

**IEE Colloquium - UK Broadcast Manufacturers**

**Marconi - Tom Mayer, CBE, F.Eng.**

I have been asked to cover Marconi's contribution to the radio and television broadcasting equipment manufacturing industry during the post war period.

In view of the fact that I left the Company in 1981, I was reluctant to do so, but as Richard Ellis could not find anyone else, and as the Company suggested that I should do so, I agreed.

Unfortunately, I have been unable to obtain access to the company's records - indeed I have been given to understand that these, and the relevant photographs and press releases, no longer exist. I have therefore had to rely almost exclusively on my own memory, and that of a number of ex-colleagues, who have been kind enough to share their recollections with me.

It is quite a task to cover the achievements of Marconi's Broadcasting Division over 50 successful and important years, in 45 minutes, so I can do little more than present a catalogue of products and customers, together with a few personal reminiscences.

In the limited time available I will naturally concentrate on television, somewhat to the detriment of radio, and in particular on television cameras, as in the days when everything was analogue, cameras were the most important product. However, I will start with sound radio and move on to television later.

It is hard to believe, but immediately after the war, there was virtually no equipment at Chelmsford, due to the 100% concentration on the war effort, and the broadcasting business was rebuilt on the back of equipment bought back from the Forces Broadcasting System. The earliest "new" equipment was an unattended medium wave transmitter consisting of three 660 watt units operating in parallel. In the unlikely event of one or two of the units failing, the remaining unit or units carried on transmitting. Very reliable, very expensive and typical of the belt and braces, and the customer satisfaction attitude of the Company at that time.

At about the same time Marconi started on the design of the first high powered medium wave air cooled transmitter and two of these 100 KW transmitters operating in parallel were installed at Daventry in 1949. Similar transmitters were installed in Denmark, Finland, Argentina and Egypt. A long wave version was also produced which was sold to Denmark and Norway.

A few years later Marconi carried out exhaustive tests as to the best way of cooling high power transmitters. This showed conclusively that air cooling was the most efficient, and therefore a new 100 kilowatt HF transmitter was designed using air cooling. Although repeatedly offered to customers none was sold, because steam cooling was fashionable, and therefore preferred by customers. The transmitter design was altered to steam cooling and successful orders were obtained from overseas.

The Diplomatic Wireless Service had a requirement for a 750 KW medium wave transmitter. This was built, and occupied virtually the whole of the Transmitter development laboratory in Building 46. Test could only be carried out at night, without closing down the rest of the factory, and even then there were reports of television interference. Similar transmitters of this power were subsequently sold to Romania, Abu Dhabi, Kuwait, Dubai and Qatar.

The company also had a thriving business in low power transmitters ranging from the 2KW unit already mentioned through 10KWs, to a 50KW using a single valve. During the

EOKA problems in Cyprus, the broadcasting service there operated a Marconi 2KW transmitter. This was frequently blown up, and therefore Marconi used to keep a 660 watt unit set up on the Cyprus frequency, ready to be flown out from Stansted by an RAF Hercules.

I have already mentioned short wave transmitters, where in the more recent years the emphasis has been higher powers. The original design of Marconi 250KW HF was installed for the BBC in 1964 and a year or so later similar transmitters were also sold to the Deutsche Welle and to the Voice of America.

A number of these short wave stations were supplied together with extensive antenna farms, as for the BBC in Ascension Island and a large turnkey installation in Ghana.

There was always some conflict within Marconi Broadcasting Division to try to decide which requests for quotations were worth responding to and which were not. I always insisted that we could not tell, and that we should quote for them all. However on one occasion when we were very busy, I was surprised that our sales staff had decided to go ahead and quote for a 250KW shortwave transmitter for Switzerland, the home country of one of our three main competitors. I was even more surprised when we obtained the order.

The requirements for HF gradually changed to 500KW, and although the BBC preferred the Telefunken design, some Marconi transmitters at this power were sold to them. The Voice of America decided to evaluate competitive designs, and chose Marconi ahead of Continental and American competition. I believe that twenty one such transmitters have now been supplied to them, as well as two 600 Kilowatt medium wave transmitters.

This business continues to be successful for the company.

Marconi was also very much involved with the start of Frequency Modulated transmission in the United Kingdom. Around 1950 two transmitters with identical radio frequency characteristics were installed for the BBC at Wrotham. One had a FM drive and provided an output of 25 KW, and the other had an AM modulator producing an RF power of 18 KW. They were used for comparative reception tests to see whether a FM transmission network was feasible.

When eventually the BBC decided to proceed with a FM network, Marconi lost out to STC, who produced a newly developed range of the required 5 and 10 KW transmitters, whereas Marconi could only offer an anglicised version of the RCA range of 1, 3 and 10 KWs, which they had just sold to Poland.

Before Sweden proceeded with the installation of its FM transmitter network, extended tests were made on transmitters installed by three different manufacturers. Unfortunately, Marconi did not have a suitable transmitter to offer, and therefore did not quote or receive one of the three contracts. The Foreign Manager of Marconi at the time was Raymond Bangay, a gentleman who wrote the first text book on radio and who was exceedingly well known to the various Post and Telegraph organisations in Scandinavia, largely because he managed to keep them supplied with transmitting valves throughout the war. He learnt about the orders which the Swedish PTT had placed, and was furious with Marconi's broadcasting division for not having quoted. On his next visit to Sweden, he went to see the Chief Engineer of the PTT, and threatened to sit in his office until he received an order for a Marconi transmitter to take part in this evaluation as a fourth contender. Bangay duly returned to Chelmsford with an order for a non-existent 5 KW transmitter, which was then designed, manufactured, delivered and evaluated, leading to the largest orders Marconi ever received for FM transmitters - 128 in total.

Success in Sweden led to major orders from Norway, and substantial sales were also achieved in Hong Kong, Denmark, Eire, Italy, Singapore, Switzerland, France and, of course, in the United Kingdom.

I would now like to turn to television transmitters, starting with the low power transmitters for the first BBC post-war station at Sutton Coldfield. The five kilowatt Band I vision transmitter was designed by Joe Sutton and the accompanying two kilowatt AM sound transmitter by Gordon Coop, who also designed the range of FM transmitters mentioned earlier. Similar transmitters were supplied to Holme Moss, Kirk O'Shotts and Wenvoe, together with Marconi television and FM aerials.

Whilst these installations were proceeding an enquiry was received from Denmark for three five kilowatt Band I stations, and an order duly obtained. The only problem was that the salesman had ignored the fact that Denmark operated on 625 lines, and therefore the five kilowatt 405 line transmitter would only deliver 3.5 kilowatts on the wider bandwidth. The subsequent battles between Keith Elphinstone, the Sales Manager, and B.N. MacLarty, the Marconi Chief Engineer, which I was privileged to attend, are engraved on my memory. Eventually the transmitters were modified to obtain almost five kilowatts, and an FM modulated drive provided to produce a three kilowatt sound transmitter. These installations were also the first on which the copper tube co-axial feeders to the aerials, were replaced with flexible cables manufactured by Felton and Guilleaume. I remember that on one of the installations, some water got into the cable, which after much consultation with all the experts, was removed by carefully drilling holes in the outer, avoiding the layers of insulation.

Similar installations were also sold to Canada, Spain and Venezuela. In the case of Venezuela for the first time Marconi supplied a complete studio and transmitter installation, together with a number of English Electric television receivers, to become the first television station in that country. Serious interference problems were experienced with the studio equipment housed in the same building as the transmitter, and these were overcome by decoupling the headset cables, which were picking up the radio frequency.

At around this time, 1951, the Italians wanted to set up a permanent television service, and Marconi was invited to send a representative to serve on a commission, which included representatives from the Italian Post and Telegraphs and RAI, to select the site and the frequency. At the last moment, Cyril Gillam, the head of the aerial group was unable to go, and I was sent on my first overseas trip as the Marconi Expert! Monte Mario and Band III were chosen, leading to the first United Kingdom design of what was, at that time, an extra high frequency, that is 200 Megahertz, transmitter. This was achieved using Mullard tetrodes housed in coaxial cavities, the transmitters were designed, built, tested and blessed in the transmitter development laboratory in Building 46 at New Street, and then duly installed in Rome and Pisa.

Shortly after these transmitters were installed, the United Kingdom took the decision to start commercial television. As transmitters were obviously long lead items, the government of the day instructed the Post Office to place an order for the first three television transmitters. Marconi obtained this order, and thank goodness Dougie Smee, the Broadcasting Division manager at the time, had considerable experience in negotiating with government departments. The Italian transmitter was duly redesigned for 405 line positive modulation vision, and the sound transmitter had an AM modulator added to it. These transmitters were later installed for the ITA at Croydon, Lichfield and Winter Hill.

At this time Marconi's Propagation Group in the Research Laboratories at Great Baddow, under Gerald Isted, was probably the world's leading authority on high frequency propagation, and provided Television Coverage forecasts not only overseas, but also to the BBC and the ITA. In fact, I believe Marconi not only provided the coverage predictions which the ITA published, but also did much of the initial frequency planning. Marconi's were therefore involved in the discussions and site visits, which took place to decide whether or not the ITA transmitters should be co-sited with the existing BBC stations. I well remember the visit to Holme Moss with Sir Francis McLean, the Director of Engineering of

the BBC, and P.A.T. Bevan, Chief Engineer of the ITA, when weather conditions forced us to leave our cars, and walk the last mile or so to the station. Thank goodness the medicine cabinet had some brandy in it!

I think it was in the early sixties, that the first television transmitter was being installed in Cyprus. On his return to England I met with Ian Long, the installation engineer, who proudly told me that one morning he discovered a bomb with a timer inside the 500 watt transmitter, which he threw outside before it could go off. He was suprised, to say the least, when I reprmanded him, for losing an order for a replacement transmitter.

The next major transmitter project undertaken was that for Crystal Palace, where for the first time the two 18 kilowatt vision and their accompanying sound transmitters, were operated in parallel.

Subsequently New Zealand required some ten kilowatt Band I transmitters and Marconi offered a version of the Crystal Palace transmitter, with just a single tube in the output stage, and obtained the order. These transmitters were designed, manufactured and delivered within ten months - a notable achievement- and proved to be the most reliable valved television transmitters ever manufactured by the company.

During the late fifties and early sixties Marconi transmitters were supplied to provide the first television transmissions in many countries around the world. This included four of the first six Australian stations, Nigeria - where a studio and 500 watt transmittter where installed in the corrugated tin roof town of Ibadan to become the first television station in Africa. Other firsts were Kenya, Mauritius, Malta, Singapore, Uganda, Ghana and Jordan. Transmitters were also supplied to Eire, Brazil, Yugoslavia, Argentina, Lebanon, Portugal, Greece, Mexico and Libya. But perhaps the greatest achievement was to obtain the contracts for half the very substantial number of television transmitters for Sweden.

UHF transmitters were introduced at the same time as colour in the United Kingdom and Marconi with their klystron

transmitters obtained a substantial share of both the BBC and IBA orders, from the start to the present day. Again UHF transmitters have been supplied to numerous countries, and two highlights were deliveries to the United States and South Africa. In the United States transmitters were supplied to WGBH in Boston and KTPS in Tacoma. In South Africa Marconi obtained a half share of the transmitter contract, for the first television service in the world to open in colour.

Its now time to leave the more profitable side of the business, and turn to the more glamorous subject of television studios. In order to understand the immediate post-war position at Marconi, it is important to remind ourselves of the pre-war situation.

In March 1934, the Marconi-E.M.I. Television Company was formed, to bring together Marconi's experience of facsimile transmission, wide-band modulation and antenna design, with E.M.I.'s knowledge of camera tube manufacture. As you all know the Marconi-E.M.I. 405 line system was one of the two chosen to begin experimental transmissions in November 1936, and subsequently the system chosen in February 1937 to provide the world's first public high definition television service. It is of some interest, that C.S. Franklin, one of Guglielmo Marconi's original collaborators came out of semi-retirement to design the aerial. The service was discontinued in September 1939 on the outbreak of war.

Transmission was resumed on the 7th June 1946, using the pre-war equipment. Although engineers from the two companies were still collaborating at this time - indeed they had suggested scrapping the 405 line, positive modulation system in favour of a 525 line, negative modulation system - it was eventually decided to dissolve the joint venture. I am not sure whether this was because it was Marconi, or E.M.I., or both, who did not want it to continue. Marconi were in the process of being taken over by the English Electric Company, and could therefore re-enter the valve market through English Electric, and make and sell television camera tubes. E.M.I.



in general, and Sir Ernest Fiske in particular, on the other hand may have been upset because they were not successful in acquiring Marconi.

The English Electric takeover of Marconi took place in August 1946. Marconi engineers visited the United States and were impressed with both the image orthicon tube and the opportunity of a much simplified camera design which it made possible. The Marconi valve laboratory was reconstituted as the English Electric Valve Company and started work on image orthicons in 1947. E.M.I. won the contract for the Sutton Coldfield high power vision transmitter - Marconi won the high power sound, the medium power vision and sound standby transmitters, the antenna and the feeder systems, already mentioned.

The Marconi-E.M.I. Television Company was officially dissolved in 1948.

Marconi entered the television studio business by utilising its cross-licensing and manufacturing agreement with the Radio Corporation of America and used this to obtain existing camera designs and those of associated equipment. The man mainly responsible for this initiative was L.H. Bedford, who became the Company's Chief Television Engineer in 1947. The RCA designs were re-engineered to accommodate the 405 line system, and so the Mk I camera was born, using the American three inch image orthicon tube. I believe only six of these cameras were made to RCA blueprints - yes blueprints, white lines on blue sheets of paper.

This was followed by a further six Mark IB cameras, which incorporated considerable improvements. Some of these cameras were accepted by the BBC and used on numerous outside broadcasts, including, I believe, the first televised Boat Race and the historic transmission from Calais in 1950. Some were also sold to the Canadian Broadcasting Corporation.

In the meantime a Mark II camera had been developed using British components, and incorporating a number of changes. These included a lens turret pistol grip, a focus lever

instead of a wheel, and a plug-in electronic viewfinder fed by signals from the camera control unit. Also by now the Image Orthicon tube was being manufactured by the English Electric Valve Company, largely from RCA components. It was no mean feat transporting its glass targets one tenthousandths of an inch thick - or thin - across the Atlantic. However, a major innovation was provided by Eric Hendry of EEV, and that was the inclusion of a field mesh in the Image Orthicon tube, which considerably reduced the objectionable edging effect, typical of American orthicon pictures.

About 110 of these cameras were sold, with some 80% going overseas. Among these successes were cameras originally installed at the Palais de Chaillot in Paris, and later transferred to New York to become the first permanent television installation at the United Nations Headquarters; major installation for the Canadian Broadcasting Corporation in Toronto and Montreal; the first sales of complete television station, that is, including associated studio equipment, transmitter and antenna as already mentioned to Venezuela; and last but by no means least the BBC's first image orthicon studio installation, in studio E at Lime Grove, in 1953.

A Mark II camera was also the first to be used underwater, in a container manufactured by Siebe Gorman, to find the sunken submarine, H.M.S. Affray.

The events which enabled Marconi to become one of the leading, if not the leading camera supplier, world wide from the mid-fifties through the sixties, were a number of further visits by Marconi engineers to RCA. I believe the engineers concerned were Leslie Jesty and George Partington who went to Camden, where Otto Schade demonstrated a 4 1/2 inch Image Orthicon to them. They were immediately impressed with the substantially improved resolution, grey scale, and above all, signal to noise ratio. However, the prototype camera was cumbersome as it had to use non-standard large lenses, in order to fill the photocathode.

Once back in the United Kingdom, the go-ahead was eventually given by Marconi management for the Company to proceed with the design of a camera - the Mark III - and for the English Electric Valve Company to proceed with the development of a 4 1/2 inch tube. The Mark III camera was designed to take either 3 or 4 1/2 inch tubes, and had a variable graded filter to replace remote iris control, as well as plug-in units for ease of servicing, and the first tilting viewfinder. I do not know whether it was George Partington at Marconi, or Walter Turk or Eric Hendry at EEV, who came up with the idea of image magnification in the camera tube, but it was this technical innovation, which allowed the development of a usable camera. This meant that standard lenses could be used to put a 3 inch size picture on the photocathode, which was then magnified in the camera yoke to put a larger picture on the image orthicon target, thus getting the best of both worlds.

The BBC had decided to install the new Mark III cameras in Studio E in Lime Grove, replacing the Mark II's. Unfortunately, when the Mark III's were installed late in 1954, the cameras did not match up to the performance of the prototype and in addition were subject to severe microphony. In the words of George Partington, this gave rise to a new industry - the dropping of dustbin lids! So the 4 1/2 inch tubes were withdrawn, and replaced with 3 inch ones.

Both the shortcomings in performance and the microphony problems were eventually overcome, and 4 1/2 inch tubes

refitted in the summer of 1955. It was a few years after this that the studio control room was modified, for hands off operation, allowing a single camera control operator to set up and operate a full studio complement of cameras.

The problems at Lime Grove were solved in time to allow the Mark III to become the workhorse of the newly announced Independent Television service. Marconi obtained the major share of the studio equipment contracts for Associated Rediffusion, Alpha, Granada and ABC Television, who all went on the air using Mark III cameras. The orders by Rediffusion and Granada were placed in good time to allow manufacture and installation to proceed in an orderly manner. However, ABC were a late starter, following the withdrawal of Kemsley and Maurice Winnick, and so the Alpha installation in Birmingham - to serve both ATV and ABC on a seven day basis - was somewhat rushed, and opened with the same four channel vision mixer that had been used temporarily at Rediffusion. The Alpha experience was minor compared with that at ABC in Didsbury. The order for Didsbury was placed in February 1956, and the studio went on the air on Cup Final day - the third of May 1956. This was achieved by virtue of a large number of Marconi engineers from Chelmsford paying regular visits to Didsbury, usually bringing with them a piece of equipment which had just been completed at Chelmsford, and it went on the air with the same vision mixer.

The start of commercial television meant that there was a shortage of television engineers and cameramen, and so Marconi's Television Demonstration Unit set up a studio in London, converting the old Viking film studios at St. Mary Abbot's Place for this purpose. The BBC who already used Marconi's Television Demonstration Unit for horse racing, swimming and other outside broadcasts, such as Princess Margarets' wedding, eventually started both the "Tonight" programme and "That Was The Week That Was" from the Marconi Studios in London, using Mark III cameras. Subsequent Marconi camera designs certainly benefitted greatly from this type of "hands-on" experience.

But the real success of the Mark III came in exports. In spite of the large numbers of cameras used for the start of commercial television in the United Kingdom, of over 300 cameras made, 60% , that is, over 180 cameras were sold overseas. Mark III cameras were used to start regular television services in Canada, Italy and Australia. In Australia, Marconi obtained the orders for four of the first six television stations, both the Australian Broadcasting Commission Stations in Sydney and Melbourne, as well as ATN-7 in Sydney, and HSV-7 in Melbourne. These orders covered cameras, studio equipment, transmitters and aerials.

It was on my return from Australia in the late fifties that I called in to see Ampex at Redwood City, having previously attended their lecture, at the IEE, on their newly announced videotape recorder. The recorder had a marginal signal to noise ratio at this time, and Ampex were therefore anxious to take advantage of the improved signal to noise ratio which the 4 1/2 inch tube offered. Ampex asked Marconi to lend them a Mark III camera, with a switchable syncpulse generator, to allow them to demonstrate their multistandard videotape recorder to the CCIR meeting in Los Angeles in 1959. This marked the start of a very fruitful relationship, of which more later.

Another interesting order at this time, was an order from the Soviet Union for two outside broadcast units, complete with two Marconi 100 milliwatt 7 Megahertz microwave links. A Russian acceptance engineer virtually lived with at Chelmsford for over a year, and checked everything, even going to Welwyn's to see the actual resistors, which were going to be used in the equipment, being wound. A lot was learnt from him. For instance if a picture monitor specification quoted a certain resolution and a certain brightness, then he expected both to be demonstrated with the same control settings! However, once the units had been accepted and delivered to the Soviet Union, there were never had any comebacks.

It is also worth mentioning that a Mark III camera was modified for High Definition Films, to operate at 1100 lines , 60 fields, producing excellent pictures.

The major shortcoming of the Mark III was its size and weight, partially due to component availability, and partially due to it having been designed to meet a BBC specification, which included a number of peculiar requirements, for instance that the focus handle could be on either side of the camera - in case they employed any left handed camera operators!

This led Marconi to design the Mark IV, which featured printed wiring circuits, magnesium castings, magnetic iris servo amplifier and transducer power supply regulator. The Mark IV was undoubtedly the most successful British designed and manufactured television camera. Over 900 were sold, of which more than 800 went overseas.

There were a number of noteworthy achievements, the biggest probably being the camera's success in the United States. Cameras were sold to CBS and to Ampex. CBS chose to order directly from Marconi and their new studios in New York and Los Angeles were equipped with them. At this time there was a close relationship between Marconi and CBS, and a number of Marconi engineers were seconded to CBS to help Dick O'Brien, Bob Hammer, Blair Benson and Joe Flaherty plan their new studio installations, using the experience gained in helping a number of the UK programme contractors with their studios. CBS also bought a number of other studio items from Marconi, including some specially designed television slide projectors. This close relationship was to be particularly important to Marconi, when they came to market a colour camera.

Because of the improved signal to noise ratio Ampex were anxious to have their recorders used with 4 1/2 inch tube cameras, and therefore had undertaken to represent all Marconi's studio products in the United States. In fact the pictures from the 4 1/2 inch cameras were thought to be soft by the American broadcasters, as they did not have the sharp edges prevalent with 3 inch tubes. Eventually, largely through CBS's efforts they were well accepted, and indeed were a major contributory factor in raising picture standards in the United States. As a result Marconi and EEV were the first non American recipients, jointly with RCA, of the Emmy Award

of the US Academy of Arts and Sciences, for the 4 1/2 inch tube and camera.

Ampex sold a large number of cameras, not just to television station studios, but also to production houses, universities, military establishments such as the Redstone Arsenal, and most important of all, to the United States Navy. With more than a little encouragement from Ampex, the US Navy installed three Mark IV cameras directly linked to three videotape recorders on one of their shorebased training establishments on an experimental basis. As a result of the favourable experience gained, they decided to install three Mark IV cameras, one centrally on the side, one at the end of the flight deck, and one on the conning tower, on each of their carriers, both seagoing and land based. The flight deck cameras were mounted beneath the deck, pointing upwards, with a mirror system to give a level view of the flight deck. This allowed them to debrief their flight crews immediately they left their aeroplanes, thus enabling them to point out any errors in their approach and landing on the carrier, thereby saving a considerable number of pilots' lives. In view of the difficulties which British companies had then, and indeed still have now, in selling to the United States military, these sales were quite exceptional, especially as they were standard cameras using commercial, and not military, components and magnesium castings which had to be replaced at least once a year on the cameras exposed to the sea. It did result in Marconi having to supply the production drawings to the United States Department of Defense, but then more than 90 cameras were sold to them. It is worthwhile reflecting that the largest user in the world of Marconi Television cameras was the United States Navy!

Marconi's presence in the United States meant that they had exposure to early Zoom lenses, one of which, the Zoomar Lens of Bill Peglar, with a five to one ratio, was used with the Mark IV in the early sixties. This was before the first zoom lens in the UK was produced by Watson's, also five to one I think, and subsequently Rank Taylor Hobson's ten to one Varotal lens.

Mark IV cameras were sold in many other countries, including some to NHK and TBS in Japan. I remember visiting NHK in Tokyo and being shown the Mark IV studio, where two cameras were conspicuous by their absence. When I asked if they were at Toshiba being copied, all the Japanese engineers who accompanied me, and who previously could only converse with me through an interpreter, assured me in good english that this was not the case!

Iron curtain countries were also good customers for the Mark IV, including an Outside Broadcast Unit for Rumania. This order was placed by their Commercial Attache in London. Iron curtain countries always expected a substantial discount when finally negotiating a contract, and the secret was to quote a price initially which was high enough to allow you to grant this, but not too high, otherwise you would be excluded from the final competition. When faced by the Commercial Attache in London, he showed me a contract made out to one of our United Kingdom competitors, at a price some twentyfive percent lower, and told me that they preferred Marconi equipment, but to obtain the order we would have to meet them halfway on the difference in price. Marconi obtained the order.

A notable sale at home was to ATV, who for obvious reasons only used Pye cameras. However, they wanted to do some Tom Jones shows from their Elstree Studios, for use both at home and for export to the United States. As it was before the days of standards convertors and as it was possible to change standards on the Mark IV cameras by a number of switches on various units, it was best for them to run through the show twice using the same cameras, which the Mark IV enabled them to do.



With the advent of transistors, and before colour transmissions started, Marconi introduced their fully transistorised Mark V camera, at their own studio, in their newly opened television studio design and development laboratory at Waterhouse Lane in Chelmsford in 1965. It is interesting to note that at this time the development laboratory staff comprised 142 people, including electronic and mechanical engineers, printed circuit layout staff, draughtsmen, technicians, apprentices, clerical staff and storekeepers, and also had a dedicated model shop.

I believe the Mark V camera was the first production model not to have a turret, and to cater only for a single zoom lens. Over 400 cameras were built of which 88% were sold overseas. Indeed around this time, Marconi's Broadcasting Division typically achieved export sales of between eighty and ninety percent.

Major sales were again achieved in the United States, as well as in Canada, Brazil, Colombia, Mexico, Venezuela, Spain, Greece, Egypt and Turkey, to name but a few.

In the same year Marconi also introduced their Mark VI Broadcast Vidicon camera, intended for news and interview studios, and for low budget operations. This camera cost little to develop, being based on an established industrial vidicon camera developed by the company's Closed Circuit Television Division, and achieved modest success, with 80 sold, of which 50 were exported. Of this total only 35 were used in live studios, and I believe Ulster Television was the only station to use them exclusively when it first went on air. There was also a version for use with telecine and television slide scanners.

During this time Marconi was also producing a full range of studio equipment. Telecine was not a particularly great success, although Flying Spot telecines and caption scanners were produced, followed by image orthicon, and later vidicon and leddicon telecines.

However in the search for a successful flying spot telecine, a fast pull down mechanism was commissioned. This was required to pull down a single frame, in the frame blanking period, and to present the next frame perfectly still in the projector gate, an almost impossible task due to the considerable forces involved. Eventually the mechanisms were made to work adequately, and they were incorporated into a 16mm Television Recorder of which as many as thirty were made. They were, in their time, the best means of recording television programmes, and were used on many important occasions, including recording the Football World Cup in Sweden in 1958. Pictures from some of these recordings are still being broadcast and provide excellent archival material.

Another notable engineering achievement was the discovery that in the standard Post Office uniselector switch, the capacitance and inductance of each route through the selector would match a 75 ohm co-axial cable. This led to the design and supply of a number of studio master control and assignment switchers. What was, I believe, the largest of these was installed in the Post Office Tower in London to route transmissions between all of the Independent Television studios and transmitters.

In the late fifties Reg Hammans at Granada expressed interest in the automation of programme switching, and so George Partington designed a system using uniselectors and relays, to route and switch all programme sources. An order was placed and the equipment was designed, manufactured, installed and eventually used by Granada. It is a project which I remember well, not only because of its considerable technical innovation, but also because of a memorable commercial experience. The equipment had been installed and was in daily use, but unfortunately not all the spares and instruction books had yet been supplied, neither had Marconi's been paid. Granada's Purchasing Director, Charles Stringer, was unable to help me resolve the situation, and suggested

that I bring my boss, Sir Neil Sutherland, to lunch with his boss, Sidney, later Lord, Bernstein. This I did, and when over coffee the conversation turned to payment, Sidney asked how he could be sure that our partial invoices for partial supplies matched the order, which only quoted one price for the complete equipment, including spares and handbooks. I advised that our total invoices would never be greater than the order value, which led Sidney Bernstein to ask why we did not itemise the prices for the various items such as switchers, power supplies etc. on our quotation. I explained that when we quoted we had not designed the equipment, and therefore only estimated the total price, and were therefore unable to break it down into discreet items. He wondered whether this did not cause us to lose money, and I told him that we could not work in any other way, as we only won one order for every five or so quotations which we sent out, and that on the basis of swings and roundabouts, we made money on some and lost on others, but were able to remain in business. To this Sidney Bernstein replied, with a perfectly straight face, and I quote "Mr. Mayer, my brother Cecil and I used to operate a fairground, and on that fairground we had swings and we had roundabouts, and I want you to know that it is possible to lose money on both". My boss collapsed in laughter and was therefore not much help, but we did eventually get paid.

Marconi also supplied a fully automated presentation switcher to Channel 10, in Sydney, Australia.

In the early 1960's Marconi were commissioned to design and partially develop a pay-per-view system for cable television by a Hollywood film producer. The system offered a choice of three channels, usage being signalled to a centre for automatic computer billing by signals sent back up the cable from the set top paybox. Unfortunately the customer ran out of funds and it was not possible to sell the system as a private venture elsewhere, as the world was not yet ready for pay-per-view systems and existing cable networks needed extensive modification to allow them to carry the return signals. Nevertheless the technology, as written up by George Partington at the time, would have been adequate for present day pay television systems.

Turning now to colour, Marconi started giving consideration to this in the early fifties. It was on the 11th May 1954, that the company staged the first United Kingdom demonstration of compatible colour television, at Marconi House in the Strand. Two types of camera were demonstrated, a three tube 3 inch orthicon camera, once again built to RCA drawings, and an experimental two tube camera designed by L.C.Jesty. They were demonstrated both at full bandwidth, that is a red plus green plus blue picture, and also coded into NTSC. The United States had started NTSC colour transmissions in the previous year, and once again some Marconi engineers recommended a change to 525 lines for the United Kingdom, in spite of the fact that the Television Advisory Committee had recommended that any new colour transmissions had to be compatible, that is capable of reception by existing black and white receivers.

Marconi then decided to build a number of the RCA three tube cameras. I believe the RCA type number was TK 30, and visitors to last years IBC will have seen one of these cameras on the stand of the Bradford Museum of Motion Pictures and Television, to whom we are indebted for most of the exhibits here today.

Although broadcasters were not ready to buy colour cameras at this time, there was considerable interest in colour television for medical use. A large outside broadcast unit was built for the American pharmaceutical company, Smith Kline and French, equipped with three cameras, and this was extensively used for demonstrations in the United Kingdom and on the continent. Some of us remember that most of the early colour pictures which we saw were rather lurid, and mostly a good blood colour. I believe the unit eventually finished up in Australia.

Last, but not least, one or two of these cameras went to the BBC Research Department at Kingswood Warren for experimental use and demonstrations.

Because of Marconi's substantial presence in the American television market, it was realised that there would be a considerable demand for colour cameras in the United States

before such a requirement existed at home. Accordingly serious consideration was given to the design of such a camera.

Shortly before George Partington tragically died in 1963, he had built a three tube 4 1/2 inch image orthicon camera. This used the dichroic mirrors of the three 3 inch cameras, with the three 4 1/2 inch yokes mounted on a very large piece of metal. So "camera" was perhaps not the right word to use, and it became known as the flying bedstead, after an experimental VTOL aircraft of the time. The pictures from it were by far the best that any of us had ever seen at that time, although to get moving pictures, you had to move the object in front of the camera. I often wonder how those pictures would have compared with modern colour pictures.

Also at this time, Philips having produced the plumbicon tube for mainly medical purposes, had demonstrated a three plumbicon colour camera. However, compared with the orthicon pictures, the pictures were not sharp enough, that is they appeared short on resolution, and so Marconi started to give serious consideration to a four tube camera.

The BBC then published a preliminary specification for a colour camera, which called for a 4 1/2 inch image orthicon in the luminance channel and three 1 inch vidicons in the colouring channels!

Marconi, of course, also discussed the colour camera requirement with CBS, who also felt quite strongly that a four tube camera would provide a better picture, and would be substantially easier to operate and maintain in studio conditions, than a three tube one at that time.

So when the time came to make a decision, Norman Parker-Smith, who had succeeded George Partington as Chief Television Engineer, and I decided to go ahead with a four plumbicon camera - the Mark VII. This was a risky decision for two reasons. First, and most important, plumbicon tubes were not available for Marconi to obtain from Philips, and secondly we were not sure if such a camera would be acceptable to the BBC.

The non availability of plumbicon tubes caused us two problems. The first concerned our ability to design the

camera, this was overcome with the help of a friend at Mullard's who provided us with so called medical quality tubes, and would you believe some of them were near enough broadcast quality. The second concerned our customers ability to obtain tubes, and here I took the view that Philips would not refuse to supply tubes to them, as they were after all also their customers.

A prototype of the camera was demonstrated to a number of CBS engineers, and CBS duly placed an order for some twenty or so cameras, presumably having assured themselves that they could obtain the tubes, as it was made clear to CBS that Marconi could not supply them.

The camera was unveiled to the world at large at another demonstration in the Marconi studio at Waterhouse Lane, with news of the CBS order, and that was the first time that anyone other than CBS or Marconi engineers had seen it. Most of our potential customers, including the BBC were relaxed about this, as they did not have any immediate requirements, but that was not the case with ABC Television from the United States. Julie Barnathan, who had just been appointed as Chief Engineer in succession to Frank Marks, berated me for not having given ABC the opportunity to buy the cameras, explaining to me in words of one syllable that ABC were just as important as CBS, etc. etc.. Although Julie and I became good friends, ABC did not buy any Marconi cameras, but did buy a number of other items of Marconi studio equipment.

It was a year or so later that Sir Francis McLean came to Marconi at Chelmsford. He stated that the cameras which the BBC had ordered would not be ready in time for the opening of their colour service, and pleaded with Marconi to let the BBC have four studio's worth of cameras. So an order was placed by the BBC with Marconi for 17 Mark VII colour cameras, which were duly installed in the BBC's first four colour studios - the only Mark VII cameras ever sold to the BBC.

Once again, Marconi had produced a camera which was extremely successful in overseas markets. Of 330 cameras made, more than two-thirds were exported. As you would expect by far the largest number went to the United States, with

major orders also for the start of colour services in Canada and Mexico. In Mexico, Doug Smee had established excellent relations with Don Emilio Azcarraga, the owner of Televisa and as mentioned earlier considerable numbers of monochrome cameras, and other studio equipment had been sold to them. I was due to go to Mexico City to discuss their requirement for colour cameras, from Los Angeles, where Norman Parker-Smith and I had attended an SMPTE convention. Just before leaving my room to go down to dinner with Bill Moreland, the Head of Conrac, from whom we were buying all our colour monitors at this time, I received a call from Mauricio Gerdes, our agent in Mexico, to tell me not to come as Televisa had just placed the order with Philips. On arriving at dinner with a long face, and Bill asking why, he advised that I should still go as the ink on the order would not yet be dry. So I did, and met Romulo O'Ferral, who was suprised to hear about the order. He made some enquiries and found that Emilito Azcarraga, Don Emilio's son, had in fact placed an order, but that no down payment had been made. I should mention that at this time there was a power struggle going on between Emilito and Romulo as to who would take over from Don Emilio. So Romulo promptly gave me an order for eight Mark VII cameras, together with a cheque for a twenty percent downpayment, and instructed his people to cancel the other order. Although I could not cash the cheque, I did spend that weekend in Acapulco! This is really just another example of how in those days much of the business depended on being in the right place at the right time, and knowing, and having good personal relations with, the right people.

The United Nations in New York also started in colour with Mark VII's, and they were the first colour cameras to be used in Australia, Egypt, Kuwait, Libya, New Zealand, Quatar, Spain and Yugoslavia, mostly with EEV leddicons.

At home, besides the BBC, Thames, Tyne Tees, Southern, Scottish and Yorkshire Television all equipped their new colour studios with Mark VII cameras.

Although the Mark VII camera had a number of innovations, such as the use of thin film circuit modules to improve stability, it soon became dated because improved plumbicon and EEV leddicon tubes, together with the possibility of improved yokes and circuit design, made it possible for a three tube camera to match the performance of a four tube one.

Marconi therefore designed a new three tube camera - the Mark VIII. This was the world's first camera to have push button sequential line-up, dynamic centering and push button colour balance, in other words fully automatic setup. The tube mountings and optics assembly was a substantial mechanical structure to aid registration, the scanning coils were printed on borosilicate glass, and there were minifier lenses in the red and blue channels to eliminate colour lag. Originally the camera was to just have automatic registration using a pattern on an inbuilt diascope based on an idea from BBC Research at Kingswood Warren, and Trixie Claydon developed this idea into a working reality and obtained a patent for it. This was only one of a very large number of patents which Broadcasting Division engineers obtained over the years.

It was again unveiled at the Waterhouse Lane studios in 1970, and as with previous changes of camera marks, not all customers switched to the new design immediately. A little later a cut down portable version of this camera was produced - the Mark VIII P - and there was also a version for telecine use.

Nearly 600 Mark VIII's were sold, of which 87% were sold overseas. Major customers included Australia, Belgium, Canada, Czechoslovakia, Kuwait, Libya, New Zealand, Qatar, Spain, Yugoslavia and, of course, the United States. By this time Ampex had decided to try to get into the camera business themselves, and Marconi were therefore now represented by another company, namely A.F.Associates in New Jersey.

The company was fortunate that the Mark VIII came available just as Australia was changing to colour, and the Mark VIII made almost a clean sweep in that territory, with over 90 being sold there. And they were similarly fortunate in New Zealand, where 40 Mark VIII's were sold.



Yugoslavia was also interesting, as the six regions got together to purchase the equipment for their second network, both studios and transmitters. Marconi was the most successful supplier winning four of the studio and two of the transmitter contracts. But it was once again touch and go, with many trips to Yugoslavia and negotiations via interpreters well into the night, with much Slivovitz. When eventually it got to the stage of supposedly signing the contract, just as Mr. Budakov of Novi Sad had his pen poised to sign, he asked for "a little more discount". By that time my sense of humour had deserted me, so I put my pen away and started to get up to go - but he said he was only joking, and we signed.

From hereon Marconi substantially reduced their spend on studio development, and only a cut down version of the Mark VIII, the Mark IX, was produced of which just under a hundred were sold. As mentioned previously, Marconi were less successful with telecine, although integrated ones were produced using the Mark VIII and Mark IX camera components. In spite of winning the Royal Television Society's Geoffrey Parr Award in 1975, only a total of 130 were sold, with the largest numbers going to Australia, Egypt, New Zealand, Qatar, Spain and Yugoslavia, and in the United Kingdom to Independent Television News, and Ulster and Yorkshire Television. Egypt was another country where Marconi managed to get in on the start of colour in a substantial way.

Later on a digital telecine was produced, using solid state image sensors.

Before ~~moving~~ closing on television studio equipment there is one more item which I must mention, and that is videotape recorders.

Although I have not specifically drawn attention to it, many overseas customers wished to order complete television stations, especially those in the less developed countries. We used to say that any country which obtained independence wanted three things - a national flag, a national airline and

a television station, with, of course, good reception at the president's house. When Marconi was invited to tender for such stations or studios, they were able to do so from their own resources, as a full range of vision and sound equipment, including quite sophisticated mixers, was manufactured in house, the exception being flying spot telecines and videotape recorders. Telecines were not a problem as the United Kingdom supplier of flying spot telecines - Cintel - was not competing for the whole studio. But videotape recorders were, as RCA had always competed across the board and Ampex were beginning to do so, and therefore quoted silly prices for recorders. So Marconi seriously considered buying IVC in Sunnyvale, but it was decided not to do so. However, when IVC was granted a licence by Ampex, it was realised that Marconi could also obtain one. A single day of negotiations with Don Kleffman in Redwood City resulted in a patent and manufacturing licence for the VPR 1, which became the MR 1. This was followed by an anglicised version, the MR 2, but unfortunately I have no information on how many units were sold, although I believe it was reasonably successful.

There are numerous products and activities which I have had to pass over in this rather dull catalogue of products and customers.

I have mentioned operating transmitters in parallel, and the technology to combine the radio frequency outputs, owes much to B.N. Sosin, as does the combining in one feeder of both sound and vision transmissions. Also S.U. Nolan's aerial group of the Marconi Research Laboratories at Baddow made considerable contributions to the design of all sorts of television aerials, many of them being directional patterns especially tailored to meet the customers requested coverage. And not just television, but also MF and HF antenna farms.

I have not mentioned sound studios. Marconi still manufactured microphones after the war, and for many years made a full range of sound mixers, and also, of course, programme input equipment. Also, having made steel tape audio

recorders before the war, Marconi were offered the german magnetic tape recorder brought back after the war, but decided it was not a commercial proposition!

On the television studio side many hours were spent on demonstrations and exhibitions. Memorable are the various exhibitions in the Soviet Union, where the Russians always purchased whatever you were showing, including the exhibition stand itself! Walter Turk has reminded me of one such foray into Moscow, when we were all staying at the Rossiya Hotel, and had gathered in my room for a banquet of soup, and other delicacies which we had brought from England. When my immersion heater was plugged in to heat some soup in a cup, the fuses in the room blew. So we moved out into the corridor to a new, and we hoped better power point, and proceeded to put the whole floor into darkness. As Harold MacMillan said "Exporting is fun".

Also memorable was the first demonstration of colour television behind the iron curtain at the Leipziger Messe. And having to have a colour camera on the Ampex stand at NAB, when the only camera available was a three vidicon camera from the Closed Circuit Television Division.

Marconi also produced industry standard photographic test charts for many years, to allow cameras to be effectively tested. I remember showing the first colour test chart to Howard Steele on one of his frequent visits to Chelmsford, which he immediately wanted to buy, offering to pay cash! I could not resist, but it was a new and sobering experience to provide Howard with the receipt he requested.

I hope I have been able to give you some idea of how successful and influential Marconi were in the pioneering years after the war. Success was not only achieved by technology and excellent equipment, but also by good relations with customers. Perhaps most important of all was delivering to the customer what he expected, irrespective of the small print in the contract. A good after sales service was also an

important factor, and Marconi had a separate department for this, which issued regular bulletins on improvements.

Everything considered, Marconi's Broadcasting Division was a substantial and, by the industry's standard, a most successful organisation. You will have realised that it was a maid of all work, and master of some. It was active in many diverse aspects, including turnkey projects, where a customer provided a piece of real estate and Marconi was responsible for the building, maybe the roads, power supplies and all the broadcasting or television installation, and sometimes its operation and maintenance.

It is extremely regrettable that such an organisation, which sold more than 2900 television cameras, is no longer in that business. But it is not just Marconi's, but virtually the whole industry, in spite of the Department of Industry's efforts in the early 1980's to try to get all the UK companies together, under an umbrella of UK Television Studios Ltd.

In preparing this talk, I have relied heavily on W.J.Baker's history of the Marconi Company. I am also grateful to Tony Heightman, Eric Hitchen, Gil Husselbury, John Mahoney, Stan Moore, John Ridgewell, Doug Smee, Cyril Teed, Walter Turk and Peter Turrall for sharing their recollections with me. And also to David Davies for making his collections of Marconi photographs available to me.