The Development of the ANITA Calculators at the Bell Punch Company

I joined the Bell Punch Company in February 1956 and after a period working on Ground Position Indicators, navigational instruments designed and produced by the Company for the R.A.F., I became involved with the SAM (Semi Automatic Multiplier) calculator. This had complex mechanisms giving an advanced multiplication feature and was probably the last notable milestone in advanced mechanical calculator design produced by Mr. C.F.Webb, the Company's Chief Designer, before his retirement. It was launched around 1958 and I recollect being given the task of producing an illustrated handbook for the production and service departments which had detailed assembly and adjustment guidance. It comprised a series of photographs in order of the machine's assembly, each with a transparent overlay pin-pointing the important features together with a detailed description outlining the checking and inspection of each stage of assembly in the correct sequence.

I joined the ANITA design and development team in the early stages when a lot of work was necessary to satisfactorily interface the electronics with the necessary mechanical features. This revolutionary calculator, "**A** **N**ew **I**nspiration **T**o **A**rithmetic", was, by necessity, a transitional stage between the accepted electro-mechanical machines of that period, and electronic calculators as we know them today. It was not smaller than the machines it was replacing, and it still had a ''full' keyboard. That is, lines of key buttons numbered from 0 to 9. And it still included a number of precision mechanisms. However, instead of calculations being effected by a system of key bars, gears, cams and 'number' wheels printed with the figures 0 to 9, they were achieved electronically with the answers displayed on numicator (Nixie) tubes, fast and comparatively silent. Funnily enough, experienced calculator operators were slow to appreciate the technological breakthrough because they could not get used to the lack of ''feel' and noise that was inherent in mechanical machines. The same phenomenon was experienced by typists changing from manual to electric typewriters.

The task of translating the output of the ANITA electronic design team's proven circuit diagrams into a tangible product had to be undertaken by the Company's drawing offices. The overall responsibility for this was given to the then Chief Draughtsman, Gerry Mude, and subsequently, myself.

Electronics were in their infancy. Microprocessors were a long way off and transistors were not yet available at a price that would be economically viable considering the numbers that would be required for ANITA. The initial development included a Dekatron counter tube, thermionic valves, cold cathode 'trigger' tubes and large numbers of discrete components linked via various switching methods to precision mechanisms. The novel use of the cold cathode tubes was at the heart of the first ANITA's and the concept was displayed in the Science Museum in London almost as soon as the first machines appeared on the market.

The development of the machine was extremely interesting and the Company did a great deal of pioneering work, much of which was patented, and, in keeping with its past philosophy, everything possible was manufactured 'in-house'.

For electrical safety reasons the casework of the machine was designed as four interrelating plastic mouldings and a steel keyplate coated with a special insulative paint. Large injection mouldings were in their infancy and although the Company had its own plastic moulding facility, it did not have the expertise and equipment to produce these for ANITA at that stage, so they were sub-contracted to General Electric in Birmingham.

The lines of keys were of similar basic design to those in the Company's previous mechanical calculators, except that instead of being entirely precision mechanisms, they now had to operate electrical switches. This was achieved by attaching to each line of keys a printed circuit with associated rotary switches. Following the Company's willingness to pioneer new methods, the pivot pins for the switches were moulded directly into the printed circuits using a nylon moulding material. The switches themselves were small printed circuits which were assembled onto the pivot pins making a three-point contact with silver graphite contacts riveted to the keyline printed circuit. The switches were held against their mating circuit by conical springs retained by circlips. As usual, we designed and manufactured all the parts ourselves but initially these switches were troublesome and became part of our 'learning curve'. If a key was struck hard, the sudden transference of movement from the key to the rotary switch sometimes caused the switch to bounce and momentarily part company with one or more of its contacts on its printed circuit board. This was enough to create wrong answers and was a problem we were saddled with for some time during the development of the ANITA. We eventually solved it by mounting the printed circuit on rubber grommets rather than fixing it rigidly to the metal keyline, and providing a flexible moulded nylon arm to the rotary switches which dampened the effect of harsh key operation.

Another aspect of ANITA which was new to the Company's experience was the use of printed circuits, then in their infancy. Bruce Routledge, a tool design and methods engineer, was given the task of setting up the initial printed circuit production facility from scratch, which was quite a challenge. It involved precision photography, silk-screening, etching, plating with precious metals as well as the normal machining processes of blanking, piercing and drilling. From the design office's point of view, it meant taking the electronic engineer's circuit diagrams, suitably partitioned, and designing the printed circuits to take into account required size, optimum position of the electronic components to be soldered to the board, method of fixing within the machine, and width and spacing of conductors. As we progressed and became more knowledgeable, many other factors had to be taken into account, but in the beginning our methods of designing the printed circuits were necessarily basic. The circuits were drawn twice full size which had two main benefits. It was easier to maintain accuracy, and when the drawings, or artworks as they were called, were reduced photographically to their required size, any slight inaccuracies were reduced by 50% automatically. Looking at today's printed circuit design methods using suitably programmed computers, our methods in those days seem positively archaic. We first drew outlines of the required copper track and component solder pads in pencil, and after careful checking the outlines were overdrawn in ink. Then, using a fine paint-brush, the outlines were filled in with matt black ink - quite a laborious process. The master artworks, which were the outcome of all this work, were ultimately photographed and reduced in the process to their required size. The photographic positives/negatives were then used to produce silk-screens, which in turn were used to transfer the images of the printed circuits to copper-faced laminated board using a solder resisting ink before etching away the unwanted copper.

As we gained experience, so our methods of designing and producing printed circuits became more sophisticated. Self-adhesive tape appeared on the market which dramatically reduced the time taken at the design stages by eliminating the pencil and ink drawing methods. And we evolved systems of control which ensured that all 'master' drawings applicable to any one printed circuit were interrelated so that expensive mistakes could not be made during production. Until the appearance of ANITA the Company's products had been designed to be tough and durable. Electronic products were new to the Company, and although the first ANITA was a milestone in calculator design as far as its functions were concerned, a number of shortcomings began to manifest themselves as a result of the way they were handled in transit. The very heavy constant voltage transformer in the machine broke loose in a number of instances, and the Decatron and other valve-like components sometimes jumped out of their sockets during transit. Even worse, the numicator (Nixie) tubes tended to collapse causing their 10 or 12 lead-out wires to short circuit with each other. All these things were a part of our learning curve and had to be dealt with quickly. Fortunately, the Company was a subscribing member of the Paper and Packaging Research Association in Leatherhead through its considerable paper manufacturing and ticket printing business and we were able to commence an ongoing programme of transit testing at their laboratories. Whilst each new ANITA model was at the design prototype stage we would take a couple over to Leatherhead for testing. Packaging is not a precise art and the optimum solution depends on an estimate of the product's 'fragility' and the type of handling it is likely to encounter during transit. It is not for the faint hearted to watch a pack containing months of design work being dropped on all Six sides and eight corners in various situations and from various heights to simulate the hazards of road, rail and air transportation.

It was also necessary to ensure we complied with the mandatory international standards in respect of electrical safety and other standards such as those concerning radio and television interference. As a first step I was required to submit an ANITA to the British Standards Institution for testing. Being the first of its kind, the ANITA aroused a lot of interest at the B.S.I., and whereas their testing of previous office equipment followed well proven parameters, I think they reappraised those parameters when confronted with a machine which was so revolutionary at that time. After stringent testing by B.S.I. and some minor redesign work on our part, the ANITA was granted the B.S.I. Certificate of Electrical Safety, and so continued a long association as we developed one machine after another.

At that time, there were no reciprocal agreements between the various International Standards Authorities, and most Countries had differing requirements in respect of electrical safety. The U.S.A. had many differences in their standards and my next task was to get ANITA approved by the Underwriters Laboratories of America. From its name, this organisation, although the equivalent of B.S.I., was obviously linked to, and supported by, the American insurance industry, and once we had shipped an ANITA out to them, I had a lengthy period of correspondence with questions and answers flowing back and forth. Underwriters Laboratories gave us a difficult time and the worst thing was that they insisted on the ANITA casework being moulded in an acceptable flame-retardant material. At that time the cases were injection-moulded in an ABS (amyl-butadiene-styrene) material which was not flame retardant but which had been accepted by B.S.I. as not hazardous in our application. The moulding material we had to turn to was a polycarbonate called Makrolon which met the requirements but was new at the time and a difficult material to mould, particularly if the mouldings were large. The General Electric Company, who were producing the ABS mouldings for us, had a great deal of difficulty in using polycarbonate, but eventually overcame the problems and we were able to gain U.L. approval for ANITA.

But that was only the beginning. Germany, Switzerland and the Scandinavian countries all had mandatory standards with which we had to comply. Switzerland had a particularly annoying one concerning mains cables. Whilst the European countries tended to have different colours for the insulation of the mains, neutral and earth wires to that of Britain, Switzerland went one further and insisted on a special identifying thread inside the moulded cable. At that time, this special cable was only obtainable in Switzerland, and as our mains leads at that time had a special socket moulded on one end, it was expensive and a nuisance, to manufacture a relatively small quantity just to meet our export requirement for Switzerland.

The demand for more and more features to be included in ANITA resulted in the introduction of the Mk9 with a chain multiplication feature and the Mk10 with the capability of displaying results in sterling currency. These machines required some additional mechanism design and a considerable increase in the amount of 'hard' wiring which introduced production and service difficulties. Further development of the ANITA as a full keyboard machine was exhausted.

The introduction of the ANITA Mk11 & Mk12 with a '10-key' keyboard was a major step forward although the overall size of the machines remained the same as their predecessors. As a matter of expediency I retained the original base and rear mouldings and redesigned the top moulding and keyplate. To circumvent the lead time necessary to produce injection moulded top mouldings we found a local company who were able to manufacture a quantity in fibreglass. Only five keylines were necessary to carry the 0 - 9 and control keys, and whereas the keylines in the first ANITA's ran north to south, those in the Mk11 & Mk12 ran east to west and the interior chassis arrangement was correspondingly different. With the reduction of the number of keylines from 13 to 5, and the increasing availability of transistors and diodes, there was more space for the electronics. This in turn allowed the partitioning of the printed circuits to be improved and the amount of ‘hard' wiring to be reduced - very desirable from a production and service point of view.

In 1966 the calculating machine part of the Bell Punch Company's business became a separate company within the Group. The research and design aspects became Sumlock Anita Electronics Limited and was moved into a new purpose-built building on the Uxbridge site. I was appointed Chief Draughtsman and was able to bring with me the designers, draughtsmen and ancillary staff that had been gradually assembled since the advent of ANITA.

Coincident with the move, we started development of the next family of calculators - the ANITA 1000 range. These were to utilize Marconi-Elliot integrated circuits together with conventional Ferranti Silicon transistors, which were now economically available, allowing the design to break new ground. Apart from using our existing keyboard switching arrangement, the electronics took what is now the common form of a ‘mother' printed circuit board loaded with connectors into which were plugged up to 25 ‘function boards. Breaking down the electronics in this manner revolutionised production and servicing allowing the various functions to be separately tested in the factory before final assembly. Servicing was usually a case of just replacing a particular printed circuit board. The power supply arrangement was also designed as a separate module for ease of assembly and servicing.

For many years, the Bell Punch Company had retained the services of John Barnes, a well known industrial designer based in Warwick. He advised on the aesthetic aspects of new Bell Punch products and we continued to take his advice. The new concept of ‘mother' board and function boards, and the use of integrated circuits and conventional transistors, dictated a box-shaped machine. John Barnes suggested styling for the ANITA 1000 range precluded the usual method of a top and bottom moulding screwed together from the underside and was solved by designing the casework as a front and rear moulding. This solved a lot of other problems also. We were able to design a chassis onto which everything, including the front moulding, was assembled. The completed assembly was then slid into the rear moulding and secured by four screws on the underside. From the outset time was spent considering the manufacturing and assembly aspects of the machine, particularly with regard to minimising the number of parts necessary. The left and righthand side plates of the chassis, instead of being two separate items, were designed as identical precision sand-castings and the same philosophy of common design was applied to as many components as possible.

With electronic calculators becoming increasingly accepted, users began to demand facilities that were unheard of in conventional mechanical machines. Sophisticated memories, square root, percentage and many other features were progressively designed into our machines to meet demand and increase sales. Some customers were used to electro-mechanical add-listing machines that provided a print-out which could be checked and filed, so it was logical that we should be looking to produce an electronic printing calculator. The ANITA 1000 range, with its bulky shape, gave us the opportunity to re-engineer the chassis and case to accommodate a SEIKO printer. This was a Japanese printing unit of sophisticated design and very reliable, and although the 1000 range had not been designed originally with this in mind, the final result complemented the rest of the machines in the range very well.

Electronics world-wide was now moving very fast indeed. Marconi-Elliot, a British company, were producing ‘large scale integrated circuits’ which contained up to 200 transistors and were the fore-runners of today's micro-chips. Marconi were contracted to manufacture integrated circuits for us to our own requirements and this huge step forward, compressing 1,000 transistors into say five small components, allowed us to shrink the total electronic element and make our machines considerably smaller. The resulting new range of machines was called the 1000 LSI series; LSI standing for ‘large scale integration'. With the dramatic reduction in necessary size, our industrial designer, John Barnes, had considerable scope to come up with some revolutionary styling, and this he certainly did. World design trends at that time evidently favoured sharp edges and corners, as opposed to a rounded look, and John's proposals reflected this. His styling of the electronic display area involved a cantilever effect, rather like the roofing of a sports stadium, and the whole shape was quite pleasing and 'different'. However, John had given us some design and production problems. Although we were back to basic top and bottom plastic mouldings for the case, it was an impossibility to mould the top moulding in one piece whilst still retaining the styling concept. The solution was to design the top moulding in two pieces and ultrasonically weld them together, hiding the otherwise visible join by inserting a ''click-in' beading of a contrasting colour. The top moulding was coloured sky-biue and the base dark blue so we made the contrasting beading dark blue, moulding it in the same mould as used for the base rather than in a separate mould. Following our usual practice of designing and manufacturing everything ourselves as far as possible, the keyboard was a completely new concept. With the considerable reduction in size, we could not continue using the previous keys and switching arrangements. We spent a lot of time perfecting a key-switching arrangement that fitted into the relatively small amount of room available. The contact arrangement comprised a silver-graphite stud and a silver plated beryllium blade, both soldered into the keyboard printed circuit. The keys comprised two plastic mouldings assembled together with a compression spring between them, the bottom moulding clipping into the printed circuit, and the top moulding, when depressed against its return spring, activating the contacts by pushing the contact blade against the silver-graphite stud. The contact blade was an interesting design exercise. Working closely with Johnston Matthey, a precious metal supplier, and our factory in Portsmouth, we settled on beryllium copper strip about an inch wide with an inlaid silver strip along one edge. In fact, due to their production processes, Johnston Matthey could not supply it in any other form and this created a slight problem. The blade had to have a semi-circular bend at one end and the Silver contact area at the other. The bend ensured that the contact acted as a spring and only touched its mating silver graphite stud when pushed downwards by its key. On the face of it, the blades would have to be pierced out of the strip at 90 degrees to the edge of the strip in order that the silver area was at one end of the blade. However, because the strip was produced by a continuous process, the ‘grain' of the beryllium copper was along its length which would give the contact blades an inherent weakness across the bend. We had to reach a compromise here by piercing the blades out of the strip at 45 degrees to its length. Our tooling department at Portsmouth did a marvelous job by anticipating the coming of automatic insertion of components into printed circuit boards which is now common practice. They designed a 'progression' tool which progressively pierced the blades from the beryllium copper strip, bent them, formed the legs to match their mating holes in the printed circuit board and then finally inserting the contacts into the various switch positions on the board - all as a continuous sequence of operations.

The ANITA 1000 LSI only weighed about 800 grammes and it became very obvious at the design stage that the size of the integral mains power lead, as required to meet the BSI electrical safety requirements at that time, was far too heavy for our machine to remain stable on a desk surface. BSI accepted our arguments and allowed us to use a lighter mains power cable.

The 1000 LSI series calculators were very popular with our customers and we were continually introducing enhancements to the range. In fact, it was this machine that prompted some customers to make the point that its size and weight almost made it a portable machine - except that it had to be connected to a mains electricity supply. The possibility of a battery-operated machine was now very close, but the limited space in the 1000 LSI series for the electronic content precluded the addition of batteries. Instead we designed an exterior battery 'pod' assembled to the rear of the machine to house a rechargeable battery. It was not the ideal solution.

It was during this period of the Company's development that our horizons were broadened. We commenced work on an electronic ‘billing' machine which combined a Triumph Adler electric typewriter with an LSI calculator together with a considerable amount of electronics, all housed in a custom-designed desk. Our use Of Triumph Adler typewriters in our Billing machines probably played a part in bringing the two companies together. Triumph Adler was an old-established company in Nurnberg, Germany, and was very much like the Bell Punch Company, both in the general appearance of its buildings, the sort of products it manufactured, and the fact that it was now venturing into electronics. However, instead of producing their own calculators, they were getting other suppliers to manufacture them to their own specification, and with their own Triumph or Adler label. They were getting them from Japan where electronic desk calculators were now in production.

It so happened that Rockwell International, who had been a major contributor to the American Space Programme, were having to diversify due to cut-backs in the Programme by the American Government. They decided to invest in commercial enterprises such as televisions and power tools to name just two. They also wanted to capitalize on their microprocessor design and production capability and approached the Company with an offer to supply calculator 'chips'. The decision to purchase calculator 'chips' from Rockwell coincided with an approach by Triumph Adler to produce a handheld calculator for them and I was given overall responsibility to oversee the mechanical design, printed circuit design and final production to meet the Triumph Adler specifications.

The availability of Rockwell chips meant that the amount of electronics in the handheld calculator would be physically minimal. Nevertheless, there was more than is found in the pocket calculators of today. The power arrangements alone were very comprehensive. It was to be powered by three 1.5 volt disposable batteries, or three re-chargeable batteries or by a mains power supply via a separate battery charger which was to provide both the recharging and the mains supply facilities. Once again the keyboard switching arrangement was to our own design and comprised gold plated wire contacts soldered into the keyboard printed circuit relative to each function key, together with a network of spiral 'bell-pushes', which, when depressed by the individual keys, made contact with the wire contacts. The network of spiral contacts was etched from stainless steel foil, gold plated and soldered directly to the keyboard printed circuit. This keyboard switching arrangement was successfully developed and was used in all our subsequent calculators, including larger desk types. Although we had set up a pilot ''Nixie' tube production line, and an experimental liquid crystal display design facility, we had nothing of our own design for our hand-held calculator and had to utilize a small 9-character Light Emitting Diode (L.E.D.) display manufactured in Canada.

Triumph Adler had their own particular 'livery' for all their calculators with which we had to conform. The casework had to be black; 'Number' keys grey with black numbers; 'Clear' key orange; 'Minus' key red; 'Plus' key blue and the remainder black. The calculators were to be sold in some countries with the name 'Triumph' and in others 'Adler' and this was catered for in production according to order requirements. We also provided the cartons for each individual calculator printed to conform to Triumph Adler's corporate style of lettering and colour. And to simplify matters, we also shipped the calculators to T.A's customers and agents worldwide. Coincident with finalising T.A's requirements and setting up the production facility in our factory in Portsmouth, we also put our own requirements into production. Basically this only involved settling on our own colour schemes for the hand-held calculator. It was necessary for us to make it look different from the T.A. models because, in effect, we would be in competition with them in the market place. We did not involve John Barnes at all this time but in looking ahead, decided to recruit our own industrial/graphic designer, Alan Pittaway. The ANITA versions of the hand-held calculators was the first job we gave him.

Gunther Woithe was the Sales Director of Triumph Adler in Nurnberg and he made several liaison visits to Uxbridge during the design and early production stages in 1972 and 1973 and I made two visits to Nurnberg, mainly in connection with the provision of battery chargers. Then, suddenly, towards the middle of 1973, our lives changed dramatically. John Drage, a Chief

Electronics Engineer under Norbert Kitz, came to see me to tell me that we were being taken over by Rockwell International and that all senior staff were to go to London in two days time to meet the Rockwell executives. "However", he said, "Gunther Woithe doesn't know about this and he is out in Tokyo at the moment. The M.D. wants you to fly out tomorrow and break the news to him. It is not the sort of thing that should be done over the phone and it will give you the opportunity to search out some battery charger manufacturers". I flew out the next day and the following morning booked into the hotel where Gunther was staying. On his return in the evening I met up with him and gave him the news. He appeared visibly shaken and went off to telephone or Telex Nurnberg.

The following day he was travelling down to Kyoto to visit OMRON, the electrical controls company who were also manufacturing electronic desk calculators. I accompanied Gunther to find out if OMRON were interested in making battery chargers for us. The outcome of all this was that our association with Triumph Adler began to fade and Omron began making hand-held calculators for T.A. which were remarkably similar in design and appearance to Sumlock's. On my return from Tokyo I found that Norbert Kitz and John Lloyd had left and rejoined the Bell Punch Company, John Drage had been appointed Director of Engineering and I had been appointed Technical Manager of the Company. Ron Higgin, the M.D. of the Bell Punch Company, had moved over and become M.D. of Sumlock Anita Limited.

Rockwell International, in their bid to become a major force in the calculator business, not only purchased Sumlock Anita but also a small company in Cupertino, California, called Unicom. This company had apparently not been in the calculator business very long and were taking advantage of the availability of Rockwell's calculator chips and perhaps had started life under the Rockwell umbrella from the very beginning. Ron Higgin, our new M.D., said that I should go over on a liaison visit to Unicom in Cupertino and in due course I flew over with one of our electronic engineers, a software engineer and a product analyst from the sales side of the company. Cupertino is situated in what is commonly called ‘silicon valley', some 30 to 40 miles south of San Fransisco. Unicom were occupying a section of a modern building but seemed to be operating on a shoestring with all of the design functions being carried out on one floor in an open-plan environment. Tooling and styling were sub-contracted and final production was carried out in Nogales just over the border in Mexico, where labour was extremely cheap.

Back in Uxbridge we had designed and produced a prototype of the first of our desk calculators using a Rockwell chip. There was a general consensus of opinion, mainly on the sales side, that this calculator should have a rechargeable battery facility from the outset. It was therefore designed with an internal battery compartment and had a rounded back following the form of the batteries. Ron Higgin took an instant dislike to its aesthetic properties and it was shelved and I doubt whether a prototype of this model survives. Although the ANITA desk calculators that followed during the Rockwell era gave no indication of a possible battery facility through their exterior shape, the top and bottom case mouldings were designed internally to take batteries if the decision was ever taken. At first it appeared that Rockwell International would support Sumlock Anita and use our strong team of design, manufacturing and marketing personnel to diversify into other types of office equipment, such as word processors. All the indications were that we would become an integral part of Rockwell. Being such a large organisation meant that they were very conscious of their Corporate 'image' and I received several large volumes dealing solely with this subject. Every aspect of our company administration had to conform to their stringent requirements. Slowly but surely the signs began to appear that they were losing interest in their commercial ventures, and in retrospect, it coincided with their re-entry into the American Space programme by gaining the contract for the Space Shuttle. Admiral, the American television manufacturing company they had acquired, was sold off, and as far as we were concerned the writing was on the wall. Rockwell began concentrating on Unicom calculators rather than ours, and as the competition increased they looked farther afield for cheaper production costs. First to Puerto Rico, and then to the Far East, but it was all in vain and it soon became obvious that whatever assets Sumlock Anita represented were to be liquidated. A team of Rockwell executives arrived to look at our organisation and make the necessary decisions, and I was heavily involved in providing them with product information in order that they could assess the worth of patents, tooling, parts, etc. The outcome of this was that an electronics company was found in Nis, Yugoslavia, who were interested in buying both the design and the production facilities of our hand-held calculators. This included all drawings, parts lists, production tooling at our Portsmouth factory, and our recently set up plastic moulding facility in East Kilbride in Scotland.

The most heartbreaking aspect of the whole Rockwell saga now began. Virtually every week a number of staff were made redundant until we closed down altogether. We had been a comparatively happy team that had been welded together over many years and for everyone to be so coldly dismissed was very traumatic.