A historical perspective of the development of British computer manufacturers with particular reference to Staffordshire

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Abstract
Beginning in the early years of the 20th Century, the report summarises the activities within the English Electric and ICT groups of computer manufacturers, and their constituent groups and successor companies, culminating with the formation of ICL and its successors STC-ICL and Fujitsu-ICL. Particular reference is made to developments within the county of Staffordshire, and to the influence which these companies have had on the teaching of computing at Staffordshire University and its predecessors.

1. After the second world war
In Britain several computer research teams were formed in the late 1940s, which concentrated on computer storage techniques. At the University of Manchester, Williams and Kilburn developed the "Williams Tube Store", which stored binary numbers as electrostatic charges on the inside face of a cathode ray tube. The Manchester University Mark I, Mark II (Mercury 1954) and Atlas (1960) computers were all built and marketed by Ferranti at West Gorton. At Birkbeck College, University of London, an early form of magnetic storage, the "Birkbeck Drum" was constructed.

The pedigree of the computers constructed in Staffordshire begins with the story of the EDSAC first generation machine. At the University of Cambridge binary pulses were stored by ultrasound in 2m long columns of mercury, known as tanks, each tank storing 16 words of 35 bits, taking typically 32μs to circulate. Programmers needed to know not only where their data were stored, but when they were available at the top of the delay lines. Cambridge constructed the Electronic Delay Storage Automatic Calculator (EDSAC 1949), which had 16 mercury tanks, and thus the memory size was only 256 words (Wilkes 1975). It had 3,800 valves which needed replacement at the rate of 40 per week. Input was by 5-track punched paper tape at a rate of about 15 characters a second. This design was then re-engineered by the National Physical Laboratory as the ACE Pilot, and Alan Turing was part of the team at NPL.

2. Computers in Staffordshire
The genealogy of International Computers Limited (ICL) is illustrated in Figure 1. The Staffordshire links originate from the English Electric group of companies, but there are many and varied other constituents, such as Tabulator Ltd / British Tabulating Machines / BTM, Powers-Samas, Electronic and Musical Industries (EMI), Ferranti, Elliott Brothers, the computer interests of GEC, Singer Business Machines, STC, Fujitsu, Nokia Data, and even Joe Lyons teashops.
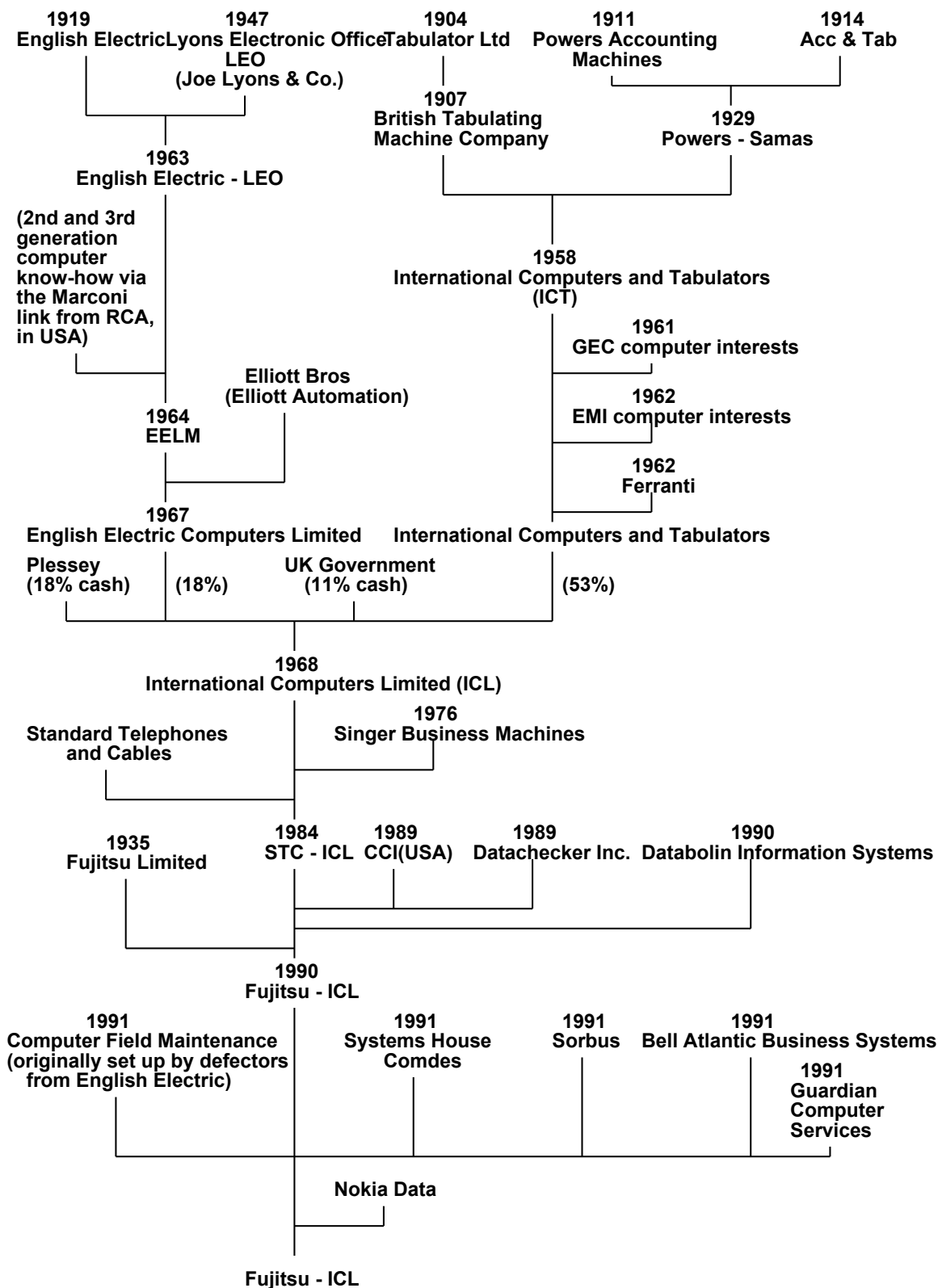
1919
English Electric

1947
Lyons Electronic Office
LEO
(Joe Lyons & Co.)

1904
Tabulator Ltd

1911
Powers Accounting
Machines

1914
Acc & Tab

1907
British Tabulating
Machine Company

1929
Powers - Samas

1963
English Electric - LEO

(2nd and 3rd generation computer know-how via the Marconi link from RCA, in USA)

1958
International Computers and Tabulators
(ICT)

1961
GEC computer interests

1962
EMI computer interests

1962
Ferranti

Elliott Bros
(Elliott Automation)

1964
EELM

1967
English Electric Computers Limited

International Computers and Tabulators

Plessey
(18% cash)

(18%)

UK Government
(11% cash)

(53%)

1968
International Computers Limited (ICL)

1976
Singer Business Machines

Standard Telephones
and Cables

1935
Fujitsu Limited

1984
STC - ICL

1989
CCI(USA)

1989
Datachecker Inc.

1990
Databolin Information Systems

1990
Fujitsu - ICL

1991
Computer Field Maintenance
(originally set up by defectors
from English Electric)

1991
Systems House
Comdes

1991
Sorbus

1991
Bell Atlantic Business Systems

1991
Guardian
Computer
Services

Nokia Data

Fujitsu - ICL

Figure 1. The formation and development of ICL

2.1. Tabulating machines

Electric tabulating machines were invented by Herman Hollerith to help with his job in the American Bureau of Census for the 1890 census. He had calculated that to process the census data by hand would take twenty years, but another census was due in 1900, so they were clearly in trouble, and the process had to be automated. Hollerith set up his own company Tabulating Machine Corporation (TMC).

The system using punched cards for recording data had been invented by Jacquard for the control of weaving looms to produce patterned cloths, and the concept was also used by Charles Babbage for the programming of the Analytical Engine. The machines were a progression from cash registers, typewriters and lever set calculating machines, and relied on the recording of data as holes in cards, and the tabulation and sorting of this data. For the census data a card was punched for each person, with fields for date of birth, gender, etc. and the machines then counted the number of holes in selected positions and combinations, and produced a tally. Spring-loaded pins passed through holes in the cards and dipped into a container of mercury, thus completing an electric circuit. A counter included in the circuit was then incremented, and many such counters produced the required tallies. The sorting box consisted of thirteen compartments which were opened for a hole in a particular row on a card in the selected column (or no hole at all), thus filing cards of the same type together.

The company "Tabulator Ltd" was set up in 1904 by Robert Porter, Raleigh Philpotts and Everard Greene, but was floated on the stock exchange in 1907 as "British Tabulating Machines" (BTM). Porter had met Hollerith not long after TMC had been set up, and it was as a result of this relationship that BTM was formed. BTM contacted Hollerith with a view to licensing the technology and introducing it to the UK. Hollerith asked for a payment of £20,000, later lowering it to £10,000 for the licence to sell the tabulating machines in the UK and Europe. Philpotts and Porter attempted to raise the required finance from bankers, friends and even families, but could only manage £2,000. Having failed, they returned to TMC and asked whether this sum plus a 25% royalty on all the revenue of BTM would be acceptable. TMC agreed, with the proviso that BTM could only hire out the technology purchased from TMC, and the deal was struck. BTM soon realised that they had come off extremely poorly in the bargain, and for a number of years made very little profit. Most of their money was taken up by buying machines from TMC at dictated prices, and on top of this they had to pay the 25% royalty. The market for the new machines did not take off in Britain as it had in the USA, and it was not long before BTM were defaulting on their royalty payments to TMC. This unfortunate hiring and royalty decision was to plague BTM right through their development, even into the 1970s, and was ultimately the reason for the extremely hostile relationship which grew between IBM (having taken over the interests of TMC) and ICL (having taken over BTM) until the present day.

TMC became part of the "Computing-Tabulating-Recording Company" (C-T-R) in 1911, later renamed as "International Business Machines" (IBM) in 1924. The new management of IBM discovered that BTM had defaulted payments, and saw them as a company who had failed to capitalise on the technology market opportunities, deserving of contempt, while BTM saw themselves as being bled dry by IBM. This difference of opinion led to IBM holding back spare parts, a ploy which was frequently used by IBM for many years. A request from BTM for the dropping of the 25% royalty was declined by IBM, and the relationship got worse when Thomas J. Watson was appointed — during the 1920s and 1930s he turned IBM into a fantastic success which BTM could never hope to match. However, BTM were helped enormously by the British Government, who employed them to build machines at Bletchley Park to crack the Enigma codes. This left BTM with greatly increased assets after the war, assets which the Government had paid for.

2.2. Powers-Samas

About the time of the "Computing-Tabulating-Recording Company" merger, the "Powers Accounting Machine Company" was formed by James Powers in New York in 1911. Powers had worked as a technical expert for the American Bureau of Census, largely working on the maintenance of Hollerith's tabulating machinery. Whilst working for the Bureau, Powers made several improvements on Hollerith's original designs, the most important being the incorporation of an automatic printing mechanism ("tabulator"). The Powers machines also made use of a mechanical hole-sensing mechanism, much more reliable that the Hollerith mercury electrical system which was affected by conductive impurities in the cards. However, many features of the Powers machines were very close to the Hollerith machines, and this resulted in a lawsuit brought by a German company, acting for C-T-R, on copyright grounds. Although the German company won, they were obliged to grant Powers Germany a licence to use Hollerith's patents on a royalty

basis. Powers continued to develop the machines, adding slide punching machines, removable and easily programmable tabulator boxes, etc. and all this led to increased competition within the industry.

A company formed by the Prudential Building Society "Accounting and Tabulating Company of Great Britain" (Acct & Tab) in 1914 added to the competition in Britain, and formed a relationship with Powers in the USA. This relationship eventually led to Acct & Tab becoming known as Powers (UK). The parent Powers company was taken over in the formation of Remington Rand, becoming known as the "Tabulating Machine Division" of Remington, and this company later became Univac. The relationship between Remington and Powers (UK) then became difficult. After a merger with the Samas company in 1929, the new title "Powers-Samas" was adopted. The company was then bought out by Vickers and continued to compete with BTM.

2.3. International Computers and Tabulators Limited (ICT)

In 1959 Powers-Samas and BTM, both weakened by competition with IBM, merged to form International Computers and Tabulators Limited (ICT). In 1961 the computer interests of GEC were absorbed, and in 1962 those of Electronic and Musical Industries (EMI) and Ferranti were also absorbed, but the name ICT was retained.

2.4. The English Electric Group of Companies

The story of the electrical industry in Staffordshire began when the German company Siemens Bros built a large factory to the south of Stafford in 1901. However, after the First World War all German possessions in Britain were nationalised as war reparations. A new company, The English Electric Company Limited, was formed in 1919 from the Stafford factory and several other companies such as the diesel engine manufacturers Whillans and Robinson of Rugby, the Stephenson railway company at Darlington, and the Phoenix Dynamo Company at Bradford, a manufacturer of aircraft components. English Electric thus had wide interests in electrical engineering, electricity generation, transformers, switchgear, diesel engines, railways, aircraft, meters, relays, instruments and electrical components. The Articles of Association were framed so that the company could manufacture virtually anything. In Staffordshire its chief factories were at Stafford, and at Kidsgrove on the edge of the Cheshire plain. English Electric also set up the Nelson Research Laboratories two miles east of Stafford, using an old Second World War aircraft engine testing facility in Blackheath Covert (known to this day as the "Blackheath Lane" site of Staffordshire University) and a new three-winged building on the slopes of Beacon Hill (a Medieval signal station), later named as "Beaconside".

The EDSAC / ACE Pilot computer design was manufactured as the Digital Electronic Universal Computing Engine (DEUCE) by English Electric, and tested at the Blackheath Lane site of the Nelson Research Laboratories. DEUCE naturally follows ACE, but the "Engine" part of the name was also an acknowledgement to Babbage.

2.5. The Joe Lyons teashop chain, Lyons Electronic Office (LEO) and English Electric-LEO Computers Ltd

In London, Joe Lyons, the famous teashops chain with its traditional "Lyons Corner Houses", found in the early 1950s that there was no commercial computer on the market that could perform the teashop ordering and accounting required by Lyons, so the company took the unprecedented step of founding its own computer manufacturing company, named the Lyons Electronic Office (LEO). The general philosophy was to design the central processor, but to use external suppliers for the peripheral equipments. The paper tape readers for input came from English Electric, and the console for control and output was an electric typewriter from a small but growing office equipment company of the time — IBM. Several models resulted: the LEO I (1953) based on EDSAC (Pinkerton 1991), LEO II and LEO III, but then Lyons decided sensibly that it was not really a computer manufacturer but a teashop company, and sold out its computer concerns to English Electric. The combined computer interests became English Electric-Leo Computers Ltd, based at Kidsgrove and London.

2.6. Second generation computers at English Electric, the Marconi influence, and EELM

Meanwhile the first generation computers such as DEUCE, built of thermionic valves, were becoming obsolete. A new semiconductor device, the transistor, which replaced the function of the triode valve, was invented by Shockley in the USA in 1950. Transistors, together with other discrete components such as resistors, capacitors and diodes were assembled on printed circuit boards to build the second generation of

computers. Where was English Electric to get transistor know-how? The answer was provided from yet another component company of English Electric, Marconi at Chelmsford.

The Marconi companies were set up by the Italian radio engineer in every civilised country of the world. They had two rights: radio manufacturing and *sole* broadcasting rights. The first radio broadcast in Britain took place from the roof of the Chelmsford factory. Naturally the sole broadcasting rights were attractive to the Governments of the countries concerned, so all the Marconi companies were nationalised by their respective Governments. In Britain the broadcasting rights were vested in the BBC, and the radio manufacturing plant was sold off to English Electric. In the USA the broadcasting rights formed the NBC, and the radio manufacturing business became the Radio Corporation of America (RCA), which also manufactured computers. The key point was that the Marconi personnel working in the USA and Britain still regarded themselves as working for the same company: transistor know-how and computer designs soon passed by agreement and licence from RCA to English Electric. The second generation computer KDP10, manufactured at Kidsgrove, was a copy of an RCA design. Using the same technology the KDF9, a home-grown hardware stack-based computer which was one of the first to demonstrate multiprogramming, originated at Kidsgrove, while the KDN2 was an industrial control computer built at Chelmsford. The company name was changed to English Electric-Leo-Marconi (EELM) in acknowledgement of the link to the Marconi group.

2.7. The third generation

The single transistor in its can was replaced by 1960 by small scale integrated circuits (SSI) with about ten components on the same 5mm square "chip" of semiconductor. This evolved into medium scale integration (MSI, about 100 components per chip) by 1965, and large scale integration (LSI, about 1000 components per chip) by 1970. LSI chips were used in the third generation of computers. Where was EELM to get its integrated circuit know-how? From RCA again, resulting in the System 4–50 computer built at Kidsgrove from the RCA Spectra 70/45 design. Again, a home-grown larger version, the System 4–70 was Kidsgrove-designed, while the System 4–30 was built at Chelmsford.

2.8. English Electric Computers Ltd

As a result of Labour Government policy of the time, British computer manufacturing firms were forced to form two large groups. As a result, Elliott Brothers of Borehamwood were absorbed by EELM, bringing with them the Elliott 4100 series of computers, licensed originally from the NCR 4000 series. The company was renamed yet again, to English Electric Computers Ltd. The other group was ICT, whose formation has already been described above.

2.9. International Computers Limited (ICL)

Finally, in 1968, the Labour Government forced a merger to just one British computer manufacturing company. The original assets of English Electric Computers Ltd (18%) and ICT (53%), together with money from the memory manufacturer Plessey (18%), and an unprecedented Government shareholding (11%), formed International Computers Limited (ICL). ICL continued to occupy the northern West Avenue factory at Kidsgrove formerly operated by English Electric Computers Ltd. ICL then built the 2900 series of computers (1974), designed to run software from both the ICT 1900 and English Electric System 4 ranges of machines by means of firmware. The concentration was on mainframe computers, a trend nearing its end. However, through the acquisition of Singer Business Machines in 1976, ICL was able to introduce a series of small computers for office and specialist systems. After a period of financial difficulties, ICL was purchased by Standard Telephones and Cables plc (STC) in 1984. This resulted in the company becoming the second largest UK-based industrial electronics group. STC-ICL began to suffer financially, and in November 1990 the Japanese company Fujitsu took an 80% shareholding in ICL, STC Ltd (now owned by Northern Telecom of Canada) retaining a 20% shareholding. This made Fujitsu-ICL the second largest computer group in the world, giving ICL more stability in a period of recession. Several other small computer firms were also bought by the group during 1991. In October 1991 ICL merged with Nokia Data, thus strengthening its personal computer business, and also taking a stronger foothold in Europe. As part of the terms of this agreement, the Nokia Group acquired options on 5% of ICL's shareholding for the re-floating of the shares on the London Stock Exchange.

2.10. The General Electric Company (GEC)

Sadly, English Electric itself is no more — it was absorbed into the giant multinational GEC group of companies in 1968. GEC, in partnership with the French company Alsthom, still operates the main Lichfield Road, Stafford factory (originally built by Siemens) as GEC Alsthom, the base for many constituent companies involved in electricity transmission and distribution, switchgear, turbine generators and transformers. Other sites in Stafford are the GEC Alsthom Measurements Ltd St Leonard's works for meters, relays and instruments and electronic assemblies, the Stafford Foundry, GEC Alsthom Ceramics at the Castle Works, and GEC Computer Services Ltd at the Hollies, Newport Road and Stychfields. Other sites in Staffordshire are GEC Electromotors Ltd at Lower Milehouse Lane, Newcastle-under-Lyme, GEC Meters at Stonefield Works, Stone, GEC Industrial Controls in the former southern factory of English Electric at West Avenue, Kidsgrove, and GEC Hotpoint at Kidsgrove.

3.   Staffordshire University and computing

These notes would not be complete without a mention of computer education in Staffordshire. English Electric was philanthropic in setting up training facilities for its apprentices at Stafford, originally at the local Stafford College of Further Education (now Stafford College). Later, English Electric actively promoted the formation of a new technical college, the Staffordshire College of Technology (SCOT) on an elevated site adjacent to the Nelson Research Laboratories at Beaconside (see Figure 2) in 1963, under the Principal Mr R.S. Paradise (Davies 1964).

Figure 2

The original Beaconside site of the Staffordshire College of Technology in 1964. Note the circulating road system, which still exists, the former main entrance with driveway (now covered by the C block extensions), the small isolated nuclear physics block at the rear (later surrounded by wooden huts), and the three-wing building of Nelson Research Laboratories top right (the nearest wing of which is now encased in yellow brick as the Nelson Library).

A nucleus of lecturers moved from the Stafford College of Further Education, while others were recruited from industry, notably from the English Electric sites at Stafford and Kidsgrove. Several Governors were also English Electric people, for example Mr J.R. Sully, General Manager, Stafford and Kidsgrove Works, Mr W.E. Scott, Managing Director of English Electric-Leo Computers Ltd, Mr J.K. Brown, Mr J.M. Ferguson and Mr B.J. Tams. The Departments at the new technical college were Electrical Engineering; Mechanical, Civil and Production Engineering; and Mathematics and Science. Officially opened by Alderman F.J. Oxford, the then Chairman of Staffordshire County Council Education Committee, in March 1964, it was said to be a perfect nucleus for a University. Alderman Oxford stressed the support being given by English Electric and other industrialists, and said that everyone connected with the college was pressing for University status (this was finally achieved in 1992).

The Staffordshire College of Technology joined the North Staffordshire College of Technology at Stoke and the Madeley College of Education to form North Staffordshire Polytechnic in 1970, under the Director Dr J.F. Dickenson, awarding its own degrees validated by the Council for National Academic Awards. The Polytechnic was originally under the control of Staffordshire County Council, but was incorporated in 1990 as Staffordshire Polytechnic. Finally it was awarded university status as Staffordshire University in 1992 under Vice-Chancellor Keith Thompson (formerly Principal of Madeley College of Education), awarding its own degrees from 1993. Chancellor Jack Ashley, CH, MP was appointed in 1993.

The original Department of Mathematics and Science, under Head Dr H.L.W. Jackson, soon changed its title to Mathematics, Statistics and Computing, to incorporate the new discipline of Computing Science. In 1965 one of the first British degrees in Computing Science began at Stafford. The course was devised by a small

working team of industrialists, most of whom came from EELM, working with college staff. The first intake consisted of just eleven students, many of whom were sponsored by EELM, including one Roy Newton (now Professor Newton, Dean of the School of Computing). The first computer, a DEUCE, was installed by crane via a second floor window into what is now C Block at Beaconside.

After a spell at Beaconside, the Department moved to the Blackheath Lane site of Nelson Research Laboratories. The second world war building had received many piecemeal extensions. The roof leaked, there was no main drainage, and the car park had not long been surfaced. The pleasant woodland setting was easy on the eyes, but foxes had taken up residence in the heating ducts, and rats gnawed at the back plane wiring of the mainframe computer, leading to many store parity errors. Eventually, Mathematics and Statistics split off as a separate department, leaving the Department of Computing at Blackheath Lane. The Department was also an innovator of Information Systems degrees in 1977, and of Information Technology degrees in 1983. Other innovations have been courses in Software Engineering, Technology Management, Business Information Technology, Industrial Mathematics, Applied Computing, Interactive Systems Design and Business Decision Analysis. The Department became the School of Computing in 1990, operating within the Faculty of Computing, Engineering and Science. In 1991 Mathematics and Statistics joined the School. When the Faculty structure was abandoned in 1992, Computing became one of the new University's eight Schools.

As part of the "Flagship" building programme of the Polytechnics and Colleges Funding Council, a new computing building was built at Beaconside, called "The Octagon", and this was occupied by the School of Computing in 1992. On closure of the Nelson Research Laboratories, one wing of the three-winged building at Beaconside was retained as the Polytechnic Library, and in 1993 this was encased in yellow brick to match The Octagon, and was renamed the "Nelson Library", being opened by Lord Nelson of Stafford, the former Managing Director of English Electric.

The small 1963 department of nine lecturers and one technician in the new subject of Computing Science became in 30 years the huge 1993 School of Computing with more than 100 lecturers and 1800 computing students, the largest teaching facility for computing in Britain, and possibly in Europe. It is placed by industrialists as the best training facility for computing graduates in the new Universities, and among the top ten when all the traditional Universities are included. The former English Electric and Staffordshire as a whole can be justly proud of its new University, and of its heritage in computing.

Bibliography

DAVIES, H.N. (ED.), 1964. "University of the future?", *English Electric and its people* 19 (June 1964), 8–9

Pinkerton, J.M.M., 1991. "Taming Leo: Overcoming the inherent unreliability of Leo I", *IEE Review* 37 (1) 17 January 1991, 13–17

Wilkes, M.V., 1975. "How Babbage's dream came true", *Nature* 257 (October 16, 1975), 541–544

Additional Reading

HARTREE, D.R., 1946. *Nature* 157 (April 20, 1946), 527