
Citation:

Martin, I (2012) Too far ahead of its time: Barclays, Burroughs and real-time banking. IEEE Annals of the History of Computing, 34 (2). 5 - 19 (15). ISSN 1058-6180

Link to Leeds Beckett Repository record:

<https://eprints.leedsbeckett.ac.uk/id/eprint/940/>

Document Version:

Article (Accepted Version)

The aim of the Leeds Beckett Repository is to provide open access to our research, as required by funder policies and permitted by publishers and copyright law.

The Leeds Beckett repository holds a wide range of publications, each of which has been checked for copyright and the relevant embargo period has been applied by the Research Services team.

We operate on a standard take-down policy. If you are the author or publisher of an output and you would like it removed from the repository, please [contact us](#) and we will investigate on a case-by-case basis.

Each thesis in the repository has been cleared where necessary by the author for third party copyright. If you would like a thesis to be removed from the repository or believe there is an issue with copyright, please contact us on openaccess@leedsbeckett.ac.uk and we will investigate on a case-by-case basis.

“Too Far Ahead of its Time”: Barclays, Burroughs and Real-Time Banking

PRE-PUBLICATION DRAFT

Note: this is a draft. It differs from the final published version. When citing always refer to the published version:

Martin, I. (2012) 'Too far ahead of its time: Barclays, Burroughs and real-time banking', *IEEE Annals of the History of Computing* 34(2), pp. 5-19. ISSN 1051-6180.

Ian Martin

I.L.Martin@leedsmet.ac.uk

The historiography of computing has until now considered real-time computing in banking as predicated on the possibilities of networked ATMs in the 1970s. This article reveals a different story. It exposes the failed bid by Barclays and Burroughs to make real time a reality for British banking in the 1960s.

In 1969, BBC television’s popular science and technology programme, *Tomorrow’s World*, broadcast an item that looked forward to the introduction of a banking system that would “usher in [the country’s] cashless economy”.¹ The show’s narrative of technological change envisioned point of sale terminals in British high street shops linked to a central super computer in real-time. The basis for the show’s prediction was a plan by Britain’s biggest bank, Barclays, to have in place its new nationwide computer banking system in time for 15

February 1971. Barclays was not alone. Its close competitors, the Midland and the National Provincial, also saw “Decimal Day” – the day when Britain would decimalise its currency – as the deadline for the real-time computerisation of the whole of their branch networks. None of the banks went as far as including point of sale terminals in their plans, but each foresaw its own real-time computer linked to a national branch network of intelligent terminal satellites. In all three cases it was US computer manufacturer Burroughs that was to provide the banks’ real-time systems.

Not untypically for *Tomorrow’s World* its prediction turned out to be wildly optimistic, but so too were the ambitions of Burroughs and the banks. At the time of the programme’s broadcast, one bank had already abandoned its plans, and relations between the other two and Burroughs were being sorely tested. Real-time banking never materialised in the 1970s, let alone by 1971, and to varying degrees each project could be considered a failure. In this article, I examine the details of the Barclays’ case and its relation to the real-time ideal in order to challenge accepted truths regarding technological innovation in banking and expand the historiography of computing further beyond the bounds of success.

In *Computer*, their wide-ranging history of the computer, Martin Campbell-Kelly and William Aspray suggest that the exigency for real-time computing in banking came from the introduction of the Auto Teller Machine (ATM) and that it was inertia from batch-oriented accounting methods that prevented real-time accounting in banking taking place in the 1970s.ⁱⁱ Elsewhere, overviews of the computerisation of retail finance portray it as a staged movement from batch processing in the 1960s to on-line and then real-time processing in the 1970s and 80s.ⁱⁱⁱ Bátiz-Lazo and Reid have recently begun to untangle the links between the ATM and real-time computing in their account of the development of cash dispensing technology in the UK,^{iv} but technology’s linear progression remains a self-evident truth.

Here I want to argue that a history of computing in banking that includes its failures has a different story to tell – one that highlights the non-linear nature of technological change and the relevance of technical and social ideals. Drawing upon oral testimonies and archival material, I offer Barclays’ perspective on the Barclays-Burroughs real-time project to show how a community of practice made up of Barclays programmers and Burroughs engineers struggled to make the rhetoric of the cashless society a real-time banking reality alongside the bank’s IBM-based batch-processing developments. I explore the co-construction of real-time computing and its “interpretive flexibility” as “real-time” was reconfigured as “on-time” in the face of a number of material and immaterial difficulties. These difficulties – environmental challenges at the computer centre, delivery delays, cancellations and manpower shortages – exacerbated the already considerable challenges of real-time software creation and resulted in the project’s eventual demise. I conclude by showing how the community of practice on the ground and those responsible for the real-time rhetoric in the air came to terms with the project’s unfortunate end as they re-incorporated its failure into the prevailing technological discourse to judge, in retrospect, the technology of real-time computing for banking and the idea of the cashless society as “too far ahead of its time”.

The real-time impetus

In the 1950s, escalating volumes of work caused by an increased demand for banking services had intensified the pressure on the British high street banks. Short of space and staff for their branches in London and other major cities, and faced with a shrinking labour pool and rising operating costs, the banks saw the commercial arrival of large-scale electronic computing technology as a solution to their problems.^v By replacing electro-mechanical accounting machines in the branches with an automated branch book-keeping

system at a computer centre, the banks believed they would be able to continue to provide their current services to an increasing number of customers at a cost they would be willing to pay.^{vi}

This first wave of automated accounting at the banks' first computer centres – operational from 1961 – relied on computer systems that processed customer account updates in batch. This meant that the updates to customer accounts delivered in batches by hand, or over Post Office telephone lines, from branches throughout the day were not processed at the centre until later that evening when all entries had been received. Branch staff saw the results of their updates the following morning when printed lists of accounts in the form of ledgers and statements had been delivered back to them. Whilst the computer itself processed information very quickly, the move from mechanised accounting in the branch to computer accounting at the centre increased overall processing times. Real-time computing offered the possibility of banishing this delay.

By the mid sixties, the reservation systems of major American and British airlines had proved the commercial viability of real-time computing. Like American Airlines' pioneering reservations system, SABRE, real-time computing for the banks offered immediate updates and information retrieval with the potential for improved management information and business control.^{vii} In banking, however, the application of real-time computing was still a global frontier. The cachet of realising the world's first real-time banking system appealed to Barclays at a time when a draft internal memo revealed concern from an unnamed source that the bank was in danger of losing its position as technological pioneer amongst the British banks.^{viii}

The impending decimalisation of British currency precipitated Barclays towards real-time. In his budget of 1966 the Chancellor of the Exchequer, James Callaghan, had announced that Britain would convert to decimal currency. Decimal Day, or "D-Day" as it

came to be popularly known, was set for 15 February 1971.^{ix} The Chancellor's announcement gave the state, businesses, and the public five years to prepare for the change from pounds (£), shillings (s), and pence (d) into the new pounds and pennies. The new pound would continue to have the same value as the old, but would be divided into 100 new pennies rather than 20 shillings each worth 12 pence as it had been before. The government's decision meant a massive enforced change for all British businesses, and banks, in particular, were under tremendous pressure to get the conversion right. Decimalisation not only meant handling a new currency at the counters in the banking halls of the branch, but also necessitated wholesale changes to accounting procedures and technologies in the back offices. Accounting machines, adding machines, ledger books, customer statements and paper forms all required replacement or conversion. There were significant costs associated with the replacement or conversion of existing branch equipment, procedures and stationery for decimalisation, much of which would be redundant after computerisation. In 1966, computerised branch accounting in British banking still remained a highly localised and selective affair. Of the 2,300 branches in its national network Barclays had automated only 100 – those biggest and busiest London branches that were experiencing the greatest shortages of staff and space.

In the computer centres accounting programs also had to be rewritten and stationery updated for decimalisation, but the conversion of centralised computer centre branch accounting programs presented itself as a fairly quick and manageable task. One set of programs at the centre did the accounting work for all branches, so a change to these programs would change all the branches in one fell swoop.^x Conversion of mechanised accounting practices and equipment across an entire branch network was an altogether more complicated proposition. Given the complexity of the change, its associated costs and the growing inevitability of computerisation, it made economic sense for the banks to have

computerised the accounting of as many of their branches as possible before decimalisation day.^{xi}

Enter Burroughs: agent of the future

By the mid-sixties the British banks were predominantly purchasing their computers from IBM. After two initial purchases from British electronics manufacturer – and Barclays' customer – EMI,^{xii} Barclays looked to IBM for computers to stock its cheque clearing centre and its second and third branch accounting computer centres. Barclays had initially planned an IBM installation for its fourth branch accounting computer centre, but other US office appliance manufacturers were also targeting the UK market intent on contesting IBM's hegemony as computer supplier to four out of the "Big Five" British banks.^{xiii} Of these, it was another US manufacturer, Burroughs, that stepped forward its solution for real-time branch accounting to three of the five largest British banks.

Burroughs was a member of a group of IBM's seven biggest US rivals that the trade press had labelled the "seven dwarves" to indicate the comparatively small share they had of the burgeoning computer market in relation to the US giant.^{xiv} Burroughs had established itself in Britain in the 1890s, however, and the company's entrepreneurial founder, William Seward Burroughs, having worked in a bank knew only too well the tedious repetition that characterised much of the work of the bank clerk. He began his company by developing an adding machine that he identified by personal experience as fulfilling a need in the branch book-keeping process. The company went on to produce a series of small-scale mechanical and electro-mechanical machines that could be accommodated within a typical office and fulfilled a succession of banking needs.^{xv}

After World War II, Burroughs invested significantly in electronics and began to expand vigorously. It opened new factories in the UK and relocated its adding machine

production facilities from Detroit to Strathleven, Scotland.^{xvi} In 1950 its investment in electronics resulted in the production of a new kind of branch accounting machine called the Sensimatic, which it considered “the greatest advance in accounting machines in 25 years”.^{xvii} However, as the 1950s progressed, Burroughs was slower than IBM in making the move from office equipment supplier to business computer supplier. Its first vacuum tube based machines only sold modestly in the 1950s,^{xviii} and its business computing efforts were largely focused on selling equipment that could fit within the confines of a traditional office environment. Of the ten “data processing” products it showcased at the Business Efficiency Exhibition in London in 1959, its 220 “large-scale computer” was the only one that would find a home in a computer centre.^{xix} Unlike IBM, Burroughs had not been a manufacturer of the tabulators that had acted as a useful stepping stone in the transition from office appliance manufacturer to business computing manufacturer.

Like IBM, Burroughs’ first inroad into large-scale computing with the British Banks was via cheque sorter readers. Lloyds Bank ordered a Burroughs cheque sorter-reader in 1960, and followed this up with an order for a Burroughs B270 computer in 1962.^{xx} The Midland ordered a total of ten Burroughs sorter-readers to be controlled by a Burroughs B370 by 1965.^{xxi} Two years later, Burroughs’ cheque encoding machines, which were used in the branch to print the amount in magnetic ink on cheques paid in over the counter, had a three-quarters majority share of the British market.^{xxii}

Burroughs stepped up its computer sales efforts to the British banks in 1965 by expanding its London sales office and creating a “London-Banks” office dedicated to serving the needs of the high street banks. Its sales team aggressively went after new business, seeking to persuade the banks to change commitments to existing computer suppliers and instead buy Burroughs. Burroughs competed on four fronts with IBM and other established computing suppliers. First, it competed on price, offering to undercut the competition.

Second, it levered its long-standing links with the British banks to promote itself as fully understanding their specific needs. Third, it competed on technical excellence, waxing lyrical about the virtues of its integrated hardware and software developments at the computer centre and in the branch. Fourth, it was intent on selling itself as the business automation company of the future, declaring in advertisements in newspapers and trade journals that it was “bringing business automation to far-sighted companies”.^{xxiii}

The B8500 Computer

Burroughs gained its initial real-time experience working as a subcontractor on the SAGE (Semi-Automatic Ground Environment) real-time defence system and a number of other US government sponsored projects. To the private sector, it marketed its 500 series machines as on-line and real-time systems particularly suited to financial applications.^{xxiv} The range began with the entry-level B5500, the commercial counterpart of its D825 military real-time machine. At the top of the range was the B8500 supercomputer. Produced by the Burroughs Defense, Space and Special Systems Group, the B8500’s origins were as a high-speed scientific computer for the US Atomic Energy Commission. It shared the integrated modular design found in the B5500, expanding the concept further to offer a maximum of 16 interconnected processors and I/O modules.^{xxv} The B8500 represented Burroughs’ biggest and most ambitious system to date, which it set about marketing outside of the defence and space fields, trumpeting it as “the most powerful computer system ever designed”.^{xxvi} In addition to the American defence contract, Burroughs had secured a \$20 million order from US Steel and a \$15 million order from the University of Wisconsin.^{xxvii}

Burroughs demonstrated the machine’s technical pedigree to senior bank managers, analysts and programmers who were invited on tours of Burroughs Research Unit in Detroit and installations at US Steel and the North American Air Defense (NORAD) combat

operations centre inside the Cheyenne mountain near Colorado Springs.^{xxviii} At NORAD, Barclays representatives were suitably flattered to have been granted privileged access and impressed by what they saw inside. At the heart of the complex was a Burroughs behemoth, a D825 multiprocessor computer that used radar and satellite input to make real-time evaluations of incoming threats to the North American continent.^{xxix} Its multiprocessor architecture meant that not only did it offer high performance, but that it also boasted non-stop capabilities. This was an important selling point for a complete solution that relied on a single computer at its centre. Barclays technicians judged the Burroughs machine to offer superior reliability in comparison to its competitors.^{xxx} The visiting team was also impressed by the synergy between Burroughs hardware and software teams, of which one of the results was an automatic “self-discovery” of any changes in hardware configuration at Initial Program Load (IPL). Burroughs appeared technically and organisationally very advanced and able to offer machines with superior technology and system reliability to those of the firm’s competitors, particularly those from IBM.^{xxxi}

The D825 was not available commercially, but Burroughs was building a B8500 to order at US Steel to serve as its real-time control system. Barclays’ representatives were shown the prototype super computer, but they had no way of knowing that the machine they saw “in bits on the floor” would never be completed. US Steel continually changed its requirements and, although Burroughs attempted to respond with modifications to increase processing power,^{xxxii} the machine was unreliable and Burroughs was unable to rectify its flaws cost effectively.^{xxxiii}

The TC 500 intelligent terminal

It was the appeal of Burroughs’ programmable branch terminal, the TC 500, however, that led Barclays to its all-Burroughs solution.^{xxxiv} The TC 500 offered an intelligent terminal

interface to its operator within the branch that was judged by Barclays programmers to be “streets ahead of anything else at the time”.^{xxxv} Rather than relying on hardware to control printer positioning, the TC 500 was controlled solely by application programming.^{xxxvi} This made it incredibly versatile. An operator in the branch could load a TC 500 with programs held on paper tape in order to perform different branch accounting tasks on the same machine.^{xxxvii} Figure 1 shows a Burroughs TC 500 in Burroughs’ advertising literature of the time.

Figure 1. A Burroughs TC 500. Source: *Burroughs TC 500 Terminal Computer: Introduces a New Approach to On-Line Systems Design*, c. 1967, 2.

The TC 500 was marketed an intelligent branch terminal as Burroughs management came to understand that the technologies of office appliances and computers were converging.^{xxxviii} A sophisticated programmable electro-mechanical machine with three processors, the TC 500 was considered by some to be a computer in its own right.^{xxxix} The *Financial Times* reported one claim that there was the same calculating capacity in this small office machine as there had been in an IBM 1401.^{xl} Burroughs stressed the TC 500’s power in its advertising literature as fulfilling an important contributing role towards a balanced computing system where processing was shared between remote terminal and central computer.^{xli} Connected to a Burroughs large-scale computer a TC 500 could make customer records at the computer centre available to the branch in real time.

A complete solution

Burroughs extolled the virtues of its intelligent TC 500 terminals for the bank branches and its B8500 computer in the computer centre and promised that this combination would be powerful enough to handle a bank’s entire branch accounting needs. Burroughs offered

Barclays all the computing capacity it would need for its own real-time national computing network comprising a Burroughs B8500 at the centre and a network of Burroughs TC 500 terminals in the branches. It was a system that was claimed to be capable of providing an up-to-date response to any branch transaction within two and a half seconds, and able to handle a million of these transactions every hour.^{xlii} Burroughs' system was half the price of that proposed by IBM.^{xliii} Barclays dropped IBM in favour of Burroughs as the new supplier of its computing technologies that would decimalise the majority of its branch accounting. On 2 March 1967 it placed an £11,500,000 order with Burroughs for one B8500, priced at £4.5 million, and 2,300 TC 500 branch terminals.^{xliv} Another order from another British bank, the National Provincial, quickly followed that of Barclays. Then, in February the following year, both banks were followed by the Midland, which was experiencing difficulties in its relationship with British computer manufacturer English Electric Leo Marconi.^{xlv} The two remaining big British banks, Lloyds and the Westminster, stayed committed to IBM, and, to differing degrees, committed to batch processing. Burroughs, proud of its coup, made sure the rest of British business knew about it. Figure 2 is an advertisement published in the *Financial Times* of 22 May 1967, following the orders from the banks.

Figure 2. Burroughs advertisement published in a banking supplement of the *Financial Times*, 22 May 1967.

Although Barclays had done little business with Burroughs up until this point, preferring to partner with NCR for its electro-mechanical book-keeping machines,^{xlvi} Burroughs' real-time computing offered Barclays the opportunity to further its ambitions for the position of technological innovator. It reckoned its new system would be the largest real-time banking system anywhere in the world.^{xlvii} Now it was not just cash that was portrayed as outdated

and dangerous *Tomorrows' World* had cast it, Barclays wanted the batch mode of computerised branch accounting to look decidedly old fashioned.

Tomorrow's banking world was still years away, however. Lead times from order to delivery of large-scale computers were still typically eighteen months to two years, and installation of the Burroughs' B8500 super computer was promised for the first half of 1969.^{xlviii} In the meantime Barclays looked for a space to house its new computer and began to source the analysts and programmers that would realise its real-time banking vision.

Close to the machine

In the spring of 1967, two programming teams were assembled. The first was an applications team that would write the real-time branch accounting applications; the second was a small technical team assembled, in the words of one of its members, in order to "get to grips with [the B8500] in its technical glory".^{xlix} This team was made up of the bank's most experienced and skilled programmers drawn from Barclays' other computer projects. These programmers, who had been bank clerks five years previously, were complemented by a number of computing outsiders recruited for their technical specialisms.

The technical team's brief was to understand what could be done with the Burroughs machines by working alongside Burroughs engineers "close to the machine" and advising the applications team accordingly. The machines the team had to understand were the Burroughs large-scale B8500 computer and the smaller-scale TC 500s that would be installed in the branches. Getting close to the B8500 presented a considerable challenge as the machine would not be ready for delivery for another two years.¹ This was not an unusual length of time to wait for a large-scale computer. There was no need to wait for the delivery of the Burroughs large-scale computer to make use of the TC 500s, however; the

intelligent branch terminals could operate as standalone book-keeping machines capable of being used for both decimal pre-decimal working with some reprogramming.^{li} The bank was intent on replacing its non-decimal NCR 160 and 3204 accounting machines with TC 500s as fast as Burroughs could make them available.^{lii}

Learning in a community of practice

Meanwhile, in the first half of 1968, one of the applications programming team attended a CUBE (Cooperating Users of Burroughs Equipment) meeting in New Orleans. CUBE was a computer user group for Burroughs' customers similar to SHARE, set up by the scientific and technical users of IBM computers, and GUIDE (Guidance for Users of Integrated Data processing Equipment), an association of IBM's commercial data processing users. Its purpose, like SHARE and GUIDE, was to share knowledge, ideas, practices and programs and to agree upon standards.^{liiii} It was a formal incarnation of what educational theorist Etienne Wenger would consider a "community of practice".^{liv} At the meeting, one Burroughs' representative shared his knowledge that production of the B8500 was in delay and Burroughs was about to offer Barclays two B6500s instead. Not only was this solution seen as less than satisfactory, the manner in which it had been communicated to the bank was deemed wholly inappropriate. Burroughs decision to relay something of this magnitude to a chief programmer at a user group meeting rather than communicating it directly to them was considered disrespectful by Barclays managers.^{lv} As a stopgap and peace offering until delivery of the first of the B6500s, Burroughs promised to supply Barclays with a B5500. Barclays managers might not have been happy, but the bank's programmers were at least able to begin testing.^{lvi}

Although some US banks had made use of the Burroughs B5500,^{lvii} there was little experience of it in Britain. The bank's technical team began working closely with Burroughs

engineers, forming a smaller, tightly-knit community of practice, to gain experience of the machine's capabilities as quickly as possible. The team soon realised both the B5500 and the TC 500s were sophisticated machines, but that Burroughs had not yet worked out how they would work in harmony as a real-time system. Telecommunications between multiple processors in multiple terminals connected over multiple lines to a multiprocessor computer wasn't catered for in the B5500's operating system. The real-time systems up to this point – including those from IBM as well as Burroughs – had made use of dumb rather than intelligent terminals. The sophistication of the TC 500 terminals added an extra layer of complexity with which Burroughs and Barclays had to deal.

Then exploded a first bombshell. The Burroughs' engineer who was to design and write the software for two-way data communication between the TC 500s and the B5500 computer left Burroughs. Burroughs had nobody else available to replace him.

The Burroughs' programming job was picked up in 1968 by Barclays' employee David Parsons, who had retrained from his role as a bank clerk to become a programmer of the EMI computers at Barclays' first computer centre.^{lviii} His new team leader, Stan Gray, had faith that he could pick up the challenge of getting the TC 500s to communicate effectively with the B5500 computer. The branch accounting programmes for the EMI computers and IBM System/360s at the bank's other computer centres had been written in machine code and Assembly language. The application programs for the new Burroughs real-time branch accounting system were to be written in COBOL, which was supported by the B8500, but in order to get the TC 500 machines in the branch to communicate with the central computer required coding at a lower level. Although the B8500 and B5500 were in the same Burroughs "family" of computers, they were not machine-language compatible like IBM S/360; instead compatibility was achieved through the use of higher-level languages.^{lix} All of the system software for the B8500 was written in ALGOL (ALGO^rithmic Language).^{lx} It

was ALGOL that Parsons set about learning from the Burroughs-supplied manuals. He worked with another computer specialist Barclays had recruited from outside the bank, Peter Atkins, and sharing a strong work ethic both men were soon deeply immersed in the workings of the TC 500 and the B5500. One weekend the two of them took a complete program listing back to Parson's house in Barnet, North London and worked their way through it. Working without Burroughs' support and unable to make sense of the logic behind the data communications they decided to re-write relevant sections of the operating system so that they could understand it.^{lxi}

They re-wrote what they could and then arranged for it to be typed up into punched cards the following week. Prior to one scheduled test session on the B5500, the two Barclays men approached Peter Groves, the Burroughs engineer responsible for the machine, and explaining the situation to him. David Parsons remembers saying:

You know we've been having trouble trying to make the telecommunications stuff work. Now Peter [Atkins] and I have written a whole new chunk of code for the operating system, and in our session this morning I'm going to recompile the operating system to our version. I know that means that because it's not Burroughs-written amendments, I get no support; so I don't expect any support. But I thought I ought to tell you that's what I'm going to do.^{lxii}

The Burroughs engineer is recalled as smiling and saying, "Don't be daft, of course I'll support you. Let's see how it goes." The three men worked together to recompile the operating system and then reinitiated the machine with test TC 500s in place. They started the test telecommunications programmes and a couple of seconds later the TC 500s started to chatter. The bank's programmers experienced a sense of the mastery and exhilaration of programming close to the machine described by Sherry Turkle in *The Second Self* and Steven Levy in *Hackers*.^{lxiii} The informal collaboration between the Barclays-Burroughs

team members had succeeded in getting the TC 500s to talk to the Burroughs computer. After the test, Parsons and Atkins submitted their changes to Burroughs so that their amendments could be incorporated formally into an operating system release. When the release was issued the programmers were proud of a comment in the B5500 master control program that acknowledged their contribution in supplying this code.^{lxiv}

The interpretive flexibility of “real” time

The TC 500s may have been talking to the B5500, but getting them to update customer accounts in “real time” was still a long way away. Challenges associated with real-time updating, including implementing restarts and recoveries, also had to be tackled. The real-time concept had been open to a number of different interpretations. For example, US military projects for flight simulation and air-defense interpreted “real time” as an immediate response without delay. For the American Airlines’ SABRE project, “real time” was considered to be a response of less than three seconds and this was the paradigm used by the *Communications of the ACM* when it reported the newly announced Barclays-Burroughs system of being capable of providing an up-to-date response to any branch transaction within two and a half seconds.^{lxv} But pragmatic concerns led Barclays to interpret the real-time concept in a more flexible manner, which led to the design of a system that classified branch transactions according to one of three different levels, to provide an “on-time” rather than real-time response.

Gerry Jarvis, the designer of the bank’s real-time system, remembers the response level classification as follows. The first level consisted of enquiries and urgent amendments. If a clerk in the branch wanted to make an enquiry – a read-only request – this could be provided straight away. Certain update transactions, such as stopping a cheque, were classed as urgent amendments that also needed to be done immediately. A second level

response consisted of daily branch accounting entries to customer accounts. These were accumulated and processed when the computer was not busy responding to immediate enquires or updates. The deadline for completion of all these entries on the computer would be the end of the day, as it had been in the branch. The third level was account amendments, for example change of address, for which there was no immediate urgency within the day. These were collected together and done all at the same time in a manner akin to batch processing.^{lxvi}

Progress was being made implementing the “on-time” design, but work was taking longer than planned and Barclays programmers still faced a number of challenges. Meanwhile the computer centre was throwing up fresh challenges of its own.

A computer centre in suburbia

Barclays had quickly settled on an old motorbike warehouse at Harrow Road, Willesden in the North West of London for its Burroughs Computer Centre.^{lxvii} Located five miles to the north west of the City of London, the centre lay at the beginnings of a suburban sprawl that in 1924 the Metropolitan Railway had dubbed “Metro-land” to promote suburban development along its extended London underground Metropolitan Line.^{lxviii} At 51,000 sq. ft., the computer centre was Barclays’ biggest yet, and its first in a suburban as opposed to urban location. The area was home to a mixture of the light industrial and the residential and consideration had to be given to adequate sound proofing in the centre’s design lest noise from its standby diesel generator might disturb residents sleeping nearby.^{lxix}

It wasn’t the centre’s impact on its environment that would be Barclays’ main concern; it was the impact of the environment on the centre. Barclays had previously experienced problems providing the right conditions for its large-scale computers, space having been reclaimed from shops, factories and warehouses. Barclays’ cheque clearing

system in the City of London consisting of an IBM 1401 and associated cheque readers had experienced “all sorts of faults [...] because the electric switches on the building’s lifts were interfering with the system.”^{lxx} But this was nothing compared to the problems Barclays experienced with the equipment installed at its Burroughs Computer Centre at Willesden.

Burroughs computers and disk drives suffered innumerable problems and it was difficult to distinguish whether these problems were inherent to the Burroughs equipment, or whether they were due to adverse environmental conditions. Many pointed a finger at the computer centre’s location, sandwiched as it was between a main road at the back and a busy railway junction in front. Vibrations from fully loaded freight trains running past at night could be felt throughout the centre. The Burroughs’ machines were considered “very sensitive” by workers at the centre and the building’s vibrations were blamed for a host of failures.^{lxxi} There was also a suspicion that other environmental factors, including dust from the road and rail traffic and less than adequate air conditioning, might have been at play.^{lxxii} Barclays continued to make modifications, including rubber damping for the computer floors, to cater for the site’s inadequacies,^{lxxiii} but it was soon clear that the building’s location, and its repurposing from motorcycle warehouse to computer centre, had made for a computing environment that was far from perfect.

The TC 500s in the branch were not without their issues either. Operating as standalone book-keeping machines they were initially slower and more troublesome than the older machines that they replaced.^{lxxiv} They were also prone to breakdown within the first three months. Barclays’ project team advised branches that a “running in period” of ninety days was required after which the breakdown rate settled down within acceptable limits.^{lxxv}

The first branches to be connected to the Burroughs machine at Willesden, in August 1969, suffered terrible processing delays. “On-time” processing was carried out in

parallel to the branches' normal book-keeping, but it was far from "on-time". The B5500 computer was having difficulty operating in batch update mode only, and at one point rumours circulated at the bank's batch-based IBM computer centres that colleagues at Willesden were doing well as they were "only 8 days behind with their processing".^{lxxvi} A friendly rivalry was developing between the bank's Greater London Computer Centre (GLCC) – its IBM computer centre less than five miles away on London's Tottenham Court Road – and the Burroughs computer centre at Willesden. Some in the Burroughs' real-time camp began to wonder if there was more than *schadenfreude* occurring at the GLCC, as rumours began to circulate that IBM was using Burroughs' misfortune to its own advantage in order to plot Burroughs' downfall.^{lxxvii} This would not have been the first time accusations of this sort had been levelled at IBM: the FUD (fear, uncertainty and doubt) factor was an effective weapon employed by IBM against its competitors.^{lxxviii}

Then, to make matters worse, in 1969 what had been an interim solution became the only solution as Burroughs pulled the plug on the B8500 project and its offer of two B6500s became the only offer on the table. The B6500 now became the company's flagship machine as it was billed its "System for the Seventies". Burroughs had a backlog of 60 firm orders for the B6500, worth a total of \$300 million, but it promised the British banks that they would be amongst the earliest to receive this system.^{lxxix} Nonetheless, it could offer no better estimate than the first of Barclays' two machines being ready for delivery in June 1969. With significant investment already made in the project, Barclays was not about to give up and pressed ahead and accepted Burroughs offer of the two B6500s. Burroughs also attempted to broker the same deal with the National Provincial, but the bank pulled out of its commitment to Burroughs large-scale computer, in part due to its impending merger with the Westminster bank which had invested heavily in IBM. The new National

Westminster bank would go forward with a hybrid of IBM computers linked to Burroughs' terminals. The Midland, like Barclays, persevered with an all-Burroughs solution.^{lxxx}

Failure and closure

When initial plans for the real-time project had been drawn up mid-way through 1967, project managers had hoped to link the first branches to the Burroughs machine by August 1969. After this first milestone was reached, they anticipated rolling out real-time automation to the remainder of Barclays' branch network by the end of 1970. However, an announced merger with a smaller bank, Martins, in 1968 added a further 732 branches to Barclays' 2,612.^{lxxxi} It was clear that it would be impossible to accommodate these extra branches into existing real-time plans.^{lxxxii}

Side-stepping the challenges thrown up by the merger and in spite of the problems thus far, Barclays remained optimistic that the original project plan was achievable. In spite of teething troubles connection of the first two branches, Watford Junction in Luton District and Chorleywood in Oxford District, to the Burroughs B5500 computer at Willesden on 9 August 1969, provided the team with a much-needed boost. A number of other teething problems, however, caused those in charge of the project to admit that the branches' initial experiences of the new system were bad. The two branches continued to run their mechanised in-branch book-keeping in parallel with the new system as Barclays worked with Burroughs to try and iron the problems out.^{lxxxiii}

Amidst the environmental problems at Willesden, and the challenges of programming for real-time, Burroughs announced that delivery of the first B6500 would be at first four, and then nine months late. It looked unlikely that Barclays would have its B6500 installed and working before October 1970. Burroughs promised Barclays another B5500 free of charge,^{lxxxiv} but as replacements for the B6500s the B5500s were woefully

inadequate for the job. In comparison to the specifications for the never-to-materialise B8500 they were chronically underpowered. Barclays had connected eleven branches to the first B5500 and envisaged connecting only another twenty four more to that machine before it would be running at its capacity. A quick calculation estimated that Barclays would need a hundred B5500s to cope with all its branches.^{lxxxv} Even with a B6500 installed and running by October 1970, Barclays' best estimate was that there would be fifty more branches on that machine before "D-Day". Whilst Barclays' programming manager insisted "[t]here is nothing wrong with the Burroughs system as such, and when installed it will provide us with the most up-to-date computer network in the world", it was clear that the project's deadline was not going to be met.^{lxxxvi}

The all-important "D-Day" for decimalisation was recast as an interim milestone by which time all of the branch accounting equipment not suitable for decimal conversion had to have been replaced with Burroughs TC 500s. Overall project completion was now shifted to the winter of 1971 with the technical team anticipating working flat out once the B6500s had been delivered.^{lxxxvii} With "D-Day" fast approaching, Barclays' main efforts were now redirected towards the IBM installation at the GLCC, where IBM personnel were only too happy to provide assistance and another S/360 machine.^{lxxxviii} Programmers supplied by CAP (Computer Analysts and Programmers) were brought in to begin work writing a version "2b" of Barclays' branch accounting programmes to run on the IBM mainframes. The new programmes improved the speed, capacity, reliability and security of the system, but updates to customer accounts would still be made in batch overnight.^{lxxxix}

By "D-Day", rather than acting as the hub for the whole of the branch network, the Burroughs computer centre at Willesden was serving only 30 bank branches and was limping along in batch mode rather than real-time. The Barclays-Burroughs relationship had gone sour, and Barclays' senior management were looking for a way out while trying to

keep the bank's dignity intact. For a while Barclays kept the Burroughs B6500s – which were upgraded to B6700s – at Willesden, and attempted to get them to operate like IBM's S/360 machines. CAP produced an S/360 emulation programme for the Burroughs computers, but predictably it ran slowly.^{xc} Plans to install any further large-scale Burroughs computers were shelved, and almost all effort was directed back into the well-established batch mode of working on IBM machine. Only a small programming team remained working on the Burroughs' real-time project.^{xci}

Barclays was not the only British bank that suffered with Burroughs. The Midland suffered too. Its optimistically named "Project 70", later re-titled the "Online Computer System", was plagued with similar setbacks, but it persevered after Barclays had cancelled its project.^{xcii} In the US, Trans World Airlines (TWA) was also experiencing major difficulties with Burroughs. The machines it had delivered to run its real-time airline reservations system were underpowered and unreliable. The Burroughs' system was never operational and TWA sued the company while it replaced its machines with high-end System/360 computers from IBM.^{xciii}

Of all the British banks only Lloyds that managed to have all its branches connected on-line to a computer by 15 February 1971.^{xciv} Lloyd's achievement was significant, but Barclays technicians were keen to point out that it wasn't the on-line *real-time* system to which Barclays had aspired.^{xcv} Lloyds had decided to go for the more achievable goal of an on-line system where the branch was connected to the computer centre via telephone line and entries were made and stored on the computer during the day. Updates were still applied in batch overnight rather than in real time as the clerk entered them in the branch.^{xcvi} Lloyds' task was also made all the more manageable because it was the smallest of the "Big Five" banks both in terms of the size of its assets and the size of its branch network. And, of all the banks, only Lloyds had chosen an all-IBM solution. It had remained

faithful to IBM as its computer supplier all the way through the 1960s, and as result enjoyed some stability during a period of continual technical change. Unlike Barclays and Midland the stability of this relationship also provided for a long and continuous period of learning for those involved on both sides.

By 1972, Barclays' real-time project was beginning to look like a failure. What had to be done now was to construct it to be something else. On 15 December 1972, Barclays publicly announced that its remaining large-scale Burroughs computers were to be replaced by IBM machines.^{xcvii} Salvaging what it could from the project, Barclays didn't sever all links with Burroughs and the real-time project, however. It kept the technically elegant TC 500s in the branches linked to IBM computers at the GLCC and Willesden. This meant that, in part at least, the project could be considered a success. The majority of the money Barclays had invested in the real-time project had been on the TC 500 terminals in the branches and these remained, but now connected to IBM mainframes. They were fulfilling an important function for the bank, but not the real-time function that had originally been envisaged.

Barclays' merger with Martins in 1969 had increased the size of its branch network and the heterogeneity of its technology, exacerbating existing difficulties, however it was also the merger with Martins that offered Barclays a way out of its predicament publicly with some semblance of grace. Amongst the external factors cited in an internal memo as responsible for the ongoing project delay was the merger between Barclays and Martins bank.^{xcviii} This internal memo formed the basis for a public response when Barclays' real-time project leader was interviewed by the *Financial Times*. The newspaper reported this explanation for continuing project delays:

[T]he major setback could be traced to the merger with Martin's [sic] Bank. Prior to that merger, things were going smoothly and Barclays expected to have completed its

huge 3,000+ branch network all linked to a giant Burroughs B-8500 computer costing £4m.^{xcix}

Merger also offered Barclays closure. Although from the outside the merger appeared to be a takeover of Barclays by Martins, on the inside there was a feeling of the reverse. In the computing division the merger was experienced as more of a takeover of Barclays by Martins.^c Amongst those from Martins taking up senior positions in Barclays was Warwick Broadbent who was appointed head of Barclays computing department.^{ci} With a Martins manager now in charge of the merged bank's computing division there was a chance for this new broom to sweep things clean. Between the two banks they were running computers manufactured by five different suppliers all purchased in the space of a decade. Broadbent was given the job to rationalise these assets. Replacing the Burroughs' computers with IBM machines, it was argued, was the rational thing to do. By 1974, all of the Burroughs computers been removed from Willesden.^{cii}

Barclays confessed to losing £4 million on the project – the original order price of the B8500 – which Ackrill and Hannah, authors of the bank's official history, suggest the bank put down to experience.^{ciii} Elsewhere the Midland and Barclays estimated between them that the Burroughs real-time project had cost £16m in lost savings.^{civ}

Publicly Barclays may have reached closure, but privately those working closest to the Burroughs machines couldn't understand the decision to cancel the project. What was left of Barclays' Burroughs programming team, was reluctant to give up on the Burroughs real-time project, and insisted they were on the verge of a working real-time system. Decades later, they still struggle to explain its demise. A number of the team felt let down by senior managers and maintained that given six more months they would have been able to deliver the system the bank deserved. Many of those involved couldn't understand why the

project had been shelved now that they had come so far.^{cv} Looking back and searching for explanations the majority view from those working on the system was that Burroughs' real-time technology was simply "too far ahead of its time".^{cvi}

Barclays' official history concurs and suggests that senior management attributed no blame to anyone inside the bank for the Burroughs affair.^{cvi} Many years on this is still a sensitive issue, but my research suggests that notions of blame at the time weren't entirely absent. Whether it was a matter of causation or correlation, the innovators from the technical team were given research roles or moved to other areas away from the operational frontline.^{cvi}

Conclusion

In *Computer*, Campbell-Kelly and Aspray contend that archaic batch-oriented accounting methods prevented innovations such as real-time accounting in banking taking place and that banks had no need for real-time computing until the introduction of ATMs.^{cix} I have shown that the pursuit of real-time accounting for three of the British banks occurred alongside batch-oriented accounting and was influenced by a number of factors, none of which was the contemporaneous introduction of ATMs. Rather, the need was constructed out of a combination of manufacturer marketing, enforced change due to decimalisation, and the allure of a technical ideal. It is perhaps because this episode was considered one best forgotten according to Barclays' official history,^{cx} that the "failure" of real-time computing in banking in the 1960s has been written out of the history of computing.

Graeme Gooday and Kenneth Lipartito both warn historians against preserving binary distinctions between "success" and "failure".^{cx} "Failure" was certainly not a category used by the actors involved in this case. Archival material in Barclays Group Archives made no mention of project failure, and the closest any of the interviewees came to talking of the

project in terms of a failure was referring to another project in the same breath as “another failure”. I do not wish to debate notions of the project’s success and failure, but conclude by considering whether it is possible to the project’s unsuccessful outcome as something more than a necessary lesson for those involved at all levels of the project.

Lipartito see both failures and non-failures as “socially resonant” and capable of shaping future options.^{cxii} The explanation given by those in the community of practice working close to the machine was echoed by the wider rhetoric of real-time. At a macro level, the demise of the Barclays-Burroughs real-time project did not weaken the desire for real-time banking technology and the cashless society; it merely modified the parameters required for its success. Commentating on the episode, the British banking journal, *The Banker*, concluded that:

Until stores, garages and so on each have terminals on-line, real-time to the same computer system as the banks[,] cheques and credits outstanding with them will distort the condition of individual accounts [...] The distortion is all the more evident if other banks are not participating in the system. This said, all the British clearing banks would agree that real-time will be a feature of the financial system sometime in the future, but when planned and implemented on a national scale rather than when introduced piecemeal by individual financial institutions.^{cxiii}

The Banker did not call into question the very idea of real-time banking, just how and when it might happen. The end of the Barclays-Burroughs’ real-time project signified a change in the technological path leading towards real-time banking and the cashless society. It was not declared a dead end; it just needed someone else to find the way. It was left to the savings banks, devoid of the temporal distortions of cheques and the clearing system, to pioneer real-time computing for British banking in the 1970s.^{cxiv}

References and notes

ⁱ BBC, “Computerised Banking Ushers in a Cashless Economy”, *Tomorrow’s World*, first broadcast 9 December 1969, available from:

<http://www.bbc.co.uk/archive/tomorrowsworld/8012.shtml>

ⁱⁱ Martin Campbell-Kelly & William Aspray, *Computer: A History of the Information Machine* (Basicbooks, 1996), 175.

ⁱⁱⁱ See, for example, Lars Heide, “Retail Banking and the Dynamics of Information Technology”, in *Technological Innovation in Retail Finance: International Historical Perspectives*, ed. Bernardo Bátiz-Lazo, J. Carles Maixé-Altés, and Paul Thomes (Routledge, 2011), 275–285, and James W. Cortada, *The Digital Hand Volume 2: How Computers Changed the Work of American Financial, Telecommunications, Media and Entertainment Industries* (Oxford University Press, 2006), 54.

^{iv} Bernardo Bátiz-Lazo and Robert Reid, “The Development of Cash Dispensing Technology in the UK”. *IEEE Annals of the History of Computing* Early Access, available from:

http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=5396280

^v Barclays Bank, “No. 1 Computer Centre Press Release” [courtesy of Jim McClymont], 3 July 1961. See also *Financial Times*, “Automation Banking”, 9 December 1955, 1; Alan Booth, *The Management of Technical Change: Automation in the UK and USA since 1950* (Palgrave Macmillan, 2007), 142–144; Hamish McRae and Frances Cairncross, *Capital City: London as a Financial Centre* (Eyre Methuen, 1973), 1.

^{vi} Barclays Bank, “Our First Computer”, c. June 1961, 3.

^{vii} Alan Booth, *The Management of Technical Change: Automation in the UK and USA since 1950* (Palgrave Macmillan, 2007), 150–151.

^{viii} Barclays Group Archive (hereafter BGA)/758/32, “Suggested Basis for Local Head Office Circulars to Branches”, undated, c. 1967.

^{ix} “Mr Callaghan’s Budget Preview: 50m Gambling Tax to Finance 4¼ p.c. ‘Option’ Mortgages: Decimal Coinage in 1971”, *The Times*, 2 March 1966, 8.

^x One Barclays' manager was reportedly quoted in a newspaper that the computerised conversion could be done in *seconds*, Gerry Jarvis, interview with author, Macclesfield, 28 September 2008.

^{xi} For the decimalisation impetus see Alan Booth, "Technical Change in Branch Banking at the Midland Bank, 1945–75". *Accounting, Business & Financial History* 14, no. 3 (2004): 292, and Bernardo Bátiz-Lazo and J. Carles Maixé Altés, "British and Spanish Savings Banks, circa 1950–1985 in *Technological Innovation in Retail Finance: International Historical Perspectives*, ed. Bernardo Bátiz-Lazo, J. Carles Maixé-Altés, and Paul Thomes (Routledge, 2011), 137–154.

^{xii} See Ian Martin, "Britain's First Computer Centre For Banking: What Did This Building Do?" in *Technological Innovation in Retail Finance: International Historical Perspectives*, ed. Bernardo Bátiz-Lazo, J. Carles Maixé-Altés, and Paul Thomes (Routledge, 2011), 37–70.

^{xiii} Booth, *The Management of Technical Change*, 151. The "Big Five" were Lloyds, Westminster, Midland, National Provincial and Barclays.

^{xiv} Campbell-Kelly & Aspray, *Computer*, 135–6. The dwarves were General Electric (GE), Radio Corporation of America (RCA), Sperry Rand, Honeywell, Burroughs, National Cash Register (NCR), and Control Data (CDC).

^{xv} James W. Cortada, *Before the Computer: IBM, NCR, Burroughs, and Remington Rand and the Industry they Created, 1865–1956* (Princeton University Press, 1993), 37; Memorex, "Burroughs Traces Founding Back Nearly 100 years", *Memorex Intercom - A Special Intercom Issue on Burroughs Corporation*, December 1981, 1.

^{xvi} Booth, *The Management of Technical Change*, 40.

^{xvii} Memorex, "Burroughs Traces Founding Back Nearly 100 years", *Memorex Intercom - A Special Intercom Issue on Burroughs Corporation*, December 1981, 2.

^{xviii} Jeffrey R. Yost, *The Computer Industry* (Greenwood Publishing Group, 2005), 62.

^{xix} "Burroughs" [display advertising], *The Times*, 11 May 1959.

^{xx} Lloyds Bank Group Archives (hereafter LBGA)/Winton File: "Computers, Howland 2.11.77"; "Lloyds Bank Order £120,000 Computer", *The Times*, 13 November 1962, 21.

- ^{xxi} “Further Automation by Midland Bank”, *The Times*, 1 February 1965, 20.
- ^{xxii} Anthony Harris, “How Burroughs got £20m out of the Banks”, *Financial Times*, 7 April 1967, 13.
- ^{xxiii} Booth, *The Management of Technical Change*, 41; Anthony Harris, “How Burroughs got £20m out of the Banks”, *Financial Times*, 7 April 1967, 13; Gerry Jarvis, interview with author, Macclesfield, 26 September 2008; David Parsons, interview with author, Manchester, 7 August 2008. Quote from Burroughs advertisement in “Banking: A Financial Times Survey”, *Financial Times*, 22 May 1967, 24.
- ^{xxiv} Burroughs, *Burroughs TC 500 Terminal Computer: Introduces a New Approach to On-Line Systems Design*, c. 1967; Martin Campbell-Kelly, *ICL: A Business and Technical History* (Oxford University Press, 1999), 23; BGA/725/3, Alan Duncan, interview with Jessie Campbell, 11 August 1998.
- ^{xxv} Burroughs Corporation Defense, Space and Special Systems Group, “B8500 Information Processing System”, c. 1966.
- ^{xxvi} George T. Gray and Ronald Q. Smith, “After the B5000: Burroughs Third-Generation Computers 1964–1980”, *IEEE Annals of the History of Computing* 31, no. 2 (2009): 48; Burroughs Corporation, “Burroughs B2500 and B3500 Electronic Data Processing Systems: A New Level of Computer Responsiveness”, March 1966.
- ^{xxvii} “Computing Success”, *Time Magazine*, 23 December 1966.
- ^{xxviii} Alan Duncan, interview with author, Snettisham, 23 September 2008.
- ^{xxix} Memorex, “Burroughs traces founding back nearly 100 years”, 1; Joyce A. Post, “The Burroughs Research Center in Paoli”, *Tredyffrin Easttown Historical Society History Quarterly* 40, no. 1 (January 2003): 3–18.
- ^{xxx} BGA/725/3, Alan Duncan, interview with Jessie Campbell, 11 August 1998.
- ^{xxxi} Stan Gray, interview with author, Haslington, 22 July 2008.
- ^{xxxii} Gerry Jarvis, interview with author, Macclesfield, 26 September 2008.
- ^{xxxiii} Gray and Smith, “After the B5000”, 48.
- ^{xxxiv} Gerry Jarvis, interview with author, Macclesfield, 26 September 2008.
- ^{xxxv} BGA/725/3, Alan Duncan, interview with Jessie Campbell, 11 August 1998; Peter Blackburn, telephone interview with author, 21 July 2008.

^{xxxvi} Burroughs, *Burroughs TC 500 Terminal Computer: Introduces a New Approach to On-Line Systems Design*, c. 1967.

^{xxxvii} Margaret Shilleto, telephone interview with author, 5 August 2008.

^{xxxviii} Burroughs' president, Ray Macdonald, in a 1969 presentation is quoted as predicting two years previously that 'electronic accounting machines, electronic accounting systems, terminal units and electronic computers [might become] one continuous market from small machine to giant computer' in Franklin M. Fisher, James W. McKie, and Richard B. Mancke, *IBM and the US Data Processing Industry: An Economic History* (Praeger, 1983), 249.

^{xxxix} David Parsons, interview with author, Manchester, 7 August 2008.

^{xl} "D-Day Ushers in the Mini-Computer", *Financial Times*, 21 April 1969, 29.

^{xli} Burroughs, *Burroughs TC 500 Terminal Computer: Introduces a New Approach to On-Line Systems Design*, c. 1967, 2.

^{xlii} "Business Notes", *Communications of the ACM* 10, no. 5 (1967): 330.

^{xliii} Ackrill and Hannah, *Barclays*, 332–334.

^{xliv} "Barclay [sic] £11½m. Computer Buy", *The Times*, 30 March 1967, 15.

^{xlvi} The Midland placed an order of £5m for two Burroughs B6500 computers, see Kenneth Owen, "Blow for Computer Merger", *The Times*, 24 February 1968, 11. It had already invested heavily in Burroughs equipment for the branches.

^{xlvi} Gerry Jarvis, interview with author, Macclesfield, 26 September 2008.

^{xlvii} Ackrill and Hannah, *Barclays*, 333–334.

^{xlviii} "Business Notes", *Communications of the ACM* 10, no. 5 (1967): 330.

^{xliv} David Parsons, interview with author,

ⁱ Ibid.

^{li} BGA/758/32, "Suggested Basis for Local Head Office Circulars to Branches", undated, c. 1967.

^{lii} BGA/758/34, "Computers – Summary", undated.

^{liii} For more on CUBE, see David Alan Grier, "Working Class Hero", *Computer* 40, no. 5 (2007): 8–10.

For corporate collaboration and voluntarism in SHARE, which was generally capitalised by its

members but is not an acronym, see Atsushi Akera, "Voluntarism and the Fruits of Collaboration: The IBM User Group, Share", *Technology and Culture* 42, no. 4 (2001): 710–736. For GUIDE, see Deborah Sojka and Philip H. Dorn, "Magic Moments in Software, *Datamation* 29, no. 9 (1981): 7–16 cited in Richard Hull, *In Praise of Wimps: Social History of Programming – Some Work in Progress – Including a Chronology and an Extensive Bibliography* (Alice Publications, 1992).

^{liv} For an introduction see Etienne Wenger, *Communities of Practice: Learning, Meaning and Identity* (Cambridge University Press, 1998).

^{lv} Brian Hull, interview with author, Wilmslow, 21 October 2008.

^{lvi} BGA/758/34, "Computers – Summary", undated.

^{lvii} Booth, *The Management of Technical Change*, 41.

^{lviii} The EMIDEC was a business computer produced at the beginning of the 1960s by British company EMI Electronics Limited. See <http://www.emidec.org.uk/>.

^{lix} Fisher, McKie and Mancke, *IBM and the US Data Processing Industry*, 245.

^{lx} John T. Lynch, "The B8500 from Burroughs", *Datamation* 11, no. 8 (August 1965): 49–50.

^{lxi} David Parsons, interview with author, Manchester, 7 August 2008.

^{lxii} Ibid.

^{lxiii} Sherry Turkle. *The Second Self: Computers and the Human Spirit* (MIT Press, 2004), 165–168; Steven Levy, *Hackers: Heroes of the Computer Revolution* (Penguin, 2001).

^{lxiv} David Parsons, interview with author, Manchester, 7 August 2008.

^{lxv} "Business Notes", *Communications of the ACM* 10, No. 5 (May 1967): 330.

^{lxvi} Gerry Jarvis, interview with author, Macclesfield, 28 September 2008.

^{lxvii} Barclays Bank, "The Story of Gloucester", *Barclaynews*, 1979, 4.

^{lxviii} Peter Clarke, *Hope and Glory: Britain 1900-2000* (Penguin, 2004), 149.

^{lix} "Keeping it Quiet", *Financial Times*, 24 November 1970, 11; Barclays Bank, "The Story of Gloucester," *Barclaysnews*, 1979, 4.

^{lxx} BGA/725/3, Alan Duncan, interview with Jessie Campbell, 11 August 1998.

^{lxxi} BGA/754/31, David Bound, interview with Janet Sykes, 19 October 1990; Derek Finnis, interview with author, North Rode; David Parsons, telephone interview with author, Manchester, 7 August 2008.

^{lxxii} Roger Jefferyes, telephone interview with author, 3 August 2010.

^{lxxiii} Jean Perkins, interview with author, 28 July 2008; John Evans, interview with author, Congleton, 22 July 2008.

^{lxxiv} Margaret Shilleto, telephone interview with author, 5 August 2008.

^{lxxv} BGA/758/34, "Computers – Summary", undated.

^{lxxvi} Brenda Baker, interview with author, 28 July 2008.

^{lxxvii} Roger Jefferyes, telephone interview with author, 3 August 2010; BGA/275/3, Alan Duncan, interview with Jessie Campbell, 11 August 1998.

^{lxxviii} The "FUD Factor" was coined in 1975 by former IBM employee, Gene Amdahl, who left to set up a competitor company making IBM compatible computers. See Richard Thomas DeLamarter, *Big Blue: IBM's Use and Abuse of Power* (Macmillan, 1986), Chapter 15: "The FUD Factor".

^{lxxix} BGA/758/34, "Burroughs Reports", December 1969.

^{lxxx} Ted Schoeters, "1971 Target for Computer Networks", *Financial Times*, 20 October 1969, 14.

^{lxxxi} Ackrill and Hannah, *Barclays*, 182.

^{lxxxii} Ted Schoeters, "Barclays D-Day Computer Plan Suffers Serious Setback", *Financial Times*, 27 February 1970, 23.

^{lxxxiii} BGA/758/32, "Suggested Basis for Local Head Office Circulars to Branches", undated, c. 1967.

^{lxxxiv} Ibid.

^{lxxxv} Gerry Jarvis, interview with author, Macclesfield, 26 September 2008; Brian Hull, interview with author, Wilmslow, 21 October 2008.

^{lxxxvi} BGA/758/32, "Suggested Basis for Local Head Office Circulars to Branches", undated, c. 1967.

^{lxxxvii} BGA/758/34, "Computers – Summary", undated.

^{lxxxviii} Gerry Jarvis, interview with author, Macclesfield, 26 September 2008.

^{lxxxix} Brian Hull, interview with author, Wilmslow, 21 October 2008; Gerry Jarvis, interview with author, Macclesfield, 28 September 2008; “Barclays/CAP Team Builds Big Accounting Package”, *Financial Times*, 3 September 1970, 13.

^{xc} Gerry Jarvis, interview with author, Macclesfield, 26 September 2008.

^{xcⁱ} David Parsons, interview with author, 7 August 2008; Gerry Jarvis, interview with author, Macclesfield, 26 September 2008.

^{xcⁱⁱ} Gerry Jarvis, interview with author, Macclesfield 26 September 2008.

^{xcⁱⁱⁱ} Fisher, McKie and Mancke, *IBM and the US Data Processing Industry*, 246-247.

^{xc^{iv}} Booth, “Technical Change in Branch Banking at the Midland Bank, 1945-1975”, 295.

^{xc^v} Gerry Jarvis, interview with author, Macclesfield, 28 September 2008.

^{xc^{vi}} Kenneth Owen, “British Bank Systems may be Model for US”, *The Times*, 27 May 1969.

^{xc^{vii}} “Barclays Making a Major Change”, *Financial Times*, 15 December 1972, 10.

^{xc^{viii}} BGA/758/32, “Suggested Basis for Local Head Office Circulars to Branches”, c. 1967.

^{xc^{ix}} Ted Schoeters, “Barclays D-Day Computer Plan Suffers Serious Setback”, *Financial Times*, 27 February 1970, 23.

^c Gerry Jarvis, interview with author, Macclesfield, 26 September 2008.

^{ci} BGA/275/3, Alan Duncan, interview with Jessie Campbell, 11 August 1998.

^{cⁱⁱ} BGA/754/31, David Bound, interview with Janet Sykes, 19 October 1990; Gerry Jarvis, interview with author, Macclesfield, 26 September 2008.

^{cⁱⁱⁱ} Ackrill and Hannah, *Barclays*, 332–334.

^{c^{iv}} Board Minutes; Roger Vielvoye, “Computer Delay Will Probably Cost the Banks £16m in Lost Savings”, *The Times*, 9 August 1971, 16.

^{c^v} BGA/275/3, Alan Duncan, interview with Jessie Campbell, 11 August 1998; David Parsons, interview with author, 7 August 2008; Gerry Jarvis, interview with author, Macclesfield, 26 September 2008; Bob Hall, telephone interview with author, 5 August 2008.

^{cvi} See, for example, Brian Hull, interview with author, Wilmslow, 21 October 2008; BGA/725/3, Alan Duncan, interview with Jessie Campbell, 11 August 1998; Stan Gray, interview with author, Haslington, 22 July 2008.

^{cvi} Ackrill and Hannah, *Barclays*, 332–334.

^{cvi} Brian Hull, interview with author, Wilmslow, 21 October 2008; Gerry Jarvis, interview with author, 26 September 2008.

^{cix} Campbell-Kelly and Aspray, *Computer*, 175.

^{cx} Ackrill and Hannah, *Barclays*, 332–334.

^{cx} See Graeme Gooday, “Re-writing the ‘Book of Blots’: Critical Reflections on Histories of ‘Technological Failure’”, *History and Technology* 14 (1998): 265–291 and Kenneth Lipartito, “Picturephone and the Information Age: The Social Meaning of Failure”, *Technology and Culture* 44, no. 1 (2003): 50–81.

^{cxii} Lipartito, “Picturephone and the Information Age”, 54–55.

^{cxiii} *The Banker* (August 1971).

^{cxiv} Hadyn Taylor and Harry Read, interview with author, Milton Keynes, 17 July 2008.