Automation and Management Accounting

in British Manufacturing and Retail Financial Services, 1945-1968

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ABSTRACT

This article looks at the effects of office mechanisation in greater detail by describing data processing innovations in major building societies during the dawn of the computer era. Reference to similar developments in clearing banks, industrial and computer organisations provides evidence as to the common experience in the computerisation of firms in the post-war years. As a result, research in this article offers a comparison between widespread technological change and changes unique to service sector organisations. Moreover, research in this article ascertains the extent to which the adoption of computer-related innovations in financial services sought to satisfy financial, rather than management accounting, purposes.

[Work in Progress. Please do not quote.]

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The usual caveats do apply.

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1) INTRODUCTION

Close links between financial services and the office equipment industry date to the origins of office mechanisation in the nineteenth century. William S. Burroughs (1855-98), for instance, was a bank clerk whose career in business machine supplies resulted from his desire to automate the accounting clerk's function.[1] By the inter-war years, banks and insurance companies were clearly established as major clients for tabulating machines and other office equipment manufacturers on both sides of the Atlantic. During the years after the Second World War, the introduction of office equipment (and in particular the use of computers to keep up with the growth in business volume) was associated with service and operational function innovations in financial services.[2]

On the one hand, innovations in service offering included the possibility for individual items to be credited to an account-holding branch on the same day that they were paid in to another retail bank branch. Towards the end of this period, enquiries could be initiated on accounts at non-account-holding branches when individual customers wanted to cash a cheque without prior arrangement.[3] Service innovations also included the introduction of automated bank statements and cheque guaranty cards. On the other hand, operational function innovations included solving very specific problems and the automation of existing practices at specific departments. Operational function innovations primarily aimed to reduce the cost of labour intensive activities (such as those around the clearing system).

Speculation still remains, however, as to whether or not the main impact of office mechanisation in the 1950s and 1960s was limited to reducing the value of transaction processing (with most computer systems essentially being punched-card systems in electronic form[4]). Documented evidence is somewhat obscure when assessing the impact of office mechanisation on the adoption of management accounting techniques in financial services. 'Management accounting' developed in the 1950s and it was most closely associated with the introduction of standard costing, budgetary control and, possibly, direct/marginal costing. Anecdotal evidence suggests a lack of systematic attention to the intricacies of cost accounting governing US banking organisations until well into the 1980s.[5] Systematic empirical evidence in the form of case studies and survey questionnaires of UK banks and building societies, likewise suggest that in the 1990s management accounting of financial services comprised *ad*

hoc profitability analysis, budgeting and performance reporting.[6] Surveys of accounting information systems in building societies during the 1990s also suggest that, for the adoption of computer systems to have modified management accounting practice in financial services, new activities, ideas or behaviour should have been associated with changes in[7]:

- measuring the profitability of products, service, retail bank branches and managers of retail branches;
- budgeting and variance reporting;
- evaluating new business initiatives;
- special studies relating to branch closures; and
- long-term financial planning using financial models to generate predictions for a number of different scenarios.

If accurate, evidence documented in the 1990s would imply that much of the use of accounting machines and the introduction of computers between 1945 and 1968 was limited to keeping customer accounts and, presumably, overall financial accounting aspects of the business.

This article looks at the effects of office mechanisation in greater detail by describing data processing innovations in major building societies during the dawn of the computer era. Reference to similar developments in clearing banks, industrial and computer organisations provides evidence as to the common experience in the computerisation of firms in the post-war years. As a result, research in this article offers a comparison between widespread technological change and changes unique to service sector organisations. Moreover, research in this article ascertains the extent to which the adoption of computer-related innovations in financial services sought to satisfy financial, rather than management accounting, purposes.

The article proceeds as follows. In section two, brief reference is made to the development of digital computing and the commercial application of computer power in the UK manufacturing sector. Section three summarises the introduction of computers into US and UK banking. Section four discusses the use of electronic office equipment and digital computing power around clearing processes for mortgage repayment and long term investments ("share deposits") at building societies. Section five discusses the main findings in the light of the impact of computers on the

management and management accounting practice at building societies. This section also offers some conclusions and points to further research.

2) THE DEVELOPMENT OF ELECTRONIC COMPUTERS

'The Birth of Baby': From Specific-Purpose Analogue Computing to General-Purpose Digital Computing (1939-65)

The concept of a 'stored-programme electronic digital computer, goes back to the mid-1940s'[8], while the first universal automatic computer was built at Harvard in 1944[9]. According to Small, the key technology for the creation of this type of machines can be traced to the development of alternating and direct current (DC) operational amplifiers. Operational amplifiers were initially created by George A. Philbrick in the late 1930s but the bulk of the research took place during the Second World War at the Bell Telephone Laboratories and Columbia University.[10] An era of rapid technological change then took place during which computing technology (i.e. analogue or digital) developed in combination with different types of applications (i.e. special purpose or general).

Analogue computing operates on continuous data, where parameter values are represented by the rotation of a shaft or transformed into voltage.[11] Variables are measured and mathematical operations[12] performed directly. Digital computing operates on discontinuous and discrete units of information because input data and parameter values (which vary during the calculation) are broken unto numerical values.

In the mid-1940s, a divide existed as analogues were quicker while digitals were more precise. In the US Navy's Project Cyclone[13], for instance, the average run time for calculations to a single solution for a three dimensional guided missile would take approximately one minute on an analogue computer, while up to 75 hours on an IBM CPC and from 60 to 130 hours on an Elecom 100. Electronic analogue computing was well established by 1947 but, in the late 1950s, its advantage started to erode as it began to be common to find hybrids, that is, machines combining digital and analogue computing. Hybrids dominated the computing market by the mid-1960s and it would seem that, during the early years, the type of application would influence the balance between analogue and digital computing.

Applications of computers can be broken down into specific-purpose and general purpose.[14] Most specific-purpose computing was to be found helping the military and scientific communities to solve engineering problems. Indeed, specific-purpose analogue computing developed in the US and Britain when electronic components were used to perform the necessary calculations to control antiaircraft gun directors.

General-purpose electronic analogue computers could be used for a variety of applications. General-purpose computing emerged by altering the arrangement of interconnections between the computing elements. The computers could then be set up (i.e. programmed) to solve many different problems. First commercial uses were applications in aircraft manufacturing and electrical and chemical engineering. As such, general purpose computing could be considered part of the office equipment industry as such computers were requested on demand, interconnected with other office equipment (such as sorters, punch-card readers, label printers, etc.) and utilised to provide help in specific tasks or processes.

Computer Manufacturing in the UK and the LEO

Although there is no clear single point for the development of programmable computers in the UK, after the Second World War there were three leading research centres in Britain where computers were under development: Cambridge University, Manchester University and the National Physical Laboratory at Teddington.[15] All bar one of the computers that were developed in Britain in the late 1940s and early 1950s were "being constructed in computing laboratories as 'mathematical instruments'"[16]. Gradually, computers began to interest manufacturers in two main fields: former office accounting equipment manufacturers like the British Tabulating Machine Co. Ltd. (BTM) and Powers-Samas Accounting Machines Ltd., and electrical/electronics firms. The exception was J. Lyons & Co., the caterer and food manufacturer, which, in November 1954, had formed LEO Computers Ltd. to manufacture and install the computers which it had been developing since 1947.[17] By 1960, there were eight British manufacturers of computers: Ferranti, English Electric, EMI, Elliott Automation, Standard Telephone & Cables (STC), AEI, ICT (the result of a merger of BTM and Powers-Samas in 1959) and LEO Computers.[18]

[Insert Table 1]

As table 1 shows, between 1950 and 1959, 127 computers were sold in Britain, of which 10 had been sold by LEO Computers. The LEO computer was quite distinct from those of the other manufacturers, including IBM, in that it was a machine developed purely for business utilisation. For J. Lyons & Co., the developer of LEO, the pursuit of more efficient office and accounting procedures had been a goal from the early 1920s when "it was becoming clear to the family that with continued growth the limitations of traditional accounting systems could seriously threaten the welfare of the company"[19]. In 1923, Lyons appointed J.R.M. Simmons, who had graduated from Cambridge with a first class degree in mathematics, to build up a system of management accounting. Simmons set about this task and over the next ten years became increasingly interested in scientific office management and the use of electronic devices.

Lyons' computer came into use in 1951 for mathematical work, followed by demonstrations of elementary clerical procedures. Shortly after, the Bakery Valuation Job, a "relatively simple cost accounting task in the bakeries Department" was carried out at slow speed, and by the end of the year, carried out on a regular weekly basis.[20] LEO was then used not only to carry out internal tasks for Lyons but also for contract work. Amongst the tasks carried out were the following: ballistics calculations (firing-range tables) for the Ministry of Supply; computational work for the Meteorological Office; production of PAYE tax tables for the Inland Revenue; calculation of joint-life and last survivor tables for the Institute of Actuaries; and guided missile calculations for de Havilland.[21]

It was only in late 1952 that work started on programming the Bakery valuations and payroll jobs to run on the new equipment. As this equipment was delivered during 1953, a series of pilot runs of both programmes was made and, at the beginning of December, a full-scale payroll programme was run for the 1,700 staff of the bakeries department.[22] By the end of 1953 "LEO, which stands for Lyons Electronic Office, was ready for effective operation"[23]. This machine was later claimed to be "the first high speed fully automatic computer to be designed and built for general commercial clerical work"[24]. "By the end of 1954 LEO was carrying out the payroll job weekly for about a third of all Lyons employees, taking six-and-a-half hours for the job as opposed to 55 man-weeks of clerical effort beforehand"[25]. In addition it was carrying

out two other tasks, supplying teashops and co-ordinating factory production, and analysing tea stocks in order to provide management information.

Commercial Applications of the LEO

In 1954, just as LEO I was beginning to be put through its paces on a regular basis, work began on the specification for LEO II. It had become realised that LEO I could not cope with the increasing demands that would be placed upon it within Lyons, let alone cope with work for other customers. During the mid-1950s contract work grew and by mid-1957, LEO was not only carrying out payroll jobs for Lyons, but also for the Ford Motor Company, Stewart & Lloyds and Kodak.[26] In 1959, additional tasks for manufacturing companies carried out on LEO II/1, located at Elms House, were the Ford Motor Company (stock replenishment control), Tate and Lyle (payroll) and Ever Ready (van sales and stock control). [27]

Some companies decided to purchase their own LEO machines. In 1956, LEO Computers Ltd. had received orders from Imperial Tobacco and Ford's spare parts division for LEO II's, the first deliveries being made in spring 1958. In 1959[28], at Imperial Tobacco, it was used for invoicing, sales, accounting and sales statistics at the Bristol offices of W.D. & H.O. Wills, while at Ford it was used for depot stock control, preparation of despatch documents and invoices, sales accounts and sales statistics at the Aveley offices of its Parts division. The steel manufacturer, Stewart & Lloyds, used their machine in May 1959 for payroll, invoicing and stores control purposes.

In 1959, Renold & Coventry Chain Ltd. (R&CC) began to investigate the potential of electronic computers. In 1959, R&CC received a report from LEO Computers indicating the use to which a computer might be put at the company.[29] These included not only the replacement of orthodox clerical work, but also the aiding of management control of productive processes and the sales field, and the provision of a rapid, regular and incisive picture of costs and profitability. The following year, expenditure of £34,000 to be incurred over the next two years was sanctioned in respect of a "pilot scheme in order to assess the possibility of performing Works Planning on a computer, the scheme to be on a service basis provided by Leo Computers"[30]. By early 1961 eleven LEO II's had been built and nine delivered, at a price, including basic peripherals of c.£100,000 each, though more complex systems

cost up to £200,000.[31] By 1959 work had commenced on LEO III, the first order for this machine being from Dunlop, despite fierce competition from ICT and IBM.[32]

It was not, however, only manufacturing firms that became interested in the use of LEO.[33] Amongst the utilities, the South Eastern Gas Board was using LEO II/1 before the end of the 1950s for prepayment billing, while the North Thames Gas Board utilised it, on an experimental basis, for the weekly control of stores. In the pensions arena, in 1959, LEO II/1 was conducting annual renewals and valuations for 330 group pension schemes covering 100,000 lives for the Eagle Star and Atlas Group, and a LEO computer was installed in the 'clerical factory' of the Ministry of Pensions at Newcastle. In 1959 it was also noted that programmes were in preparation, amongst others, for a LEO II machine to be delivered during the year to Glyn Mills Bank, the London clearing arm of the Royal Bank of Scotland.

The Impact of Computers on the Business World

While computers were initially developed to carry out highly complex mathematical calculations, especially in relation to scientific research, their major impact in the business world was to be their use for more mundane, routine tasks. In particular, they could save on clerical manpower since they could be used for "pay-roll accounting, inventory control, and production planning and control"[34]. In this way, computers revolutionised the operation of large-scale business and made the administration of large-scale organisations more tractable.[35] At Lyons[36], where some 2,500 of the 30,000 employees in the late 1930s were engaged in routine calculations on stock, receipts, wages, etc., the potential savings from the computerisation of these tasks were potentially immense. Thus, in May 1955, it was estimated that by the end of the month, LEO would be regularly preparing the payroll for 10,000 employees, the task taking about 4 hours compared to the previous situation where it had represented a full-time job for over 30 clerks.[37] When the Lyons board gave the go ahead for preliminary work on LEO, it was estimated that its cost would be £100,000 and that it would generate an annual saving of £50,000. When the LEO II computer was developed in the mid-1950s[38], the cost of each machine was expected to be £100,000, and potential annual net savings at least equal to this amount.[39]

"By 1964 it was estimated that nearly 22,000 computers were installed in the USA, at least a quarter of them in government departments. In contrast, the UK

had less than 1,000 computers, just fifty-six of them in government departments. Thus a large market for industrial users of computers existed in the early- and mid-1960s. However, computers were then very expensive. The cheapest system in 1963 cost £15,000. An American product, it undercut the cheapest British system by £5,000. Many cost over £100,000. IBM's very popular second-generation 1401 series (over 7,600 installed world-wide in 1964) cost £120,000. The dearest, a Ferranti Atlas, a very high-speed scientific computer of which only four were sold by 1964, cost £2 million"[40].

The Introduction of Computers into UK Industry (the BICC and R&CC cases)

At British Insulated Calendar Cables (BICC), where top management was increasingly concerned at the level of overheads in the early 1950s, a keen interest was taken in the possible application of computers. In 1955, Brazier, Director of Research and Education, was instructed, on his forthcoming trip to Western Electric in America, to discuss the issue of the business use of electronic computers.[41] In their report to the company's Managing Director's Committee, Brazier, Miller and Ormerod noted that "The scope for computers within the Company was 'very wide indeed' both in relation to clerical and mathematical work".[42] The company continued to keep the development of computers under review, carrying out discussions with both Ferranti and Elliotts about the possible installation of an appropriate machine. In June 1956, and despite increases in the initial estimated cost from £50-60,000 to over £70,000, an application was made to the BICC Board to sanction the necessary expenditure, it being felt that "there was no point in depriving ourselves of immediately realisable benefits by waiting until development [of computers] has become stabilised"[43]. The potential benefits of the use of a computer at the Prescot Works for wages, payroll and bonus work would eliminate 37 clerks, saving c.£15,000 p.a. "although this work would absorb the computer for only a fraction of its capacity"[44].

At R&CC it was noted that LEO Computers had drawn up an integrated scheme which showed "how orders are automatically followed through to production, invoicing, accounting and statistics and how physical movements are reflected in financial transactions in the Company's cost and control accounts"[45]. Thus, by the end of the 1950s, the business use of electronic computers had developed beyond their mere use for payroll and stock control purposes and into the realms of management

accounting and planning. That Lyons and LEO were in the forefront of this process is perhaps not all that surprising given the company's early interest in techniques such as standard costs and the use of budgets for control purposes from the early 1930s. At Lyons, the application of LEO I to costing was one of the subjects discussed in a number of reports and memoranda drawn up within the company between 1954 and 1956.[46] During the late 1950s and early 1960s, the focus of Simmons at Lyons was on a system referred to internally as Management Accounting and Planning (MAP)[47], a development which accompanied moves towards the adoption of the multi-divisional form of business organisation.[48] In 1963, Julian Salmon, managing director of Lyons, talking on the topic of 'The Office and LEO', claimed that "The 'Office' is an invaluable service department providing a management accounting and planning service to the company's management. LEO … was developed in order to make these services more effective .."[49] Salmon referred to MAP as "management self-accounting"[50].

The Introduction of Computers into Nationalised Industries (the NCB case)

Computers also began to be introduced into the nationalised industries in the late 1950s and early 1960s, an example being British Rail which introduced them in 1961.[51] A few years earlier, in 1958, the National Coal Board (NCB) had announced that it was investigating electronic data processing in three of its Areas, essentially to process labour costs and paybills.[52] First installed at Chatterley Whitfield in North Staffordshire in July 1958, this was followed by an installation in No.4 Area, North Durham by the end of 1958. These and a third installation, in the No.2 Area, Northern Division, were stated to be making good progress during 1959. The North Staffordshire installation had taken over the paybill for all 22,500 men employed at the collieries in the Area, while the Durham system was dealing with the wages of 10,000 men[53]. During 1959 the NCB began to consider the application of electronic data processing (edp) to general accounting and statistical work and, in 1960, the decision was taken, in principle, to establish edp in each Division "to provide an integrated service to process wages and salaries and related expenses, sales, materials, and suppliers' accounting, statistics and other data"[54]. In 1961 it was reported that arrangements had been made with manufacturers to supply the necessary computers and ancillary equipment for most of the proposed centres, but it was noted that "The

installation at each centre will be built up progressively over a period of some years"[55].

In 1962 it was revealed that there were to be seven centres, that the first computer equipped with magnetic tape had been delivered, and many programmes written and tested.[56] By March 1964 all seven centres had been duly equipped and it was noted that "Sales invoices and marketing statistics had been transferred to computer processing in four Divisions and processing of wages by computer had been started in three Divisions. Already the wages and salaries of over 100,000 employees, and the related statistics are being handled in this way"[57]. In the 1963-4 Report it was also announced that computers were being used for critical path scheduling and other similar techniques, and in the report for 1964-65 it was claimed that "The Board are among the leaders of British industry in the use of computers to improve efficiency and reduce costs"[58]. It was also indicated that the computers were proving of greatest value as an aid to management decision-making and, in the following year, a management information services section of the NCB's computer service was established at Cannock[59]. Here, management problems were analysed and programmes prepared for solving them with computers. In its Annual Report for 1965-66, the NCB recorded that it had 18 computers handling a payroll of 400,000 workers[60], while in 1966-67 it was noted that there were 20 computers in use and that the transfer of the industrial payroll had been substantially completed.[61] During 1966-67 the work of preparing the financial and cost accounting records for all Areas was transferred to the computer centre at Doncaster, and "the systems analysis and programming work for the first phase of the computer system of stock control for purchasing and stores was completed"[62]. Implementation of the latter began in January 1967.

In 1965-66, the NCB, together with manufacturers, began to explore data transmission systems for use with a network of linked computer centres. By the mid-1960s, with the payroll work almost completed, attention increasingly turned to the development of the NCB's management information service, which was considered "an essential pre-requisite for a flexible business planning system. The basis of this system is the Planning and Control procedures, on which a considerable amount of work has already been done"[63].

Despite the increasing use made of computers by the NCB, these developments did not employ their equipment for anywhere near the whole time.[64] In an attempt to make money out of their spare computer capacity, and stimulated by the Economic Development Council, a scheme was drawn up, in conjunction with International Reservations Corporation, to provide a computer based hotel reservation system, but it was never a success. Success was achieved in the early 1970s, however, following the formation of Compower Ltd., which took over responsibility for the NCB's computer centres. The company marketed the NCB's spare capacity so efficiently that in the late 1970s and early 1980s the external activities grew faster than the internal ones, generating profits of under £1 million in 1973-4, rising to £4 million in both 1981-2 and 1982-3.

3) THE INTRODUCTION OF COMPUTERS INTO BANKING

Computers and the Rising Costs of Cheque Clearing in the US

In the US, during the 1920s banks experienced a period of growth that continued in spite of the Great Depression. A reflection of this growth was the increasing number of paper-based transactions, such as cheques being cleared, the figure reaching six billion annually by the mid-1920s.[65] "The spectacular rise in cheque volume and activity, with no corresponding increase in the value of deposits, placed a severe strain on the banking system."[66] Management of cheques became a critical problem as cheque clearing was expected to continue growing and this called for specialised mechanical aids. In the early 1950s, cheque clearing had long represented an important area of mechanisation of accounting functions. However, what the banks needed at this time was a cheque-reading machine.

Computer manufacturers were unwilling to invest in developing a system that would help in the proof reading and book-keeping of cheques.[67] As a response, Bank of America, then the largest in the US with assets in excess of $12,000,000,000 and 844 retail bank branches in 1963, approached the Stanford Research Institute (SRI) to design and eventually build a prototype that included the interconnection of tabulating machines, sorters, punch card readers and hybrid computing technology (i.e. a combination of transistors, vacuum tubes and operational amplifiers). Developing the system, called Electronic Recording Machine - Accounting (ERMA), required some

$10 million dollars and three years of work, culminating with its launch in September 1955.

In spite of an apparent familiarity with technology by directors at Bank of America (see below), engineers at SRI had to modify the bank's requirements for these expectations to fit what the technology could actually do.[68] As a result of the combination of business priorities with technological possibilities the ERMA only delivered a bookkeeping machine, primarily aimed to reduce labour costs.

In the early 1950s at least seven out of a 40 strong staff in one of Bank of America's retail bank branch were employed as full-time clerical workers.[69] The issue of labour costs in retail branches was made more acute by an exceedingly high turn-around rate amongst these young (aged between 18 and 24), female staff whose monotonous work mainly consisted in sorting pieces of paper, running an adding machine and bundling checks. Cheque clearing was thus a major concern for directors in spite of other banking services (such as consumer loans, mortgages and other lines of credit) becoming available to large parts of the population and adding to banks' paper-handling woes. Concerns with increased (and increasing) expenditure around cheque clearing were also fuelled by the top management of banks being unwilling (or unable) to price individual services in exchange for deposits at below market rates.

To no surprise, then, the development of the ERMA primarily addressed the way in which the Bank of America accounted for changes in the balance of current accounts and recorded the history of these transactions. There is little else that emerges as associated with this new system in terms of changes in organisational control or profitability of individual services. The ERMA, however, did allow current account book-keeping to be moved from retail bank branches to centralised locations (although for some banks this process was still on going in the 1980s[70]). The ERMA was also instrumental in the Bank of America maintaining a lead in retail finance for over a decade and a half.[71]

Developments around Bank of America's ERMA changed the banking industry in the US and elsewhere when other banks built around the ERMA's associated innovations (in particular, its patent for magnetic character recognition). This change took the form of a standard for cheque recognition as designed by the American Bankers Association (ABA). Between 1954 and 1960, the ABA shared results of internal consultation with major computer manufacturers and the Federal Reserve and

these meetings were to establish guidelines specifying that a cheque should itself be a carrier of information for input into mechanical sorting (1955), through the use of magnetic-ink character recognition or MICR encoding (1956), based on Arabic numerals so as to be both man- and machine-readable (1958) and portraying standardised codes and symbols (1960).[72]

One would have been lead to believe that Bank of America's location in Silicon Valley would help in explaining the bank's unusual step in crossing industry boundaries and developing its own computing system. Indirect links with the computer industry, through retail and corporate customers, were to be expected because, since the turn of the century, Silicon Valley had become one of the major recipients of defence contracts in the US and would remain at the centre of the military-industrial complex well into the twenty-first century.[73] Moreover, 38 percent of analogue computing capacity was located in the West Coast in 1955 (primarily in military applications and aeronautical research.)[74] The Silicon Valley link, however, breaks down when it is recognised that First National City Bank of New York, similar in size and strategic orientation as Bank of America, worked closely with International Telephone and Telegraph to build a runner up system to the ERMA by developing its own system and equipment to process demand-deposit accounting. [75] Nevertheless, the ERMA, the West Coast system and the ABA standard were directly responsible for the development and widespread adoption of the high-speed sorter reader.[76]

Computers and the Rising Costs of Cheque Clearing in the UK

In the UK, the clearing system had also represented an important area of mechanisation of accounting functions. Clearing banks were alert, early on, to developments around automation and the introduction of computer power into US banking. For instance, Mr. A. M. MacGregor, manager of the Midland Bank's Machine Department (renamed Operations and Methods in 1961), visited the US in 1956 with the specific purpose of looking into the development of electronic bookkeeping methods and computers in banking.[77] In Britain, it was Powers-Samas which had been the main supplier of accounting machinery to the clearing banks.[78] Powers-Samas had an expertise in the development of devices to handle punched-cards, but it knew that the development of a cheque reader was beyond its resources.

Thus, in 1956, in an attempt to remain a major force in this sector, Col. A.T. Maxwell, chairman of Powers-Samas, arranged a secret and historic meeting with BTM. The result of this meeting was the setting up of a joint working party to determine a strategy for a joint venture in bank mechanisation, which proved to be the first step towards a merger of the two companies to form ICT in 1959.[79] According to Townsend and Edwards, in conjunction with an American firm, BTM had, by 1958, jointly developed a large-scale computer for use in banks and similar organisations.[80]

UK manufacturers had an incentive to enter the market for commercial applications because, according to Channon, banks and other financial service organisations began to invest heavily in computers in the late 1950s and early 1960s.[81] Indeed, in 1959 Bank of Scotland installed an IBM 1401 and thus claimed to be the first UK clearing bank to use a computer to handle accounting information.[82] In 1960, Lloyds Bank purchased a Burroughs B.101 Sorter-Reader. The purchase of this equipment by Lloyds was used by Burroughs to boost its marketing by demonstrating the benefits of automation to other clearing banks and to building societies.[83] Specifically, alongside the physical equipment, directors of other financial intermediaries were shown a US-produced film (with running commentary) illustrating the posting of accounts on the B.251 Visible Record Computer coupled with the B.101 Sorter-Reader and the P.700 Amount and Account Number Printer.

The B.101 Sorter-Reader was a high-speed digital sorter, primarily intended to be used by banks for sorting cheques and credit slips into branch and account number before posting. It read magnetised figures and sorted documents, at approximately 1500 a minute, into 13 sections – 10 for the main digital sort, 2 for special items, 1 for rejects. The exhibition of the Burroughs' Sorter-Reader in semi-private functions clearly suggests efforts by US manufacturers to disseminate their technology in the UK. It also reflects the fact that, like their US counterparts, UK clearing banks were anticipating an increased work load resulting from a projected huge increase in wage payments by cheque, and hence the increased number of personal accounts that would be opened.

The alternative to computers was increased personnel and, with increasing unionisation amongst bank workers, rising costs. In such circumstances, Channon argues that banks "turned gratefully to computers, which could be used to handle routine business and increase the strained capacity of many small branches"[84].

Computerisation reduced costs and "helped towards a slow but steady reduction in the number of branches."[85]

Automation offered banks the potential of achieving improved levels of productivity but the use of data processing equipment was very price sensitive. For instance, the B.101 Sorter-Reader machines were priced at £35,000 each, while being 12 ft. long by 3’6” at its widest, 5 ft. high, weighed 4,000 lb. and were "very noisy"[86]. The P.700 Amount and Account Number Printer (i.e. the machine used for embossing magnetic characters) ran at £1,500 each. The investment in automation would sky rocket to over £100,000 if a bank decided to run the sorter together with a B.251 Visible Record Computer (i.e. the device that would use magnetic characters to calculate debits and credits for each account, update the balance and generate a statement).

Local competitors to US-developed computer technology for commercial applications included Lyon's LEO. However, according to Hendry, "whereas LEO II was sold to industry for general data processing, Pegasus II [Ferranti] was sold either as a scientific computer or to banks and insurance companies."[87] Ferranti's Pegasus II had found users amongst financial service organisations, including Martins Bank.[88] Instead of using magnetic characters as with the Burroughs equipment, in the Ferranti machine all of the information fed into the computer was stored on perforated or magnetised tape and then stored in “memory drums”. Statements of accounts and other information could thereafter be produced very speedily, as and when required. In spite of this apparent strength in servicing British financial service organisations, Ferranti's directors perceived there was an insufficient demand to justify substantial investments in production facilities or to continue with development of mainframe computers. As a family-owned firm, Ferranti was also going through a period of reduced liquidity and in the process of exploring overseas markets. In the computer market "while faced with overwhelming American competition the window of opportunity proved so fleeting that there was little time to fashion elaborate expansion plans."[89] As a result, during the 1950s Ferranti let go of its lead in mainframe computers for general commercial use and focused most of its resources on defence sectors. In 1963, main frame computers were finally divested.[90]

Meanwhile, the process leading to the amalgamation of 11 into five English clearing banks between 1968 and 1973 was another clear incentive for banks to bring

costs under control and increase profitability. Efforts to increase efficiency of check clearing continued with the introduction of magnetic characters for cheque recognition in the UK. This innovation chiefly adopted the US standard and built around the creation of the British Automated Clearing System (BACS) in 1968. At the same time, the Wilson government took steps to allow greater numbers of people into the banking system by introducing Continental style Giro Credit accounts at the Post Office also in 1968[91].

Automation in UK banking, however, was not entirely predicated on efficiency considerations. A "non-efficiency" related incentive for to automate emerged from the increased use of external advisors and management consultants.[92] Clearing banks and insurance companies even began to appoint individuals connected with computer manufacturers to their boards as non-executive directors. According to Channon, such links were to be found amongst clearing banks including the National and Commercial Banking Group (Honeywell), Grindlays Bank (GEC), National Westminster Bank (NCR and IBM-UK), and the Midland Bank (Rank Organisation).[93] Amongst the merchant banks, links were forged at Schroders (IBM Corporation), Morgan Grenfell (GEC and International Computers Holdings), Hambros (Thorn Electrical Industries), Kleinwort Benson (NCR) and Hill Samuel (IBM - USA).[94] While amongst leading insurance companies, links existed at Sun Alliance (Thorn Electrical, IBM - UK and GEC), Legal and General (IBM - UK), Guardian Royal Exchange (Rank Organisation), Prudential Assurance (Rank Organisation and Honeywell - UK) and Equity & Law Life (International Computers).[95]

4) THE INTRODUCTION OF COMPUTERS INTO BUILDING SOCIETIES

Building Societies and their Markets

Building societies had similar capabilities as those of commercial banks but had emerged as mutual organisations focused on long-term financing for the purchase of private dwellings and excluded from money transmission transactions by lack of access to the clearing process (finally resolved in the Building Society Act of 1986). Building societies then had to establish correspondent agreements with clearing banks since the chief method of transferring money within Britain came to consist of the

transfer of bank deposits through written instructions on debtor banks. In other words, cheques predominated over the use of coins, bank notes or bills of exchange.[96]

Although in the UK commercial (i.e. clearing) banks were free to enter the mortgage market, building societies operated a system under which they queued deposit customers against priority for the restricted supply of mortgages. In practice, this system was an effective entry barrier to the mortgage market, encouraged through the growth of a trade association called the Building Societies Association (BSA).

Since the passing of the Building Societies Act of 1939 (which restricted their activities to residential mortgages), the Council of the Building Societies Association (BSA) issued recommended rates for personal deposits, enabling societies to reward loyal depositors (called "members") by pricing mortgage loans below market interest rates. However, effective implementation of the recommended rates by the BSA had to wait until the end of the Second World War.

During the war property values increased as half a million homes were destroyed or rendered unfit, while the number of families had actually grown[97] and the number of building societies fell (from 960 to 890.)[98] Some societies had been at the forefront of merger activity amalgamating smaller providers. One of these had been the Co-operative Permanent Building Society or CPBS (today Nationwide) which, by 1948, had positioned itself amongst the top six mortgage providers in the UK, with £50m in total assets (some 20 and 30 years after, respectively, the biggest clearing bank and biggest commercial insurer).

The surge of mortgage lending under recommended rates after 1950 and during the 1960s promoted both the retail society branch network and balance-sheet growth of building societies until 1979. Growth of retail branches for building societies during the post war period was important because, up to the 1920s, they had generally conducted business from a single retail branch located on the ground floor of the head office building.[99] Throughout the inter-war years, building societies combined own branches with agency agreements through which they sought to receive mortgage referrals by paying commission fees to estate agents, lawyers or independent accountants.

Retail branches of building societies were used as ‘small’ savings banks, attracting personal savings accounts and these provided funding for the much needed short-term liquid resources. Deposits were captured in the form of share certificates but in 1959

passbooks were introduced to replace the certificates. Although passbooks were a superior alternative by which to record changes in balances and the history of individual transactions, they left the front office relationship unchanged and controlled locally through asynchronous, analogue systems.

National retail branch networks eventually emerged for individual building societies. First for the Halifax in 1937, followed by Abbey National and the Woolwich in 1948, while CPBS came fourth in 1952.[100] National networks were created more slowly and more organically than for banks, whose networks were created by the amalgamation process that swept British banking at the end of the nineteenth century. During the post war years, national retail branch networks for building societies grew on the back of the mortgage rate cartel (i.e. forced customer loyalty)[101], which together with inflation and low savings rates were to result in unsatisfied demand for mortgage funds.[102] As a result, between 1952 and 1979 the number of building society retail branches grew from 1,455 to 5,434 while the number of societies consolidated from 796 to 287. Growth was uneven, however, as the five biggest societies expanded retail branches at double the sector's rate.[103]

Substituting Manual Clerical Work for Calculating Machines (1945-59)

The introduction of office equipment during the 1920s and 1930s seems to have done little to modify the way customers entered the banking system and the way banks and building societies rendered their services.[104] Developments in office technology included new procedures (such as encoding or coloured card systems) and the mechanisation of clerical tasks based on typewriters, more effective internal communications (telephones or pneumatic tubes) and the introduction of calculating machines (arithmometers, tabulators and punched card machines). During the 1920s, the arrival of tabulators and punched card machines that could print alphabetical characters as well as numbers made the information provided potentially useful for internal bookkeeping and administration and for presenting information to clients, because additional information had to be typed or encoded numerically.[105] Steel filling cabinets and electric lighting also had some impact on the internal workings of UK financial organisations.

Some building societies followed clearing banks and manufacturing firms by introducing office equipment during the 1920s and later on punched card technology

and tabulating machines during the 1930s and 1940s. Dissemination of office technology, however, was quite diverse amongst the societies. The CPBS, for instance, did not purchase its first tabulating machines from BTM until 1944. These machines were purchased to enhance working conditions of senior staff at the Mortgage Department. Shortly after, in 1946, devolution of individual account control to staff at retail branches took place accompanied by the purchase of 12 additional adding and listing machines that supported the growing network of branches and agents. The potential of these machines, as well as of punch-hole "accounting" machines purchased in 1945, however, was not fully exploited until after 1951, when rent controls were lifted and increasing the size of the branch network and divesting itself of under-performing agents became a priority for CPBS.

Just like the Provincial Building Society and the N.A.L.G.O. Building Society, the CPBS used a combination of the Hollerith 80-column card system and electronic equipment to generate monthly ledgers. Hollerith cards were processed by electrical contacts whereas Powers-Samas' machines processed cards by "feeling" punches in relation to tiny roads. Another society using electronic and punch card technology based on Powers-Samas was the Alliance Building Society, one of the ten largest. Mechanisation at the Alliance is a good example of how the initial introduction of calculating machines resulted in the substitution of manual clerical work.

In 1957 the Alliance was already an experienced user of punched cards to generate monthly ledgers for individual retail branches.[106] Forty-column cards (with separable mortgage accounting cards for cash, balances, monthly debits and annual insurance debits) were created from a combination of summary listings ("till sheets") and individual slips. Before processing, the cards were checked by a special team of clerical staff who confirmed that credits were mortgage repayments and debits had the correct account number and identifier[107]. Confirmation was necessary because a full listing of account numbers was not always available for staff at retail branches (but, following procedure, staff at the branch would add the address of the individual member in the credit or debit slip). Credits to a member's (i.e. customer's) account had to be matched to a cheque, deposit slip at a clearing bank or deposit slip at one of the society's retail branches.

Cards were then expected to pass at a rate of up to 6,000 per hour through each stage of the system, namely, conversion to punched card, tabulator, collator,

calculator and posting transfer interpreter. Interest warrants would be printed on continuous stationary, which was imprinted first by the addressed system and subsequently by the Powers tabulator (who would also leave a trace through punched paper tape.) However, no interest was calculated exclusively by the tabulator. Interest for long-term deposits ("share interest") was calculated half-yearly by the branches and checked at head office ("Chief Office"). Mortgage balances were tabulated and sent to an outside advisory agency where the annual interest was calculated, noted on the card and the card returned to the society for the interest to be punched.

When the addresses had been printed on the forms, these were called over with a tabulation of current balance cards so that after this "call-over" the balance cards were arranged in the same order as the addressed warrants. The addressed warrants were then fed into the machine with the cards and, automatically, the account number and capital and interest amounts were printed. The warrants were then checked and initialled, the checker's duties being limited to verification that the account numbers in the address section and the financial section agree. The Alliance had three mortgage payment dates: first, second and third Tuesdays in the month, and consequently three posting dates. All the cards for the same posting date were fed through the tabulator for posting at one time and there was a monthly arrears debit for every account.

The Alliance would run term deposits ("investments") and mortgages through different equipment. Burroughs equipment was initially used and then Powers-Samas introduced for both systems. The Powers equipment "was custom-built and [was] not formed of interchangeable units."[108] Changing to Powers required from six months to a year as well as having to train all but one of the operators (specific skills meant that the former Burroughs operators were either transferred to work elsewhere or left the society). Migration to the Powers system resulted in the Alliance handling "twice as many accounts as they had when they changed from Burroughs, with the same staff. Postings [were] more easily kept up to date and statistical information [was] more readily available."[109]

The approach of the Alliance to centralise all individual account information at head office in Brighton contrasted with that at the Halifax, traditionally the biggest of all building societies in terms of assets, which gave retail branches full responsibility for the contents of the account records and control of the administration of individual accounts.[110] The Halifax used Powers-Samas punched card equipment for

summarising daily records of receipts and payments rather than for maintaining individual accounts. These records were analysed under various headings after being sent daily for processing to head office from each retail branch, thus permitting the General Ledger to be written up on a daily basis and showing the up to date financial position of the society.[111]

Dissemination of office technology not only differed as between the societies but also within the societies themselves. For instance, the clerical and bookkeeping effort needed to deal with increased business volume within the most active retail branches of the CPBS was alleviated when, in 1959, the society purchased three 'Sensimatic' Burroughs accounting machines (model F 203 ½ at a price of £1,595 each). These adding and ledger posting machines had part-manual and part-electronic features. They differed from previous models in that ledger sheets and statements could be posted simultaneously while the balance to be brought forward was stored in magnetic stripes on the reverse side of the ledger sheet.[112] The machines were to be located at the Nottingham, High Wycombe and Bradford offices (and later in Belfast) while smaller bookkeeping machines were then relocated from those offices to retail branches in Swindon, Northampton and Middlesborough which, at the time, still operated by hand.[113]

Challenges to Simplify Bookkeeping through Calculating Machines and Tabulators

Practices at the CPBS, the Alliance and the Halifax suggest that the influence of early mechanisation in the form of calculating machines and batch processing offered a cheap and efficient way to simplify bookkeeping systems rather than developing methods by which to manage information. Simplifying bookkeeping through mechanisation, however, also associated with some disadvantages and these were going to become more significant by the 1970s.[114] These disadvantages included, firstly, account decentralisation, resulting in staff at retail branches having to deal with several listings for sufficient details to emerge and to build up-to-date information on an individual account. Secondly, because of postal delays, a branch could expect a four to five day "turnaround" between the occurrence of the transaction and the reflection of the transaction in a centrally generated listing. Finally, data preparation tasks concentrated in a single location (eventually called Computer

Centre) which eventually resulted in problems of staffing and space (which became critical for some societies in the early 1970s.)

The main challenge for the utilisation of electronic equipment by building societies "was to devise [administrative] procedures for it and to provide suitable input and output equipment."[115] This problem of peripheral input and output devices was similar to that encountered by Simmons at Lyons in the 1950s. For the team at Lyons, the need to link the clerical systems of the company to the computer necessitated the overcoming of two problems: "a hardware systems problem concerned with providing the appropriate input and output at the appropriate speed, and an engineering problem of converting from the decimal and sterling records of the office system to the binary form required by the computer and back again".[116] Solutions to these problems were not easily found, despite linking up with various organisations such as the Post Office, STC, Ferranti and BTM. Indeed, continuing problems with the peripheral input and output devices during 1952 meant that it was only in late 1952 that work started on programming the Bakery valuations and payroll jobs to run on the new equipment.

Another limitation for widespread adoption of office mechanisation, in spite of mortgage financing being perceived as entailing substantially higher administrative expenses than commercial loans[117], was that the punched card technology of BTM and Powers-Samas offered limited storage possibilities. Developments in the late 1950s around electro-magnetic storage devises were attractive as these innovations offered more convenient input and output interfaces as well as the possibility to arrange account information in a variety of ways. Leo Computers Ltd. was readily recognised as the leading and most experienced manufacturer of the technology. However, in 1957, a price tag of £75,000 for a Leo II (including ancillary reading and printing equipment) resulted in some building societies keeping their lines of investigation open. Moreover, migration to a new system could be lengthy and quite dear. To little surprise directors of building societies wanted reassurance of the system's effectiveness:

> "I think it may be agreed that we would not wish to keep our records by [electronic/electro magnetic means] until these [systems] have been in practical use on a wide scale for many years."[118]

High Speed Equipment, Elementary "Data Systems" and Electronic Accounting

Up to the end of the 1950s, the performance of agents, retail branches and regional offices was measured by growth in size, such as the volume of mortgage and investment referrals, rather than efficiency or effectiveness (such as financial profitability or credit risk exposure). Financial performance of the retail branch network and individual retail branches was identified only when specifically commissioned by the Board or the Finance Committee. Treasury operations were simple, as funds were either in mortgages or invested in government securities and war bonds. However, as suggested in Table 2, directors of building societies could see a number of potential applications for electronic equipment (including general purpose computing technology).

[Insert Table 2]

Data in Table 2 shows the monthly mortgage repayments as the largest item of accounting work. Most of these payments were received through deposits at clearing banks and thus, banks provided building societies with a "posting medium which [was] sorted, listed and used for posting to the ledger account."[119] For the convenience of both the bank and the society, these transactions were distributed amongst banks retail branches so that the sorting and listing would also be spread between several building society retail branches. Detailed information emerging from the Woolwich also shows that, in spite of having outsourced a number of paper-based transactions to clearing banks, the society's retail branches received on average around 2,500 paper-based transactions related to mortgage repayments (through a combination of transactions at the counter of the retail society branch, postal deposits, agent and clearing bank deposits). At the time, the Woolwich had 40 branches and 750 agents (of which only 100 remitted some form of business on a daily basis), however, "larger branches might receive up to 8,000 mortgage [related transactions] per month."[120]

The interaction between banks and building societies further suggests how, in spite of the system of accounting for deposits, term investments and mortgage payments being administratively more cumbersome than that for clearing cheques, building societies had a more "relaxed" time frame in which to deal with their processes. Indeed, clearing banks in the UK had three to four days to credit or debit an account whereas building societies worked on monthly and semi-annual cycles.

Conscious attempts at data gathering (such as sources used to inform our compilation of Table 2), has revealed attempts by functional managers and directors of building societies to improve administrative processes and financial accounting procedures inside individual societies. For instance, in 1960, managers at the Woolwich speculated on the possibility of issuing an annual, full statement of all debits and credits to an account, rather than rely on the use of passbooks and summary listings. Moreover, managers and directors also speculated on how "to provide, in one operation, means of reconciling cash for the cashier, a receipt or passbook entry for the member (preferably the latter) and a posting medium for the accounting system."[121]

In the realms of management, however, there is some evidence of the use of accounting information for control and evaluation purposes. In 1962, the CPBS began to produce quarterly financial information statistics by which to evaluate the performance of its 112 retail branches. For building societies, the branch network (rather than agency contracts) was quickly turning into the main point of contact with retail customers[122], and the growth in their number increased the need for effective managerial control. Quarterly financial information reports initially distinguished annual performance according to the permanence of individual retail branches in the network, while tracking the number and value of mortgage accounts that were opened by each retail branch. The emergence of these reports was significant because they established, for the first time, a regular discussion amongst top management as to why some branches performed less favourably than others. Top management was then able to comment on the potential benefits of alternative sources of information by which to assess the society's growth in previously unexplored cities or to intensify the society's representation where business had already developed.[123]

Quarterly financial information reports were the key to the management of the CPBS's retail branch growth when the society moved forward and expanded again after 1965. At the time, staff at the society already numbered 1,200 persons and the development programme listed over 100 towns where new branches were considered viable. By 1967 the reporting system provided consolidated information about withdrawals and gross investment receipts emerging from the 124 strong network. Factors which could result in some retail branches (or even regions) performing better than others included the influence of the overall economic environment, individual

branch location (including type of business centre and position within the 'high street') and other features unique to individual premises (such as rent characteristics or use of the society's own dwelling). Comparative analysis of individual branch performance then started to consider not only whether to open new branches but also whether to direct marketing budget appropriation to branches in most need of refitting or relocation.

Programmable Computers and the Dawn of Management Information Systems

Staff at the Woolwich and the CPBS seem to have thought long and hard about managerial needs prior to introducing a computer. Documenting the potential application of electronic equipment and computers seems to have been a job shared between directors (i.e. members of the executive Board) and functional managers. Examples of the latter included accountants at the Internal Audit Department (i.e. Office of the Chief Accountant at the Woolwich) and experts in administrative processes working (i.e. Operations and Methods Department at the CPBS). Examples of directors tracking developments in computers and office technology include efforts of the Woolwich to oversee developments in the US-based savings and loans institutions (S&Ls).

The S&Ls first began using computers in the 1950s and adopted other office equipment innovations (such as microfilming of signatures) during the 1960s.[124] However, their large size and high cost limited the use computers to the most labour-intensive operations such as data processing associated with cheque clearing. This was to change in the early 1970s, following the perfection of electronic funds transfer (EFT) services which allowed the movement of money accurately between different accounts and institutions. In 1959, Alexander Meikle, then General Manager of the Woolwich and newly appointed chairman of the Building Society Association (BSA), took a month long-tour of the US to explore, among other things, the most recent practices at the S&Ls.[125] Meikle wrote about his travels in staff and trade magazines (such as *The New Advance*), with admiring comments on the S&Ls. His only criticism was that he thought they had let technology run riot:

> "They have still to learn that simplicity is the keynote of a good accounting system – but then that is a lesson only to be learned the hard way and over a long period of years."[126]

The building society-S&L link was also influenced by the adoption of an NCR 315 in 1962 by the Leicester Permanent. People at the National Cash Register Company (NCR) then began a study of building society requirements and this study followed a similar (but considerably bigger) study of S&L requirements in the US.[127] Other smaller societies then followed the Woolwich's lead and travelled to the US. For instance, in 1966, the deputy chairman of the Leek and Westbourne (today Britannia), "visited North America to absorb many of the latest ideas in the fast-growing world of computers."[128] This trip was conducive to the building society installing an ICL System 4-40 in 1968 to deal with internal administration, the processing of investments and mortgage accounts, and to provide statistical summaries.

It is unclear, however, whether these travels were influenced by the NCR study (which invited societies to visit NCR's manufacturing facilities) or whether smaller societies were responding to Meikle's position of prominence and the efforts made to disseminate his views. In any event, the installation of digital, programmable computers promised swiping changes to the operation of building societies such as "the abolition of the mortgage passbook and the centralisation at Lombard Street of all mortgage subscription bank collections."[129]

Computer manufacturers fought hard to position their products but the superiority of US-based technology was ever more apparent. At the Woolwich, the search to invest £200,000 in computer equipment included a consideration of the potential for a tailor-made system, in particular the adaptation of STC's Stantec Zebra transistorised computer with paper tape reader and Creed 1000 printer.[130] The Woolwich, however, also considered machines from companies at the forefront of computer technology such as NCR, ICT (Hollerith-Powers) and IBM. Meanwhile, in 1964, the Board of the CPBS was introduced to the workings of IBM's System 360 equipment.[131] This prompted the General Manager, Joseph Henry Simpson, to appointment a Computer Manager and a Senior Programming Assistant. The new manager would head the newly created Computer Department (which replaced the Operations and Methods Department) and:

> "… had to be experienced in the Building Society work and, in particular, to have a thorough knowledge of the Society's methods and administration procedures. He

(sic) would also be required to attend courses in computer programming and other operations in order to carry the project through to installation."[132]

As had been the case in US retail finance[133], the decision of building societies to automate via the use of a computer was based on perceived cost-savings and a technological frame of reference that viewed the computer as a high-output paper processing machine. According to Yavitz, the most important factor in evaluating the savings potential of a proposed computer installation in banking was the anticipated payback period, that is, the number of years of cumulative cost savings required to pay back the initial implementation cost.[134] Payback was used as an indication of the effectiveness of the investment in new technology and Yavitz estimated payback periods in US banking during the mid-1960s ranging from one and half to eight years, with a 3.3 year average and a three and a half year median. At the CPBS, however, it was estimated that capital costs and revenue expenditure would be compensated by savings emerging from automation over a period of 12 years but only if the society double its size and reached £1,000 million in total assets by 1976 (i.e. the end of the 12 year period)[135].

Clearly, the most significant result of introducing programmable computing power was the substitution of high-speed equipment for manual clerical work and slower-speed calculating machines. The effects of computers were to be felt in retail branches. For instance, the Abbey National used the installation of a Honeywell 400 in 1963 to help eliminate hand written passbooks by substituting them with computer pre-prepared record slips. Having paper-based slips directly routed to Lombard street would save a considerable amount of work at the retail branches.[136] It also had the advantage, for the society, of increasing the volume of funds cleared into an interest bearing account, since cleared funds could be invested two days earlier than had been the case prior to the adoption of computer technology.

The gains from the introduction of computers at head office included:

- The elimination of strain and extra work caused by peak loads associated with borrower's annual statements, investor's warrants and statements, clearing returned interest warrants and changing interest rates.
- The possibility of exchanging magnetic tapes with clearing banks, which included details of mortgage credits that could be fed directly to the building society's computer.

- Much quicker turn around of mail, particularly with reference to the computer calculating redemption quotations and investment valuations for withdrawal.
- More flexible administrative systems. In particular with regards to arrears and the control of information at head office:

"It was acknowledged that the reasons put forward for adopting E.D.P. [Electronic Data Processing] were similar to those which could be stated in considering the case for centralisation of accounts. The important aspect to be borne in mind, however, was that centralisation, other that on a computer system, would be impractical at this stage of the Society development.

It is perhaps inevitable that there would be some loss of personal service to members but Management expressed the view that this was not likely to have any material effect on the development of the Society."[137]

Greater efficiency associated with automation suggested that managers and directors of building societies faced an apparent paradox: on the one hand, greater efficiency through automation would result in greater centralisation. On the other hand, enhanced service offerings to customers associated with devolution of discretion to customer-facing-staff at retail branches (i.e. greater decentralisation). Senior managers decided for greater automation (in the form of newly introduced electronic and programmable computers) and improved communications, such as automatic internal switchboards. Automation resulted in the establishment of central accounting units and in the centralisation of customer account control so that regional and branch managers eventually lost autonomy to centralised senior managers. For instance, the central accounting unit of the CPBS was established in the summer of 1966 in Chesterfield House and within a few months the first batch of the society's retail branches was using computer-style accounting numbers for all new businesses. A practice that was, shortly after, extended to all of the 124 retail branches.[138]

5) CONCLUSIONS

This article has presented evidence relating to the development of the use of computers within building societies and clearing banks, and attempted to place this within the context of the general development of computers and their use elsewhere in the economy, including in the manufacturing sector.

Initially, the adoption of electronic office equipment by banks and building societies (such as sorters, tabulators and analogue computing power) seems to have emphasised cost (overhead) reduction, echoing the experiencing the situation which prevailed at the cable manufacturer, BICC, during the 1950s. The initial emphasis to reduce overhead is evident in the search for electronic office equipment which would make possible large reductions in the number of clerks needed at headquarters to process information flows. Equipment such as high-speed sorter readers, for example, helped to address this key problem in the cost structure of clearing banks. However, as well as generating important cost savings, computers also helped to increase the speed at which jobs could be completed in both banks and building societies. This provided financial benefits, through enabling building societies to more rapidly transfer funds into interest-bearing deposits. Computers also made it possible the more rapid supply of information and hence the identification of problems, making more effective managerial control possible. Furthermore, the new forms of technology opened the way for enhancing both the nature and the flow of management information, rather than merely speeding up the provision of information that had been previously available.

While the financial service sector appears to have lagged behind some parts of the manufacturing sector in the adoption of computers, the early usage of computers in the financial arena between 1945 and 1968 was dogged by similar problems to those which had been faced some years earlier by manufacturing firms, not least their suitability for the task in hand, late deliveries of equipment, inappropriate capacity and rapid technological change. Furthermore, their capacity was lumpy, being too large for some firms, while too small for others. Coupling all these with the fact that the costs of early computers was often high, the decision to invest in computer technology by any firm was clearly not an easy one. Evidence presented in this article is suggestive of the fact that, within the financial services sector, building societies may have lagged behind the banks in their utilisation of computer technology, but only by a short period of time. One possible explanation for this is size: major building societies in general, and CPBS in particular, were smaller in scale than the major banks or insurance companies. Given the lower level of transactions being accounted for during the early days of computers, building societies would have had a smaller incentive to mechanise as clerical administrative processes would suffice. It

was only when the scale of building societies reached a critical threshold during the 1960s (as major societies surpassed £100 million in total assets) that the application of computers became appropriate. That this period coincided with an improvement in the nature of the technology, and increasing costs of clerical workers, provided a further impetus to the implementation of computers.

The evidence presented in this article also suggests that the main impact of office mechanisation and the introduction of computers in the late 1950s and 1960s in financial services was in terms of reducing the costs of transaction processing. It would appear that directors of firms operating in the financial sector took well informed decisions, adopted new technology but only after documenting both upside and downside, while using computers to overcome potential problems such as those associated with the growth of transactions and of branch networks.

Indeed, it appears to have been the size of the respective types of financial institutions, and of individual firms within each type, which had an important influence on the timing of the introduction of the use of computers. Moreover, there seems to have been a clear link between the growth of building societies in the 1960s and their introduction of computers. Growth of building societies, through the establishment of an increased number of retail branches, meant that computers provided an alternative to significant increases in the number of employees and made such expansion feasible. While computers not only made possible the expansion of their business with fewer workers, they also aided the financial accounting operations through enabling automatic posting of transactions to the ledger. While the precise causal relationship between expansion and computerisation remains to be fully investigated, the simultaneous timing of the two events appears to have been more than merely coincidental. Notwithstanding, all of the major societies and many of the mid-sized societies had recognised the benefits of using computers by the end of the 1960s, echoing the experience of manufacturing firms and banks somewhat earlier.

On the other hand, while there is some evidence from the CPBS towards the end of the study period that management began to use the potential afforded by computers to produce statistics which would be useful for management control purposes, e.g. measuring and monitoring branch performance, there is little or no evidence to suggest that contemporary modern tools of management accounting, such as standard

costs, budgetary control or marginal costing, were being applied by firms operating in the financial sector.

It remains to be seen if the further application of computers and associated technologies from the late 1970s within the financial services sector had a major impact on this scenario. There is some evidence of a closer link between financial businesses, management consultants and computer manufacturers during the late 1960s and 1970s, and the development of this link and its subsequent impact on accounting methods, both financial and management, would seem to warrant further research if we are to better understand the process of computerisation in the financial sector. Another related area which possibly deserves further research effort, is the extent of the tie-ups between computer manufacturers and financial sector firms, such as that effected through the exchange of directors or other personnel.

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Table 1: Main Computer Manufacturers in the UK (Market shares, 1950-59)

	Value (£000s)	% share of market	No. of sold computers
Elliott Automation/NCR	3,930	32.4	25
Ferranti	3,190	26.4	36
Leo Computers	2,000	16.5	10
English Electric	1,875	15.5	25
ICT	870	7.1	29
IBM	240	2.0	2
Total	12,105		127

(*Source*: Campbell-Kelly, 1989, p.215.)

Table 2: Data Susceptible to Application of Electronic Equipment (1960) **

Investment Accounts: Shares and Deposits*	Mortgages
Number of accounts (Actual) Share accounts 130,000 Savings shares 6,000 Deposits 30,000	Number of accounts: 110 accounts (requiring 18 alphabetical runs on a regional basis)
Number of postings (Monthly average) *Receipts* *Payments* Share accounts 7,500 3,500 Savings shares 6,000 - Deposits 3,000 2,500	Posting media (Sources of original transactions) *Average of monthly mortgage repayments* Counters of retail branches 18,000 By post and through agents 15,000 From banks 76,000
Basis for interest calculation - • Share accounts - Day to day interest of transactions • Savings shares - Interest from the end of the month of deposit up to the beginning of the month of withdrawal. Monthly credit of interest to be received on every account. • Deposits - Interest from the end of the month of deposit up to the beginning of the month of withdrawal.	Information required on ledger (Arrears and correspondence) 1. Debiting of advances 2. Monthly posting of cash credits an all accounts 3. Monthly notification to Arrears Department on accounts which were two months in overdue (average 4,500 in Dec 1959).
Preparation of interest warrants - (Semi-annual interest paid or credited on June 30th and December 31st, based on transactions up to the previous month) *Num of half yearly transactions* Interest sent by warrant 58,000 Interest sent to banks 39,000 Compounded (i.e. added to capital) 28,000 Credited to deposit accounts 3,000	Application of variable interest rate charges - Mortgage deeds contained conditions for changes in rates. The majority of mortgages provided for a regular monthly repayment but there were some 6,500 "Endowment Plan" mortgages (i.e. fixed interest and endowment period payable at irregular intervals).
Notification to banks - One alphabetical run, according to name of "investor", sorted into banks, listed and sent to bank with covering cheque.	Furnishing statements to borrowers - • Interest is based on the balance at the beginning of the year. The majority of the accounts carry interest at one rate. • Annual statement of capital balance (total debited during the year and notice of balance due/remaining).
Furnishing data to Inland Revenue • No income tax calculations were involved in the payment of interest. Under a special arrangement the society paid tax on behalf of long term depositors (i.e. "share investors"). • Details of a 30% sample of individual account holders with balances of £1,000 or more and 3% of all other accounts had to be sent in intervals of	Furnishing data to Inland Revenue Notification of estimated interest for the coming year and actual interest debited for the previous year.

three to four years. Details included name, address, total investment balance and total interest credited per year.		Insurance (Annual debit of fire insurance premiums) Lady Day 55,000 Midsummer 17,500 Christmas 3,000
Channel (work flow)		Channel Holiday debits

* In the text we have used demand deposits, savings accounts and term investments for deposits, savings shares and share investment accounts respectively.

(*Source*: Woolwich Equitable Building Society, *Brief Report on Automation*, c.1964)

NOTES

[1] Cortada, 1996, p. 31.

[2] Bátiz-Lazo and Wood, 2002, p. 193.

[3] Midland Bank Staff Magazine, *The Branch Terminal*, January 1968, p. 435.

[4] Campell-Kelly, 1992, p. 136.

[5] Parker, 1981, p. 140.

[6] Innes and Mitchell, 1997; Drury, 1998; Nightingale and Poll, 2000; Helliar, I. Cobb and J. Innes, 2002.

[7] C. Drury,1998, p. 127.

[8] Hendry, 1987, p. 73.

[9] Edwards and Townsend, 1958, p. 82.

[10] Small, 1993, p. 9.

[11] Unless otherwise stated these definitions are taken from Small, 1993, pp. 8-9.

[12] Addition, subtraction, multiplication, division, differentiation or integration.

[13] Small, 1993, p. 18

[14] Small, 1993, pp. 8-9.

[15] Campbell-Kelly, 1989, p. 163.

[16] Campbell-Kelly, 1989, p. 165.

[17] Hendry, 1987, p. 86.

[18] Hendry, 1987, p. 73.

[19] Hendry, 1987, p. 74.

[20] Hendry, 1987, p. 81 and 48.

[21] Hendry, 1987, p. 84.

[22] Hendry, 1987, p. 84.

[23] Simmons, 1955, p.133.

[24] Simmons, 1955, p. 133.

[25] Hendry, 1987, p. 85.

[26] Hendry, 1987, p. 88.

[27] Manchester Central Library, M501 681.3 RC 959/5, section 7.

[28] The details in this sentence and the remainder of this paragraph, unless otherwise stated, are taken from Manchester Central Library, M501 681.3 RC 959/5, section 7.

[29] Manchester Central Library, M501 681.3 RC 959/5.

[30] Manchester Central Library, M501 650.0522 R&CC 949/3, MDC Minute 505/60, 21 Sept. 1960.

[31] Hendry, 1987, p.88.

[32] Hendry, 1987, p.89.

[33] The details in this paragraph are taken from Manchester Central Library, M501 681.3 RC 959/5, section 7.

[34] Edwards and Townsend, 1958, p. 84.

[35] Hannah, 1983, p. 151.

[36] Unless otherwise stated, information on Lyons in this paragraph is taken from Jeremy, 1998, p.215.

[37] Simmons, 1955, p. 134.

[38] In May 1955 it was recorded that it was 'now being built' (Simmons, 1955, p.134).

[39] Simmons, 1955, p.135. In May 1959 the actual cost of equipping and installing LEO II/1 at Elms House was given as almost £200,000 [Manchester Central Library, M501 681.3 RC 959/5, section 7].

[40] Jeremy, 1998, p. 215.

[41] Balfour Beatty, BICC, CEC, ????

[42] Balfour Beatty, BICC, CEC, min. 13/55.

[43] Balfour Beatty, BICC, CEC, min. 115/56.

[44] Balfour Beatty, BICC, CEC,, min., 13/55.

[45] Manchester Central Library, M501 681.3 RC 959/5, f.1.

[46] University of Warwick, Modern Records Centre (hereafter MRC), MSS.363 S4/6/1.

[47] This is the title of a 28 folio manuscript dated 25 July 1963, MRC, MSS.363 S3/1.

[48] The topic became the subject of a book published in 1970, entitled *Management of change - the role of information*.

[49] Salmon, 1963, p. 172.

[50] Salmon, 1963, p. 175.

[51] Jeremy, 1998, p. 513.

[52] NCB, Annual Report, 1958, Volume I, p. 21.

[53] NCB, Annual Report, 1959, Volume I, p. 19.

[54] NCB, Annual Report, 1960, Volume I, p. 18.

[55] NCB, Annual Report, 1961, Volume I, p. 25.

[56] NCB, Annual Report, 1962, Volume I, p. 13.

[57] NCB, Annual Report, 1963-4, Volume I, p. 29.

[58] NCB, Annual Report, 1964-5, Volume I, p. 28.

[59] NCB, Annual Report, 1965-6, Volume I, p. 33.

[60] NCB, Annual Report, 1965-6, Volume I, p. 33.

[61] NCB, Annual Report, 1966-7, Volume I, p. 31.

[62] NCB, Annual Report, 1966-7, Volume I, p. 31.

[63] NCB, Annual Report, 1966-7, Volume I, p. 31.

[64] Ashworth, 1986, p. 513.

[65] Cortada, 1993, p. 129 quoting W. H. Leffingwell *The Office Appliance Manual*, New York, National Association of Office Appliance Manufacturers, 1926, p. 180 and S. Ratner and others *The Evolution of the American Economy*, New York, Basic Books, 1979, pp. 505-10. However according to Yavitz, 1967, p. 11 quotes 1.5 billion cheques were cleared in 1939, increasing to 6.5 billion in 1950 and to 13 billion in 1960.

[66] Yavitz, 1967, p. 11.

[67] Yavitz, 1967, p. 20; Weaver-Fisher and McKenney, 1993, p. 46.

[68] Weaver-Fisher and McKenney, 1993, p. 48.

[69] Weaver-Fisher and McKenney, 1993, p. 44.

[70] See further Holmes and Green, 1986, pp. 248 and 303; Morris and Westbrook, 1996; Wood and Bátiz-Lazo, 1997.

[71] McKenney, Mason and Copeland, 1997.

[72] Yavitz, 1967, pp. 24-6.

[73] Leslie, 1993, p. 49.

[74] Small, 1993, p. 12.

[75] Yavitz, 1967, p. 22.

[76] Yavitz, 1967, p. 27.

[77] Anonymous, *The computer - and the story behind it*, Midland Bank Staff Magazine, January 1963, pp. 432-3.

[78] Campbell-Kelly, 1989, p. 178. See also De Wit and Van Den Ende, 2000; Wardley, 2000.

[79] Campbell-Kelly, 1989, pp. 99 and 178.

[80] Edwards and Townsend, 1958, p. 83.

[81] Channon, 1977, p. 45.

[82] Saville, 1996, p. 805.

[83] WEBS, Brief Report on Automation, 4 April 1960, Ref. 144.

[84] Channon, 1977, p. 45.

[85] Channon, 1977, p. 46.

[86] Unless otherwise stated, data on this paragraph comes from WEBS, Brief Report on Automation, 4 April 1960, Ref. 144.

[87] Hendry, 1987, p.93, who adds a cryptic reference, apparently to F.M. Fisher, J.W. McKie and R.B. Mancke, *IBM and the US Data Processing Industry: An Economic History*, New York, 1983.

[88] WEBS, Brief Report on Automation, 4 April 1960, Ref. 144.

[89] Wilson, 1998, p. 103.

[90] Wilson, 1998, p. 102.

[91] See further Wood and Bátiz-Lazo, 1997; Bátiz-Lazo and Wood, 2003.

[92] Saville, 1996, p. 692.

[93] Channon, 1978, pp. 73-6.

[94] Channon, 1978, pp. 82-5.

[95] Channon, 1978, pp. 112-116.

[96] Pringle, 1973, p. 22.

[97] Davies, 1981, p. 64.

[98] Davies, 1981, p. 64; Cassell, 1984, p. 56.

[99] Davies, 1981, pp.27 and 63.

[100] Davies, 1981, pp. 87-8.

[101] The cartel ended in 1984, when the Chancellor of the Exchequer threatened to review it in light of the Restrictive Trades Practices Act (see Boléat, 1986, p.180).

[102] According to Davies, 1981, p. 55 and Drake, 1989, p. 272, this demand was to grow to an estimated £1,500 million sterling or 3% of the outstanding mortgage stock in 1979.

[103] Davies, 1981, pp. 58 and 165-6.

[104] De Wit and Van Den Ende, 2000, p. 99; Campell-Kelly, 1992, pp. 126-30; Wardley, 2000, p. 83.

[105] De Wit and Van Den Ende, 2000, p. 99

[106] WEBS, Electronic Accounting, c.1957 (Ref 1 The use of electronic and punched card accounting equipment by building societies).

[107] Instead of a "check digit" the Alliance used the first three letters of the borrower's or depositor's surname. This was deem of great assistance to ensure that the cash card was married to the correct balance card before posting [WEBS, Visit to the Alliance Building Society's Punch Card Accounting Installation, 5 Apr 1957 (Ref 1Practical points applicable to any punched card system)].

[108] WEBS, Visit to the Alliance Building Society's Punch Card Accounting Installation, 5 Apr 1957 (Ref 2 The change-over from Burroughs and benefits).

[109] WEBS, Visit to the Alliance Building Society's Punch Card Accounting Installation, 5 Apr 1957 (Ref 2 The change-over from Burroughs and benefits).

[110] Anonymous, *Computer Systems and Services*, Halifax, Halifax Building Society, c. 1979, p. 2.

[111] WEBS, Electronic Accounting, c.1957 (Ref 1 The use of electronic and punched card accounting equipment by building societies).

[112] Anonymous, *The computer - and the story behind it*, Midland Bank Staff Magazine, January 1963, p. 432.

[113] CPBS, Board Minutes, 25 Jun 1959 (Ref Accounting Machines).

[114] Unless otherwise stated, data on this paragraph comes from Anonymous, *Computer Systems and Services*, Halifax, Halifax Building Society, c. 1979, p. 2.

[115] WEBS, Electronic Accounting, c.1957 (Ref 2 Reasons for the use of punched cards in conjunction with electronic means of accounting).

[116] Hendry, 1987, p. 80.

[117] Yavitz, 1967, p. 13.

[118] WEBS, Electronic Accounting, c.1957 (Ref 2 Reasons for the use of punched cards in conjunction with electronic means of accounting).

[119] WEBS, Data Relevant to Utilisation of Electronic Equipment, 28 January 1960 (Ref 3 Sources of Entry).

[120] WEBS, Data Relevant to Utilisation of Electronic Equipment, 28 January 1960 (Ref 3 Sources of Entry).

[121] WEBS, Data Relevant to Utilisation of Electronic Equipment, 28 January 1960 (Ref 3 Sources of Entry).

[122] In 1962, under a strategy that halted asset growth while aiming to receive advances from the Treasury under the House Purchase and Housing Act of 1959, CPBS cut its ties with half of its 2,500 agents.

[123] CPBS, Notes to the Minutes of the Board, 31 Jan 1963.

[124] Unless otherwise stated, information on S&Ls in this paragraph is taken from Mason, 2001, 'A Revolution in Financial Technology'.

[125] Ritchie, 1998, p. 88.

[126] As quoted in Ritchie, 1998, p. 88.

[127] WEBS, Internal communication from General Manager to Accountant, 9 July 1962.

[128] Redden, 1986, p. 86.

[129] WEBS, The Effect of a Computer, 13 Mar 1964 (Ref. Borrowers).

[130] The Chairman of the Woolwich was also Chairman of STC and, not surprisingly, pushed the former to link up with STC but, in the end, the Woolwich's Accountant and STC's engineers recommended against it.

[131] CPBS, Special Policy Board Meeting: Electronic Data Processing, 16 Apr 1964.

[132] CPBS, Minutes of the Board, 7 May 1964 (Ref Computer Manager).

[133] Yavitz, 1967, p. 38.

[134] Yavitz, 1967, p. 46.

[135] CPBS, Special Policy Board Meeting: Electronic Data Processing, 16 April 1964 (Ref. 296.e Economics of E.D.P.)

[136] The Woolwich estimated that in November/December of 1959, 1/3 of borrowers used bank orders and 1/6 credit transfers to pay their subscriptions. As a result half the number of payments accrued to bank-based transactions. The other half was made out of transactions at retail counters or by post (1/3) and through agents (1/6). WEBS, The Effect of a Computer, 13 Mar 1964 (Ref. Borrowers).

[137] CPBS, Special Policy Board Meeting: Electronic Data Processing, 16 April 1964 (Ref. 296.b Centralisation of Accounts - Service to members)

[138] Cassell,1984, p. 86.