all units, other than the transmitter and receiver, were housed in 19-inch wide, standard-height racks. Over the years, many different processing functions were designed - MTI cancellation circuits, Pulse Length discriminators, Video Blanking and Range gating units, Azimuth Following units, Angle Marker and Range marker units, Power Supply and Video Distribution units etc., etc. All these could be utilized to meet a wide variety of customer requirements. Each of the units had their characteristics (physical size, power requirements, inputs and outputs etc.) described in a library of Data Sheets. From this library, the Systems Engineer could determine the optimum equipment content for a given system and its rack layout in a very short time and an accurate equipment schedule could be quickly generated for budgetary quotations.

Often, the customer requirements could not be met by existing designs. Here the Systems Engineer would discuss the problems with Development Engineers and would subsequently write a specification for the designers to work to. Systems Engineers would also be responsible for generating the technical content of sales literature and proposals, participate in presentations to prospective customers and would be responsible for writing the overall performance specifications, often including Flight Trials and other operational tests.

Thus, from the late '50s and onwards, Systems Engineering became a key function in the Division's operations, setting the scene for its further growth of importance.

A Change of Culture

In the earlier days of the Division's operations, Systems, Systems Planning and Installation costs would be added to price estimates on a straight 'percentage' basis, the number being raised or lowered annually and its value determined by yearly business results. In those innocent days, English Electric gave Divisions a business target of around 15% return on capital employed - if the results were 7%, nobody got terribly excited; 10% return earned praise and a pat on the back!

Changes began in 1960. The costs mentioned above began to escalate, because of the increased work-load of Systems engineering.

But, more importantly, there was a change of business culture moving towards better financial control. Detailed price estimates were now required for every quotation, big or small. Traditionally, the Sales department was responsible for generating and managing estimates, but with the rise of the need for special engineering, the search for suitable OEM's equipment etc., responsibility for costing the ever-increasing peripheral activities fell to Systems Engineering, leaving the Sales Department with not much more than the pricing of the equipment schedules to generate, plus their eternal fight to reduce estimates.

Ian Donaldson, who became Manager of systems in 1965, was a meticulous man who thought very highly of his staff; so much so, that he was quick to persuade others to devolve more and more responsibilities to his Department. Systems Engineers became key players in collaborations and agreements with other companies, there being too few Sales staff who, on their own, were able to make good assessments of all-important technical issues. Thus the staff of Systems Engineers grew from about 20 in 1960 to about 150 in 1970.

This increase in the role of Systems Engineering in the Division's activities was given more impetus by the speed with which technology changed at that time. Sales staff had great difficulty in keeping up with the battery of new radar techniques which emerged, particularly with the advent of the widespread use of digital techniques. They sought and got, help from Systems Engineers who then became important members of Sales teams. And so, systems engineering became about the most interesting job in the radar game; and I was one of them - Great!

In 1960, the Sales, Systems, Development and Manufacturing groups were all at different locations. The all-important partnership between Systems and Sales was not expressed in the Division's management family tree. From the foregoing, it may have appeared that the relationship was not entirely a happy one. On the contrary; the Systems Department had a great many people who not only had an appreciation of technical matters, but enjoyed the business of 'Business' and the world of commerce. They wore, as it were, two hats - one technical and the other, commercial. Thus, they were able to bridge a gap between the two different worlds. At the working level this bridge carried its traffic in a very informal but effective way. Salesmen and Systems engineers would meet, almost daily, for lunch at various local hostelries and much useful interchange of business information would take place. Sales staff would get to know of new technical developments and their possible sales value; Systems staff would get to know of prospective sales opportunities. This ad hoc interrelationship existed for the military, naval and civil marketing groups into which the Division was organized at that time.

The Development group was centralized at Great Baddow in 1960 and frequent visits were necessary to conduct the growing need for interchange between the Systems and Development engineers. This separation had, for me at least, a very useful by-product. Because it took time and organization to make the trip from Church Green to Great Baddow, one was moved to make the best use of the visit. As a result, when the immediate business was done, it would be possible to 'do the rounds' of the labs to catch up on what progress had been made with their work, learn about emergent technology, etc. I recall going into the Display development labs on one occasion. I was eagerly beckoned by the Group Chief to witness the working of a new PPI which could write alphanumeric characters on the screen during the 'dead time' between radar repetition periods at more than twice the rate of current designs. This would be of great benefit operationally and a big marketing 'plus'. I enthused over their success and he looked very gratified. But suddenly his expression changed to concerned alarm. He looked earnestly at me and said 'Now you won't tell your mates at New Street about this, will you - they'll only go and sell it?. On my way back to base I pondered this rejoinder. It could be that he trusted in my silence, in which case it would make a good wry humoured joke to tell which showed that such blinkered attitudes still existed. On the other hand, he might have known that the first thing I would do would be to tell this 'joke' and their new success would become widely known. I like to think the latter was true.

It was about this time that I became aware of a paradox regarding the close connection between Development and Systems engineers. In the late '80s, I became anxious that this paradox was becoming dangerously real: it can be expressed thus:

As technology changes ever faster and sophistication in design becomes more complex, Development engineers are forced to specialize in narrower fields, for example, modulator design, transmitters, power supplies, etc. They begin to know more and more about less and less until, in the limit, they will know everything about nothing! On the other hand, Systems engineers, from the same pressures, are required to know something about everything. As technology changes ever faster, they are forced to know less and less about more and more, until, in the limit they end up knowing nothing about everything!

Stepping up a Gear

Col. Elford and his staff had, by 1961, built the Radar Division into a formidable player in the international radar market. In May of that year he relinquished his office as Divisional Manager to his deputy, Dr. Tom Straker. About this time, the UK Ministry of Transport and Civil Aviation (MTCA) began forming its specification for widespread implementation of Secondary Surveillance Radar (SSR) to supplement the primary radar coverage of the whole of the UK-controlled airspace. The only Company in the UK which had established itself in SSR technology was A. C. Cossor and Marconi saw an opportunity to challenge Cossor's pole position. This was encouraged by MTCA; if Marconi entered the bidding, MTCA could be seen to be encouraging competition in the cause of reducing public spending, for they were a Government Organization at that time.

SSR had proven to be an extremely useful tool for air traffic control. It gave not only aircraft position by its use of pulsed radar technique, but identity and altitude by virtue of the multi-pulse replies sent from aircraft using the internationally-agreed pulse position code structures. A further benefit was the SSR system's freedom from clutter; the Ground Interrogator used 1030 MHz on the up-link and the aircraft's replies were made at 1090 MHz. At that time, the SSR system characteristics agreed by ICAO allowed two different 'Signals in Space' formats for the Interrogations. The differences were primarily politically maintained - the '2 pulse' system upheld by European-influenced countries and the '3 pulse' by those aligned with the USA. The full story of this dreadful muddle would fill a book by itself. Suffice to say that because transponders used either one format or the other - and not both, ground interrogators had to be capable of stimulating replies from both types.

Thus, the UK MTCA. specification for the ground interrogators and their antennas required that they generate both up-link formats; but even more onerous - they had to be able to change from one to the other during the interpulse periods between successive interrogations. The complex design resulting from these requirements can be seen from reference (3). In 1962 the ATC world at large was looking more and more towards SSR to ease its problems. At every ATC Conference at that time and for years to come, it was a key topic of discussion. It was realised that there was going to be a very big market for SSR internationally. The Company was well placed to execute the design of the ground interrogator and its complicated antenna. But it would be seriously stretched if it had to develop the reply processing system as well. Taking these two circumstances together and, once again, 'thinking big', approaches were made to the Compagnie Francais Thomson Houston (CFTH) with a view to collaboration in the SSR market, for they had SSR decoder designs and expertise in reply processing. But, more importantly, both companies could see the benefits of collaboration on a much wider scale. Discussions at the highest level were entered into embracing the possibilities of shared research programmes and work.

In a post-Colonial world, both parties saw the advantages in combining activities in areas of the world where French or British influences and sympathies were still to be found; It represented a huge area of the globe.

By 1965 the total Anglo-French system -'SECAR' - came together at Rivenhall and in March of that year a week of demonstrations to an international audience was held (see fig. 5). At Dr. Straker's behest, an 'open day' was held at the end of the demonstration week for the families of those who had worked so hard and long to produce the system. The demonstration was a grand affair, despite miserable weather. Buffet lunches and general largesse were dispensed in a large marquee and coach-loads of visitors were bussed in and out.

Working with the French engineers was a novel experience for most of us working on the system; I had the job of liaison between the engineering groups. To us, it seemed that our French colleagues were forever arguing among themselves; so much so that one suspected that they would never be finished in time. However, they all seemed to pull together at the last moment and all was well. We became quite used to speaking 'Franglais' and, sometimes, we would find Anglophones speaking it among themselves.

All our hard work produced only very modest success in marketing terms. When bidding time for the UK MTCA business came (it was for the interrogator and antenna elements, without the decoding) we went through the long process of proposal writing and pricing. We lost the business. I subsequently learned from a member of the adjudicating committee that we were the only bidder to meet the specification and that our major competitor had been given a chance to resubmit their bid and won with it. However, we did win, jointly with CFTH, the Eurocontrol bids to supply two systems, one in Shannon, Ireland and the other for Brussels to serve the Eurocontrol ATC Centre (see fig. 6).

Later in 1967, we took the whole system over to Russia; they had advertised a huge country-wide requirement for SSR. Over a period of three weeks we gave lectures and demonstrations to a host of people. Time - lots of time - passed and little by little the prospect of succeeding dwindled. After 18 months, during which time I expect every circuit had been thoroughly examined and every unit drawn up, we offered the prototype for sale; 'Thanks, but No Thanks' came the answer and the equipment was shipped back to England, to become a test-bed for further work.

5 'SECAR'- interrogator response rack

6 `SECAR' antenna at Brussels airport

These were the high days of Charles de Gaulle. When it became known that Marconi and CFTH were collaborating, and Plessey and CSF were 'cosy', French policy determined that there would not be two handshakes across the Channel, but a single handshake across France - CSF and CFTH were merged to become the giant French outfit - TVT; the cry of 'Tout pour la Gloire' was once more heard in the land.

Our attempt to 'get into Europe' before the issue became a national one had failed. For myself and I believe many others, this was a sadness. Our history would have been completely different had the venture succeeded. Fortunately, as we will see later, our fortunes in the SSR field recovered.

More Bread upon Much Water

The bid to get into Europe and widen our market was complemented by another. A British Industrial Exhibition was to be held in Beijing (Peking at that time) in October of 1964. The Marconi Company was invited together with a large number of others ranging across a wide spectrum of industries. This was the first event of its kind since the 1949 Revolution in China, and at a period when nobody was allowed, nor even wanted, to go there. A representative from each of the Product Divisions of the Company formed a team which met for the first time in the offices of Marconi China in Hong Kong a week before the Exhibition. I was chosen to represent Radar Division and, in the preceding weeks, we were given the opportunity to submit papers on our 'specialist' subject - I chose The Role of Radar in ATC. All participating Companies were allowed to enter the lists - only a small number would be selected to present them during our stay during the Exhibition. All our team's submissions were accepted.

In Hong Kong, after having been briefed and taught to eat with chopsticks, off we went by train and plane, to the fabled city. We stayed for two weeks. During the second, we gave our presentations. The procedure had already taken on the character of a formal examination, by the submission of written papers; the next stage was the 'viva'. We were, individually, put in front of an inquisitor and invited to sit opposite him at his simple trestle table. He, like most of our courteous hosts, was dressed in the standard 'train-driver's' uniform. After a few pleasantries I was asked 'What do you specialize in?'. I tried to give some idea of what systems engineering was and that its nature required one to acquire breadth of knowledge rather than depth, that being provided through the principle of 'I don't know, but I'll find out from a man who does': thus, systems engineers specialized in not specializing. This cunning Western conundrum seemed to baffle him. I stopped trying to explain it when he began talking about the weather! Nevertheless, I began my presentations next day. These turned into virtual lectures lasting almost the whole of the working day. After the first day I was warmly thanked and asked if I could continue the next day. This I did, and for the next - and the following Saturday morning. I had managed to 'sell' the philosophy of 50cm as the best wavelength for an ATC radar and the beauties of our 'SECAR' SSR and fixed-coil display systems during this time. I came to realise afterwards, comparing notes with others, that our Chinese friends had a technique for dealing with visiting experts. They adopted something akin to the ancient Mandarin Civil Service examination which consisted of one question: 'Write down all you know'. They allowed us to give lectures until they knew we had no more to give. But I have to emphasise that it was all done with the utmost courtesy, grace and consideration.

Having had experience of life in Russia around that time and that we were in China just prior to the Cultural Revolution, one never felt quite at ease. I must admit that when, on the homeward journey, we crossed the bridge at Lo Wu out of Mainland China, I felt much as Christian in the Pilgrim's Progress must have felt when he was relieved of his burden at his journey's end.

Upheaval and Resettlement

The combination of new technology, widening markets and our success in reaching them looked, to Corporate Management, as though it could lead to severe overload if left to continue. It was decided to seek a better overall structure which would meet the changing business and technical world better. The business consultants, McKinsey's were engaged to do this in 1964, and their recommendations were acted upon. This led to the creation of three new groupings of the Marconi Company's Product Divisions. They were Telecommunications, Electronics, and Components Groups. Radar Division found itself in the Electronics group alongside two new related partners - Automation Division and Computer Division. The Telecomms Group contained a new Division - Space Communications, which was to take over work previously done by Radar Division.

In 1965, Dr. B. J. O'Kane, the Electronics Group Manager, appointed Mr. John Sutherland as Radar Division's Manager, who later became the Radar Company's Managing Director; posts he held with great success and distinction, until 1982. He thus became the longest serving CEO in Marconi Radar's history.

The reorganization into three Groups was largely motivated by market judgements which foresaw: a) a slowing down of Radar Air Defence business; b) a fast burgeoning of Space Communications business; and c) a growing market for Automation using microelectronics. Whilst proponents and antagonists for this forecast remain alive, there will always be argument on the matter; suffice to say that all these judgements were completely misguided as far as Radar Division's fortunes were concerned. History has shown that the Division stood on the threshold of its biggest growth and that the successes of the SCAT and Apollo Space Communications projects did not lead to a sustainable future in the business.

Similarly with microelectronics. Despite much effort and investment in plant and staff, the Company could not meet the competition of the day. The only real success in that realm was the emergence of the 'Myriad' computer, the fastest real-time machine on the market in those days (see fig. 7).

The re-organization had created new Divisions which took valuable skilled staff from Radar Division and exacerbated delays on several significant MoD contracts. Notable among these were the massive 'Linesman' and 'Green Ginger' projects. Both of these were regarded as vital to the defence of the realm. Linesman was the military part of a combined civil/ military project, the civil part being named 'Mediator'. They were aimed at getting comprehensive defence and air traffic control requirements satisfied in a harmonious manner. These projects included not only a large number of gigantic modern radars, but all the necessary control centres and communications infrastructure. For instance, Linesman involved three Type 85 and four Type 84 radars plus a Passive Detection system developed jointly with RAE. Green Ginger consisted of a mobile surveillance radar and height finder. Those wishing to know more of these should seek reference (2).

7 Myriad computer

The next explosion of radar business came from the NATO plan to establish the new NATO Air Defense Ground Environment (NADGE). In 1965 it was NATO practice to award contracts to consortia of companies from several different NATO member nations on the basis of the countries' contributions to NATO funds. Thus, there was a flurry of wheeling and dealing along the powerful corridors of Brussels, Paris, London and the like. Multi-partnered weddings were proposed, engaged, dissolved and, finally, consummated and bidding in earnest began. Marconi joined a consortium led by Hughes Aircraft Corporation together with four other European companies. After much negotiation and a second round of bidding, the Hughes bid won the contract which was let in 1966. The main content for Marconi was the supply of an updated version of the nodding height-finder, which now became the Type S269. In the first round of bidding for this business, Marconi included the Passive Detection system referred to above. This was unique to the Marconi Company and thus, could not be bid by any other competitor. This went against the NATO bidding rules and so had to be deleted from the second round bid. MRSL supplied updated versions of the S247 and fourteen S269s.

A New Impetus

The new corporate structure of the three groups included the establishment of formal Product Planning. Such a Department was set up in Radar Division in 1966. Gerald Taylor managed this small group of four people, myself included as his Deputy, with the brief to investigate such things as future ATC requirements, the likely lifetime of ILS, should we still be in the Radio Link business? etc. Alongside this, and independently, a small high-powered group of three - J.W. Sutherland, Divisional Manager, R.W Simons, Technical Manager, and H.N.C. Ellis-Robinson, Chief Development Engineer - deliberated on the next generation of military radars. Much market research was done

An observation is worth making here: it will be noted that the team of three mentioned above were all engineers. They were to make vital decisions with deeply significant commercial implications. The track record of technically-led ventures of this kind in our industry in the past was very bad;

I myself had seen Cossor ruined as a company because, after the war, it had been driven by engineers with little regard to the real commercial world and then virtually done to death by changing its management to one almost entirely dominated by accountants. The '50s were rich in such examples. Fortunately, this small team had the benefit of a great deal of commercial experience within them, being led by the Divisional Manager himself. Above all, they were all knowledgeable and experienced engineers with recent or current practice in modern technology.

Operational requirements were discussed and agreed: these were seen to be rooted in three main principles:

a) It must be a mobile system, capable of rapid deployment.

b) It must be very robust in the face of different types of 'jamming'.

c) It must be modular, capable of meeting a wide variety of threats over a pan-climatic range.

After some weeks of thinking and debate, sometimes, as one of the team has told me, when seated on the lunchtime bar stools of a local hostelry ('The Running Mare' at Galleywood), a series of development proposals were raised by E-R's staff, with costs and a business plan. The proposals asked for about £500K funding spread over three years. Upon submission to higher management, they were not signed. Nevertheless, the work was quickly begun and the funding found. Ironically, these proposals remain unsigned to this day.

The core of the S600 series consisted of containerized radar sensors, one working at S band and another at L band complete with their signal processing equipment. To these was added a C band nodding and height-finder. The containers were all helicopter C 130 transportable and ground mobile. The designs were made with cost-effectiveness and value-for-money as keynotes. As John Sutherland recalls, the work was fascinating and proceeded at a great pace; the key participants felt that they had their head at last.

Progress was swift and the system was able to be publicly announced at the Company's Agents conference in May 1967 and the Press invited the next day to demonstrations at the Bushy test site. A fully operational system was exhibited at the Farnborough Air Show in 1968 and soon after, the first sales were made. A typical S600 is shown deployed in fig. 8.

1967 saw some other notable events; the 'Myriad' computer had been developed from its prototype,

8 S600 Convoy

'Imp' and became the heart of the design for the big Flight Plan Processing system (FPPS) to be supplied to the Ministry of Aviation. The FPPS contract was signed in that year and the specification had extremely onerous requirements; for instance, the system called for very high levels of reliability which would give a probability of not more than one system failure in 50 years! It is a tribute to the designers that in its 17 years of 24-hour service, it never did have a system failure. Three Myriad computers were operated in parallel, each fed with the same inputs; their outputs were continuously compared and a 'majority voting' system was used in the event of malfunction of one of the three. The system handled all the flight planning for the whole of the very busy Southern half of the UK's controlled airspace.

Also in that year, the PX430* Research study for the Royal Navy was well advanced and began to put work into Radar Division's Development labs. This was the precursor of what was to become GWS25 - later 'Sea Wolf', the highly successful Naval defence weapons system. More ground radar business came from South Africa, Venezuela, and Saudi Arabia.

The Division was becoming over-burdened with MoD business; the Linesman work was increasing. A new London Air Traffic Control Centre was being planned by the Ministry Aviation and they looked to Marconi to put in a bid for the business. It was judged that if we won the bidding, we could not have coped with the load of designing the display and data handling systems.

*** into a quick response point defence system**

Consequently, we declined to bid. This caused uproar within Ministerial circles and, many believe, was responsible for a great cooling-off of relations between us from then on.

A Place of One's Own

In 1968 it was decided that the Division could no longer operate efficiently with its many arms at different locations - we should all be on one site. The old Crompton-Parkinson works at Writtle Road in Chelmsford was purchased and relocation began. During the year, most of the Development staff had moved there, joining the Sales and Marketing Departments. Over the next year the Systems Department also re-located and the Division was at last under one roof; metaphorically, for there were many buildings and long walks between them. Personally, I found my contacts with Development engineers became fewer than when we were separated by a car journey!

At this time the S600 series was creating great interest in MoD circles and it was found that the S600 met the initial specification the MoD put out for a transportable radar system. As so often is the case, they gradually increased the requirements and this resulted in failure to achieve the business.

Another Absorption

In 1968 English Electric took over Elliott Automation. Its Airspace Control Division was gifted to Radar Division which gave it responsibility for contracts which we had previously lost to Elliott on price. Fortunately, corporate management allocated funds to cover any losses incurred.

However, much good came from our inheriting some of their staff, business and technology. It was very fortunate that Elliott had expertise and business in SSR signal processing and also in radar simulators. Readers may remember that the Company's attempt to get a world-wide partnership with CFTH was wrecked by the French Government. The initial tangible example of the collaboration was 'SECAR', for which CFTH provided the decoding and SSR reply processing. Now, with Elliotts on board, Radar Division could replace the CFTH elements with those of our new colleagues. This task was not difficult, for the SSR system characteristics, pulse durations and spacing etc. were all laid down in ICAO specifications. Again, fortunately, in 1968 ICAO resolved the muddle of two different signals-in-space formats and settled upon the so-called'3-pulse system. For those interested in the history of electronics per se there is an irony here; the 3-pulse system was used by the USA and its adherents. It was the best because it demanded so little output power relative to its 2-pulse alternative. The 3-pulse system was originally proposed by the British in the mid-fifties!

The huge interrogator-Responser racks of the original SECAR were able to be substantially reduced in size. The interfacing with the Elliott decoding system was readily accomplished and the 'Challenger' SSR was born (see fig. 9).

9 ***Challenger interrogator-responser rack***

However, with a great deal of business to prosecute, and even more potential business within our grasp, a new trauma was upon us!

The EE and GEC Merger

In 1968, having previously assimilated AEI, GEC merged with English Electric. In the following year, 1969, the Radar Division was expanded to include the AEI establishments at Leicester and Trafford Park, plus assumption of responsibility for their contracts. The Division now became Marconi Radar Systems Limited. The perceived image of GEC within Marconi was not a good one. There seemed to be a great disparity between them: the swift selling of English Electric House in London seemed to confirm fears that 'GEC is a cash-hungry asset stripper'. Many Marconi people were seen to be, metaphorically, 'looking over their shoulders' expecting some nasty retribution from their new masters. The long-service, paternal, family ethos of Marconi was felt to be in jeopardy. This ethos was, for me exemplified by my observation that Marconi establishments were always within easy walking distance of places of interment; my own experience in the first ten years with the Company confirmed that. In fact, when I was re-located to Writtle Road my office overlooked the

Crematorium opposite. 'At last', I had often been heard to remark, 'I can see where I'm going!'

The fears remarked upon above were confirmed for many when the Trafford Park site was shut down within six weeks of the merger. The speed with which this was done caused great pain, havoc and confusion; it took three years to sort out the transfer and backlog of unopened mail etc.

The Board of Directors at the start of MRSL were:

J.W Sutherland	Managing Director,
M.C. Wolf	Marketing Director,
R.W Simons	Technical Director and Quality Director,
LP. Evans	General Manager (Borehamwood),
P. Way	General Manager (Leicester), and
D. Edmundson	Production Director.

In previous years, AEI had won a contract to supply Saudi Arabia with radars, Type 40T2. These were based on the Type 85 radar made by Metropolitan-Vickers but with some changes to the mechanical engineering. Marconi Radar were sub-contractors to AEI for the provision of displays. Under the merger, MRSL now became responsible for the whole contract. Unfortunately, AEI had accepted the business with a £3.7 million loss which MRSL now inherited, together with some technical problems. In fact, most of these inherited jobs required significant attention. The Saudi business 'SAGEU', was part of a massive defence project carried out by a consortium of British Aircraft Corporation, Airwork and AEI. It covered supply of 'Lightning' and 'Strikemaster' aircraft, a large training programme, maintenance and support across the board. After coming into its inheritance, MRSL had 3 GEC project managers on secondment to help recover from delays. They organized re-estimates of time and costs. It was found that the Saudi Air Force were themselves creating delay and thus a claim for extra funding was made, based upon the re-estimated figures. After much negotiation, the short-fall of £3.7 million was almost completely made up. From then on the MRSL part of the business progressed, now under MRSL management, according to the new plan, and handover achieved. The five 40T2s supplied were to feature in MRSL history at a later date (see fig. 10).

At the time of the AEI acquisition they were working on the SEADART tracking radar, Type 909 for fitment to Royal Navy Type 42 destroyers and 'Invincible' class aircraft carriers. The AEI teams were experienced in ground radar systems but lacked experience on recent naval environments and technology. They were having a difficult time. The fact that the contract disallowed the retention of prototypes for engineering or production reference proved to be a very false economy. As Mr. Sutherland expresses it: 'The combination of these two factors led to a system which met its specification but suffered reliability problems and acquired an enduring adverse reputation for the Company over a long period of years; this lingering blight was unjustified in the later years'. Four 909 radars were sold to the Argentine navy in two Type 42 destroyers sold by Vickers.

10 40T2-AEI's stacked-beam surveillance radar

Leicester were engaged in several diverse projects over the subsequent years: naval gun control systems, directors, launchers and turning gears, and their long-established degaussing and cathodic protection systems. They also designed a PV range of lightweight tracker radars for naval use, obtaining overseas sales; the Egyptian navy procured six fast patrol boats from Vosper Thornycroft equipped with these trackers.

This gradual progression of success was to receive a big set-back in 1980/81. As a result of defence cut-backs and a major MoD defence review, the majority of the Leicester development work on Type 909 improvements plus derivatives of the Surveillance and Target Indication Radar (STIR) was summarily cancelled. This represented a very high proportion of the total design and engineering load. Substantial claims for cancellation charges were made and granted; the projects could have been completed at almost the same overall cost. This cut-back, despite efforts at staff redeployment, led to making 600 development staff redundant - a tragic waste of talent and money.

The Impact of Technology on History

The history of any company results from the interplay of a great number of factors, particularly economics and politics. Those in the sphere of engineering are no less affected by these and, as for other types of business, they have little - if any - power to control them. But in engineering, there is one factor which is of high significance over which they do have a great deal of influence and control and that is the development and adaptation of technologies. The degree to which this is true can be gauged from the history of Marconi Radar in the Air Traffic Control field.

The technical, operational and commercial advantages gained by the Company's exploitation of the 50cm wavelength has already been mentioned. A further reason for its success is all too often forgotten, probably because of its simplicity. For decades beyond the '50s, radar displays were operated in real time; the radar signals were written on the tube's phosphor as they appeared in the system and lasted (at low light level) for as long as the tube's afterglow was visible - about 20 to 30 seconds in the very low ambient lighting of ATC Operations rooms.

The original 50cm radars, S232 and S264, had beamwidths and pulse durations which gave the radar signals a relatively large size on the 12-inch diameter tube screen. For example, in the S232, with a beamwidth of four degrees and pulse duration of two microseconds, the aircraft signals when seen on the short-range scale of the display had physical dimensions of about a centimetre in azimuth and four millimetres in range at the tube's edge. This changed itself' to a four millimetre square at mid range.

The MTI was capable of removing ground clutter from the screen and thus, the aircraft signals appeared clearly. So large and clear were they that it gave the radar a unique character. As one stood at the threshold of an operations room door and looked through the gloom at the displays some ten metres away, one was **shown** the aircraft - they did not have to be **looked for** as in many other types of radar. This clarity was of great benefit to Controllers who often had to do things that caused them to look away from the tube's face-peripheral vision allowed them still to see the signals because of their size.

These radars and their successors, S650 and S670, developed as part of the S600 series were sold to 15 different countries over the period 1957 to 1976. A total of 57 installations were achieved.

But why did they become, eventually, unmarketable when their performance was so good? Here, politics and technology combined to play their part. In the early days of their history, these radars had sole use of the 24MHz band allotted at 600MHz as, by international agreement, 'Navigational Aids'. The fact that they used a self-coherent system through the use of power amplifiers for transmission gave the MTI exceptional (for those days) quality. Their 10cm rivals had great trouble countering weather clutter; in fact, apart from circular polarization techniques, there were only crude ways of enhancing the target to weather clutter ratio. Things were made slightly more difficult in 1965 when the international regulations split the 24MHz band into three lots of 8MHz with users able to share the 8MHz sub-bands with communications facilities.

Although there were 23cm radars emerging at this time, they were without benefit of digital signal processing and thus, could still not match the 50 cm MTI performance even with the improved analogue dual cancellation techniques available to all radars at that time. In fact, many viewed a 23 cm radar as giving the 'worst of both worlds' - it still had a much larger antenna than its 10 cm rival and had not sufficient weather immunity to match that of 50cm. Although the target visibility on displays was improving by the use of plot extraction, such processors were still quite crude and, without associated SSR, crossing tracks would become confused and ambiguous.

From the '70s, solid-state and digital engineering grew apace and soon became applied to MTI and Plot Extraction processes. These, together with improved stability of transmitters, produced MTI performance in 23cm systems which equalled that of 50cm equipments in pre-digital days. The concurrent spread of the use of SSR in conjunction with primary radars, plus the invention of better tracking algorithms meant that radar signal display need no longer be limited to the real-time domain and high-brightness target visibility was obtained.

In 1980, at the Company's test site at Bushy Hill, I saw the first example of a 23cm ATC radar, using digital MTI and other processes which gave as good a 'real-time' picture as the 50cm equivalent - at long last.

The Payoff Begins

The successes of the early sixties gave the Radar company a growing reputation in the international market-place, both in the civil and military spheres. Now began a tremendous spurt of sales of the S600 radars in the military area. In the decade

'67 to '77, 74 systems were sold world-wide. The Sales figures for the period of Radar Division's history show, on a five-year running average basis, £4 million in 1956 rising to £30 in 1967. In 1977 the order book was in excess of £150 million. The first half of the '70s saw a massive increase in business for the S600 military systems, finding markets in unlikely places such as the former Yugoslavia, which proved to be a very big customer over a long period of years. Development of the S600 series was still going on in the late '60s. Product Planning had carried out a world-wide survey of primary radar ATC requirements. It showed that the world was looking to 23cm for the future with high priority being given to anti-clutter performance plus reliability. In an attempt to improve MTI performance, some manufacturers had modified their existing antenna designs to include a second beam by the addition of another feed horn. It had less gain at the lower elevation angles. The idea behind this was that by reducing the gain at very low elevations - which would include ground clutter - and keeping higher gain at higher elevation angles - which included aircraft - there would be an improvement in the over-all aircraft-to-ground-clutter ratio. The upper beam of course would be used in a 'receive only` mode, having its own separate receiver. A simple coaxial change-over switch would allow beam selection at a given range, thus preserving the full force of the main beam's gain at low elevations outside regions of high-level local clutter. This 'add-on' approach meant compromise in the antenna performance, for the second beam's feed put up antenna blockage and the reflector's profile had been designed only for a single beam.

In response to this, the Antenna Department at Baddow designed a double-curvature antenna with dual beams formed by two horns at a long focal length. It was designed from the outset specifically to produce the best enhancement of aircraft-to-ground-clutter ratio at low elevations and with emphasized gain at high elevation, so that any swept gain applied to reduce the main beam's gain at short ranges would not unduly eat into high cover at close ranges. This became the first antenna specially designed for the ATC role having dual beam operation. The S600's L-band transmitter/receiver and signal processor was simply modified to include a range-dependent changeover switch and the whole system formed the S654 (see fig. 11).

The first of these radars was installed in 1972 as the bed-rock of a Military ATC radar system for the Royal Canadian Air Force at Lahr in Germany with a companion system far away in British Colombia at Comox, just north of Vancouver.

These were both established as the second of a two-phase programme, the first phase being the installation of standard S600 L-band primary radars. The first phase, in Comox in 1970, began with the crash delivery (in nine months) of the primary radar by Hercules air-lift. The success of the S654 led to its being supplied to Saudi Arabia in the SIMCATS Project, of which more later.

Consolidation

It is difficult to convey the spirit of the times for the Company in the '70s; there were so many relatively small groups of people - Sales, Systems, Contracts, Field Services, Installation Designers etc., - who were expert in dealing with their own special corner of the market, their customers and system users. It was these groups, seeing new opportunities as they arose in their own special areas, who were the power house of the growing order books.

In the Naval sphere, the PX430 study into the design of an anti-missile system had crystallized into Sea Wolf in 1970 and major parts of the system were designed in 1971. Work on an Infantry Patrol Radar was still going on and the FPPS system was preceding apace. Despite the busyness of people with work on hand, thoughts for the future were still bubbling up. The S600 series was based on an operational principle which, in turn was part of a philosophy of the time; this was that the provision of Radar Air Defence facilities by a 3-D radar, although possible, was too inflexible and expensive to be practicable at the time - far better to have modular 2-D Surveillance radars, backed by a small height-finder and making them all easily and rapidly deployable and mobile. It was realised, of course, that the cost of 3-D radars and

11S654 - L-band dual-beam surveillance radar

their reliability would, in time, both be brought to acceptable levels - we must be prepared for this and plan to use the technique of 3-D for the future. As a result, the beginnings of what was to become the Marconi Radar 'flagship' - Martello - were proposed. The first seeds were sown by research work carried out at Baddow in 1968 onwards into a new way of generating and extracting radar data. The technique entitled STAR (Storage Array Radar) was one in which a broad beam was used to 'floodlight' an area. A linear array of elements forming a receiver array with a narrow beam had phase shifters in each element so that the narrow beam could be 'steered' to particular azimuths across the floodlit area. The whole system was non-rotating and allowed long integration times - the received signals were 'stored' in the system permitting correlations to be sought. RRE gave the Company a contract in 1970 to build a demonstration system. From this came the precursor to Martello - the Rampart system whose metamorphosis will be described later.

Another contract inherited by the Company from Elliott was the Stand-by Early Warning and Control system (SLEWC). This started its life as a joint project between Decca and Elliott under the MoD title of GL161. It was to provide a data handling equipment, giving autonomous interception control capability to Air Defense Reporting Stations. The SLEWC installations were modified to include the use of SSR/IFF data in its digital processing inputs and, in one, a simulator facility was also included which provided software for later exploitation in other marketing areas. Much profitable business was created by this, including the ability to extend our capabilities in the ATC radar market. The contract was completed in 1974.

Elliott Automation was a pioneer of digital technology and its Airspace Control Division brought to Marconi Radar the data handling elements of automated air defence systems, digital processing of SSR signals and the then new technology of digital radar simulation systems. These were of tremendous use to those engaged in the training of fighter controllers and air traffic controllers. Elliotts had been responsible for developing this technology under RRE sponsorship and, as we have seen, brought contracts with them when they joined MRSL. I got first-hand knowledge of the usefulness of the techniques of radar simulation when I inherited systems responsibility for a contract to supply the Egyptian Air Force with two simulator systems. Their value to the user lay in the realism created by the system which allowed extremely life-like scenarios to be presented to students without the need for actual aircraft flights, thus avoiding the enormous expense of flying and the hazards of real-life interceptions going wrong! The Elliott 905 computer and its peripheral equipment generated radar signals to simulate ground and weather clutter, radar signals generated by aircraft, complete with 'target glint', realistic vertical polar diagrams with mountain 'shadowing' where appropriate and IFF signals for friendly aircraft. Aircraft tracks could be set up and steered by 'pilots' operating one of a suite of tabular displays and keyboards upon which speed, heading, aircraft size (echoing area), state of weapons etc. could be input. The 'pilots' would be in simulated radio contact with trainee controllers who would exercise their skills by viewing the radar PPI. Thus, with these same facilities, both air traffic controllers or intercept controllers could be trained. In interceptions for added realism, the aircraft's missiles would sometimes fail in a random fashion by dint of the system 'rolling a die' upon which one face said 'Bent Weapon'!

The two systems were completely assembled in the Precommissioning Test Area at Baddow in 1971 so that the software and all facilities could be thoroughly checked before delivery. I was sorry to see them disappear to their destination in 1972 - I'd never had such a lovely big toy to play with before. When a scaled-down version of it was taken to the Farnborough Air Show we became hoarse from telling the hoards of visitors all about its workings. Subsequently, about fifteen similar systems were sold to Singapore, Jordan, Kenya, Oman, Australia and the Royal Air Force.

1972 saw the hand-over of the FPPS system at West Drayton and the start of the Comox phase two programme. This went very smoothly, the S654 having had its teething troubles sorted out at the other Canadian Air Base at Lahr in Germany. It was at this station that further work on 'Angels' was carried out. The S654 had the best available MTI and anti-rain clutter facilities of the day, the antenna having circular polarization built into its feed horns. Nevertheless, in spring the display screen would sometimes become absolutely covered in what appeared to be high level noise. For a radius of 120 nautical miles, the radar was swamped with this unfamiliar clutter. It would last for long periods over a stretch of days and then subside, only to re-appear a few days later. Its movement did not always correlate with winds. The same thing occurred in the autumn and the effect ascribed to various possible causes. The main contender was 'Angels' - flocks of birds as discovered by Dr. Eastwood many years previously and reported in his book 'Radar Ornithology'[(4)]. 1 was responsible for the whole system there and, in company with the Canadian Air Force Project Officer, asked the question that if the cause was birds, why weren't we knee-deep in bird droppings? There were such multitudes of them that they surely would have made themselves visible by more than just radar means. Eventually the RCAF Project Officer commissioned a study to be carried out. Fortunately, we had the services of Mr. George Rider, himself a co-worker with Dr. Eastwood on his definitive angel studies. Various techniques to isolate the strange clutter signals were tried, including an analysis of the Doppler components. No proof positive came until an old X-band narrow-beam approach radar was adapted to look straight up in the air, without scanning. Film records were made of the video output from this which could be correlated with simultaneous records of the PPI display. The make-shift X-band radar had resolution enough (100 ns pulse duration) to register individual birds which were seen, upon showing the film, passing through the narrow beam in great profusion. They correlated extremely well with the clutter on the PPI. Subsequent calculation showed that these birds flocked from north to south down the Rhine Valley in streams of millions during their migratory journey to sunny climes. The noise-like character of the clutter they created was caused through their flying in uncoordinated flocks; there were enough of their number in a resolution cell of the S654 to create a signal above noise and their individual motion gave no coherent Doppler signature within any specific resolution cell; hence the noiselike nature of the clutter A quickly-designed modification to the system's Swept Gain circuits gave a selection of values from which to choose and the clutter was cleared without great sacrifice to radar performance on aircraft.

Support

The S600 series sales were exclusively export business; mainly to emergent and under-developed countries. Although training courses at the Marconi College were established to ensure that when the systems were put into service, there were trained personnel to keep them running, the way of the world prevented this from happening in all cases. Some of our customers sent keen young officers to the College with the intention that they absorb enough knowledge to be able to train instructors upon their return home. Quite often, these officers were 'high fliers' and when they got back to base, found that they had been promoted, leaving the business of training instructors undone. Others considered the trip to the UK as a sort of reward for good behaviour and did not treat their training course with the seriousness it demanded. As a result, too often it was found that the equipment in the field became poorly maintained and off the air for long periods for want of the skills to effect repairs.

I remember the late Bruce Neale telling me once of a trip he made to investigate this sort of trouble at first hand; he was the Chief Development Engineer at the time and deeply concerned with and for the S600. When he arrived on site, in blistering heat, he went into one of the transmitter cabins. There, he found a distraught mechanic peering intently at the small temperature gauge on the transmitter's control panel. He was tapping it furiously. 'Oh, Sahib', he cried plaintively, 'Oh, Sahib, If only the little needle would go away from the red and back into the green, all would be well!' Needless to say, it was not long before the station got a Resident Maintenance Engineer under contract to sort things out and to give on-the-spot tuition.

This method of ensuring that the necessary expertise was in place was used increasingly as the S600 and other radars found their way into the wider market - it was not only the newly-emerging nations that found themselves in need of the RME's services. This on-the-spot support had the advantage that the RME could make his own assessment of the competency of the local Technicians, bring them up to the required standard and thus ensure that the Company's reputation was not sullied for wrong reasons.

Support Division originally came under the wing of Marconi's Central Division. When the Radar Company was formed, Support Division was split between the Radar and the now independent Communications Company.

Although a Division of the Radar Company in its own right, 'Support' in its widest sense came from distinct but related arms. Those closest to the Customer when a system was put into the field were the members of Field Services from which the installation teams were drawn. They also furnished the RMEs when they were called for after an installation was completed. Next came Spares and Repairs - to many, a boring but absolutely vital part of Customer support. In parallel with these came the Marconi College who provided the training courses at different levels, sometimes running courses for Instructors so that the students could set up their own training courses for technicians in their home country. A vital arm of Support was the Technical Publications Department from whom came all the Operating and Maintenance manuals. Finally, a function carried out as a long-term background to our business was the Post-Design Services Department. They were concerned to ensure that any components which became obsolete had modern and adequate substitutes. They also conducted tests on equipment where designs were suspected of 'out-of-spec' performance.

They also handled the business of implementing modifications which enhanced performance of existing equipments or became necessary to accommodate new components replacing obsolete ones.

All these Support functions created a huge amount of revenue for the Company and were an enormous help in raising the reputation of Marconi Radar as a company upon whom one could rely for back-up when in trouble. Support Division itself developed its own entrepreneurial expertise in selling refurbished systems. In the years of the rundown of the use of 50cm radars, there were many equipments being scrapped by users who had been forced by the international regulations to abandon the frequency. There were yet others who were able to keep them on the air (since their Regional Authorities had reserved the band still for radar use). These faithful users were glad to have a source of major spares such as antenna turning gears etc. The UK CAA was among these and much business was created by re-cycling previously-used equipment.

Sea Wolf - GWS 25

Sea Wolf, the rapid reaction anti-missile defence system for the Royal Navy, was to become the Company's breadwinner in later years and so deserves more than passing mention. Development work was conducted at a rapid pace from 1970, resulting in achieving production versions in 1973. It consists of a Surveillance radar, which allows targets to be acquired by entirely automatic means. Missiles launched at the mother ship are automatically tracked and their position and track data passed to the anti-missile launching system. Upon launch, it has steering data passed to it by a J-band data link. The whole system is fully automatic, requiring no manual operations in target acquisition or evaluation. There is, however, a television sub-system which monitors the defending missile's flight; this sub-system can also be used for back-up in the event of a radar system failure. The design philosophy was one wherein the missile was kept as simple and cheap as possible, all complications resulting from this were in the ship-borne equipment and thus much easier to manage. The defending missile was made by BAC under contract to a Ministry different to that funding the ship-borne system; these two Ministries seldom talked to each other, which created unwanted and frustrating delays. These were further exacerbated

12 G WS 25 -naval defence radar and tracker

by the imposition of a Ferranti computer in the system. BAC began their work well in advance of the Radar Company and, as MRSL were breaking new ground in tracking techniques, delays were generated by software problems. Despite this, the trial firings on HMS Penelope in early 1975 were repeatedly successful. For these, an 'attacking' vessel would lay off about 20 km from the GWS25 - defended ship and fire a 4.5-inch shell at it at a randomly-chosen time unknown to the defender. Within seconds, the GWS25 system would detect and destroy it in flight. This impressive 'party trick' was used as a standard demonstration to prospective customers - it was very persuasive! The first system was delivered to the Royal Navy in 1977. Its success led to the development of lightweight versions which sold in significant numbers to the export market. The system is illustrated in fig. 12.

The system's performance was outstanding, not only because of its completely automatic operation, but for its intrinsic radar performance. The Surveillance radar had a 99.9% PD on a 0.1 m2 target, using pulse Doppler clutter suppression (90db) when the ship was making 10 knots. The Tracking radar, also using pulse Doppler, had similar clutter suppression performance. It used differential tracking on both attacking and defending missiles (the latter being distinguished by gaining the name 'Hittile'! The track difference became the command signals for guidance of the 'hittile'). The system was also able to command two 'hittiles' at once.

Once, using the standard 'party trick', the Royal Navy were showing the system off to a group of visiting American admirals. The visitors refused to believe that the whole thing was 'for real' - they said: 'You Brits are having us on'; they couldn't believe the 90% success rate achieved. However, we didn't lose any business through their disbelief - the 'Buy America' act saw to that.

GWS25 was another 'world first' for Marconi. It is the Royal Navy's standard fit today. To me, it represents yet another example of the - somehow innate - genius that the Company fostered. In the example above we have an experienced group of sophisticated people who refused to believe their eyes. I am reminded that there were others in the past who refused to believe that Marconi himself had heard the 'the Morse Code S s'. More fool they.

The Scottish Air Traffic Control System - SCATCC

In the '70s, the legacy of a great deal of experience in the use of microelectronics bore a new fruit - the idea of using intercommunicating printed circuit boards by means of a 'highway', system. The architecture led to a very compact and flexible system of providing all sorts of facilities.

The engineering form - entitled 'Locus' used boards of a standard size with all contacts at one end which plugged into a multi-tracked 'mother' board at right angles to them. Thus, a standard 19-inch frame unit with its mother board could take all manner of different processors, all communicating through the highways on the mother board. This architecture endured for very many years and by 1990 had over 150 different types of processor that could be put together in a wide variety of roles. In 1974 the UK CAA placed a contract with the Company for the provision of a new ATC Centre at Prestwick for the purpose of controlling the air traffic in the whole of the Scottish region of the UK. Its task was to take the data from radar outstations in the region and allow operators to select them for display and control. Tracking routines within the system made it possible to display targets in symbolic form, with leader lines emanating from the target. These lines had a length proportional to the target's speed and their bearing representing the target heading. The outstations had both primary and secondary radar sensors, so the Control displays had the most complete data on air traffic that it was possible to extract - position, heading, speed, height, identity. In all there were over 30 PPI displays, each fed by Locus-engineered processors. The system is illustrated in fig. 13.

Management Reorganization

In the following year,1975, the Company was reorganized without General Managers. Central control of the Company was re-established at Chelmsford with Mr. R. W. Simons assuming Production Directorship of the three main manufacturing centres at Chelmsford, Gateshead and Leicester.

13 SCATCC -display suite

He still retained his role as Technical Director. By this time, the Company had grown out of all proportion to its humble beginnings, having now an annual turnover of £66 million with 5500 personnel. Work and plans for the future continued apace.

SIMCATS: The Saudi Integrated Military and Civil ATC System

The history of this business is a prime example of the sometimes, almost literally, elephantine gestation period for the radar market. The first stirrings of business came in 1971 with an invitation to a meeting in Geneva with the Lockheed Corporation to discuss a mutual strategy for the business. Lockheed were to be prime contractors, with MRSL handling all the radar and associated electronics. ITT were to supply other substantial communications systems. The meeting was attended by Mike Wolf, MRSL's Commercial Director at the time; he was accompanied by Gerald Taylor (for many years, manager of the ATC Group) who used his great experience and expertise in all technical matters pertaining to ATC. It was agreed that a Study be carried out which would end with a series of recommendations for implementation.

From these, a priced proposal would emerge. A series of meetings from then on, together with the study work, led to a proposal being presented to the Saudi Authorities in 1974. This was well received, but, they said, it is not extensive enough!. They asked for the project to be enlarged to embrace a full-scale modernization of all their Civil ATC facilities. A new proposal was submitted and approved. Then began the long process of contract negotiation before a final contract was entered into in 1976. The contract value for MRSL was a staggering $120 million, embracing the modification of the Type 40T2 radars installed under the SAGEU project, the supply of four S654 primary radars, nine S464 SSRs, primary and secondary radar plot extractors plus display suites for the Control Centres. An example of each of the system elements was installed at a Training School to ensure that Engineers and Operators were given adequate training.

The SSR was a new design, begun in 1974. I was given the task of coming up with a system which would be a low-cost market competitor to our main rival Cossor, who dominated in parts of the world not under US sway. The biggest question was: 'should we make our own Interrogator/Responser or buy in?' The old SECAR design - far too expensive even to contemplate using - was quickly discarded and estimates prepared for a new 'bare bones' unit with the minimum power necessary to meet ICAO requirements. In the end the decision was to buy in both the antennas and Interrogators from US sources. Both were extensively tested and found to be first class and in NATO service (see fig. 14). Unfortunately, I had followed my brief too assiduously 'Keep the costs as low as you can'; when our Customer's Project Leader inspected it, he demanded some cosmetic re-engineering.

He had a nasty habit of being gratuitously insulting to the Company and expressed himself, continuously, in a foul-mouthed manner; so much so that I took great exception to it. As a result I became, as it were, *persona non grata* before we got into contract. It was not without bonus, however, since I was not required to join the 'in-country' team. I felt so strongly on the matter of the abusive terms used against us that I was prepared to resign rather than put up with it. However, all was made well and I was kept out of the way!

From the mid-sixties, the Company had embraced the principles of Project Control through the use of the fashionable PERT and related techniques. We were, almost to a man and woman, sent on PERT courses to learn how to use these novel tools. Unfortunately, in practice, too many people thought that a progress chart was meant merely to tell how late a project was! The SIMCATS contract required that monthly progress charts be submitted and sent to the Lockheed Project Office in Riyadh. This, of course, was done. I remember Gerald Taylor, one of the prime architects of this huge business, saying that when he paid a visit to site towards the end of the implementation phase he was shown around the Project Office premises. He asked of a particular room not offered to him for inspection - 'What's in there?' Upon entering he found ceiling-high stacks of computer print-out paper. He enquired what all the paperwork was; 'Oh, they're all your monthly Project print-outs - nobody ever looks at them!' Still, one mustn't carp; at least we can sing with Flanders and Swann: 'It all makes work for the working man to do'.

Early on in the contract, the whole Project team were located separately from the main Writtle Road buildings and operated from 'Y' Block. This was a set of offices next to the Crematorium on its eastern side (see earlier remarks!). This avoided any visiting members of the Prime Contractor accidentally encountering work in progress (or not in progress).

It was a great pity that such a large and prestigious body of work, in a very important part of the market at the time, was not able to be publicized. The Saudi Authorities would not permit any advertising of this great success. This was a time when we could very well have benefited from such publicity. On the 'plus' side - a very big plus - was the fact that Mike Wolf, the Marketing Director of the day, insisted that our contract with Lockheed was for payment in US Dollars. As the Pound was almost consistently falling during the whole contract period, the Company gained greatly from this. The contract ran for four years and, towards its end, extra revenue came from a claim the Company made against Lockheed for compensation for delays caused by them. Geoff Wheeler, a Senior Project Manager and an old hand at managing such matters, succeeded in squeezing another $3 million from them.

14 S464-interroqator-responserrack

Martello

The S600 series of radars was an unqualified success. This success resulted from applying classical marketing principles, notoriously difficult to do in the High Cost Capital goods field; predicting what the market wants and planning to produce it at a price users are prepared to pay means long-term commitment of massive resources - if you get it wrong, the results can be ruinous. It had been judged that the S600 series would become obsolescent by the late '70s and that the market need would be different. It was argued that the requirement for larger and more expensive systems was being satisfied in the UK by 'LINESMAN', in NATO by NADGE, in Saudi Arabia by SAGEU - in all of which MRSL was a major player. In the US these needs were satisfied by their own indigenous products, almost impossible to dislodge. However, the need persisted for the performance of the big static radars to be achieved by a mobile system. At the same time, electronic warfare was increasingly significant and resistance to 'jamming' was also vital. Air Defence radars have to provide height data on non-co-operative targets, thus to meet the needs the new radar must, perforce, be 3-D.

The STAR system described earlier had been tried out, using an S600 radar as an illuminator with a STAR vertical array to provide the necessary height data by within-beam scanning in the vertical plane. This was found to be much too expensive in bandwidth and money to give a marketable product. However, the technique could be adapted to provide a set of beams, overlapping in elevation. Each beam would have its own receiver and because the beams would be present simultaneously, monopulse technique could be used to get height data on targets from a knowledge of elevation and range. The beams would be formed by combining the receiver outputs at IF. By governing the precise phase and amplitude of these IF outputs and combining them in a passive beam-forming network, the individual beam's elevation angle could be accurately fixed. For target illumination the beams would effectively be combined to form one 'cosecant squared' pattern during transmission. It was decided that the Company make a massive investment in a new family of 3-D radars using this systems architecture, with the family name 'Martello'.

The early work had already begun in 1973; a programme of definition for development having been mapped out. This was under the project name of RAMPART. At the time NATO had only an outline specification but it included restricting the operating frequency to the S-band (10 cm). It became clear that the range requirement called for exorbitant output power, extremely difficult to achieve; an L-band solution would clearly be preferable.

The UK MoD had expressed the view that the frequency band ought not to be specified in order to give manufacturers the greatest freedom to offer a wider variety of systems. In 1974 NATO deleted its preference for S-band, but their specification was still incomplete; there was still dissent among the NATO host countries on details of the specification. In the light of this, the Company took a chance and started a major development programme on an L-band solution expressly aimed at the NATO draft specification. Thus, the S713 began its life as father of the Martello family.

Its antenna was a planar array consisting of a vertical stack of identical linear radiators, each 6 m wide and centre fed. There were sixty of these mounted on a central spine on a rotating pedestal. The vertical stack was 10.6m high. When I first stood alongside this gigantic structure I was awestruck; it seemed impossibly large and I marvelled at the courage it took to risk such a huge investment; what if it should not succeed?.

The array formed eight beams in the vertical plane. When in transmit mode, their combined pattern was used to radiate power provided by a coherent wide-band Twystron; pulse compression was used to enhance clutter rejection and resolution. The gigantic antenna was raised or lowered by a hydraulically-powered set of rams, the whole being transported on a long trailer chassis. A subsidiary trailer fitted with a twenty foot ISO container carried the radar head electronics including a two position radar management display suite. Readers will get some impression of the great engineering skill required to bring the system into being from fig. 15. MARTELLO was first exhibited at the Farnborough Air Show in 1978, creating a great deal of interest. Soon after came an order from the UK MoD for four systems and, not long after that, the Company was awarded the Queen's Award to Industry for Technology.

Despite the well-deserved and much-appreciated praise heaped upon all those engaged in designing and producing Martello, all was not as well as one would desire. There is no end to the 'gamesmanship', lobbying, persuasion and pressurizing by 'interested parties' to influence those who write specifications. Up to the time Martello was produced there had been no substantial changes to the NATO specification. However, there had been considerable debate between the Service and Technical Groups of host countries. By the end of 1978 it became apparent that the NATO and

UK definition of height accuracy determination was being relaxed, while that of target discrimination was being tightened. These changes were taking the NATO specification out of Martello's reach. This was a devastating set-back for the Company.

The implications were that the whole antenna, receivers, and beam-forming network would need complete redesign and become the S723. After the understandable panic had subsided, it was realised that semiconductor technology had reached a point where an all-solid-state distributed transmitter system could be a viable reality. The difficult decision to begin a re-design of the S713 was immediately taken. The same system architecture was retained with one significant difference - the transmitter was now no longer a single entity; it was provided by giving each of the linear array boards its own transistorised L-band power unit as well as its own receiver. The antenna was also re-designed and now consisted of a vertical stack of forty identical linear arrays, giving a height of 7.1 m. A narrower azimuth beam was formed by increasing the antenna width to 12.2m. The spine carrying the linear arrays was also completely different; it now contained all the electronics for the transmitters and receivers, beam-forming network, drive circuits and power supplies. The S723 formed its surveillance cover by synthesizing all eight beams. As in the S713, all beams used pulse compression and digital signal processing, the targets being plot extracted and their height given by monopulse processing. Fortunately costs were kept down because full anti-clutter processing was only required on the two lowest elevation beams. A picture of the S723 is given in fig. 16. It was first seen in public at the 1984 Farnborough Air Show. Having been over-awed

16 MARTELLO - S723

by the first sight of the S713, one would have expected to be a little blasé regarding 'big engin-eering - not a bit of it! I was absolutely bowled over when standing next to the new S723 whilst it was rotating. It was a real triumph of mechanical and electronic engineering. Its virtues were quick to be appreciated by the RAF who purchased four systems. These were accepted into full service in 1989. Martello became the Company's `flagship' radar.

Earlier, reference was made to the power of lobbyists and that sometimes pressure is brought to bear on those writing specifications to include or exclude certain things; I was reminded of an occasion when I was asked to do just this. It was during a programme of radar fitment which would later be greatly extended. The Customer's project leader mentioned that there were opponents of his who wanted to chose an S-band solution to their problems; he wanted L-band. I mentioned to him that it was possible to prepare a good case for either wavelength - there were as many 'pros' as 'cons' on both sides. Much encouraged, he said to me 'Harry, I want you to prepare me a well-balanced and impartial paper on the subject **which damns S-band to Hell!'.** I duly obliged.

Naval Radar Developments

After the remarkable success of Sea Wolf, thoughts turned to the possibility of a light-weight version for Patrol boats and Frigates. The market for these would be very large. In 1978 a design for such a system was proposed. In the following year the MoD urged the Company to increase its manufacturing capacity to step up the rate of production of the 909 Sea Dart radars by three times. At the same time, negotiations were proceeding with the

15 MARTELLO - S713

Canadian Navy for equipping their Frigates. There was yet more pressure from the UK MoD for increasing the production rate of the 909. In fact, all was hustle and bustle on the Naval Radar front. In 1980 the development of a new series - the 800 -
was increased and there was yet more debate on the proposed light-weight Sea Wolf; it began its development in 1981.

That year proved to be one of the most traumatic for the Company; most particularly for the Staff at Leicester. The then Minister of Defence, John Nott, announced massive cuts in the Defence Budget. The Navy's funds were deeply slashed and the shipbuilding programme was reduced, removing the need for extra 909 radars. As a result, 600 redundancies were declared at Leicester. Just about half of the Engineering staff were required to go. This bitter blow, the first of many to come, is still felt. When I talked to Roy Simons about this history and he recalled the day he had to go to Leicester to break the fell news; I could see the pain of it still lingering. Nevertheless, the new 805 SW was completed and in 1984 the Company handed over the first system to the Royal Navy. At that time the Navy had already ordered 32 805SW trackers. In the Royal Navy Frigates, the tracker operated in conjunction with a new Surveillance radar, the Type 967.

More ATC Business

In the late 70s it was realised that a market would soon open up for a small Airfield Surveillance Radar. This was because the Plessey AR 1 - widely used throughout the world - would become obsolete. Thus, a replacement market of at least 180 sets would come into play, plus others, since the world's number of small airfields had grown during the twenty or so years that the AR1 had been exploited. A very rough market survey was done to see if we could characterize the features required to make it a sure-fire winner. Fortunately, the basic parameters were easy to lay down by reference to International specifications and recommendations, together with the Company's own accrued knowledge from years of dealing with the ATC market and the ATC community's ways of working. The watchwords were to be: Modernity, Simplicity, Value, Reliability.

The very latest S-band technology consistent with simplicity led to the choice of a modern magnetron for the power generator - but with a very significant difference; it was to be driven by an all-solid-state modulator and the two (magnetron and modulator) were to be treated as a single entity. The solid-state components chosen allowed the modulator's output pulse to be accurately tailored to match the conditions required by the magnetron to bring it into oscillation without stimulating unwanted spurious modes and spectral lines. This permitted a very high order of system stability in the whole transmission system, the key to good MTI performance.

The dual-beam antenna was revolutionary; not only did it go round and round, its reflector was made from carbon fibre which gave it enormous strength and a very light weight. Its corrugated horn feed provided circular polarization with the ability to feed one of the orthogonal modes into a separate receiver as a source of weather signals otherwise cancelled by the circular polarization process. The radar's signal processor was digital and unique in that it incorporated three parallel processes; one was a straightforward zero Doppler notch filter, the second had a novel 'steerable' notch which was able to sense the radial speed of the contents of each of the small range/azimuth cells into which the surveillance area was broken and to steer the Doppler notch filter so that its null fell at this velocity; thus, any residual weather clutter not removed by the circular polarization was further attenuated. The third channel of processing provided a non-coherent video which was put through a threshold detection process whereby the clutter signals in each of a matrix of range/azimuth cells set, automatically, a level just above the clutter in that cell. Any aircraft signals above this were delivered to the display output. Thus, the whole signal processing had sub-clutter and super-clutter visibility against both fixed and moving clutter. The systems architecture allowed single, dual or dual diversity working and the display system was provided by the 'Locus' technique, allowing suites of displays to be provided in a very flexible manner. Another unique feature was the use of an 'inductosyn' azimuth-telling system. The inductosyn is an 'around-the-mast' unit giving digital incrementation of 14 bits (1.32 minutes of arc per increment). Being a digital system it is possible to set its datum extremely accurately by switch operation instead of tedious rotation of the azimuth-telling unit itself.

The development programme for this new ATC radar - the S511- was completed in 1980 and production began. The first major sale was to Newcastle Airport, UK, and represented the ideal example of the market at which this new radar was aimed. It was installed in 1981 (see fig. 17). Newcastle Airport was run by the Municipality and had a fast-growing international flight schedule.

In the following year the UK CAA ordered 13 sets of the electronics to replace those of their old ARls working into the existing antennas. Although it

17 *S511 - ATC surveillance radar*

took a while for the 5511 to find general favour in the market place, it steadily built a reputation and achieved international sales in India, Canada, Africa, Spain and the Middle East. One of the most prestigious contracts was a 'turnkey' project to fit Jordan's Queen Noor International Airport with primary and secondary radars, a suite of large screen operational control displays plus an ATC training facility using a Simulator. It was officially opened by His Majesty King Hussain of Jordan in December 1985. At its tenth anniversary, the 5511 and its variants had clocked up £20 million (£30 million at today's prices) of business.

Set-backs

In 1978, the UK CAA put out a specification for completely new radars to replace their existing ones. These were almost entirely supplied by Marconi in the '60s. Although these S264As were still giving sterling service, the frequency band of 600MHz was being vacated; this meant that the new radars would be using 23cm. A great deal of time and money was spent in bid preparation for this important business and whoever won would have a terrific advantage in the International Civil ATC market; that had been our own experience in the past - a great many S264 sales overseas resulted because of the UK CAA 'seal of approval'. Unfortunately, the bid was lost in 1980 to a European consortium of Hollandse Signaal Aparaten (HSA) and Telefunken. The German Company was responsible for the primary radar antennas and the Dutch, the electronics. Not only was the loss great in terms of the intrinsic money value, it was felt for many years later; whenever attempts at selling into the ATC market were made, the first half day of a visit was spent in trying to answer the prospective Customer's question 'Why did you lose the CAA business?'

Another blow was suffered in the following two years. The RAF had, as we had foreseen, a need to replace its old ARIs. They put out a specification that could be met by the new S511; our hopes were high and great efforts were made to put together an attractive, well-priced bid. The business was very important - 33 dual equipments were to be supplied in all. Also, as in the case of the CAA business, if we succeeded it would have been a great cachet for follow-up sales. Despite strong arguments that the modern magnetron-based solution which we offered would perform (and sometimes, out-perform) the rival systems which used linear beam tubes as transmitters, our bid was not successful.

All concerned in the bid were crestfallen, for the bid was hard-fought; at one stage, Plessey, the winners, made a plea that, if they didn't win the business, their main radar establishment at the Isle of Wight would have to close, causing massive redundancies and loss of a major radar manufactory. But there it was - another severe blow for Marconi Radar. On the brighter side, although not worth much in intrinsic monetary terms, the Company won the Queen's Award for Export Achievement in 1980.

UXADGE

The UK Air Defence Ground Environment was the name given to the post-war Air Defence Control and Reporting System after the completion of Linesman, which became fully operational in March 1974. Towards the end of its institution, Linesman had been subjected to various criticisms and UKADGE was intended to address these. It aimed to provide a secure, survivable integrated communications network carrying both radar data and voice information, with nodes and associated data handling and display equipment at UK Air Defence Control and Reporting Centres. The key operations centres were to have separate standby sites, linked by multiple redundant paths to enable the continuation of essential operations in the event of failure or damage by hostile action, including sabotage. Both civil and military radar information was to be subjected to multi-radar tracking processes to provide a comprehensive air picture to Controllers. By 1980, radar plot extraction techniques had become much more reliable and operationally acceptable, making the concepts in UKADGE a viable proposition; accurate radar data could be passed over telephone lines. In the late '70s, MRSL joined a consortium with the

Hughes Aircraft Company and the Plessey Company (including Plessey Radar) and prepared a bid under the name UKSL (UKADGE Systems Limited). At the preparation stage all team members were given a course in 'American style' proposal writing. They were instructed in its arcane verbiage and taught to employ concepts such as 'motherhood' and when, and when not, to use 'boilerplating', the widespread use of 'bullets' etc. Although many thought this a dreadful waste of time, nevertheless, the UKSL bid won the day; a contract was awarded to UKSL in 1980.

Marconi Radar's main contribution was the design, installation and integration of the Display and Voice Communications Subsystem (DVCS), based on a 'universal' console. These workstations (see fig. 18) utilized a common set of man - machine interface facilities which were automatically reconfigured to provide the command and display facilities appropriate to the log-on identity and role of a particular Controller. This advanced concept also enabled role-dependent selection, control and digital transmission of voice communications information, including that for ground-to-air transmissions; thus enabling the control of fighters anywhere in UK airspace by appropriate controllers, irrespective of the actual location of the workstation used.

In all, there were more than 200 of these universal consoles made and supplied by MRSL. They were based on the use of the, by now, well-proven Locus 16. The wide variety of processors available for use in Locus allowed successful integration with a large Penetron colour graphics display and driver from Plessey Radar. High-speed serial digital links coupled the console processors with the Data Handling System designed by Hughes and using mainframe processors of the Digital Equipment Corporation. The link also tied in the voice communications Main Access Switch of Plessey. Large screen projection displays, remote and local data entry terminals were also part of the DVCS. The whole system was handed over to MoD in late 1991 and achieved full operational capability.

The project was run largely from premises in London located just off Kingsway and a convenient stone's throw from the UK CAA buildings. All three companies of the consortium had staff there. The Senior Manager was elected from each of the three on a rotational basis and the staff numbered about 100, being a mixture of Systems Engineers and Programmers.

New Tunes on an Old Fiddle: OTH – Over-The-Horizon-Radar

The Marconi Company had carried out work on Over-The-Horizon radar successfully in 1952. Using a wavelength of 13 m and a 100 µs pulse from a I kW transmitter, aircraft echoes were readily seen in the presence of competing sea clutter by using filters of an effective bandwidth of 1/3Hz using a 3s integrating time. The antenna array directed its beam out to sea off the Cornish coast. The development of microelectronics and microprocessors made the engineering of a modernized version of OTH a viable proposition(5). Work on a new OTH had begun in the late 70s and was stepped up in 1982. A prototype and development model was erected to operate across the Dengie Marshes and out to the North Sea. The site was about 3km from the shore and about 8km north of Burnham-on-Crouch (see fig. 19). Using phased array techniques, the antenna generated a set of

18 UKADGE workstation

19 HF radar -masts at Dengie

'receive-only' beams covering 90°. A wider transmitting beam was sequentially stepped through this quadrant executing its scan in two minutes. The dwell time of several seconds at each step allowed the receiving beams' contents to be analysed by a 4096 point FFT filter battery. Such fine discretion in the Doppler domain was made possible by the great speed of today's microprocessors. Assiduous sales promotion work over the following years led to very significant business, as will be told later.

Further Secondary Radar Developments

In the late '70s, SSR was becoming increasingly important as a major aid in ATC. So much so that many Administrations declared it to be the prime source of radar data for ATC. Among the numerous problems with systems of the day was that of broken vertical coverage - so much power was radiated into the ground by the very small vertical aperture antennas that deep nulls were cut into the vertical polar diagram. Also, when operated in an airport environment, interrogations would be reflected into unwanted azimuths by buildings and hangars, causing false targets to appear in the working output. Both of these problems were seen to be soluble by a new antenna design. In 1978 the Company executed a study into such new designs for Eurocontrol. The UK CAA subsequently asked for a similar study with their own design aim specification in mind. It was required to generate radiation patterns suitable both for the existing systems and with the future monopulse equipments. Great attention was given to ensuring a fast bottom cutoff for the vertical radiation pattern; this would minimize the power directed into the ground and greatly reduce vertical lobing as well as local reflections.

The Antenna Department at GEC-Marconi Research Centre (MRC), Great Baddow, had patented at this time, a revolutionary method by which it was possible to synthesize a far-field pattern by a computer-controlled programme which varied the phase and amplitude of each element in an array in an iterative manner so that the maximum efficiency could be obtained. The programme, called 'SYNF', produced very high efficiencies of around 90% on a regular basis - an unprecedentedly high figure for antenna designs. The technique produced an almost exact match between theoretical and measured practical radiation patterns. The CAA had commissioned prototypes to the same antenna specification from Cossor and Texas Instruments. These were all compared in a set of controlled tests using the traditional small vertical aperture antenna as a reference. The MRSL design (the S1095) came out by far the best and the CAA ordered seven of them in May 1984. So successful were they that the order was increased to 17 in 1985.

As mentioned above, the ATC world was looking to monopulse techniques to improve SSR performance. In November 1983, I was allotted £1.7 million to run the development programme for this new SSR- 'Messenger'[(6)]. By including novel features such as the fastest signal processing (20 MHz), Dual Phase monopulse azimuth detection, False Target detection and rejection, Receiver Sidelobe Suppression, etc., Messenger produced the world's best SSR performance of the day. Its data recovery rate in 'garbled' reply conditions was remarkably high - a great boon to Air Traffic Controllers. The prototype system was completed in 18 months and in another six, 'Messenger' had its first sale of four dual systems.

Change of Management

After seventeen years as the Chief Executive Officer of Marconi Radar, first as its Divisional Manager, then as its Managing Director, Mr. John Sutherland handed over his post to Mr. Keith Chittenden in 1982 to take up the position of Vice Chairman of The Marconi Company. His long and successful tenure as a deeply committed 'Marconi Man', brought great wealth to the Company together with a steadily growing prestige in the International market-place. All through his career he fostered the idea of the Company as a family and had a great care to ensure that youth was encouraged. His keenness for the annual Apprentice Awards Evening and putting more into the Training budget is proof of his deeper care for the long-term well-being of the Company as a whole. In recognition of his leadership in promoting export business resulting in the Company's Queen's Awards, he was honoured with a CBE.

In the following year,1983, the Company reverted to a former arrangement and re-established General Managers at Chelmsford and Leicester. Management of the Antenna Development department was transferred to MRSL under the Technical Director. The Manager of the Radar Research Laboratory was assigned as part of the Technical Director's staff and established much greater control of research programmes of concern to the Radar Company. Thus began a period - long, as it was to be found - of instability and change. It was not long before one heard the cries - not only from those who had long service with the Company -'Come back John Sutherland - all is forgiven!'

Business as Usual

The success of Martello and the 5511 which led to its military version, the 5711; the advent of Messenger and a companion set of digital signal processing and display equipment, gave the Company a chance to mount one of the most impressive arrays of its products at the 1984 Farnborough Air Show; altogether the total stand space, internal and external) occupied over 1000 m^2.

A large contract to supply Sweden with Military Operations cabins containing data handling and display equipments under the project name TOR was proceeding and another - destined for an unwonted long life - Bacchus was begun.

The Falklands War put heavy pressure on many parts of the Company, since the Sea Wolf systems were now to be used in anger and with great success. Several of our staff, although civilians, were to see active service and were subsequently honoured for their efforts to keep ships' defences in operation.

1984 also saw the retirement of Mr. Roy Simons OBE. He had served the Company since the wartime days of 1943, joining the Marconi Research Division and working on special receivers for Direction Finding. He also worked on Marine radar development and extensively on radar displays, becoming Deputy Superintendent of the Display and Data Handling group at Great Baddow. He was one of the architects of the famous Fur Hat project and thus achieved a catholic knowledge of all the Company's technical business. He was made Technical Director of MRSL in 1969. Always a source of good advice and the workings of the Company, I was particularly grateful to him for encouraging me to write a book on radar which was published in 1985[(3)]. His post was later occupied by Mr. Reg Beckley.

Yet More Change

In 1986 Mr. David Chenery succeeded Keith Chittenden as Managing Director. He had a difficult row to furrow. Defence business was declining and most of our competitors were, like we, chasing more ATC business. Competition was fierce; we found ourselves in a market which was the opposite of a monopoly. There were many suppliers after the same customers - a Monopsomy! Attempts were made to get the S511 into the US market; a demonstration model was shipped out to an airfield just on the rim of the Grand Canyon, Arizona. Despite its good showing and much lobbying, our efforts were not enough to overcome the 'Buy America' policy firmly in place at the time.

However, the S511 had found favour with the Canadian Department of Defence and over the next few years they had ordered systems for seven different sites in Germany and Canada.

On the Production side there were other changes afoot. The new Marconi Manufacturing System (MMS) was being introduced in 1986. By 1988 the intended four groups forming the MMS had been established. They were the Materials Management, Manufacturing, Engineering Services and the Manufacturing and Overseas Groups. As part of the rationalization programme all sheet metal and fabrication work which was being done at Writtle Road was transferred to Waterhouse Lane and Gateshead. Prototyping was done by a Fast Ordering manufacturing Unit in the Manufacturing Group.

A Reminder of Past Beginnings

In 1960 the world's Air Traffic Controllers began to form an organization which would give them an international voice; it became the International Federation of Air Traffic Controllers Associations - IFATCA. From its inception it invited companies who operated in the ATC field to join as Corporate Members. The Marconi Wireless Telegraph Company was one of them and we became founder members. IFATCA held annual conferences at different venues throughout the world and encouraged the Corporate Members to present technical papers and to mount exhibitions of their company's equipment and services. In 1986, IFATCA celebrated its 25th Anniversary at the conference in Costa Rica.

I attended as the Company's Corporate Representative, a post I had held since 1980. In recognition of the Company's long association with IFATCA we were presented with a commemorative shield. The value of supporting such organizations rests in the long-term benefits it can bring to the Company; the people attending Conference tend to be the 'movers and shakers' of the ATC world. Those from the emergent countries have a hard time affording the costs of attendance and small helping hands - a lunch here, a drink there, an interest shown in their country's problems, sympathy for their plight - all these things are remembered. These are the people who, at a later time, become their country's Ministers of Aviation, their Chief Officers in aviation and ATC spheres. In the spirit of this understanding the Company has also supported the UK Guild of Air Traffic Controllers (GATCO) almost since its inception in 1954. The Company joined as Corporate Members in 1959 and I became its Representative in 1978 until retirement in 1992. The Guild honoured me with a Life Membership in that year.

Note to the Editor; not to be Included in the Official Account, but Kept in the Archive Copy

It is probably evident that I'm having difficulty since the last section in writing further. This is for two reasons. First, Roy Simons' notes stop at 1984 and my store of written data is now sketchy. But secondly and more importantly, we are approaching the time of total incoherence as a 'Marconi' Company. In losing David Chenery, we enter a period of disconnection with the Marconi ethos and become prey to what I identified in the late '80s as the 'New Management'. To me, the 'New managers' - not only in our industry - were (and still are) a breed who ask themselves, upon appointment to a higher post, one question: 'Where am I going to be in two years' time? - and sod all the others'. One has only to look at the indecent haste with which people in Upper Management have come and gone in the '90s. The same is true of upper middle management. In recent years each new Managing Director in his 'Message to the Troops' paid lip service to 'the Great People of Marconi' and then presided over yet another tranche of redundancies, got a reputation for being a tough manager and moved on. This kind of hypocrisy calls to my mind a couplet from a W.H.Auden poem:

'When politicians talk of principle,
Beware - perhaps
Their Generals are already poring
Over their maps!'

1991 saw the appointment of Dr. Martin Read as Managing Director after David Chenery, and of Brian Loader who assumed the post of General Manager for the Radar Division of what now became Marconi Radar and Control Systems, the Frimley establishment playing a larger role in the Company's activities. The breakup of the Soviet empire now caused a major upheaval in the market-place - defence spending reductions were assumed to provide a 'Peace Dividend'. Coincident with this was the effect of the great ATC logjam of 1988. The airports of Europe were clogged with delayed passengers. The huge volume of traffic could not be properly handled because of the disparate ATC separation standards prevailing across its wide areas; they varied irregularly up and down between 5 nautical miles to a staggering 20 nautical miles as one flew from London to Moscow. Many conferences and forums were conducted as a result of this. I attended one in Maastricht entitled 'To fly or not to fly in '89?' Like most of the others it revealed that the only solution was for the European Community (in the guise of the ECAC - the European Civil Aviation Conference which in turn was really the group of EEC Ministers of Transport) to expedite the plans already in place for a programme called ' EATCHIP' - a wonderfully apposite name for any group working from Brussels! EATCHIP itself stands for European ATC Harmonization and Integration Programme. The Company spent a deal of time and money trying to get work from this and to some small degree succeeded. But with the rest of the radar and electronics companies of the world also competing now that the defence market had the edge taken of off it, this proved difficult. MRSL tried very hard to win a contract to supply Hungary with new radars in consortium with Hughes again. Unfortunately, at the last round of open bidding (literally all competitors round the table) one of our competitors sliced 14% off their price and 'bought' the business. The Customer's Operations and Technical representatives were furious but powerless to reject the bid; they much regretted it later and were very sorry that MRSL couldn't have won. One piece of success in getting EATCHIP money came from the programme's need to study the implementation of the new SSR system called Mode 'S'. This used the usual SSR principles and frequencies but with new interrogators and transponders capable of sending up to 112 bits on both the up-link and down-links. This permits individual aircraft to be addressed and avoids fruit generation and, more importantly, garbling. Those wishing to know more of the matter should consult reference (3).

The Company made other attempts to get European business from the newly-independent ex-Soviet states and succeeded in Poland and in Romania in 1993 with the sale of S711 radars and Messenger SSRs in 1994.

A New ATC Marketing Strategy

As noted above, the fall in defence business was accompanied by a rise in ATC business prospects - all companies wanted to realise them. A big change was coming about in the way ATC should be done and the concept of Airspace Management was brought in. Air Traffic Management principles were aimed at getting the planning and control functions to be more efficiently related by co-operatively using Flow Management Techniques for flights. Most companies exploiting the ATC market responded to this change by setting up groups with a holistic view; our own group - G-MATS, standing for GEC-Marconi Air Traffic Systems, was formed. The idea was to attack the total ATC market using all the resources of GEC-Marconi which were considerable. Unfortunately, the Chief Executive of the French company, Thomson, had declared in 1990 that 'There is room for only one European company to serve this market and it WILL BE THOMSON'; he backed this pronouncement with such force that it became largely true. Several attempts by G-MATS to obtain big business came to naught and it retired into obscurity with a bloody nose in 1994.

OTH Revisited

Under the stewardship of Ken Perry, Business Development Manager of the day and a stout proponent of OTH, the Company was successful in winning a huge contract to design and supply OTH services to Australia. The project was to furnish a radar network across the entire length of the North coast of the country-all 2400 miles (3840km) of it. In the face of fierce competition, the Company won the contract in June 1991. Teamed with Telecom Australia, a new Division was set up in Melbourne - GEC-Marconi HF Systems - to run the JORN project (Jindalee Over-the-Horizon Radar Network) as it was called. Multiple 20kW solid state amplifiers working into an antenna array 300 yards (275m) wide gave the 500 kW transmitter power required. 90 miles (144km) away, about 500 antenna masts in a straight line stretching for two miles (3.2km) forms the receiver station. The 500 elements are grouped in sub-arrays of twenty-five. The twenty sub-arrays serve processors in bunkers whose digital outputs are passed on fibre-optic links to the receiving centre where position data on targets is extracted. Six hundred miles away, the Radar Operations centre carries out further processing to derive tracks and target categorization for feeding to Air Defence Centres and other users. The JORN system covers 3% of the Earth's surface, processing the results of surveillance once every minute, 24 hours a day.

At the time of signing, the contract was worth some £ 150 million to the Marconi Company, shared between the Communications and Radar Companies. Such a large offshore project could not be run from the UK and about 200 staff were transferred from Chelmsford to Australia with the aim of finishing the project in the mid-'90s.

To me, the JORN project is highly significant in historical terms. It typifies our Founder's tradition of doing very big things with the latest technology. It has the grand sweep of a breathtaking idea, successfully carried to fruition. I'm sure he would have been delighted to see his two inspirations - wireless communications and the idea of radar - wedded together.

Although David Chenery's term of office did not last long, it was a time of significant successes. Not only was JORN begun, but Martellos were sold into Greece, Malaysia and Denmark. He was himself a participant in obtaining a huge order for an air defence system for Korea as a result of the Memorandum of Understanding signed in 1988 with the UK to export about £1 billion of defence equipment and Support Services to enhance the Korean armed forces. The Company's structure had been changed in 1989 which was to be based upon disciplines rather than market areas. Eight Directorates were established; they were: Financial, Commercial, Sales and Marketing, Projects, Engineering, Technical, Manufacturing and Quality Directorates, respectively.

1991 was also notable as the year in which the Myriad computers in the London Air Traffic Control Centre at West Drayton were finally de-commissioned. At a ceremony, Dick Marston, the MRSL Sales and Marketing Director performed the last rites by operating the 'off' switch, witnessed by about 70 'old hands' who had either worked on the design of Myriad and the FPPS system, or who had been responsible for its choice and use.

Time for Me to Go!

The following year, 1992, in July, I had reached the wondrous age of 65. Having in the past couple of years tried to get myself on the all-too-frequent redundancy lists and failed, I had to retire. I was never sure why my offer to accept redundancy was refused - was it because I was so expensive in redundancy money terms; or was it because I was cheap labour? During my last week I hardly drew a sober breath. On the Monday lunch-time I gave a smallish party for my closest colleagues. On Tuesday I was given a sherry party by the Divisional Director, Brian Loader. The next day I was invited to a lunch-time 'do' by an old ex-colleague who still worked at Cossor and was also retiring that month - we had a joint farewell. Thursday I was regaled by an old friend from whom (through myself) the Company had obtained many SSR equipments.

The final Friday I gave a large party (150) at the Marconi Sports and Social Club for all who had helped me in the past decades. I included many ex-managers for whom I had worked, hoping it would be a small recompense for all the trouble I'd caused them in the past!

Late in 1991, there was an amalgamation of Marconi Radar and Marconi Command and Control Systems. MRSL now became Marconi Radar and Control Systems Ltd. In 1992, Dr. Martin Read, its new MD, gave a resum6 of the Company's position and prospects for the future. He announced that all manufacturing at Writtle Road Works would be transferred to Blackbird Road Works at Leicester. Plans were still in place for the Chelmsford staff of MRS to move into a new building at Great Baddow. Note that, at this time MRSL had become, once again, a Division of MRCSL.

My own leaving was swiftly followed by that of the Divisional Director, Brian Loader who was replaced by Mr. David Overton.

A Past Success Remembered

A fine tribute was paid to the Company at the Farnborough Air Show in that year by Lennart Kallqvist, Head of FMVF Systems Department for the Swedish Air Board. Thirty years earlier the Company had installed the 'Fur Hat' digital data handling system in Sweden. It was still performing as intended.

The simplicity of its design and the rigour with which the tolerancing of circuits was carried out produced this remarkable reliability - considerably assisted by the fault detection and indication system incorporated. The Company was presented with a plaque containing one of the 72 synchronously-operated acoustic delay lines which form the storage medium for the system (see fig. 20). This represents another prime example of the Company's tradition in producing equipment and systems of enduring quality.

A New Home!

The plans to move the whole of MRS staff in Chelmsford to Baddow were changed in 1992. The Communications Company had begun building a new complex in Glebe Road, Chelmsford, adjacent to the New Street establishment. At that time the communications business had not reached the expansion predicted. Thus it was decided that the new Baddow building plans would be dropped and the Radar Division would move into the Glebe Road premises, due for completion by September 1993. The Support Group, however, would be accommodated in Elettra House, recently vacated by Marconi Marine. A competition was held to

20 `Fur Hat' delay line

decide an appropriate name for the Glebe Road establishment. The choice from a great many candidates was to honour the man who had signally made the Radar Company the major force it had become, Dr. Eric Eastwood.

Eastwood House was completed in the spring of 1994 (see fig. 21). The thrust of the Company was towards increased efficiency by widespread use of information technology and all areas were fitted with computer terminal outlets so that desks could immediately have access to IT facilities. Many processes which had previously been managed by

manual means had already been computerized - for example the Bidding process. Many more were soon to emerge. In the past the business of ensuring the maximum spread of relevant data among a group of people engaged in producing a new equipment had been done by co-locating the

21 Eastwood House

designers, draughtsmen, systems and development engineers, technical manual writers etc. By organizing all design data to be available via computer, this could be done without the wasteful need for co-location. Many more such principles are in the process of being designed.

A Significant Anniversary

1994 marked the Silver Jubilee of the foundation of the Marconi Radar Company. At the end of the year, Lord Weinstock paid a visit to Eastwood House to see for himself these moves towards the future. He was later to be awarded an Honorary Doctorate of Technology at Chelmsford Cathedral in recognition of GEC's support to the numerous Marconi Companies in the area and to the Anglia Polytechnic University.

This is an appropriate point for me to cease this history, since I have too long been out of touch with the day-to-day happenings; I leave the story to be continued by someone much better fitted to the task. However, I must say, before signing off, that the Radar Company's history cannot be told completely in even this long text. There will be many readers who have worked long and hard on equipments and projects and in establishments that I've not so much as mentioned. I can only ask forgiveness of them and plead 'shortness of space and time'. They must impute no intended slight on my part but perhaps take a little comfort from my recognizing that what for them were matters of earth-shattering import were indeed part of the wide warp, weave and weft of the fabric of the great enterprise which is Marconi Radar.

Acknowledgements

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