Structuring Information Work: Ferranti and Martins Bank, 1952–1968

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The adoption of large-scale computers by the British retail banks in the 1960s required a first-time dislocation of customer accounting from its confines in the branches, where it had been dealt with by paper-based and mechanized information systems, to a new collective space: the bank computer center. While historians have rightly stressed the continuities between centralized office work, punched-card tabulation and computerization, the shift from decentralized to centralized information work by means of a computer has received little attention. In this article, I examine the case of Ferranti and Martins Bank and employ elements of Anthony Giddens's structuration theory to highlight the difficulties of transposing old information practices directly onto new computerized information work.

In the 1950s the computer, previously the preserve of science and the military, was re-imagined as a business information machine.[i] Two British companies were at the forefront of that reimagining. One was teashop chain Lyons, which in 1951 developed its LEO (Lyons Electronic Office) computer in conjunction with the EDSAC (Electronic Delay Storage Automatic Calculator) team at Cambridge University to automate part of its business operations.[ii] The other was electrical engineering firm Ferranti, which made the first commercial delivery of a computer to Manchester University earlier the same year.[iii] Of the two companies, it was Ferranti, a conventional technology producer, that was in the best position to manufacture and sell business computers in volumes. However, a business market ready to receive them did not yet exist. Ferranti and a number of business communities needed to work out who the organizational users of this machine might be and how those potential users could incorporate the new technology into their business practices.[iv]

The British retail banks were strong early candidates. Banking work was inherently computational and the end of post-World War II austerity and emergence of a growing consumer culture meant that the banks' existing systems, based around small-scale electro-mechanical devices, were struggling to keep pace with increased demand. In London and other major British cities, escalating volumes of work put pressure on existing branch space and staff. A shrinking labor pool and rising operating costs exacerbated the banks' difficulties, and they looked to the commercial arrival of a large-scale electronic computing technology for a solution.[v] The implementation of a new branch accounting system, with a computer at its center, was the only way banks believed they would be able to continue providing services at a cost their customers were willing to pay.[vi]

The major U.S. clearing banks and those in continental Europe had centralized branch bookkeeping upon punched card tabulating technology between the world wars.[vii] However, the branch accounting work of Britain's eleven clearing banks remained a highly decentralized affair: 11,000 branches, each operating largely as a self-contained production unit, provided current accounts with check facilities for the whole of England and Wales.[viii] The biggest of these branches could be responsible for up to 5,000 customer accounts, but didn't generate enough work to warrant a dedicated large-scale computer of its own, even if the space needed in the branch could have been found.[ix] Therefore the computerization of British banking presented a particular challenge; its spatial distribution was at odds with the centralization computing required. To accommodate the new technology and make efficient use of the computing capabilities, it was necessary to construct a new information processing space: the bank computer center. For the first time in Britain, a large-scale dislocation of customer accounting from individual bank branches to new computer centers for collective processing was required.

The application of computing to banking is of particular interest to those interested in the history of information. Suggesting avenues for future research in the field, information historian William Aspray recently highlighted both computing and the financial services industry as real-world information businesses worthy of serious historical attention.[x] JoAnne Yates is one of a handful of scholars working in this area who has given serious consideration to the history of information technologies in information-intensive industries such as financial services. Her early work on vertical filing systems drew attention to staple, but often overlooked, infrastructural technologies of the office: loose-leaf paper and filing cabinets.[xi] In her 2005 book, *Structuring the Information Age*, Yates considered the relationship between the life insurance industry and information processing technology. In the early twentieth century—in the United States at least—life insurance was an industry dominated by a few large firms carrying out information-intensive operations from central locations. Drawing inspiration from sociologist Anthony Giddens's structuration theory, Yates showed how the structure of this information work made demands on the technologies produced by the tabulating industry, and how practices that built up around tabulating machines subsequently influenced practices of computing use.[xii] Rather than the technology determining the work, Yates made a strong case for the work shaping the technology. In a more deterministic vein, the second volume of James Cortada's Chandlerian *The Digital Hand* trilogy devotes four chapters to exploring how computers changed the work of the U.S. financial industry. Cortada links the introduction of computers to pre-existing processes and procedures built up around systems that integrated tabulators with specialist small-scale electromechanical devices such as adding machines. His survey of early computer use in U.S. banking concludes that early computerization resulted in the automation of well-established procedures for well-established purposes, albeit in a different (i.e., a digital) style.[xiii] Martin Campbell-Kelly and William Aspray also stress the continuities between tabulating and computing in *Computer: A History of the Information Machine.*[xiv] They connect the computer to a long lineage of information processing machines and place its business use within organizational structures and divisions of labor that were first designed to cope with increasing amounts of information during the Industrial Revolution of the early nineteenth century. Jon Agar's central thesis in *The Government Machine*, his careful study of the administrative work of the British state, is that work organized in a machine-like manner lends itself most readily to mechanization and computerization. Connecting the discursive with the material, Agar explored the power of the "machine" metaphor to argue that it was not only the computational nature of much clerical information processing work that made it suitable for mechanization and computerization, but also that its ordered organization was governed by "rules" that could be readily translated into machine instructions.[xv]

The spatial setting for these studies of computerization is the large office. Bernardo Bátiz-Lazo and Peter Wardley offer a small-office point of view in their examination of the growth of the British bank branch networks and comparison of the banks' early computer purchasing behavior with that of the British building societies.[xvi] Contextualizing technological innovation in retail banking is the foundation of Bátiz-Lazo's work. Together with J. Carles Maixe-Altes and Paul Thomes, Bátiz-Lazo has brought together an impressive collection of international perspectives that compare computer adoption in Europe, the United States, and Mexico by a variety of retail finance's different organizational forms.[xvii] Alan Booth's monograph, *The Management of Technical Change*, also offers a comparative analysis of automation developments in the United States and Britain from 1950. It contains two chapters that provide a succinct critical analysis of post-war British technological change and the relations between computing and clerical work. The first deals with British office automation in general; the second concerns the computerization of British banking.[xviii] Booth's case study of computerization in the Midland Bank lies closest to the ground I will cover in this article. He analyzes the shift from decentralized branch-centered operation to centralized computer-centered operation, suggests that this was done without disruption to existing working practices.[xix]

I adopt a similar labor perspective to Booth here and follow the transfer of information work from the branches of one British bank to its first computer center. However, I concentrate my analysis on the creation of new working practices at the center and the roles of computing and business cultures in shaping these practices. Following the lead provided by Yates, I employ elements of Giddens's structuration theory to expose bank structures and traditions formed out of repeated patterns of action rather than existing as monolithic entities, showing the ways in which new working practices formed around the introduction of a computer were shaped by these existing patterns. My analysis draws attention to the inflexibility of well-established structures to technological change and highlights a number of tensions with spatial, occupational, temporal, and material dimensions that arose as information work at the computer center was performed according to the ingrained rules of the branch.

This article principally draws upon research undertaken in the archives of the Barclays Group, which holds the Martins archives; work in the UK National Archive for the History of Computing; and interviews with former workers at Martins Bank. I begin by sketching out the beginnings of the relationship between Martins Bank and Britain's commercial computing pioneer, Ferranti, and their creation of Martins' first computer center. A review of Giddens's structuration theory sets up my analysis of the tensions that characterized the Ferranti-Martins relationship, followed by conclusions that consider the wider implications of this case.

Constructing the Computer as a Business Information Machine

In 1952, in order to stimulate demand for the computer as a business information machine, Ferranti's newly appointed sales manager, Bernard Swann, drew up plans for a London Computing Center (LCC).[xx] Here he envisaged Ferranti could welcome prospective customers, address their computerization concerns, and persuade them of the benefits of applying a computer to their businesses. The following year, in an attempt to court the attentions of the banking community, Swann "encouraged" the editor of *The Banker* to commission a series of articles by Mary Goldring, science journalist for *The Economist*, in which she contemplated the practical possibilities of applying electronic computing to banking.[xxi]

In the first of three articles, Goldring emphasized that the boundaries of existing information processing technologies had been reached. The use of branch accounting machines (electro-mechanical combinations of typewriters and adding machines) sped up the posting of transactions to customer accounts, but the machines' capabilities were limited. In particular, their maximum speed of operation was restricted by the speed of the fingers of the human operator. Goldring suggested that the introduction of the computer would remove this dependency and offer the potential for significant increases in information processing throughput.[xxii] However, banks had other factors to consider. Existing mechanized accounting processes met the legal requirements to keep a permanent, legible record of every bookkeeping transaction in hard copy capable of being read by human eyes; this system was itself a replacement for the traditional bound and hand-written ledger book.[xxiii] Electronic computing had not yet been able to provide large volumes of output "in a form that [could] be easily understood and that the courts [were] prepared to accept," but, Goldring argued, recent developments offered new possibilities.[xxiv] The Ferranti Mark I machine upon which Goldring based her argument used a magnetic drum store, paper tape input, and output to either paper tape or teleprinter. Magnetized metal tape was also a near-future possibility.[xxv] Goldring considered that paper and metal tape could perhaps meet one of the legal requirements required of branch accounting in that they provided "a permanent record that [could] be interpreted by a trained operator or, for that matter, by a teleprinting machine".[xxvi]

Other factors to be considered included cost and space. Drawing upon Ferranti's rough estimates, Goldring contended that the Ferranti machine would need to replace the work of 100 clerks before it could be seen as financially viable. The Ferranti Mark I used thousands of valves and was far too big to fit in any British bank branch. Miniaturization was a future goal, and the U.S. Bank of America was keen to make use of transistors rather than valves so that machines could be small enough to fit within the confines of the branch space (far bigger in the United States than in British branches).[xxvii] Smaller-scale British computing developments, such as a 500-valve machine from Elliot Automation, were in existence, but Goldring classed them as experimental.[xxviii]

Goldring premised her articles on British banks' insistence that major changes to banking practices were out of the question but, in a letter to the editor of *Financial Times*, Ferranti's sales manager stressed the need for banks to overhaul. Swann argued that if the banks were to realize significant savings in clerical costs through computerization, they would have to re-examine and change their "most treasured [book-keeping] traditions".[xxix] The banks, however, continued to regard the preservation of their long-established practices and procedures as a prime concern.

Meanwhile, the banks followed the progress made by Lyons Tea Shops as a number of articles in the popular press raised the profile of the computer and its commercial applications in the minds of the British public.[xxx] Lyons, a distributed organization, had begun to use its computer to automate the ordering and accounting for its nationwide network of teashops, but its information work was centralized long before the development of the LEO computer. Three hundred clerks at Cadby Hall, Lyons's head office in West London, processed the accounts for 250 teashops. Communication between teashop and head office occurred via telephone, and parallel records were maintained at central and distributed locations.[xxxi] Computerizing an already centralized office operation was quite a different prospect from computerizing and centralizing a decentralized activity such as the branch accounting of a bank. For this reason, although Lyons had early firsthand experience of applying computers to clerical work, it shied away from the banks as an early market for its computers. In 1955, a Lyons' report on the applicability of a computer to automating the branch bookkeeping work of the Commercial Bank of Scotland concluded:

> The installation of automatic equipment at Head Office to perform the clerical work which is at present being done in branches cannot be recommended. There is no doubt a LEO could carry out the work, but without superior and expensive means of communication between Head Office and the branches it would not be possible to provide the service which is at present available to customers.[xxxii]

The technical challenges of enabling communication between branch and center were only one side of the computerization coin. The centralization of branch accounting brought with it organizational challenges for which there was no clear answer. Accordingly, the British banks looked to the United States, where Bank of America had invested heavily in research and development to design a custom computerized solution for its branch accounting problem. The result was ERMA (Electronic Recording Machine–Accounting).[xxxiii] The British banks wanted British manufacturers such as Ferranti to come up with a similar system to meet their needs. But whereas Bank of America had provided the Stanford Research Institute (SRI) with an estimated $10 million to research and develop ERMA, and General Electric (GE) invested $48 million to produce it, the British banks expected producers to develop a solution without their financial backing. The banks reasoned that manufacturers would soon come to realize the profits of the new system as soon as computer sales took off.[xxxiv] In response, Ferranti's marketing manager suggested that banks would not get very far unless they were prepared to spend money.[xxxv]

The National Research and Development Corporation (NRDC), a self-financing governmental agency set up in 1948 to manage patents and commercialize the fruits of British invention, did inject a limited amount of cash into the nascent British computer industry, which was to be paid back when sales were made. Ferranti's share of just less than £1 million of the NRDC money was used in part to fund the development of a computer using the modular technology developed by Elliot Automation. This smaller-scale Ferranti computer was initially called the Ferranti Packaged Computer No. 1, later renamed the Ferranti Pegasus.[xxxvi] Ferranti installed a Pegasus computer in its LCC with the aim of bringing "potential customers into the center, both to experiment on the Pegasus and to solve their own problems." Within a year the LCC had hosted visits by eighty groups, including the British banks.[xxxvii] Ferranti remained eager to work with the banks despite their financial restraint; via the NRDC, the company pressed bankers to present themselves as a collective rather than approaching the firm with individual requirements.[xxxviii] The banks constituted a lucrative market, and it made economic sense that Ferranti produce one general purpose computing solution for the banking sector rather than several solutions tailored to a number of specific needs. In 1955, the banks created the Committee of London Clearing Bankers' (CLCB) Electronics Sub-Committee.[xxxix]

Joining representatives from Barclays and Lloyds Bank on this committee's three-man working party was Ronald Hindle, manager of Organisation Research and Development at Martins Bank. While Barclays and Lloyds were part of the "Big Five" British banks, Martins was at the head of a pack the press dubbed the “Little Six.”[xl] More than any other bank, Martins was a bank steeped in tradition. It had held a seat in the Bankers Clearing House since 1773, the year of its foundation, and traced its beginnings back to 1563 and Lombard Street, London where Elizabethan financier, philanthropist, and “father of English banking” Thomas Gresham had worked under the sign of the grasshopper.[xli] Many of Martins’ smaller branches continued to use the traditional bookkeeping method of the bound ledger and ink pen as late as the 1960s.[xlii] However, in the second half of the 1950s, led by Hindle, the bank developed a thirst for innovation.

Tabulation, Computerization, and Trails

As a member of the CLCB Electronics Sub-Committee, Martins Bank was well positioned alongside Barclays and Lloyds to take advantage of new business computing developments. However, Martins differed from the others in one important way. Not only was it considerably smaller than Barclays and Lloyds, and more deeply steeped in tradition, it crucially chose not to experiment with punched card tabulation on its route to computerization.

Punched cards and tabulating machines had long been used to automate the work of clerical occupations; they were well established worldwide, and had been used successfully by a number of British business sectors.[xliii] Although the British banks deployed tabulators in large head office sections to automate international and registrar work, the machines had not been used for information processing in branches.[xliv]It was only at the end of the 1950s and on the advice of IBM that the first British bank, the Bank of Scotland, began to use a tabulator to centralize branch bookkeeping at its Edinburgh head office as an intermediate step to computerization. This was recognized by *Scottish Bankers Magazine*:

> [The move made] it possible to approach full computer operation by stages, and to discover and dispose of all the major difficulties of centralised accounting and ‘book-less book-keeping’ through operations on a smaller scale.[xlv]

In England there was one punched card exception. Lloyds’s Pall Mall branch in the West End of London was the biggest branch bank in Britain, which due to its historical connections with the armed services managed over 60,000 accounts, and had made use of punched card equipment since before the Second World War.[xlvi] Barclays, although not operational with tabulators for branch bookkeeping, in 1954 began to use them as a "simulation of a computer" in order to iron out procedural and political difficulties associated with the transfer of branch accounting outside the branch space.[xlvii] The bank spent five years solving the problem of branch–center communication with an experimental punched card system in its head office before transferring accounts to a computer in 1961.

Martins decided instead to make the leap directly from accounting machines and manual clerical procedures in the branches to centralized information processing at a computer center.[xlviii] In March 1958, after a number of fact-finding missions to the United States and continental Europe and several meetings at home with interested British suppliers, Martins issued its "First Assessment of Computer Specification for Martins Bank Limited."[xlix] Several interested manufacturers responded, as the number of companies that desired a share of the burgeoning computer market had grown considerably by 1958. These could be split into three groups: existing electronics manufacturers, such as EMI and Ferranti; established office automation companies, such as IBM and BTM (the British Tabulating Machine company); and new computer manufacturers, such as consumer-turned-producer Lyons. To facilitate its decision as to which company offered the best solution, Martins carried out a series of feasibility studies using sample branch accounting information. The bank determined that Ferranti's proposal advocating the use of its Pegasus computer "appeared to stand out as the one most likely to satisfy the Bank's needs."[l] By 1958 Ferranti had completed approximately 30 Pegasus installations, making it the best-selling computer in Britain.[li]

A programming team of six bank clerks from Martins and two programmers from Ferranti proceeded cautiously from feasibility study to experimentation, learning together how computers could be applied to automate the information processes of a branch.[lii] Trials were carried out at Ferranti's LCC, and a London branch was chosen as a "guinea pig" due to its close proximity. Paper tape output from Martins' South Audley Street branch was delivered by hand to the LCC a mile away, where it was fed into a Pegasus computer to be processed by an evolving program. It was a steep learning curve for the programmers, but after nine months they had a working program that could reliably apply a typical set of bookkeeping transactions to customers' current accounts.

{INSERT FIGURE 1 ABOUT HERE}

Figure 1. The Martins-Ferranti programming team, c. 1961. Source: Ronald Hindle, "You and Pegasus", *Martins Bank Magazine* 16, no. 1 (Spring 1961): 28. Courtesy of Barclays Group Archives.

Confident that they had a working solution, Martins and Ferranti made a public demonstration in January 1960 for the press, the bank's directors, senior management, and other interested bodies, declaring that this was the first successful "live" processing of current accounts of a bank branch by an electronic computer.[liii] Buoyed by its initial success with the Ferranti machine, Martins pressed ahead and ordered a Pegasus II (an improved version of the original Pegasus) from Ferranti at a cost of £150,000.[liv]

A First Bank Computer Center

Although the trials with Ferranti were conducted in London, Martins decide to locate its computer center at its head office in Liverpool.[lv] Martins had been headquartered there since a 1918 merger with the Bank of Liverpool, and the surrounding area was widely considered Martins territory.[lvi] Liverpool's city center contained an agglomeration of Martins' biggest and busiest branches, and consolidating the accounts of a cluster of branches located within close proximity of a central point was generally considered the easiest route to centralization.[lvii] Furthermore, the head office was an important and well-established centerpoint for an organization that conducted its business through the decentralized structure of a branch network. It was the meeting place for the bank's board and a visible concentration of power.

Martins' head office was a palatial symbol of power built in the 1930s next to Liverpool's town hall.[lviii] Martins' first computer center was a converted basement in Derby House, a building adjacent to its Liverpool head office that had previously been the home of the Liverpool Commercial Reference Library.[lix] The proximity of the two places prompted the press, presumably primed by Martins, to explore the significance of the old alongside the new. A report of the computer center's opening in the *Illustrated Liverpool News* drew readers' attention to the juxtaposition of computer center modernity with banking tradition. The article, "Traditions: A Modern Approach," was accompanied by two photographs, one showing the grandeur of the interior of Martins' head office and the other the clean, modernist lines inside the new computer center. The neo-classical marble interior of the banking hall was said to "exemplif[y] in the permanence of its structure the centuries of traditions of banking which will endure for centuries to come" through its arches and columns, while the bright modernity and fluorescent lights of the computer center illustrated a move forward.[lx]

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Figure 2. The banking hall of Martins Bank Head Office, Water Street, Liverpool, c. 1961. Courtesy of Barclays Group Archives.

Figure 3. Edna Devaynes in the computer room, Martins Bank Computer Center, Derby House, Liverpool, 1961. Courtesy of Barclays Group Archives.

Martins took delivery of its Pegasus II at the beginning of 1961, earlier than the computers ordered by Barclays and Lloyds. A Martins representative commented to *The Banker* that Martins would have the first British bank branch operating bookkeeping on its own computer housed in its own computer center.[lxi] This was not to be. A strike by a Ferranti subcontractor resulted in the Pegasus II being delivered three months late, and Martins opened its computer center on August 18, 1961, a month after Barclays.[lxii] Nonetheless, the press release that accompanied the opening of the center duly celebrated Martins' computing achievements and gave the impression of solid reliability:

> Martins Bank Limited announce that an electronic computer is now in use in their premises for the processing of customers' current accounts. The period of operating the computer in parallel with normal Branch work is now over and both Branch and customers are now dependent on the computer for their records.[lxiii]

This was dutifully reported verbatim in the national press. The reality behind the rhetoric was quite different, however. A technical fault with the computer at the same time the press release was published resulted in computer center accounting grinding to a halt for several days.[lxiv]

Technical problems were not the only challenges Martins faced. There were also significant tensions between the existing information processing structures of the branch and the new ones created at the computer center. As JoAnne Yates has shown, Anthony

Giddens's structuration theory can throw useful light on organizational structures such as these, drawing attention to the relationship between action and institution.[lxv] Yates applied structuration theory with a very light touch in *Structuring the Information Age*, but elsewhere, with Wanda Orlikowski, she has used it more strongly to shed light on contemporary organizational use of information technologies.[lxvi] Kevin Borg's article "The 'Chauffeur Problem' in the Early Auto Era" is a masterful application of structuration theory as a vehicle for the historical analysis of technological change.[lxvii] Here I use it as a prism with which to split the tensions accompanying Ferranti's and Martins' new information work into their occupational, spatial, temporal, and material parts.

Transposing Occupational Rules

For Giddens, agency and structure are mutually self-reproducing. Structures emerge from repeated patterns of human action with the capacity to act as enablers as well as constraints to further action. Giddens breaks structures down into "rules" and "resources." "Rules" include not just codified and explicit procedures, but also practices and tacit assumptions that govern how people get along. "Resources," meanwhile, can be considered either allocative or authoritative. Allocative resources are objects or other material phenomena while authoritative resources are people. It is the ability to mobilize allocative and authoritative resources that Giddens regards as providing human agents with the power to transform existing structures.[lxviii]

Martins' programmers at the computer center had all previously worked as bank clerks. Ferranti, in line with suggestions put forward by other computer manufacturers, saw these workers as most suitable for the new role of programmer because they possessed the in-depth knowledge of the bank's procedures required for the necessary pre-programming analysis.[lxix] Experiments at Ferranti's LCC had highlighted that the existing branch accounting program required significant change in order to incorporate a number of identified enhancements. When Martins ordered its Pegasus II, the programming team also had to rewrite the program to cater for the architectural differences between the Pegasus II and the original Pegasus. In addition, the Martins–Ferranti team had to train new staff for what would eventually become a Martins-only programming team. Martins' programmers found the re-write period taxing, but, freed from the rigidity of their bank clerk roles, they were excited by the challenge their new jobs offered.[lxx]

The new position of programmer brought with it other opportunities. Although Martins and Ferranti programmers worked side by side, the bank continued to pay its own programmers a standard bank clerk's wage. Their assignment to the computer center was seen as temporary and they were expected to go back to their previous roles in the branch on completion of the automation project.[lxxi] But Martins' programmers found themselves in possession of a highly marketable set of skills and there came a growing realization that they could command a much higher wage working outside of the financial services sector.[lxxii] Computer suppliers had an agreement with the banks that they would not "poach" staff, but even if this could have been enforced there were still plenty of opportunities elsewhere as the market for computing services expanded. Two of the bank's programmers decided to leave during the re-write period, compounding difficulties leading up to the opening of the computer center in Liverpool.[lxxiii] The transposition of branch rules regarding pay held strong despite the loss of the team's most skilled and experienced programmers. It would be the mid-1960s before programmers and operators were given their own pay scales and the requirement for bank computing staff to continue taking their Institute of Banking exams gave way to general encouragement that computer center workers should pursue banking qualifications. This sentiment would eventually fade altogether.[lxxiv]

Martins also transposed the rules associated with other occupations in the branch onto new work at the computer center. With the computer center no more than a mile from the branches to be automated, Martins eschewed telecommunications as a solution to branch–center communication and instead concluded that "[u]nder these circumstances communication can be handled quite satisfactorily by means of porters who can physically transport data through the streets."[lxxv] Said porters were already responsible for carrying confidential paper communications between the head office and the branches, so extending their responsibilities to include the safe carriage of paper tape between the branch and computer center in the afternoon, and ledgers and statements in the opposite direction in the morning, was a logical progression. While Barclays made its center a telecommunication showpiece, Martins' pragmatic solution to the problem of communications made use of existing organizational structures and was widely adopted by Lloyds and the other British banks.[lxxvi]

Rules associated with the branch accounting machine operators were also carried over to the computer center. Martins' programming team was predominantly male, but all of its computer center operators were female. Supervising the small team of operators was Edna Devaynes. An experienced branch clerk, Devaynes had been responsible for setting up a machine training school at Martins' head office in the 1950s.[lxxvii] She trained branch staff on how to operate branch accounting machines as Martins moved from the hand posting of entries in ledgers using pen and pencil to mechanized methods.[lxxviii] As the accounting machines were introduced into branches, women increasingly became regarded as their operators.[lxxix] They found themselves sitting at the keyboards of the machines because male bank clerks did not want to carry out what was regarded as entry-level repetitive work. Cultural attitudes were that women had “essential” qualities such as an innate manual dexterity and a delicacy of touch that made them better suited to typing, and they had also long been regarded as more suited to sedentary employment, possessing more patience than their male counterparts to withstand confinement in one place.[lxxx] However, these qualities were more likely acquired than innate. In general, larger branches separated the accounting machines from the cashiers’ tills due to the heat, noise, and dust the machines generated. In larger branches it was customary to house machines and women together in what was known as a “machine room.” This separation of men from women also helped prevent women becoming a “distraction” for the men in the branch. Edna Devaynes recalled at Martins that women in the branch were forbidden to wear short sleeves lest their brassiere straps became visible.[lxxxi]

A detailed gender analysis is beyond the scope of this article, but it is sufficient to say that, with the advent of the new computer installation, the feminized machine room environment at Martins’ branch was transplanted directly into the computer room at the center. [lxxxii] Women who had previously operated machines in the branch were now retrained to operate the computers at the computer center. The computers were simply considered large-scale branch accounting machines and Martins’ training school for its machinists expanded its scope to become a training school for its computer operators.[lxxxiii]

Temporal Considerations

The transposition of the rules associated with the work of the branch machinists and wider expectations of when and where women could be expected to work had a strong influence on the nature of information processing at the computer center. Initially, the deadline for the Martins computer center to finish each day’s work was 8:00 p.m. Work at the center could only begin after the branches closed for business at 3:00 p.m., and so the 8:00 p.m. processing deadline was increasingly breached as delays caused by machine failures and input errors from the branch became more frequent and the total workload increased. It was left for the operators’ older supervisor, Edna Devaynes, and programmers at the center to operate the computers and finish off any work not completed by the time the “girls” had gone home. The operators' working hours were subsequently extended to 10:00 p.m., but never any further.[lxxxiv]

A major difference between machine-based information work in the branch and automatic information processing using a computer at the center was the pace and intensity of the work. Work at the computer center required operators to tend to the computer at its own pace. In the branch, the accounting machine operators had worked at a pace determined by their own manual dexterity. In practice, however, the computer did not dictate the metronomic inhuman pace that might first be associated with the computer as an automatic machine. The computer and its peripherals displayed a surprising degree of unpredictability, which meant that the rhythms of work in the branch machine room were far more regular than those in its computer room counterpart. The new information work was characterized by a series of irregular peaks and troughs. Days were quiet until entries from the branch began to arrive. Work then picked up as evening approached, but frequent stoppages caused by hardware failures, and the need for frequent manual intervention even under normal operating conditions, meant that those working at the computer center experienced large lulls and then often had to work furiously to catch up. This was particularly evident during the first few months of the center's opening when processing in the evening was constantly delayed and those that were permitted had to work extremely long hours. Edna Devaynes remembered work at the center during this time:

> It was all over the show. For the first three months we [Edna and the programming team] were like zombies. We had to send people out to bring us food we were that busy and we worked right through from 9:00 a.m. in the morning until we'd finished. Some days we'd be delivering statements on our way home at 2:00 a.m.[lxxxv]

The computer was at the center of a reconfiguration of the pace, intensity and duration of information work. It would be wrong to assume, however, that in contrast all work in all branches was regular and routine, as the poem in Figure 4, published in *Martins Bank Magazine*, illustrates.

{INSERT FIGURE 4 EXACTLY HERE}

Figure 4. "A Day in the Life of the Branch". Source: Rosemary Andrews, "A Day in the Life of the Branch", *Martins Bank Magazine* 24, no. 1 (Spring 1969): 58. Courtesy of Barclays Group Archives.

A working culture in the branch—where a day's processing had to be finished before everyone could go home—was easily translated into computer center work, but the difference between Ferranti and Martins regarding the temporal expectations of computing work proved more difficult to resolve. Ferranti engineers reflected on these subjective differences as they highlighted some of the difficulties they had experienced with the Martins installation. They concluded that "bank jobs" were not like working with a university where time was "not important," and that before they began they had not fully realized the implications of working with a business that ran to a daily schedule.[lxxxvi]

Ferranti also took issue with elements of branch banking routine that were seen as introducing unnecessary processing delays. A major complaint was Martins' insistence on transposing checking procedures from the branch onto the verification of work at the computer center. Ferranti's programmers believed the series of manual checks to ensure that the computer had done the bookkeeping correctly unnecessarily slowed the end-to-end accounting process. Martins, on the other hand, thought Ferranti was unappreciative of the need for checks such as these in banking because the computer firm failed to understand that absolute accuracy was required. It was only in retrospect that Martins reflected more deeply on this pitfall of its pioneering position and Ferranti's relative inexperience with business computing.[lxxxvii]

Material Frictions

Giddens's structuration theory can be useful in highlighting the importance of social practice and the affirmation of existing institutional structures, but it leaves technology's materiality barely acknowledged. Leonardi and Barley recognize the difficulties of aligning materiality with voluntaristic notions of organizational change. They suggest that, rather than being restricted to following the social, researchers interested in the co-evolution of the social and the material might find it more fruitful to follow the technology instead.[lxxxviii]

In *Vast Machine*, Paul Edwards uses the term "computational friction" to encompass the physical, economic, and human limits of computing the weather.[lxxxix] I deploy the friction metaphor more literally here. The computer and its peripherals provided their own material resistance that made a considerable contribution to the immaterial tensions of computerized centralization. Progress, rather than being enabled by technology, was continually held back by machine breakdowns. These affected the computer and ancillary equipment at the center as well as the paper tape punch machines at the branch. The "take on" of its first branch was a painful experience for Martins. It was as late as March 1963—two years after delivery of the Pegasus II—that Martins described the whole of its new computer-based information processing system as reliable. The consensus at the bank was that an inadequately tested machine had initially been supplied.[xc]

Continual technical problems with the computer in its first three months of operations put a severe strain on the relationship between Martins and Ferranti, but Ferranti's efforts to speed up processing only made matters worse. The company promised Martins a solution to a printing bottleneck in the shape of a line printer, which, when connected to the Pegasus II, could print out balance lists automatically. Ferranti assured Martins that the line printer would be available in January 1962 and the bank directed efforts into a re-write of some programming functions to make use of the new capabilities. But the printer did not arrive until October and when put into place it, too, was beset with mechanical and electronic defects that took a number of months to rectify.[xci]

It was not just Ferranti with whom Martins experienced problems. Rather than modifying their existing branch accounting machines to produce paper tape as part of existing branch processes, as Barclays and Lloyds had done, Martins chose to augment these processes with a separate machine, from Swedish firm Addo, that produced paper tape output. In response to a Martins request, Addo quickly produced a production-ready version of the prototype Addo-X machine that it had initially supplied for the bank's London trials. The machine was prone to a number of mechanical defects that introduced errors into the accounting process.[xcii] These defects were compounded by what seemed to be obvious design flaws, such as when the machine stopped as the "chad pyramid"—created as a by-product of the punch paper tape operation—reached a critical height.[xciii] The Addo-X and paper tape punch perforator were at least relatively small purchases in comparison to the Pegasus II. This allowed Martins to learn quickly from its mistake. After trialing machines from a number of different suppliers, it finally settled on an improved machine from another company that incorporated checks to ensure its paper tape output matched that which had been keyed as input.[xciv]

When it came to the Pegasus computer, however, Martins could do nothing but rely on Ferranti to rectify machine breakdowns, which were much more frequent than those of the computers purchased by the other banks.[xcv] The Pegasus's vacuum-tube design was a legacy of Ferranti's pioneering post-war position and the Pegasus II was soon outpaced by smaller, quicker, and more reliable transistorized computers from a host of newly emerging competitors at home and abroad. A footnote to a table compiled by Williams Deacons Bank in October 1961 summed up the trailing position of Ferranti's Pegasus in its survey of the bank computing field. The footnote drew attention to the fact that, among those computers chosen by the banks, "all the computers apart from the Ferranti Pegasus II are transistorized."[xcvi] and Broadbent was appointed head of the newly merged bank's computing division.[xcvii]

Conclusion

Martins, like the other British retail banks, saw the well-ordered, computational nature of banking as suitable to making the task of programming a computer achievable.[xcviii] But alongside the challenge of programming the computer came the challenge of centralizing information processing work. Martins chose to meet this challenge head on rather than experiment with punched-card tabulators as an interim step. This resulted in an awkward discontinuity between mechanized accounting and computer automation, and a necessary period of learning took place for Martins alongside the installation of its first computer. Although the use of tabulators was not commonplace in British retail banking, other British banks such as Barclays, Lloyds, and the Bank of Scotland created their own continuity between decentralized and centralized operations by using tabulators as stepping-stones, which allowed them to incrementally address the issues surrounding centralization and branch–center communication.

Martins also learned that new practices centered on the computer but modeled on the old practices of the branch worked well in some instances (for example, having porters carry paper tape), but were less successful in others. Clerks-turned-programmers were able to draw on their expert knowledge of the computer in order to seek higher wages elsewhere, as the computer became a destabilizing force that upset existing power relations between the bank's management and its workers. Structuring the computer room according to the feminized machine room of the branch imposed a time limit on work at the computing center that meant the new technology could not be used to its full capacity. In this case, transposing the rules of the branch was a stabilizing force that constrained computer center operations.

While Martins was learning about computing and its application to business, Ferranti was learning about banking as an application for its computers. It was a steep learning curve for both companies. Because all of this learning took place with "live" accounts, it is understandable that relations between the two companies were sorely tested. Both were encumbered as well as aided by their pasts: Ferranti's legacy of military and scientific computing was not well suited to the business world and Martins branches steeped in tradition were not sufficiently prepared for new ways of working through computerization.

The challenges of computerization and the tensions between the old and the new could not have been unique to Martins; all of the clearing banks must have experienced some of these difficulties to varying degrees, but a combination of factors exacerbated Martins' difficulties. It was a relatively small bank in terms of deposits and the size of its branch network, so the financial impact of the capital investment required for a computer, and the disruption of its introduction, were felt more strongly than by those banks in the "Big Five." Martins' leading position in relation to the rest of the banks also meant that it was unable to learn from the experiences of others. The material difficulties thrown up by its first-generation computer and its peripherals compounded the bank's problems.

This article has presented an analysis of first computer use exposing some of the difficult realities of the move from mechanized distributed information processing to centralized computerized automation. Technology's materiality, while a contributing factor to Martins' predicament, did not determine the bank's fate. Rather, it was the social interactions of the branch translated into work at the computer center, combined with this materiality, which proved to be an overwhelming constraint. The computer was a technology with the potential to change existing organizational and occupational structures, and this was not something determined solely by the material properties of the computer, but by the social interactions that drew on it as an allocative resource. These interactions determined how existing rules in the branch would be changed to accommodate the computer, and how new rules at the computer center would be created. While the rules of the branch had been created out of hundreds of years of practice, those of the computer center were without history. The new computer center rules were not, however, born out of nothing; the bank constructed them as a result of its computing work with Ferranti and the existing rules of the branch. In the process, Martins created a tension between the old and new that took a number of years to resolve.

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Endnotes

[i] Martin Campbell-Kelly & William Aspray, *Computer: A History of the Information Machine* (Basicbooks, 1996), 105.

[ii] In November 1951, Lyons ran the first of several routine office jobs on its LEO computer. A claim that this was the world's first business computer is made by David Caminer, John Aris, Peter Hermon and Frank Land, *User Driven Innovation: The World's First Business Computer* (McGraw-Hill, 1996), 7, and Georgina Ferry, *A Computer Called LEO: Lyons Tea Shops and the World's First Office Computer* (Fourth Estate, 2003), viii. See also Mike Hally, *Electronic Brains: Stories from the Dawn of the Computer Age* (Granta, 2005), Chapter 4: "When Britain led the Computing World".

[iii] Family-owned and managed electrical engineering firm Ferranti commercialized the fruits of a close research partnership with Manchester University to claim the world's first commercial delivery of a computer, a Ferranti Mark 1, to Manchester University in February 1951. John F. Wilson, *Ferranti: Building a Family Business, 1882–1975* (Carnegie Publishing Limited, 2007), 350–351, and Lavington, *A History of Manchester Computers*, 25, have the Ferranti Mark 1 delivery ahead of that of UNIVAC (June 1951) and LEO (autumn 1951). For more on Ferranti's computing developments, see Wilson, *Ferranti*, 341–398, and Geoffrey Tweedale, "A Manchester Computer Pioneer: Ferranti in Retrospect", *IEEE Annals of the History of Computing* 15, no. 3 (1993): 37–43.

[iv] This is a problem that is familiar to many innovators, see Nelly Oudshoorn and Trevor Pinch, "Introduction: How Users and Non-Users Matter", in *How Users Matter: The Co-Construction of Users and Technology*, eds. Nelly Oudshoorn and Trevor Pinch (MIT Press, 2003), 2.

[v] Barclays Bank, "No. 1 Computer Center 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 Center* (Eyre Methuen, 1973), 1.

[vi] Barclays Bank, "Our First Computer", c. June 1961, 3.

[vii] Mary S. Goldring, "Electronics and the Banks I – Could Computers Help", *The Banker* 100, no. 326 (March, 1953): 141; Royal Bank of Scotland Group Archives (hereafter RBSGA)/WD/366/19, "IBM Data Processing Progress Report", c. 1958, 33; RBSGA/ WD/366/5, R. D. Craig, "Operation Paperwork", June 1959.

[viii] The figures for British banks are taken from G. C. Norman, *Banking* (Clarke, Doble and Brendon, 1962), 104. There were also 1500 branches in Scotland, but the Scottish financial system, established before the Act of Union in 1707, retained a separate identity with five clearing banks of its own.

[ix] Only Lloyds' Pall Mall branch conducted the volume of business that would warrant a large-scale computer of its own. This branch, due to its historical connections with the armed forces, was responsible for 60,000 accounts and was more than ten times the size of the other banks' biggest branches. See Lloyds Bank Group Archives (hereafter LBGA)/Winton File: Computers, Ron H. Ball [chief manager – data processing], "Computers in Banking – Notes for a Talk", 7–8.

[x] William Aspray, "The History of Information Science and Other Traditional Information Domains: Models for Future Research", *Libraries & the Cultural Record* 46, no. 2 (2011): 230–248.

[xi] JoAnne Yates, "From Press Book and Pigeonhole to Vertical Filing: Revolution in Storage and Access Systems for Correspondence", *The Journal of Business Communication* 19, no. 3 (1982): 5–25.

[xii] JoAnne Yates, *Structuring the Information Age: Life Insurance and Technology in the Twentieth Century,* Johns Hopkins University Press, 2005.

[xiii] 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). The other two volumes in the trilogy are: James W. Cortada, *The Digital Hand: How Computers Changed the Work of American Manufacturing, Transportation and Retail Industries* (Oxford University Press, 2004), and James W. Cortada, *The Digital Hand Volume 3: How Computers Changed the Work of American Public Sector Industries* (Oxford University Press, 2008).

[xiv] Campbell-Kelly and Aspray, *Computer*.

[xv] Jon Agar, *The Government Machine: A Revolutionary History of the Computer* (MIT Press, 2003).

[xvi] Bernardo Bátiz-Lazo and Peter Wardley, "Banking on Change: Information Systems and Technologies in UK High Street Banking 1919–1969", *Financial History Review* 14, no. 2 (2007): 177–205.

[xvii] Bernardo Bátiz-Lazo, J. Carles Maixe-Altes and Paul Thomes, eds., *Technological Innovation in Retail Finance: International Historical Perspectives* (Routledge, 2011).

[xviii] Alan Booth, *The Management of Technical Change: Automation in the UK and USA since 1950* (Palgrave Macmillan, 2007). See, in particular, Chapter 6, "Office Automation: Computers, Clerical Work and Management Systems," 117–140, and Chapter 7, "Bank Automation," 141–154.

[xix] Alan Booth, "Technical Change in Branch Banking at the Midland Bank, 1945–75", *Accounting, Business & Financial History* 14, no. 3 (2004): 277–300.

[xx] Wilson, *Ferranti*, 365.

[xxi] National Archive for the History of Computing (hereafter NAHC)/C5/7.11425, "Letter from B. B. Swann to Lord Halsbury", NRDC, 15 September 1954; Booth, "Technical Change in Branch Banking at the Midland Bank, 1945–75", 283. Goldring's series of three articles on the application of computers to banking were: Goldring, "Electronics and the Banks I – Could Computers Help", 140–144; Mary S. Goldring, "Electronics and the Banks II – Costs of Electronic Accounting", *The Banker* 100, no. 327 (April 1953): 205–208; Mary S. Goldring, "Electronics and the Banks III – Cheque-Sorting for Clearing", *The Banker* 100, no. 328 (May 1953), 285–290. See also A. E. Davies, "Banking by Electronics", in *The Institute of Bankers in Scotland Lectures*, *1953–1954*, 1953.

[xxii] Goldring, "Electronics and the Banks I – Could Computers Help?", 143.

[xxiii] Mechanized is an actors' category used to refer to the electro-mechanical machines in the branch such as branch accounting machines.

[xxiv] Goldring, "Electronics and the Banks I – Could Computers Help?", 140.

[xxv] Although Goldring suggests that the computer installed at Manchester University read and printed on magnetic tape, this is unlikely because Lavington, *A History of Manchester Computers*, 26, states that the Manchester Mark I used 5-hole paper tape input.

[xxvi] Goldring, "Electronics and the Banks I – Could Computers Help?", 142.

[xxvii] Homer R. Oldfield, *King of the Seven Dwarfs: General Electric's Ambiguous Challenge to the Computer Industry* (IEEE Computer Society Press, 1996), 12. Reducing size by means of a transistorised computer was reported as a key objective when General Electric considered bidding for the Bank of America contract, Amy W. Fisher and James L. McKenney, "The Development of the ERMA Banking System: Lessons from History", IEEE *Annals of the History of Computing* 15, no. 1 (1993): 50.

[xxviii] For a history of Elliot Automation see Simon Lavington, *Moving Targets: Elliott-Automation and the Dawn of the Computer Age in Britain*, *1947–67* (Springer 2011).

[xxix] Bernard B. Swann, "Electronic Banking" [letter to the editor], *Financial Times*, 13 March 1954, 4.

[xxx] Ferry, *A Computer Called LEO,* vii–viii.

[xxxi] Ibid*,* 119–125; Caminer et al., *User-driven Innovation*, 14–15.

[xxxii] NAHC/C5/7.11425, LEO Computers Ltd, "Report to the Commercial Bank of Scotland Ltd. on Dealing with Customers Accounts by Means of an Automatic Computer", 29 June 1955. Goldring, "Electronic and the Banks III – Cheque-sorting for Clearing", 290.

[xxxiii] Fisher and McKenney, "The Development of the ERMA Banking System", 50; James A. O'Brien, *The Impact of Computers on Banking* (Bankers Publishing Company, 1968), 2.

[xxxiv] NAHC/C5/7.11425, J. Crawley, untitled note, 15 June 1955.

[xxxv] NAHC/C5/7.11425, Bernard B. Swann, letter to Lord Halsbury, 15 September 1954. This view was also restated in the letters page of *The Times*.

[xxxvi] Tweedale, "A Manchester Computer Pioneer", 40; Michael Rose, *Computers, Managers and Society* (Penguin, 1971), 220–222; Martin Campbell-Kelly, *ICL: A Business and Technical History* (Oxford University Press, 1999), 219.

[xxxvii] Wilson, *Ferranti*, 351, 365.

[xxxviii] NAHC/C5/7.11425, Mr Crawley, "Computers and the Banks", letter to Lord Salsbury and Mr Hennessey, 7 February 1956.

[xxxix] RBSGA/WES/1177/62, John D. Cowen, "Report of the Electronics Sub-Committee to the Chief Executive Officers", 9 May 1958.

[xl] Norman, *Banking*, 104.

[xli] Geoffrey Kelly, "The Martins Bank Story", *Barclays Bulletin* 13 (Winter 1968): 3; George Chandler, *Four Centuries of Banking Volume 1* (Martins Bank Ltd, 1964), 151–152. Thomas Gresham traded from 68 Lombard Street under the sign of a golden grasshopper which he adapted from his family crest. Successive goldsmiths at the same site continued to trade under the grasshopper sign as they formed partnerships that would be antecedents to Martins Bank. The symbol of the grasshopper was the sign for Martins Bank until after its merger with Barclays was completed in 1969.

[xlii] David Hurst, telephone interview with author, 21 July 2008; Paul Reckin, telephone interview with author, 29 July 2008. The back office of a small Martins branch in the late 1960s was remembered as "like entering something out of Dickens' Christmas Carol" by one interviewee: Brenda Lincoln, telephone interview with author, 21 July 2008.

[xliii] See Lars Heide, *Punched-card Systems and the Early Information Explosion, 1880-1945* (Johns Hopkins University Press, 2009), 139–144; 165–207.

[xliv] A. W. Brooks, "Into the Computer Age", *The Banker* 113, (March 1963): 172; Davey-Thomas, interview with author, Penzance, 15 October 2008.

[xlv] "Centralised Accounting in the Bank of Scotland", *Scottish Bankers Magazine* (May 1959): 12–16.

[xlvi] LBGA/Winton File: Computers, Ron H. Ball [chief manager – data processing], "Computers in Banking Notes for a Talk", 6–7.

[xlvii] "Automation: The End of the Beginning", *Barclays Bulletin* 35 (Summer 1974): 2.

[xlviii] Enid Mumford and Olive Banks, *The Computer and the Clerk* (Routledge and Kegan Paul Ltd, 1967), 40.

[xlix] Martins Bank, "Enter Pegasus", *Martins Bank Magazine* (Spring 1960), 10.

[l] Ibid., 11.

[li] See Simon Lavington, *The Pegasus Story: A History of a Vintage British Computer*, (Science Museum, 2000), 46, for a "definitive list of all 40 Pegasus 1 and Pegasus 2 computers built" and their destinations. By June 1962 the Pegasus was overtaken by the NCR/Elliot 803 in terms of UK deliveries, but was still ahead of the IBM 1401, ibid., 55.

[lii] Ronald Hindle, "You and Pegasus", *Martins Bank Magazine* 16, no. 1 (Spring 1961): 29.

[liii] Martins Bank, "Enter Pegasus", 11; Mumford and Banks, *The Computer and the Clerk,* 38; BGA/25/1202, "Announcement by Martins Bank Limited", 18 August 1961. The emphasis on "live" was intentional in order to differentiate Martins' achievement from the joint efforts it had previously undertaken with Barclays and the Westminster on a Remington-Rand UNIVAC using *dummy* account data on behalf of the CLCB's Electronics Sub-Committee. See RBSGA/WES/1177/62, "Memo for Board – Electronics", February 1959.

[liv] BGA/38/583 "Martins Board Minutes", 25 Jan 1960. Martins like Barclays, Lloyds and the other banks preferred to buy rather than rent equipment. Due to tax reliefs on computer purchases Martins calculated that it would save £30,000 by buying rather than renting if it could sell the Pegasus for £50,000 after five years, see BGA/38/583 "Martins Board Minutes", 1 February 1960.

[lv] The term "head office" was used by the banks to refer not just to a single office building, but to multiple offices spread within and around a very large, and suitably impressive, neo-classical centrepiece.

[lvi] Andreas Whittam Smith and Clifford German, "Banking: A Geography Lesson"*, The Telegraph*, c. 1968; David Hurst, telephone interview with author, 21 July 2008. There were two other clearing banks with head offices located outside of London, District Bank and Williams Deacons Bank, both headquartered in Manchester, for further details on the clearing banks and the location of their head offices see Norman*, Banking*, 104. When the Bank of Liverpool absorbed Martins Bank in 1918, the board considered moving head office to London, but the final decision to remain firmly in Liverpool was portrayed as a matter of civic pride rather than provincial small-mindedness, Chandler*, Four Centuries of Banking*, 429.

[lvii] LBGA/Winton File: Computers, Ron H. Ball [chief manager – data processing], "Computers in Banking Notes for a Talk", 7–8.

[lviii] Margaret Ackrill and Leslie Hannah, *Barclays: The Business of Banking, 1690–1996*, 171–184; Chandler, *Four Centuries of Banking*, 489. The building has listed status.

[lix] Martins Bank, "Enter Pegasus", 10–12; Martins Bank, "Pegasus Arrives", *Martins Bank Magazine* 16, no. 2 (Summer 1961), 19.

[lx] "Traditions a Modern Approach", *Illustrated Liverpool News* 3, no. 24, May 1962.

[lxi] "Electronic Book-keeping for Martins", *The Banker* 110, no. 409 (February 1960): 133.

[lxii] Ian Martin, "Britain's First Computer Center 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.

[lxiii] BGA/25/1202, "Announcement by Martins Bank Limited", 18 August 1961.

[lxiv] Mumford and Banks, *The Computer and the Clerk*, 46.

[lxv] Yates, *Structuring the Information Age*.

[lxvi] JoAnne Yates and Wanda J. Orlikowski, "Genres of Organizational Communication: A Structurational Approach to Studying Communication and Media",*Academy of Management Review* 17, no. 2 (1992), 299-326. See also Wanda Orlikowski, "The Duality of Technology: Rethinking the Concept of Technology in Organizations." *Organization Science* 3, no. 3 (1992), 298–427 and JoAnne Yates, "Using Giddens' Structuration Theory to Inform Business History", *Business and Economic History* 26, no. 1 (1997): 159–183.

[lxvii] Kevin Borg, "The 'Chauffeur Problem' in the Early Auto Era: Structuration Theory and the Users of Technology", *Technology and Culture* 40, no. 4 (1999): 797–832.

[lxviii] Anthony Giddens, *The Constitution of Society: Outline of the Theory of Structuration* (Polity Press, 1984), 25, 92–93, 377. Borg's, "The 'Chauffeur Problem' in the Early Auto Era", provides a good example of the application of structuration theory to technological change. Although the motorists attempted to preserve the rules from the horse-drawn era, the chauffeurs were able to draw on the motorcar, and in particular their recently gained expert knowledge of it, to elevate their social status and upset the balance of what had previously been a master-servant relationship. Borg's analysis takes place outside a formal organisational setting, but organisational theorist Stephen Barley, in "Technology as an Occasion for Structuring", has employed structuration theory as a lens to observe the relationship between the introduction of the CT (Computed Tomography) scanner and the radiology work in two different hospitals. Barley's analysis shows how the adoption of the same technology in two different contexts led to a reconfiguration of role relations and organisational structures that differed according to the historical processes and work practices in which they were situated. See Stephen R. Barley, "Technology as an Occasion for Structuring: Evidence from Observations of CT Scanners and the Social Order of Radiology Departments", *Administrative Science Quarterly* 31, no. 1 (1986), 78–108.

[lxix] Mumford and Banks, *The Computer and the Clerk*, 42.

[lxx] Ibid.

[lxxi] David Parsons, interview with author, Manchester, 7 August 2008.

[lxxii] This was a common problem faced by employers. See Joan M. Greenbaum, *In the Name of Efficiency: Management and Shopfloor Practice in Data-Processing Work* (Temple University Press, 1979), 15.

[lxxiii] Mumford and Banks, *The Computer and the Clerk*, 49–50.

[lxxiv] David Parsons, interview with author, Manchester, 7 August 2008.

[lxxv] Hindle, "You and Pegasus", 29.

[lxxvi] Ian Martin, "Britain's First Computer Center 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; LBGA/Winton File: Computers, Ron H. Ball [chief manager – data processing], "Computers in Banking Notes for a Talk", 9–10.

[lxxvii] Edna Devaynes, interview with author, Birkdale, 1 August 2008.

[lxxviii] Paul Reckin, telephone interview with author, 29 July 2008.

[lxxix] "The Banks and Accounting by Machine Methods", *Economist* [Banking Supplement], 10 May 1930, 15–16.

[lxxx] David Hurst, telephone interview with author, telephone interview with author, 21 July 2008. This is a widely noted point in the academic literature with a historiography of its own; as a starting point, see Jane E. Lewis, "Women Clerical Workers in the Late Nineteenth and Early Twentieth Centuries" in *The White-Blouse Revolution: Female Office Workers Since 1870*, ed. Gregory Andersen (Manchester University Press, 1988), 27–47.

[lxxxi] Edna Devaynes, interview with author, Birkdale, 1 August 2008.

[lxxxii] See Marie Hicks, "Compiling Inequalities: Computerization in the British Civil Service and Nationalized Industries, 1940-1979", (PhD Diss., Duke University, 2009) for an excellent gender analysis of British computing labor. Hicks makes use of a number of oral histories to reveal the detail of the day-to-day working lives of female computer operators. She also draws on visual sources in the media and marketing literature to compare popular representations of computer operators with these personal accounts. The identities of Hick's operators emerge at the intersection of social and cultural expectations of women with the burgeoning computing sub-culture of large public-sector organizations.

[lxxxiii] Ibid.

[lxxxiv] Edna Devaynes, interview with author, Birkdale, 1 August 2008.

[lxxxv] Ibid.

[lxxxvi] Mumford and Banks, *The Computer and the Clerk*, 58.

[lxxxvii] Ibid., 47–48, 58.

[lxxxviii] Leonardi and Barley, "Materiality and Change", 167.

[lxxxix] Paul Edwards, *A Vast Machine*: *Computer Models, Climate Data, and the Politics of Global Warming* (MIT Press, 2005), Chapter 5, 83–110.

[xc] Mumford and Banks, *The Computer and the Clerk,* 46, 58–59

[xci] Ibid., 48.

[xcii] Ibid., 47.

[xciii] Neil Gibson, interview with author, Knutsford, 18 November 2008.

[xciv] Mumford and Banks*, The Computer and the Clerk*, 47.

[xcv] Ibid., 58–59. [Check page numbers]

[xcvi] RBSGA/WD/366/2, Management of Williams Deacons Bank, "Table of Computer Manufacturers compiled by Williams Deacons Bank", October 1961.

[xcvii] BGA/482/392, Roy Vine, "Report for Submission to the Monopolies Commission re the Automation Activities of Barclays Bank Limited and the Savings which will Result from the Merger of Barclays, Lloyds

and Martins Banks", 16 April 1968; The Monopolies Commission, *Barclays Bank Ltd, Lloyds Bank Ltd and Martins Bank Ltd: A Report on the Proposed Merger* (HMSO, 1968); Neil Gibson, interview with author, Knutsford, 18 November 2008.

[xcviii] Stan Gray, interview with author, Haslington, 22 July 2008.