LY YESTERDAY
THE GROWTH OF THE COMPUTER

Data Recording Products 3M

Dear Customer,

'Only Yesterday' is the title of a new 3M series of publications which traces the development of six major computer manufacturers. We feel this title is very appropriate because the history of the computing industry is measured in decades rather than centuries, and the big computer suppliers have grown up over the past 30 years.

Each issue of 'Only Yesterday' deals with one manufacturer. The first of these - exploring the history of Univac - is enclosed, together with a presentation folder to take the complete set of six publications.

We hope you will agree that this new series makes fascinating reading, especially when compared with our 'History of Computers' poster produced in conjunction with the Science Museum.

Certainly we at 3M really enjoy preparing these publications, but naturally we do have a commercial motive. We want to remind you that - since computers were first invented - Scotch computer products have been matching the ever-increasing demands of a rapidly changing technology (in fact we produced the first computer tape over 20 years ago). This has been achieved by continuous research and by a close liaison with the computer manufacturers themselves.

So we genuinely feel that 3M has played a part in the exciting development of the computer industry traced in the pages of 'Only Yesterday'.

Yours sincerely,

John D. Threlfall
National Marketing Manager.
Data Recording Products.

[Signature]
IT'S A PITY to stir up a controversy in the first line of this new series of publications. But it seems inevitable. The modern computer begins effectively with the invention of the stored program. And the question disputed for 30 years is: who had the idea first? It's not even sure whether it was first suggested in England or America. But one date can be fixed for sure. June 30, 1945. That was the date of a report by mathematician John von Neumann on the possibility of a successor to ENIAC, the first large scale electronic computer.

ENIAC had been largely the brainchild of Dr J Presper Eckert and Dr John Mauchly of the University of Pennsylvania. Even before ENIAC was completed they had started work with von Neumann on a stored program machine to be called EDVAC. In the event, EDVAC was piped at the post by EDSAC which performed its first computations in May, 1949, at Cambridge University. EDVAC's delayed completion was partly due to the splitting up of its design team, Eckert and Mauchly having formed their own manufacturing company in Philadelphia in 1947.

HOT AIR

And this is where the computer industry commences. Already, a large number of companies were looking into data processing. Although ENIAC was only taken off the secret list in November, 1946, within five months 20 companies were seeking to build their own computers. They included Eastman Kodak who were working on a photographic memory and a French concern who were developing one operated by compressed air! Despite the financial resources available to the major companies, Eckert and Mauchly had the unbeatable advantage of their experience on ENIAC and EDVAC. The first machine built by the Eckert-Mauchly Computer Corporation was the relatively small BINAC. This featured two developments pioneered in EDVAC: magnetic tape input and delay line storage.

Mauchly and Eckert with ENIAC in 1946. Behind them are 4 of the 40 panels making up the central processor.
THE IDEA behind the delay line was that a signal caused a ripple in a tube of mercury. Travelling at the speed of sound, the signal emerged from the far end of the tube after a definite interval. BINAC employed an 18-inch mercury column which at 65°C gave a delay of 336 microseconds. As BINAC had a pulse time of a quarter of a microsecond, this meant that at any time the tube had in storage $4 \times 336$ binary digits. This was divided into 32 words, each holding 30 binary digits, a space for plus or minus, and 11 unused spaces to give time for switching between the significant part of one word and the next.

But a year and a half before the delivery of BINAC to Northrop Aviation, Eckert and Mauchly were already developing their Universal Automatic Computer—UNIVAC. In March, 1948, they announced that it would be capable of handling alphabetical information and a fortnight later, the Company published a catalogue for the Univac Computer. The first UNIVAC was delivered to the Bureau of the Census in the spring of 1951. It was a remarkable technical achievement; its buffered tape system, for instance, could read forwards and backwards at 10,000 characters a second. Within a week of accepting the machine, the Government team of five operators and four programmers had debugged their most complicated program. (Does this achievement still stand as an all-time record?)

UNIVAC’s leadership in hardware was matched by its early software successes. Eckert and Mauchly had been fortunate in 1949 in securing the services of Dr Grace Murray Hopper who in 1952 developed the first compiler to translate program language into machine language.

MERGE

Holberton’s SORT-MERGE Generator, developed for UNIVAC L in 1951, has been described as the first significant software development. But 1951 was to see a different sort of merge on the horizon for Eckert and Mauchly. Their financial backer was killed in an aircraft accident, placing them in immediate difficulties. They had underestimated the cost of building UNIVAC L and were faced with delivering firm orders at less than cost price. William Rodgers in his book, *Think*, has revealed that they invited IBM to join forces but although the IBM scientists were enthusiastic, the word came down from above: “No reasonable interaction possible.”

Luckily, James Rand, President of Remington Rand, was interested and in March, 1951 he arranged the purchase of 95% of the stock of the troubled Company. A year later, Rand acquired Engineering Research Associates, a Com-

Prior to joining Remington Rand, Eckert and Mauchly were backed by the Totalisator Company, makers of racetrack tote systems.
pany that had gained a valuable reputation for its one-off ERA 1101 and 1102 magnetic drum computers. Eventually, the Eckert-Mauchly Division of Remington Rand and the E.R.A. Division were incorporated to become the Univac Division of Remington Rand: A joining of resources with Sperry Gyroscope in 1955 led to the current title of Sperry Univac, a Division of Sperry Rand Corporation.

By the early 1950’s, UNIVAC was regularly in the news, a cause of much discomfort to Thomas J. Watson of IBM. According to William Rodgers’ book, “the machine and its accomplishments, and especially the publicity it received over television, shook Watson badly and caused tremors throughout the IBM organisation.” An IBM man remarked that the episode “frightened the pee out of the old man, who was convinced he had lost his grip.”

UNIVAC LIKES IKE
UNIVAC’s most celebrated piece of publicity came when it was recruited onto the CBS broadcasting team for the U.S. election in 1952. This was the moment when the man in the street first became aware of computers. Prior to election night, UNIVAC’s memory tapes were fed with voting returns of the 1948 and 1944 Presidential races, while statisticians went back to 1928 to check the reliability of predicting results from fragmentary trends. At 8.30 on the night, while the polls were still open in some Western states, UNIVAC was ready with its first prediction: a landslide for Eisenhower.

- Eisenhower to win 32,915,049 popular votes
- Eisenhower to win 43 states
- Eisenhower to win 438 electoral votes

The UNIVAC staff agreed that a landslide was possible but they felt that the machine certainly couldn’t spot it so soon. Frantically rewriting the program, they informed CBS that UNIVAC was not ready to make its first scheduled appearance at 9.25. By 10 pm, the computer offered what seemed to be a more reasonable prophecy, but the mathematicians hedged their bets and modified the program again so that by 10.30 UNIVAC was predicting a toss-up:

- Eisenhower to win 24 states
- Stevenson to win 24 states

UNIVAC added that the odds were slightly in favour of Ike at a mere 8 to 7. But it was already clear that Ike was romping home and that UNIVAC’s latest prediction was hopelessly wrong. At 11.10 UNIVAC was able to shake off its human interference and restate the odds in favour of Ike at 100 to 1. The actual results when they were counted were stunningly close to the original forecast:

- Eisenhower won 33,936,252 popular votes
- Eisenhower won 39 states
- Eisenhower won 442 electoral votes

Ed Murrow of CBS summed up the story in six words that are still worth framing in every computer installation: “The trouble with machines is people.”

But it was all publicity and it all helped to sell UNIVAC computers. A year later, General Electric announced that it had signed a lease on a UNIVAC I and expected to save $500,000 a year on paperwork. This was the first order for a computer for business use in the USA. But the thin edge of the wedge was already visible: General Electric had also just installed an IBM 701 to work on computations for gas turbine development.
IBM IS ON THE CARDS FOR UNIVAC

On the 701, input and output were limited to cards. I/O devices on UNIVAC I were varied, magnificent in concept and expensive—although not a hundred percent reliable. The card-to-tape conversion equipment was based on 80-column cards, this being the system originally developed for the Census Bureau. So for some years, UNIVAC I systems relied on IBM card installations and could not use Remington Rand's own 90-column cards!

The fact remains that most writers concede UNIVAC I to have been a superior machine to the 701 developed several years later by IBM. How did Remington Rand lose its chance to dominate the computer industry? One reason must be that in the crucial early years Remington Rand was reluctant to lease its systems, preferring a straight sale. But there were other factors:

"Few enterprises have ever turned out so excellent a product and managed it so ineptly . . . Univac's salesmanship and software were hardly to be mentioned in the same breath with IBM's. The upper ranks of other computer companies are studded with ex-Univac people who left in disillusionment."

Gilber: Burck, FORTUNE magazine.

"From the beginning, the UNIVAC I sales effort was insufficient, unaggressive and unimaginative."

Professor Saul Rosen, COMPUTING SURVEYS.

"Rand repeatedly snatched defeat from the jaws of victory."

IBM executive quoted by William Rodgers in THINK.

100 delay lines in UNIVAC I gave 1000 twelve-decimal-digit words of internal storage. 12 additional delay lines were used as I/O registers.

A Russian paper removed the name UNIVAC from this advertisement illustration and featured the machine as a Soviet invention.

UNIVAC II was promoted as the only computer of its time to read, write and compute simultaneously without extra equipment. 27 were built. The last one retired in June, 1973.

IN Hindsight such judgements are easy to make; it must be remembered that in a brand-new industry there were no guidelines to follow. One series of setbacks started in 1955 when UNIVAC I was announced. This was a response to the IBM announcement of the forthcoming 705—a successor to the unsuccessful 702. The new UNIVAC would have a magnetic core memory, would be twice as powerful as UNIVAC I and would be able to run the same programs. The mistake was to build it in Minnesota to plans designed in Philadelphia. So many things went wrong that production finally centred on Philadelphia. Late deliveries of UNIVAC II gave IBM an opportunity to gain a sales lead with its 705—a machine that was technically little advanced on UNIVAC I.

In 1966 the two rivals engaged in another contest when both started on 'super computers' for the Atomic Energy Commission, IBM with a machine called STRETCH and Sperry Rand with LARC. Although it was hoped to market LARC as a commercial product, only two units were completed.
Nevertheless it was an impressive development with a memory three times faster than anything else at the time. STRETCH was completed a year later and also presented IBM with its share of problems. Both machines, however, paved the way for more successful machines. STRETCH, although reputed to have lost IBM $20,000,000, provided a basis for the fabulously successful 7090. LARC, for its part, provided the basic design for the powerful UNIVAC III. Able to read 200,000 digits a second, UNIVAC III could rewind a 3,600 foot reel of tape in 125 seconds. Its ability to directly transfer data to and from non-adjacent areas of core storage eliminated the need for many data transfers and thus saved large amounts of time and of storage space.

UNIVAC BUYS ELLIOTT

Remington Rand’s first move in setting up a computer operation in Britain took place in 1954 when James Rand invited an Englishman, Charles Elliott, to join the Company. Despite UNIVAC’s leading position in America, introducing it into Britain was an uphill task. For one thing, H.M. Government was unhappy to see dollars leaving the country. For another thing, there were already over a dozen computer companies fighting for the U.K. market. And finally, unlike its major competitors, Remington Rand had no existing punched card installations here.

The first commercial UNIVAC installation in Britain was a USS-80, operating at Remington House in 1960. Early UNIVAC purchasers include the Manchester Computer Centre who bought a $420,000 USS-80T in 1961 and Coutts Bank and Timpsons Shoes who bought similar systems in 1962. Mr Elliott recalls that Coutts took the sensible precaution of giving their Personnel Manager a heavy measure of responsibility for the computer seeing as he was going to have to inflict it on his staff!

Charles Elliott established the U.K. marketing operation after an intensive familiarisation course with UNIVAC I in New York.

One of the first U.K. inquiries for UNIVAC I came from a mathematician in Wales. He wanted to know if it could handle a new statistical method he had devised for doing football pools. The problem was sent to a UNIVAC installation in Frankfurt and the Welshman was told that UNIVAC had generated a permutation. The snag was that the coupon entry would cost £500. That was the end of that until two years later when someone found time to test it on a dry run. For the three weekends that it was tested—sadly, without the necessary £500 investment—it generated very high dividends. It is believed that the program is still on file somewhere in Univac House.

THE REDS INVENTED IT FIRST!

In April, 1957, the staff of Sperry Rand’s Paris office were startled to see an illustration of UNIVAC I in La Revue de la Mecanographie—the caption described it as a Soviet invention. The magazine had taken the picture from the Russian newspaper Krasnaya Zveza. In fact, the Russians had simply lifted the illustration from a UNIVAC advertisement and had carefully removed the word UNIVAC from the top of the central processor.

What really upset Sperry Rand was the comment in the French journal that the computer appeared to be quite modern “even if the typewriter is old-fashioned compared to an IBM 717.”
OLD UNIVACS NEVER FADE AWAY.
THEY SIMPLY DIE.

Early UNIVACs were so well built, they just kept on keeping on. The very first UNIVAC I was retired by the Census in October, 1963, after running almost non-stop for over twelve years. Parts of it are preserved at the Smithsonian Institute. Unfortunately, the sheer bulk of the first UNIVACs means that few, if any, complete systems are going to survive as museum pieces. The water-cooling plant alone of UNIVAC II weighed ten tons—and that was after it had been pumped dry!

The last operating UNIVAC I was owned by an insurance company and was switched off in August, 1970. Its operations manager described its amazing robustness in *Datamation* magazine:

"It was the most overdesigned piece of equipment ever built. We can attest to that. When we were remodelling our building, there were jackhammers going outside, the room temperature was 92° and the air conditioning to the machine was off. There was water on the floor and so much dust on the blueprints that it had to be blown off before you could read them. The machine kept running through the whole thing. It was unbelievable."

Another time I got a call one night that there was water running through the machine from holes in the roof. We turned the power off and the machine ran again two hours after we powered it back up."

This particular machine—serial number 46 of the 48 that were built—had cost its owners $10,000 when bought second-hand in 1963. When new, it was priced at $1,259,000. Another bargain buyer is Tom Pryor whose computer bureau in California bought a second-hand UNIVAC II in 1966. In the same *Datamation* feature, he expressed his satisfaction with the purchase:

"We have less down time than we would with a 360. Less than 5%. But our electric bill is pretty high—about $1,000 a month."

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Three decades of computers.

1946 ENIAC
1949 BINAC
1951 UNIVAC I
1953 UNIVAC 1101
1954 UNIVAC 1102
1955 UNIVAC 1103
1955 UNIVAC II
1956 UNIVAC ATHENA
1958 UNIVAC FC
1958 UNIVAC SOLID STATE I
1959 UNIVAC LARC
1959 UNIVAC 1105
1960 UNIVAC NTD8
1961 UNIVAC 496
1962 UNIVAC 1107
1962 UNIVAC SOLID STATE II
1962 UNIVAC 1101
1962 UNIVAC 1109
1963 UNIVAC 1160
1963 UNIVAC 1161
1964 UNIVAC 481
1964 UNIVAC 4181
1964 UNIVAC 1161
1964 UNIVAC 1164 II

UNIVAC 1004 III 1964
UNIVAC 1055 1964
UNIVAC 491 1965
UNIVAC 492 1965
UNIVAC 494 1965
UNIVAC 1106 II 1965
UNIVAC 1107 II 1965
UNIVAC 1108 II 1966
UNIVAC 1005 1966
UNIVAC 1109 1966
UNIVAC 1109 1965
UNIVAC 1110 1966
UNIVAC 1110 1967
UNIVAC 1111 1968
UNIVAC 1112 1968
UNIVAC 1114 1968
UNIVAC 1115 1968
UNIVAC 1116 1969
UNIVAC 1117 1969
UNIVAC 1118 1969
UNIVAC 1119 1969
UNIVAC 1120 1969
UNIVAC 1121 1969
UNIVAC 1122 1969
UNIVAC 1123 1969
UNIVAC 1124 1969
UNIVAC 1125 1969
UNIVAC 1126 1969
SPERRY UNIVAC 300 1973
SPERRY UNIVAC 300 1974

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In recent years a number of firms on both sides of the Atlantic have claimed the credit for being the true pioneer of the computer. One undoubted candidate for the title is the Manchester-based company, Ferranti.

In our previous series 'The Birth of the Computer' we recalled the well-known anecdote of how Ferranti became interested in computers and despatched a man to America only to discover that the really significant developments were taking place just down the road at Manchester University. The important technical breakthrough lay in the ability to store data on the screen of a cathode ray tube, a development pursued at the University by Professor F. C. Williams.

It pains us now to have to say that this story appears to be apocryphal. The Ferranti visitor to the States was Dr. Dietrich Prinz and he has revealed that he was already aware of the Williams tube, having heard about it at the Institute of Electrical Engineering.

Dr. Prinz was a Berlin physicist who had arrived in England before the war. After periods in internment camps and in the Pioneer Corps, he worked on a secret wartime project under Dr. Arthur Porter. In 1948 Ferranti became interested in automated control and at Dr. Porter's suggestion recruited Dr. Prinz.

In June 1949 attempts were made by the National Research & Development Corporation to found a national computer industry when the new Managing Director of the Corporation, the Earl of Halsbury, spent a fruitless six months attempting to persuade the various punched card companies to act in concert with the principal electronics manufacturers. By the beginning of 1950, stored program computers were in successful operation at Manchester and Cambridge Universities and LEO was heading towards completion. Halsbury visited the States to find that with no commercial machines available, American companies were ready and willing to buy from Great Britain as soon as a machine could appear on the market. Sadly, few people in Britain could accept that making a computer to a commercial specification was other than an act of lunacy.
DOES it work? Meanwhile, Ferranti and Manchester University were working together towards the epoch-making MADM— the Manchester Automatic Digital Machine Mark I. Ferranti had already built a 600,000-digit drum backing store for a University machine known as the Prototype Computer. The Scientific Adviser to the Ministry of Supply came to see this machine and looking suspiciously at the tangle of wires enquired, 'Does it work?' The engineer switched it on for the first time. It worked.

The Ministry gave Ferranti an order for a fully engineered version to be installed at the University in a special building to be paid for by the Royal Society. MADM was completed in a year and a half, in February 1961. While MADM was being built a copy was sold to the University of Toronto. Here it quickly repaid its £40,000 cost by performing water flow calculations for the planned St. Lawrence Seaway.

Part of the Manchester University Prototype Computer, built between 1948 and 1949. Its back-up drum store held 600,000 digits.

The Ferranti Mark I. Complete Add Time was 1.200 microseconds.
Access Time: almost immediate.

It is worth remembering that MADM was distinguished by having a memory with almost immediate access time. The advantages of fast access times had been realised in Britain and America for some years and the application of cathode ray tube storage was pursued vigorously in both countries. The initial problem was that the charges were transitory and the record could be read only a few times before it faded like the grin on the Cheshire cat. Williams appreciated that once a record had been read it could be immediately rewritten in its original position and published his findings in a class c I.E.E, paper in 1949.

In the summer of 1951 reports were arriving in Britain of the success of UNIVAC at the Bureau of the Census. Unwilling to see the Americans take the lead, the NRDC gave Ferranti a contract to build at least four copies of an improved MADM. In all, five copies of this machine, the "Mark I", were sold in the U.K. and two abroad—the first machines to be commercially inaugurated outside the United States. One went to Italy and gained the distinction of being the first computer to be inaugurated in the presence of a head of state: President Gronchi. (A claim has recently been published naming ELECOM as the first commercially available computer. Built in America in 1951 by the Electronic Computer Corporation, this was designed to keep track of magazine subscriptions and to assist the advertising planning of Time magazine. ELECOM 100, built in 1952, appears to have been the first computer with an integral magnetic tape memory. Electronic Computer Corporation was bought by Underwood in 1955; after Underwood went to the wall, Olivetti took over and became the first computer company to lose millions before giving computers up as a bad job).
Until the completion of a Mark I Autocode in 1955, programmers at Manchester were obliged to use a set of 32 peculiar symbols:

/E@A:SIU:DRJNFKCTTZLWHYPQOBGMXVE

Because of the need to divide the fast store into blocks of 32 numbers for the purpose of magnetic transfers, users were compelled to employ this 32-scale numbering system for all items of information. Novice programmers were hardly encouraged to continue when they discovered that the instructions:

O/T/
@ETC
RETA

were a translation of 'add the contents of locations 24 and 34 and place the result in 44'. The 32 symbols, by the way, were chosen because they are all to be found on the upper case of a typewriter.

Work started on the most commercially successful Ferranti Machine late in 1953 when the Company gained access to the packaged electronics employed in the 401 computer made by the Elliot Brothers. Led by W. S. Elliot, a Ferranti team produced the Ferranti Packaged Computer No. 1 which appeared on the market in 1955 as PEGASUS. In the same year, Ferranti opened the first Computer Bureau in London, installing PEGASUS in a splendid eighteenth century house.

This 4096-word drum machine earned a high reputation for reliability. FERDINAND (FERranti Digital Numerical Analyser, Newcastle And Durham), the PEGASUS at Durham University, achieved a 100% reliability record as soon as it was installed!

PEGASUS was also remarkably robust. A complete system was installed and working inside of 24 hours for the first Computer Exhibition in 1958. And PEGASUS had a long working life. Some were still operating in 1969. Ferranti later regretted the money they lost by selling them instead of renting them.

Like UNIVAC I in the United States, PEGASUS was able to capture the public attention through its appearances on television. The Farnborough PEGASUS was seen by BBC viewers on April 11, 1958, when it performed calculations on the dying orbit of Sputnik II.

PEGASUS was luckier than UNIVAC I with its General Election performance in the spring of 1959. A few months earlier, UNIVAC I had been lampooned by the American newspapers when its operators made a hash of things. In contrast, PEGASUS scored a major success.

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<th>Liberal</th>
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<td>368</td>
<td>254</td>
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RESULT: 630 365* 258

*Note that the Independent, who had been a Conservative, was included in the prediction as a Conservative.

Within a few hours of the first results, the Pegasus prediction was highly accurate.
On election night the Ferranti Computer Centre in London obtained data from three sources: radio, BBC Television, and by telephone from the *Guardian* newspaper. Results from the radio and telephone were fed directly to the computer. Discrepancies were compared with the latest television reports. Differently coloured punch cards and paper tapes were used for the three information streams. Each card was introduced by a start signal and held the constituency number; Conservative, Labour and Liberal votes: and the size of the majority.

PEGASUS then analysed the early results and forecast the final state of the parties. As an independent check a Ferranti SIRIUS performed a separate forecast.

After the first approximation at 10.40 p.m., known to be based on too few results, the program settled down to give a consistently accurate prediction. The final forecast was made at 2.45 a.m. and differed by only 3 from the final figure. And one of these results was an Independent candidate who had been included for convenience as a Conservative.

**Corpus Opus** In January, 1958, Sir George Thomson, making the official opening of the Computing Laboratory at Durham University, expressed hope that PEGASUS might be able to solve problems of authorship. As Master of Corpus Christi College, Cambridge, Sir George raised the thorny topic of whether Shakespeare's works were written by another Corpus man, Christopher Marlowe.

No doubt Sir George was disappointed to read an article by the Rev. A. Q. Morton in *The Times* five years later. Using a Ferranti MERCURY to establish the authorship of certain Epistles attributed to Saint Paul, Dr. Morton had also tested the works of Shakespeare and his contemporaries. The verdict: neither Marlowe nor Bacon could have written any part of the Bard's works.

Although introduced in 1957, two years after the first PEGASUS, the MERCURY computer had been started on as early as 1951. A Manchester University team had initiated work on the machine although Ferranti later doubted that at £120,000 it would find much of a market. In fact, this outright sale price was equivalent to one year's rental of any comparable American machine: no other machines made in Europe could match the speed or scope of MERCURY when it was introduced. In its first year, MERCURY was installed in atomic research centres at Harwell, Risley, Geneva, Paris, Oslo, Stockholm and Belgium.

Five years after its introduction, one MERCURY user remarked that he could still find no new machine giving better value. Four were still operating in 1970.

May, 1959, saw the appearance of SIRIUS, Ferranti's first transistorised computer. With a store of 1,000 words on nickel delay lines – later versions had 4,000 and then 10,000 word stores – SIRIUS was priced at £15,000 and was available on hire at £15 an hour. A useful sales point was that it could be run from a 5 amp socket on a domestic mains supply!

It's only logical While Ferranti are best known for their digital computers (and we haven't room here to cover the full range), Lord Bowden in his book *Faster Than Thought* has recalled a series of small logical computers built by the Company at the same time as the Mark I.

The first was a small relay machine built in 1949. This featured five stores each containing eight relays. It dealt with the logical relations between
three propositions; A, B and C. These propositions and relationships were represented as binary numbers and stored in the relays, the ON condition standing for True and OFF position for False.

A more ambitious machine constructed the following year at Ferranti’s Edinburgh laboratories was capable of dealing with up to seven logical components and with the 128 possible combinations of the states of these components. The conditions of state were determined by the connectives Not, And, Or, Or, Else, If Then, If and Only If. For any problem the rules were set up by plug and socket connections, the board layout giving a pictorial view of the problem. A simple problem could take the form of:

I am going to University and have to decide what subjects I will take in my final year at school. The subjects I may choose are Mathematics, History, Science, English, Latin, German and French. English is compulsory. If I take Science, I must take Mathematics. If I take Latin I cannot take German as the timetable clashes. I do not want to take History. For entrance to the University I must have taken Science and French. What are my possible curricula?

The setting-up diagram is shown below. Signal lights indicated the three solutions capable of satisfying the rules:


In August, 1963, at a time when far too many competitors were seeking the British market, the Ferranti computer interests merged with ICT. lest anyone should gain the impression that David was being swallowed up by Goliath, it is interesting to refer to figures compiled at the time by the journal Computers and Automation. These show that Ferranti had installed £7.2 millions worth of computers in the U.K. and had also exported £1.9 millions worth. ICT were only slightly ahead with respective figures of £8.9 millions and £2.3 millions.

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<th>Computer</th>
<th>Average Price £</th>
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<th>On Order</th>
<th>Exported</th>
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<th>FERRANTI</th>
<th>Average Price £</th>
<th>Installed</th>
<th>On Order</th>
<th>Exported</th>
<th>Installed</th>
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<tbody>
<tr>
<td>Apollo</td>
<td>20,000</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>Atlas</td>
<td>200,000</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
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<td>1</td>
<td>1</td>
<td>1</td>
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<td>1</td>
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<td>3</td>
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<td>10</td>
<td>3</td>
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<td>12</td>
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<td>8</td>
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<td>74</td>
<td>16</td>
<td>21</td>
<td>4</td>
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Having relinquished commercial computers, Ferranti concentrated on real-time applications and direct-control systems; the company have just installed the first major direct computer control system for an ICI chemical plant at Fleetwood, Lancashire. Today, Ferranti’s Digital Systems Division is involved in such activities as air defence, air traffic control and military and naval data handling. The Company’s Canadian offshoot has achieved particular success in the information display field, its systems being installed in the Montreal Stock Exchange and at the Chicago Board of Trade.

Ferranti and ICT sales at the time of the merger.
Time Sharing time As one of its last acts, the Ferranti Computer Department had the satisfaction of seeing the success of the mighty ATLAS, first of the big time-sharing systems.

ATLAS was conceived in 1958 after the Manchester University team designed a transistor circuit capable of effecting an extremely rapid transmission of the 'carry over' process from one digit to the next during addition. In achieving the high speed of ATLAS this was a critical step forward as the carry over process limits the speed of other circuit operations.

As development work gathered momentum, Ferranti took over the task of producing working drawings and documents for the University. The ATLAS project involved considerable financial outlay and early in 1959 Ferranti approached many potential users, keeping them informed of its progress. From 1960 onwards the United Kingdom Atomic Energy Authority showed great enthusiasm for the project, placing an order for the Harwell ATLAS in 1961.

A prototype was ready for testing at the West Gorton factory in 1960 and the first complete machine, known to its owners as MUSE, was installed at the University late in 1961. The University announced that the computer and its back-up facilities would be available to any commercial user at a rate of £750 an hour.

Altogether eleven ATLAS systems were sold, at prices ranging from £14 million to £54 million. The machine at London University required its own specially constructed two-storey building; the operators liked to claim that they had the only computer room to boast its own spiral staircase. When the Queen Mother visited the London University ATLAS in 1964, the computer went through one of those demonstration routines beloved of programmers, printing anagrams of Clarence House and finishing off with a line drawing of Clarence House itself.

With the Company's head start in the late 40's and the staggering lead made by ATLAS in the early 60's, the inevitable question must be asked: where did Ferranti go wrong?

At an IEE/IERE Symposium in 1975, some answers were suggested by Mr. Bernard Swann. Now the Chairman of Programming & Software Implementation Ltd, Mr. Swann was a leading member of the Ferranti computer team; he has kindly allowed us to draw on his lecture notes in compiling material for this publication and to reprint some of his comments on how Ferranti 'might have done better'.

'We greatly under-estimated the potential demand for computers and were, therefore, unprepared for the advance when it came ... Because of this we did not prepare for a large enough production and as a number of other companies were in a similar position we competed with one another which reduced profit margins too much ... We should have gathered the industry into a few larger units in about 1958-59 after the first Computer Exhibition had shown this to be needed ... We should have rented our computers; they often lasted for a long time'.
Next door to 3M's London headquarters is another office complex bearing on the door the letters IBM. Wondering what the initials stood for, we asked someone leaving the building. He told us that because of his Company's many employee benefits it was believed to be an abbreviation of International Big Mother. The next man, however, had just returned from an assignment in New Jersey and was expecting to be sent to the Continent; he informed us, somewhat tartly, that the letters meant I've Been Moved.

In fact, rapid movement seems to be IBM's most remarkable characteristic. They've recently moved from ninth position to seventh in the Fortune 500.

Over $14 billion in sales in 1975 . . . over 60% of the American computer market. It's even more remarkable when you consider IBM's late entry. True enough, IBM had been in computers from the beginning: the Harvard Mk I, a giant electro-mechanical machine, had been delivered in 1944. But this was a one-off, as was the Selective Sequence Electronic Calculator, installed in 1948.

In the competitive market IBM's initial concentration was on relatively modest machines designed as a natural consequence of IBM's punched card business. 1946 saw the introduction of the 603 Calculating Punch. It was rather limited: it could add, subtract and multiply. But it couldn't divide. Programs were set up by wiring a plugboard.

Two years later came the 604. It was extremely popular; over 4,000 had been produced by 1960. One of its first users was Eric Blodax who in 1970 recorded his impressions in Datamation magazine.
"There was a trivial I/O restriction: all input and output had to be punched into a single 80-column card. In spite of the minor limitations of the 604, we did a good deal of vital work with it. We waded into structures problems, solved the world of trajectories in at least two dimensions, and sailed easily through long equations in applied physics, like:

\[ f = ma. \]

More impressive was the Card Programmed Calculator introduced in 1949. Over 200 were installed. An ingenious lash-up of the 604, the 422 Tabulator and the 941 Auxiliary Storage Unit, it gave 48 memory locations, each of 10 decimal digits. Eric Bloch recalls his fascination with the rising and falling of the type bars:

"They looked like the tide ebbing and advancing with the phases of the moon, and they were damn near as fast."

THE ANSWER TO UNIVAC

IBM was badly shaken by the welcome given in 1951 to Remington Rand’s UNIVAC. The future, it was obvious, lay in large computers. In April, 1953, IBM formally dedicated the now famous 701. With a 2048-word memory of Williams tubes supported by magnetic tape and drum storage, it was 25 times faster than the SSEC but a mere quarter of the size. In all, 19 of these systems were installed.

In February, 1955, IBM introduced the 702, intended primarily for commercial use. By the end of the year, 14 had been produced. The 702 was then replaced by the 705.

About the same time, the 701 was replaced by the 704. If there was ever a 703 it seems to have been stillborn in the laboratory.

The 701 family placed IBM firmly in the electronic computer market. Even more successful was the smaller 650, introduced in 1954. In its first two years over 400 were installed. Available with a 1,000 or 2,000 word drum, 60 words of magnetic core memory, and magnetic tapes, it performed a multiplication in 2 milliseconds, compared with 444 microseconds for the 701. More important to users was the high reliability of the drum.

IBM had a ready market for the 650. After all, the Company held ninetenths of the American market for punched card tabulators. From 1954 to 1960 the 650 was the largest selling single computer.

Needless to say, Remington Rand fought back, introducing the UNIVAC Solid State 80 in 1958. At first it handled only 90-column cards but in 1959 its makers (now Sperry Rand) announced that it would take 80-column IBM cards. Moreover, it could execute IBM 650 instructions through a special software package. Similarly priced to the 650, it offered faster arithmetic, twice the card reading speed and four times the printer speed. But it was just too late. By 1959 it was competing against IBM’s successor to the 650.

THE FORMULA TRANSLATING SYSTEM

A major IBM development of the mid 1950’s was the first FORTRAN compiler produced by a team headed by John Backus. In designing the

In 1948 the SSEC was booked ahead for six months and was charged out at $300 an hour. Proud to be associated with it, Shell produced an advertisement announcing itself as suppliers of lubricants to the computer.
The Card Programmed Calculator, introduced in 1949. Up to three Type 941's could be provided to give a total memory of 480 digits plus 48 signs.

package for the 704, the group started in the summer of 1954 and delivered the system in 1957.

An early report gives an example of a program employing 47 FORTRAN statements which took four hours to write. It replaced about 1,000 instructions in machine language – even though the 704 took six minutes to perform the compilation! FORTRAN wasn’t welcomed by programmers. For one thing, it tended to be full of bugs. Apart from this, programmers believed they could write more efficient codes. Perhaps, too, they felt that the ease of writing FORTRAN would rob their profession of its mystique.

By 1962, a Committee of the American Standards Association had developed two official FORTRAN specifications: FORTRAN and BASIC FORTRAN. When the time came to give commercial users a common business oriented language, IBM opposed the introduction of COBOL. RCA and Sperry Rand were the only manufacturers to implement COBOL-60 until the Department of Defence threatened to stop buying from those who didn’t provide compilers. IBM was obliged to drop its alternative, Commercial Translator, while Honeywell similarly abandoned its own system, Pact.

It wasn’t the only time IBM attempted to defy standardisation. Because of the high user investment in its own six-bit BCD coding system, IBM tried to prevent the introduction of the ASCII coding scheme. The Company raised similar objections to a punched card standard in 1966 and to a tape standard a year later.

THE SECOND GENERATION

In 1948 a neat little device was developed at Bell Telephone Laboratories: the transistor. It was ten years before it found its way into a computer of any size – the UNIVAC Solid State 80, introduced in August, 1958. In the same month IBM delivered a vacuum tube machine, the large scale business oriented 709. The introduction of transistors brought a new group of entrants into the computer industry. Philco, RCA, General Electric and Autonetics all introduced second-generation computers before IBM came up with the 7090 – a solid-state version of the 709 – at the end of 1959. But although IBM was only the sixth American manufacturer to adopt the transistor, the newcomers soon lost the advantages offered by their short period of technical leadership. By 1960, IBM had delivered the 7070, the 1401 and the 1620. Seldom has any Company in any field responded so quickly to technical change.

The 7090 was distinguished by outstanding reliability. Hundreds were sold, despite a typical system cost of $3 million. The 1620 was a small scientific computer sold in substantial numbers while the 1401 was the transistor replacement for the now outdated 650.

Sperry Rand had justifiably expected to see the SS-80 knock the 650 from its perch. But only four months after they announced its compatibility with the 650, IBM brought out the 140:. All three machines were in much the same price range. But now the 1401 was faster than the SS-80, giving twice as many commercial operations to the dollar. The SS-90
enjoyed perhaps a year as a major competitor to IBM, but the 1401 soon became the top selling computer of its time.

In due course the 1401 itself became the subject of an attack when Honeywell announced the H-200 in late 1933. Faster than the 1401; less than a tenth of the access time; four times the memory size. It was about the same price and to make life easy, Honeywell offered a program capable of translating 1401 programs.

Naturally, the Honeywell machine sold well. Nearly 700 were installed in its first year. Although it was only a fraction of the 1401 market (there were now 7,000 1401’s in the field) it was enough to get IBM fidgety. Right at the highpoint of its second-generation success, IBM decided to accelerate its progress on a design project that had been started in 1961.

IBM was keen to build a new family of machines capable of performing both scientific and commercial work. It was a desirable aim. Existing scientific and business machines used different input and output configurations; and you couldn’t swap programs between the two types of system. But would it be possible to design a machine that would be compatible with both?

The IBM executive responsible for the 1401 argued against the new project, expressing his fears that it would be cheaper for a customer to move up from a 1401 to the Honeywell H-200. He lost the argument and went off to head General Electric’s computer division.

IBM solved the compatibility problem and at the same time introduced a new technology into computers: the integrated circuit.

With an unparalleled flare of publicity IBM launched the new system in April, 1964. It was, of course— you’ve guessed it by now—the 360 range. But that’s a whole new story.

THE WATSONS

No discussion of IBM’s startling growth could be complete without an acknowledgement of the contributions made by its two towering figureheads, Thomas J Watson and Thomas J Watson Jr. By an almost evangelical leadership, complete with Company songs, the senior Watson pushed the Company’s gross income from $4 million in 1914 to $41 million by 1939.

By 1945 it was up to $142 million and by 1953 over $400 million. Yet in spite of this breakneck urge for ever-increasing sales, Thomas J Watson was prepared to refuse business from some quarters. In his book The Computer Prophets, Dr Jerry Rosenberg relates a characteristic story. Watson had given a party for United Nations representatives. Someone asked Andrei Gromyko, the Soviet delegate, if IBM machines were being used in Russia.

"I’m afraid not. Your State Department won’t let us have any.” Watson overheard this comment and interrupted, “Don’t blame the State Department. I won’t let you have any.”

In 1950 Watson senior handed the presidency of the Company over to his son. It could hardly be described as nepotism; the story goes that in his second year as a salesman, the younger Watson had met his full year’s sales quota by the 2nd of January. In the Wall Street territory where no salesman had ever met a full quota, he achieved a sales target of 231 percent.

Herman Goldstine, the ENIAC pioneer, has stated his opinion that it was Thomas Watson Jr who played the key role in moving IBM into the electronic computer field.
COURTROOM BATTLES

No Company can be as successful as IBM without upsetting a few of the others. In 1955 Sperry Rand filed an anti-trust action, charging that IBM was enjoying a monopoly of the tabulating machine industry. The complete story is too complex to describe here but in short IBM paid Sperry Rand $2 million to drop the anti-trust suit and both Companies entered into a cross-licensing arrangement of their patents. Sperry Rand was still waiting for its ENIAC patents to be granted.

Although IBM challenged the ENIAC patent application, the Company agreed to pay Sperry Rand a guaranteed royalty of $10 million. It was the only royalty ever paid on the ENIAC patent. The patent was eventually granted and Sperry Rand brought an infringement action against Honeywell. In response Honeywell charged that the IBM/Sperry Rand licensing agreement was a monopoly conspiracy. The trial lasted 135 days, the transcript being over 20,000 pages long.

It was decided that Honeywell had infringed the patent; but that the patent was invalid because ENIAC had been in public use for over a year before the patent application was filed. The judge also decided that IBM and Sperry Rand had conspired in restraint of trade and placed the damages to Honeywell at between $36 million and $55 million. However he also ruled that Honeywell had left it too late in bringing the action. In the long run neither side gained a cent in damages or court costs.

An even bigger legal fiasco commenced in 1968 when Control Data charged IBM with monopolising the market. Control Data hired a legal staff of 130 to build an automated retrieval system to examine up to 40 million IBM documents. In turn, IBM examined 120 million Control Data documents. Two years later, IBM filed an action claiming that Control Data was attempting to control the large-scale computer market.

The trial was set for late 1973 but early in the year the two Companies announced an out-of-court settlement, estimated to be worth $100 million to Control Data. IBM’s legal expenses were believed to be over $60 million.

As part of the agreement Control Data was required to destroy its computer file of IBM documents in the presence of IBM’s lawyers. On hearing that this had taken place, the Department of Justice pointed out that IBM was required by court order to preserve all materials relating to the case. The Department threatened to compel IBM to reconstruct the computer index or pay up $4 million.

The moral to all this: you’ll go further in the world as a computer lawyer than as a computer scientist.
IBM'S SLICE OF THE CAKE

It must have been an enervating experience to have been running IBM in the 1950's and to witness the Company's momentous take-over of the American market. The table below shows how dramatically IBM overcame Remington Rand's early lead in computers.

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<thead>
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<th></th>
<th>IBM</th>
<th>Remington Rand</th>
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<tr>
<td>Market shares</td>
<td></td>
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<tr>
<td>1953</td>
<td>100%</td>
<td>56%</td>
</tr>
<tr>
<td>1955</td>
<td>56%</td>
<td>38.5%</td>
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<tr>
<td>1956</td>
<td>75%</td>
<td>18.7%</td>
</tr>
<tr>
<td>1957</td>
<td>78%</td>
<td>16%</td>
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</tbody>
</table>

Today IBM has slightly less of a hold on the market. A 1975 estimate gives IBM 63 percent of the American market, 52 percent in Europe, and 58 percent in the rest of the world.

Britain presents a very special case with IBM having only 31 percent against ICL's 33 percent.

The years of steady growth and consistently high profits make IBM a stockbroker's dream. By 1973 the value of outstanding IBM stock was almost equal to the value of American Telephone & Telegraph, General Motors and Exxon, America's three largest corporations.

Don't you wish you had a time machine? In 1969 Dr Jerry Rosenberg noted that in 1914 you could have bought a hundred shares in IBM for $2,700. Through stock splits and added dividends they would have totted up to almost $18 million by 1969.

As for what they're worth now... well, for that kind of arithmetic you need access to one of IBM's computers.
As asked to name three typically British institutions, your average computer user might well suggest baked beans, the crossword puzzle and International Computers Limited. Like the beans and the crossword, in fact, ICL’s origins are on the other side of the Atlantic.

The story starts in 1890 when Dr. Herman Hollerith persuaded the U.S. Census to adopt his punched card machines. The success of these machines after their adaptation for business use was noted by a British businessman, Raleigh Phillpotts. In 1904 with the former Director of the U.S. Census, now living in England, he formed a syndicate known as “The Tabulator” to bring Hollerith equipment to the U.K. Woolwich Arsenal was the first customer. In 1907 the syndicate became a public company, The British Tabulating Machine Company Limited, with a capital of £50,000. An important early contract was for the 1911 British Census, one condition being that the fifty million cards must be British made – hitherto they had all come from America. A later and more dramatic order was for a Hollerith installation to be delivered to the Normandy beach-head six days after D-day.

The war over, BTM investigated the new technology of electronics, developing an electronic multiplier in the late 1940’s and placing it on the market in 1951. More significant was the Company’s association with Birkbeck College which led to the HEC computer in 1951. Out of the HEC series came the 1201 in the mid 50’s. 1956 saw a formal link with The General Electric Company, a collaboration which was to lead to the 1301.
Sharing the Powers-Samas stand was the astonishingly sophisticated SAMASTRONIC tabulator. It's been said that had the SAMASTRONIC been pushed to its logical conclusion, this is the way computers might have developed. But it wasn't to be— for within six months its makers had joined hands with BTM. "Not a merger or a monopoly, but a marriage," stated the house journal of the new ICT.

Powers-Samas had stemmed from roots close to those of BTM; James Powers had been Dr. Hollerith's colleague. A year after working on the 1910 U.S. Census he had formed the Powers Accounting Machine Company of America. A European demonstration of his machines in 1913 gave birth to the Accounting & Tabulating Corporation of Great Britain Ltd. In 1919 this subsidiary of the American company was bought outright by its major customer, the Prudential Assurance Company— the Pru didn't like dealing with people whose headquarters were three thousand miles away. Ten years later came a merger with the French agent for Powers machines, Société Anonyme des Machines à Statistiques (Samas). In 1951 Powers-Samas became a wholly-owned subsidiary of Vickers Ltd, who coincidentally had been BTM's first customer in the commercial field over forty years earlier.

Powers-Samas' progress in electronics had been slower than that of BTM. Work on an electronic multiplying punch— Emp—had started as early as 1946 although it didn't see the light of day until 1953. Within three years, however, the Company was selling at £19,500 a time the PCC. The initials stood for Program Controlled Computer. Originally developed for British Railways at Swindon, it had a main store of no fewer than 160 words.

7,200 cards an hour was the speed of the PCC— but a sloppily written program could reduce it to 1,600 an hour.
PROJECT MAC

Eager to impress itself on the public consciousness, the new conglomerate decided to follow the well-established tradition for computer manufacturers to interpret election results: ICT’s public relations team joined forces with Reuters news agency for the 1959 General Election. Within thirteen minutes of the first results from the polls, the 1201 at ICT’s Hertford Street Computer Centre had announced a “virtually certain” victory for Harold Macmillan. In less than three hours the forecast was made of a Conservative majority of 1,500,000 votes. It tallied well with the final majority of 1,535,000.

With 16,000 staff ICT was now the largest computer company outside the United States. Nevertheless, it was still ready to acquire outside technology and in 1961 it took under its wing the computer designers and development engineers of General Electric. No-one could call the result – the 1301 – a resounding success. In fact, a few years later David Shirley in his book Choosing a Computer remarked: “If the IBM 1401 is the best secondhand buy, the ICT 1301 is certainly the worst. Its appearance alone is enough to deter the prospective purchaser, for it is physically the largest second generation computer ever produced.”

Compatible with the 1301 (but the two machines were compatible with nothing else) was the 1300. It is interesting to note that the first 1300 was delivered to the Polish Government in Warsaw and was operational within ten days of its arrival.

The General Electric people were only with ICT a few months before the Company signed a technical agreement with RCA, followed by a sales agreement a month later. Before the end of the year, ICT installed the first RCA 301, renamed the ICT 1500. Over a hundred were sold in Britain at an average price of £110,000. (About ten customers chose to buy much the same machine from De La Rue Bull; here it was known as the Gamma 30.)

Next into the ICT net swam the EMI computer department in 1962. EMI had been active in computers for just four years, a prototype for the EMIDEC 1100 having been installed at the Austin Longbridge works in 1958. The Company’s high point was the half million pound 2400 ordered by the Ministry of Pensions in 1959. Specially developed for this order was a 3,000 lines a minute printer. “All plug and socket connections will be gold-plated,” announced the official press release at the time.
AND UNIVAC...AND FERRANTI

ICT opened 1963 with yet another deal, a sales agreement with Remington Rand Ltd to handle the UNIVAC 100 Card Processor in the United Kingdom. "Until we have devised electronic machines of our own to cover the whole field, it pays us in some cases to supply machines which other firms have developed," explained the Chairman of ICT.

1,900 Ferranti people found themselves working for ICT in September 1963 when the Company took over Ferranti's commercial computer department. One of the 1,900 was Mr Basil de Ferranti; now Deputy Managing Director of ICT, he took the opportunity to complain of the lack of Government support for the British computer industry. As for the year-old ATLAS, he recalled that within Ferranti it was often referred to as BISON...Built In Spite Of N.R.D.C.

This wasn't to be the last merger of 1963. Before the year was out, English Electric and Leo Computers had united their computer activities. Both Companies had honourable pedigrees: Leo's stretching back to the historic EDSAC, and English Electric's to the equally historic ACE. English Electric now had the KDP10, KDF9, KDF6 and KDN2 under its belt; Leo Computers, the Leo III and Leo IIIIF. Marconi's commercial and scientific computer interests were added in 1964, creating the somewhat cumbersome name English-Electric-Leo-Marconi Computers Limited.

The Ferranti/ICT association was instantly fruitful. In Canada, Ferranti-Packard Electric Ltd had developed a machine known as the FP6000, based on two British designs: PEGASUS and ORION 2. In March 1964 ICT announced that this was to be the basis of the 1900 Series, a family of compatible processors including 1902, 1903, 1904, 1905 and 1906. The 1900 Series, as the IBM 360 was to do, connected peripheral devices via a standard interface. The peripherals included backing drum stores, a replaceable cartridge mass storage magnetic card file, 7-track tape systems and single channel telephone and telegraph data terminals. In the first fifteen months, 340 computers in the series were ordered throughout the world.

HOLY COMPUTER

Development of the 1900 Series was fast and furious. A cheaper card-processing system, the 1901, in 1965. A complete restructuring of the upper end models in 1966. And then in 1967, the 1906A -- claimed at the time to be twice as powerful as ATLAS and English Electric's 4/75; more powerful than the 360/90 and the UNIVAC 1108.

Came the 1901A, 1902A, 1903A and 1904A in 1968 -- like the 1906A, based on integrated circuits. And in the early part of 1968 came the 1,000th order for a 1900 Series computer. Followed a few days later by a request for a 1901 from the Church of England...for their Ecclesiastical Insurance Office.

ICT's greatest sales success was the 1900 series. This configuration includes a card reader and punch, paper tape reader and punch, magnetic tape units and a line printer.
That reference to the 4/75 a few lines back is a reminder that English Electric Computers, as they were then, didn’t intend ICT to have it easy. In 1965 they began to manufacture and market the System 4 range, based largely but not entirely on the RCA SPECTRA 70. In the long run, ICT with the 1900 Series well outsold the English Electric range, but it can’t be said that the competition was healthy for either Company. While they both slugged it out in the home market, IBM, Burroughs, Honeywell and Univac could concentrate on picking the key contracts.

Where the Americans couldn’t compete was in the Iron Curtain countries (thanks to their strategic embargoes) and both British Companies, and also Elliott-Automation, achieved worthwhile sales. In 1966 English Electric sold a big KDF-9 worth £1 million to the People’s Republic of China. When RCA and the U.S. State department disapproved the contract early in 1967, English Electric not only lost the sale but had to compensate the Chinese for construction of the empty computer centre.

In 1967, ICT surprised itself by selling several million dollars worth of peripherals into the U.S. – to RCA among others. To rub salt in English Electric’s wounds, ICT then managed to sell two 1905’s to Peking.

All in all, 1967 wasn’t System Four’s lucky year. There were problems with the 4/10, the smallest in the range and it was quietly forgotten. Delays with the 4/50 meant that the equivalent machines had to be imported from RCA to satisfy customers who weren’t prepared to wait. At least there was a summer wedding to cheer everyone up: Elliott-Automation and English Electric decided to tie the knot.

Out of the nine major British companies that had fought over the computer market in the 50’s, there were now just two left. But not for long.

The world’s first alphabetical tabulation, produced in 1914 by Charles Foster MBE of The Accounting & Tabulating Corporation of Great Britain Ltd, forerunner of Powers-Samas.

At a luncheon to celebrate the sale of the 509th 1900 in 1967, the Rt. Hon. Frank Cousins (left) and the Rt. Hon. Anthony Wedgwood Benn chat with Cecil Mead, ICT Chairman and Colonel A. T. Maxwell, Deputy Chairman.
At the close of the year, ICT’s Chairman admitted that talks had been held with English Electric toward the formation of a single British mainframe company. The new wedding took some months to set up; for one thing there was the question of how big a dowry could be provided by the Minister of Technology. Mr Wedgwood Benn turned up with £17 million, £3.5 million in exchange for 10.5%, Government ownership of the new Company and £13.5 million as a grant towards research and development over four years. Remaining shares in ICL were to be held by existing ICT shareholders (53.5%); English Electric (18%); Plessey (18%). Depending on the method of measurement, ICL was reckoned to be fourth, fifth, sixth or seventh largest in the world list of computer companies.


What is more worth knowing as a taxpayer (and therefore an ICL shareholder) is what does the future hold for ICL.

"I do believe," said Tom Hudson, ICL Chairman, in Management Today, "that Britain needs an independent data processing capability. It is one of the great growth industries of the 1980’s and we simply have to decide whether we want to be in that industry. When the 2900 series is completed, we will have one of the best product lines that exists."

And Tom Hudson should be able to judge. After all, he used to be Managing Director of IBM (UK).
"Hi ho, hi ho, it's off to work we go"

No-one knows who christened the leading mainframe manufacturers "Snow White and the Seven Dwarfs." And while everyone recognises IBM as Snow White, it was some years before anyone set out to identify the dwarfs by name. The American magazine, Datamation, compared the computer companies with Disney's characters and decided which one was closest in nature to the delightful Doc:

"Burroughs, often the leader, though not always acknowledged, continues steadily down the trail, pick on shoulder, trudging toward the mother lode."

That identification was made in 1971 when Burroughs established itself as the biggest profits earner of the dwarfs. According to one authoritative study, Burroughs' computer activities had started to become profitable only in 1968. It had been a long trudge to the mother lode. Burroughs had begun looking at the possibilities of computers as far back as 1948, hiring Irven Travis, a member of the ENIAC development team, to head its research laboratory a year later.

In 1961 Burroughs bought control of Control Instrument Corporation, a small outfit who were about to market a high-speed tabulator capable of reading 900 cards a minute and of

Built in 1950, this Burroughs computer featured a magnetic drum and was a prototype for UDEC (Unitized Digital Electronic Computer.)

The computer compass

"Have maintenance manual, will travel" seems to be the motto of Burroughs Customer Engineers. Having recently installed the most Westernly computer system in Britain (two VRC's at Stornoway on the Isle of Lewis), the company announced the most Northerly system: two B80's purchased by the Shetland Islands Council.

East and West are represented by Burroughs installations in Lowestoft and the Scilly Isles.
printing 900 lines a minute. Burroughs introduced it as part of the Series G line of card-handling products.

Offered as peripheral equipment for other people's computers - such as IBM's 705 - Series G achieved limited success and was withdrawn. It was also intended to provide input and output for the ill-fated BEAM (Burroughs Electronic Accounting Machine) projects. BEAM I, II and III never left the drawing board. BEAM IV, designed to compete with the 705, was nearly completed but was eventually abandoned.

**E for Effort**

Burroughs had more luck with the E101, introduced in January 1956. One of the first mini-computers, it sold for under $50,000. It was so mini, in fact, that a distinguished English computer scientist remarked caustically about the mountain that had laboured to produce a mouse. All the same, the key-driven E101 filled a gap in the market. One E101 operating in Britain was switched off for the last time as late as the autumn of 1977.

In 1956 Burroughs made the second and last of its computer acquisitions, when it purchased ElectroData Corporation for $3.3 million. ElectroData, who had built the successful CEC 201 in 1951, launched the sophisticated DataTron 205 in 1953. This was the first commercial machine to provide an index register and automatic relocation of subroutines in the hardware rather than by a programming system. One early version used a fast card collator as input and an IBM 407 tabulator as output. Associated equipment for the 205 introduced by Burroughs included the Cardatron which gave buffering and editing features for card systems, and the

Datafile which offered fast-access bulk-storing on strips of magnetic tape.

Burroughs were still selling the 205 in the early 60's; a press release of October 1962 announced that it was now available with a 90 day warranty at 30 per cent of the original list price.

Having absorbed ElectroData, Burroughs scrapped the BEAM IV and set to work on the 220 - the last of the vacuum tube computers. When the rest of the industry was trumpeting the virtues of the transistor it was a tough decision to make. But a wise one. The 220 was already being delivered in quantity when the highly-promoted solid-state machines appeared at last in 1960. In its favour was a high degree of reliability; users pointed delightedly to an average downtime of only 1.3 percent.
Burroughs and Atlas

ATLAS? No, Atlas - the guided rockets. Burroughs obviously couldn't ignore the transistor. Indeed, in 1957 the company built the industry's first large-scale solid-state system: for the Atlas guidance installation at Cape Canaveral. Military units became a Burroughs speciality: sales by 1961 amounted to over half a billion dollars. It is to be hoped that the salesmen were on a good commission: the U.S. Air Force bought a hundred Burroughs computers for its SAGE air defence system alone.

But in the commercial market, Burroughs were off to a slow start with Second Generation machines. Not until 1961 were they ready to announce the big breakthrough: the B 5000. A machine that was going to solve the interface problems between man and machine. (Work on the B 5000 had started quietly in 1958.)

The revolutionary idea, much appreciated by prospective customers, was that the B 5000 would use high level languages such as ALGOL and COBOL to the virtual exclusion of machine language programming, and that the system would be able to control most of its own operation. Heady stuff for 1961. To explain the compiling prowess of the B 5000, salesmen handed out Compilogram, a game consisting of a playing board, four decks of cards, an instruction manual and an answer sheet. Do any copies of the game still lurk in someone's cupboard? Doubtless, the Science Museum would like to possess such a curious relic of those long distant days.

Unfortunately for a patiently waiting world, the B 5000 was bedevilled by delays. Two years went by before a computer journalist was able to claim triumphantly, "I touched a B 5000!"

Despite the delays, it was way ahead of its time, boasting 'dynamic storage allocation' and other innovations that allowed numerous programs to run simultaneously. But sales were slow: few customers could understand its advantages. And the machine itself was disappointingly slow: the price paid for easier programming was an inefficient use of the main memory.

Burroughs sold only thirty B 5000's and lost money on them. With over thirty major changes, an improved version, the B 5500, found its way into nearly 200 installations.
Shortly after the initial announcement of the B 5000, Burroughs made a headlong assault on the punched card business by offering four systems: the B 250, a hard-copy record processor; the B 270, a sorter-lister; the B 280, a magnetic tape processor; and most significant of all, the B 260, described as a "workhorse computer", although it would have been truer to call it a sophisticated tabulator.

The B 260 was intended to penetrate the IBM stronghold, especially the lucrative 1401 market. It was a question of which way to jump. Too high a performance level would limit the size of the market. Too little would mean offering something like a 407/521 combination, giving few reasons for anyone to switch from IBM. Burroughs settled for a machine with a performance of about four or five 407's. Its ability to calculate also enabled it to replace the 804. The 260 was a striking success, selling just short of a thousand systems by 1968.

**The 15 percenter**

Much of the company's marketing success has been attributed to Ray Macdonald who became Executive Vice-President in 1964, and Chairman of the Board in 1973. Macdonald has steered Burroughs in line with his "growth theory" which holds that the ideal revenue growth is 15 percent per year.

First and foremost a marketing man, he has been credited with a remarkable flair for knowing what the customer wants. The E 2100 is a good example. In the mid 60's Burroughs developed an unpromising hybrid: an accounting machine married to a small memory. Most Burroughs people thought it would do well to sell 500 units.

Macdonald noted that his computer salesmen were earning lower sales than the men who sold straightforward accounting machines. So he took half his computer salesforce and sent them on the road with the E 2100. Taking the later successors of the E 2100 into account, they finally shifted 50,000! It was this decision to bring electronics to the smaller business that gave Burroughs the edge on its nearest competitor, NCR.

Like all the dwarfs, Burroughs is well aware of Snow White. In 1966, however, "Doc" delivered a body blow to IBM's esteem by winning a prize U.S. Air Force contract. The Air Force had called for bids to upgrade its worldwide accounting system. IBM, Burroughs, Honeywell and RCA all submitted tenders. (Sperry Rand withdrew five days before the bids were due.) With a $114 million proposal, IBM won the contract. The bids from the three losers ranged from $60 million to $70 million.

"Unfair," cried the three losers. "No," replied the Air Force, "only IBM met the specifications - so price doesn't come into it." The Senate thought differently and told the Air Force to call for new bids. The second time around, everyone met the specifications and Burroughs won with a bid of $60 million.

In spite of an apparent saving of $54 million, the Air Force weren't happy. They complained that the delay had reduced the savings to a meagre $36 million.

The machines delivered to the Air Force were a major success with commercial users, too. The medium-sized B 3500 has been the company's best-selling full-size computer, with a thousand installations generating sales of $600 million.

Macdonald demonstrated his sales flair again with the L-series of electronic accounting machines, developed in the late 60's, when he noted that they could be linked to large central processors and decided to market them as intelligent terminals in addition to their conventional use as stand-alone business machines. So far, the company has sold 150,000 L-series units. In money terms: about $2 billion!
The supercomputers

In 1961, wide publicity had heralded the announcement of the B 5000. Likewise, the B 8500 in 1967; it was expected to be the most powerful computer in the world, employing large modules of thin film memory. Unable to produce reliable components at a viable cost, however, Burroughs in due course were obliged to give it the kiss of death.

There were problems, too, with the next big machine, the B 6500. Here the snag lay in electrical impulses which had the annoying tendency of sending echoes around the circuits. To solve it, the engineers had to bring out the soldering irons to alter thousands of circuit chains.

The National Westminster Bank has three B 6700 computers at each of its two computer centres, linked to over 2,000 branch terminals. It is believed to be the world’s largest on-line network using the equipment of one manufacturer.

Burroughs has recently indicated a fresh interest in giant computers. In 1976, fifty engineers were challenged to develop a Burroughs Scientific Processor (BSP). The aim: to rival the fastest machines in existence. The BSP is the test bed for CML-2 – current mode logic – which Burroughs hope will one day find a place in its standard range of computers.

The B 80 features automatic multi-programming, virtual memory and modular system expansion without reprogramming. Basic design and development took place at Cumbernauld.
**Keeping the customers happy**

A 1971 survey showed that 91 percent of Burroughs customers who had ordered a new computer ordered the second one from Burroughs.

Loyalty figures for other companies were:
- IBM: 82 percent.
- Honeywell: 79 percent.
- NCR: 76 percent.
- Univac: 61 percent.
- RCA: 56 percent.

**The Soft Machine**

Burroughs has an honourable heritage in data processing, for it was Old Man Burroughs who, between 1882 and 1884, invented the gimmick which made possible the mass production of adding machines and launched us into the digital age.

But not everyone believes that this ingenious invention has been a boon to mankind. In a recent article in *Datalink*, Michael Orme has described the fears of one prominent American author who considers that the computer has a frightening capacity to shape our lives and even our thoughts.

With such books behind him as *The Naked Lunch* and *The Soft Machine* the author is a man whose views command some attention. His name, of course, is William Burroughs.

That’s right, the grandson of the inventor who set the whole business going.

No fault of Burroughs, but their giant computer installation used by Britain’s police is one that has lately come into criticism for infringing civil liberties. This pictorial impression of mankind controlled by the computer comes from a recent *Datalink* feature reviewing the fears expressed by the American author William Burroughs – grandson of the man who ushered in the digital age.