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Evidence from the Patent Record on the Development of Cash Dispensing Technology

Bernardo Bátiz-Lazo and Robert J.K. Reid

Abstract—There are but a handful of systematic studies on the history of automated teller machines (ATMs) yet all fail to address the issue of paternity while perpetrating ‘common wisdom’ beliefs. This article looks at the birth of currency dispensing equipment, the immediate predecessor to the ATM. At the simplest level, at least four separate instance of innovation can reasonably claim to be the origin of the concept. However, the question as to who invented it is less illuminating than an understanding of the process of innovation itself and how these competing families developed into the modern conception of an ATM. Our research supports the view of user-driven innovation as surviving business records and oral histories tell of close involvement of bank staff in establishing requirements and choosing amongst alternative solutions in the implementation of first generation technology. This case thus shows greater understanding in the user’s role in shaping and directing technological development.

Index Terms— Cash dispensers (ATMs), History, Financial data processing, Patents, Research and development, User interfaces

I. INTRODUCTION

THERE is a great deal of confusion over who should be credited with the invention of cash dispensers (the technology that fathers automated teller machines or ATMs). This is mostly as a result of parallel developments on both sides of the Atlantic that took place through a number of companies – each coming from different sectors and with its own competitive dynamics [1].

For example, a patent family emerges from the Docutel Corporation (US patent US3761682, filed on October 7, 1971) that has a claim to being the original conception of the ATM [2]. Perhaps the reason for this claim is best summed up in the accompanying illustrations which display for the first time in the patent record a full, free standing automated teller system rather than, as in the case of the machines created by Sheppard-Barron and Goodfellow discussed below, an

invention defined primarily by the verification/security system.

Developments described in this article reflect how the creation of currency dispensing technology and the evolution from cash dispensers into ATMs resulted from the convergence of different technological configurations and, in turn, how these configurations empowered individual banks to influence the design and evolution of the technology [3-5]. In this respect ATM technology can be seen as an example of user-driven innovation in which the banks influenced the design and development of the technology. Concomitant to that process of innovation is the profound influence of that interaction with technology on the banks and their way of doing business by that interaction [4].

Nevertheless, ascertaining the roots of this technology is important because there has been tendency to confuse the development of this technology in number of ways. The most common confusion has been to use the terms cash machine and ATM interchangeably, blurring the distinction in their functionality. Quite often the ATM is seen to differ from a cash machine as long as the ATM provides at least one additional service to that of cash dispensing [6],[7]. Here we will argue that such distinction is misguided. Greater functionality only emerged as cash machines moved from stand alone, analog equipment; to batch processing; to on-line, real-time terminals of mainframe computers. Debiting (and more recently crediting) customer accounts through on-line, real-time systems required not only advances in computer technology, electronic data processing and network architecture but also software for storing and managing databases of customer information.

In what follows we attempt to outline the four main families of patents that map the creation of cash dispensers. In this process we focus on some of the anomalies that emerge as well as some of the engineering challenges that different teams faced in order to deliver what is now a ubiquitous and yet industry specific technology.

II. WHO INVENTED THE CASH MACHINE?

A. Luther G Simjian and Reflectone

A popular yet misguided reference in the conventional wisdom claims to represent the patenting of an idea developed as early as 1939 by Luther Simjian [8]. An apparent typographical error seems to have been perpetrated as Simjian

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filed patent US3039582 on the April 9, 1959. Moreover, the press advertised trials of Simjian's 'Bankograph' machine in a New York City bank in 1961 [9].

Simjian's automated cash depositing patent is also interesting in the context other of his patents filled around the late nineteen thirties: they all seem to emerge out of his pre-war work in automatic photographic vending machines. As will be evident below, self service in photo booths, candies, petrol stations and dry cleaning all coincide with currency dispensing as being part of a larger concept of customer orientated automation.

B. James Goodfellow, Smith Industries and Chubb & Son

The first and perhaps most compelling claim to the original innovation, in terms of patent evidence, is a development in the UK from the specialist engineering firm Smiths Industries, who developed a system in conjunction with Chubb & Son's Lock and Safe Co. (Chubb).¹

The development of the Chubb machine is claimed to have been instigated by Sir Archibald Forbes, then Chairman of Midland Bank, who during golf invited Lord Hayter, the chairman of Chubb, to develop such a device in order to help resolve issues associated with Saturday openings.²

Established in 1818, Chubb had years of experience in providing security services to financial institutions (including the manufacturing of safes) and was considered to be the ideal partner to develop the physical housing of the machine and the mechanical components such as the dispensing mechanism plus the marketing of the system, given their history with the banks. In turn, the laboratory of Kelvin Hughes in Hillington, Glasgow (Scotland) was asked to develop the security device.

Kelvin Hughes was the marine systems arm of the then Rutherford-Smith (i.e. Smith's Industries). The role of the team at Hillington was to consider the fundamental issue of the range of options for securing the system and telling the system to dispense the cash. Jeff Constable, the Director of the research laboratory at Kelvin Hughes, ultimately posed the problem to his staff including a development engineer called James Goodfellow.

Goodfellow had spent a number of years developing data handling systems at Kelvin Hughes. He developed a number of digital data handling systems and, more importantly, in 1964 a system of dispensing oil for tanker drivers at unattended tanker loading areas using a punched card and a reed switch system. It was the confluence between the data handling experience and this simple card reader that influenced his conception of the cash dispenser in later years. However, this foundation of development was not built upon until the consumer, i.e. the bank, defined the problem of allowing customers access to cash.

The breakthrough in security was the idea that a public number (PAN) was to be combined with a private identification number (PIN). The PAN was printed in punched

holes on the card and of course, could be forged. It would be secured through the use of a PIN that would correspond to the PAN through a complex coding system. The key was that such system should be of sufficient strength to prevent anyone getting to the PIN from the PAN. Chubb tested the system by printing off 1001 cards and attempting to break this system. They failed and Goodfellow's system became the basis of the security system in the 'Chubb MD2' cash dispenser.

Goodfellow's patent was filled on May 2, 1966 (GB1197183). This is the earliest instance of a complete 'currency dispenser system' in the patent record and clearly had a profound influence on the industry as a whole. Not only did future entrants into the cash dispenser market NCR and IBM, licence Goodfellow's PIN system, a number of later patents references the Smiths patents as 'Prior Art Devices'. For example NCR referenced all the Smiths patents in their early cash dispenser patents. Clearly the influence of this system cannot be overstated.

A demonstration of the PIN system while mounted in a modified candy dispenser was put together in Chubb's facilities in Wolverhampton which representatives of the Midland Bank and the Bank of England attended. Failure to secure exclusivity in the supply of the equipment by Chubb, led the Midland Bank to finance its own device through Speytec (more below).

The Chubb system was first deployed by the Westminster Bank, at its Victoria branch on the July 31, 1967. This followed a four months joint development period by the bank and Chubb in order to bring it to market [10]. Initially, a further eight branches were to have the system installed, however Chubb was soon inundated with requests from other banks for the system and the Westminster, not wishing to have to wait in line for the innovation they had brought to market, quickly altered that figure, proposing to order of a further 40 machines only five days after the launch [11]. This expansion was at a cost of £95,000 to the bank [12]. The 'Chubb MD2' 24-hour dispenser seemed to win over the banking industry at large, voted 'Best New Idea' in the *City Editor Awards* [13].

Despite the success of this development, there was a degree of dislocation of staff during the development. Goodfellow was made redundant in January 1967 from Kelvin Hughes in the restructuring of the company. However, they offered to retain him and continue to develop the system if he was prepared to move the development to England. He was not and chose to leave and join IBM in Greenock, Scotland.

C. John Sheppard-Barron and De La Rue Instruments

Perhaps the claim that has received the most, perhaps misguided, publicity and has been prone to hyperbole, relates to the De La Rue Automatic Cash System (DACS). De La Rue's background in manufacturing of cheques for banks and their interest in Security Express (an armored truck company which had a monopoly on transportation of money for the banks) [14], brought John Adrian Shepherd-Barron into monthly contact with the various general managers of the

¹ This section, unless otherwise stated, borrows freely from an interview with James Goodfellow, March 27, 2008.

² There is no surviving record at the Midland Bank (namely HSBC Group Archives, henceforth HSBC) confirming the invitation to Chubb.

banks.³

At the time, Sheppard-Barron was also managing director of De La Rue Instruments, a division with a total of eight employees and a brief to develop systems for banking automation [17]. This division had been responsible for marketing a patent for an “Apparatus for feeding sheets” (GB912215), developed by Frank Albert Richardson, Stanley William Middleditch and Reginald Leslie Walker, which was essentially a banknote transport system combined with a counting system. This was later developed into a patent filled on September 25, 1964 entitled “Sheet feeding and counting apparatus” (GB1109466) developed once again by Stanley Middleditch with Victor Richard Sels. The expertise flowing from this innovation was central to the development of the cash dispenser.

Equally, De La Rue Instruments had knowledge of the use of Carbon-14 as a token verification system. Beginning with Patent GB990256 “Improvements in or relating to security documents and monetary tokens”, with a priority date of November 30, 1962, De La Rue developed the use of radioactive material as a security device. This was published alongside a patent for a “Sensing Mechanism for Automatic Vending Machines” (GB990255), focusing on automation of customer service, rather than any specific goal of automating banking technology.

In a similar vein to Goodfellow, Carbon-14 impregnated tokens aimed to help an oil company (in this case, Royal Dutch-Schell) in the distribution of after-hours fuel to unattended depots. A soft beta emitter of the sort described in GB990256 was used to verify the token. This was to prevent delivery drivers stealing fuel from Shell through short measures at the garages and retaining the excess.

Shepherd-Barron paints the picture of a rather esoteric development over the course of a weekend,⁴ with the idea emerging on the Saturday when he couldn’t get any money out near his home in Cobham, Surrey having arrived too late for the Friday opening after a series of meetings with his team at De La Rue Instruments. This part of the story by Sheppard-Barron is inconsistent with the historical record. Since 1964 bank staff and their unions were reluctant to continue with Saturday opening of branches and this was the key for British banks getting involved in developing cash dispensing technology. However, it was not until 1971, well after cash dispensers had proven their effectiveness, that banks stopped servicing retail clients on Saturday mornings.

Shepherd-Barron claims that he came up with a concrete development idea using a chocolate bar dispenser as the basis

³ Born in Shillong in Assam, India, on 23 June 1925, he was educated at Stowe School and during the war attended the University of Edinburgh through the military before being admitted at Trinity as a pensioner in October 1948 [16]. He initially read for the Economics Tripos, and appears to have been allowed a pass in the first part of the examination in 1949, but did not complete his degree [17]. Following his time at Cambridge he moved to De La Rue as a management trainee based in Surrey where he eventually worked at the board level, including chairman of an armored truck company division (Security Express Ltd. [15]) and managing director of De La Rue Instruments.

⁴ This section, unless otherwise stated, borrows freely from an interview with John Shepherd-Barron on March 26, 2008.

of the design and the concept of an identification number. Moreover, that the next working day, in his capacity as the managing director of the armoured truck company, he had a meeting with Harold Darvill, general manager of Barclay Bank, to whom he touted the idea, receiving an immediately positive response. The story continues that within two days Derek Wilde, chief executive from Barclay’s, fleshed out the idea and made a contract ordering six of the devices as prototypes with a view to develop 250 further machines. There are no surviving records at Barclays relating to the genesis of the technology. However, in the records that do survive, discussion over cash dispensers is in evidence after their first deployment in July 1967 and thereafter they never appear in the minutes of the top echelon of Barclay’s management team meetings (as opposed to, for example, the introduction of credit cards which dominated the strategic thinking of that group at the time).

Despite these issues, the DACS (marketed by the bank as “Barclaycash”) was the first cash machine ever deployed when installed at the Enfield branch of Barclay’s on June 27, 1967, beating the Westminster’s Chubb system by a month [18].

The patent record is interesting on this point. Once again, as with Goodfellow’s patent, the verification of the customer was at the heart of the DACS. Developing this interface could be seen as a spin-off technology from De La Rue’s investment in verification systems. Indeed, the patent record further emphasises De La Rue’s interest in the verification side of the system rather than the overall cash dispensing technology. Yet the earliest De La Rue cash dispensing related patents in the record are for simply an “Encoded Card Like Device” (GB1308331), filled on January 13, 1971, whilst the first complete system within the ATM family patented by De La Rue emerges until GB2046975 (filled on April 2, 1981).

The impact of the Barclaycash system should not be overlooked as the first cash dispensing system (albeit by one month) however, the apparent surge in interest at Chubb following the Westminster launch was not replicated at De La Rue. An exclusivity arrangement between De La Rue and Barclay’s for the DACS system hampered the expansion and competition for systems that Chubb encountered (more detail below).

Within a few years, De La Rue, moved to the supply of components for the ATM market. The increasing interest in the technology by NCR and IBM pushed De La Rue out of that market and moved to them towards OEM supply of dispensing mechanisms for NCR. This was mostly the result, in a similar story to the development at NCR, due to a lack of expertise in developing electronic components and the expense involved in developing that technology.

D. Edwards et al., Speytec, Burroughs and Midland Bank

Perhaps the claim that has received least publicity yet shows the greatest involvement of a bank as a user, determining development, is related to UK patent GB1329964, filed on September 9, 1969.

During our interview, Shepherd-Barron stated that he had

initially conceived of the idea of a cash dispenser as a joint project of the Committee of London Clearing Banks (CLCB), to be offered to all the clearing banks equally to standardize the system. It is plausible that this initiative was a response to the establishment of a permanent committee within the CLCB to consider the issue of Saturday closing in 1964. The exact membership of that permanent committee is unknown but its existence does help to substantiate some of the claims by Sheppard-Barron and Goodfellow, regarding the involvement of the Midland and Westminster Banks with Chubb.

As stated above, Midland parted company with Chubb after failing to secure the exclusive supply of its cash dispenser. Some time in the summer of 1966, Midland awarded a contract to develop their own machine to a small engineering outfit called Speytec.⁵

Based in Croydon (south London), the company was established by John Edwards, Len Perkin and Mrs. Simons and Young (hence the acronym resulting from the shuffling of the first letter of the last names). Perkins had a background in radar technology. Edwards was the more entrepreneurial of the lot and had been involved in developing dry cleaning machines in the USA. He came back and formed the company on the back of a contract to deploy technology for depositing and retrieving dry cleaning after hours. This system required as token a plastic card impregnated with two magnetic stripes.

Unable to find them in England, Speytec designed and manufacturer the cards but found that besides being expensive to make, the magnetic stripes were easily damaged. The dry cleaning business never really took off. However, the ever entrepreneurial Edwards, considered what other uses could be made of their card, is said to have contacted a number of managers of bank retail branches, finally getting the attention from Midland Bank, then second biggest bank in the UK (after Barclay's) in terms of deposits and more importantly from the point of view of customer relations, it had a "larger number of units than is operated by any other financial institution in this country and the biggest branch system among the commercial banks of the western world"[19]. Surviving records from the Management Committee of the Midland Bank are consistent with them having been approached rather than sought Speytec [20].

The bank commissioned W. G. Kneale, General Manager (Administration), to liaise with Speytec and the National Physical Laboratory (NPL) on 'developing an alternative approach' to Chubb and De La Rue [21]. It is interesting to note here that during our interviews engineers at Speytec, Chubb and probably De La Rue, said to be working in isolation and only became aware of alternative designs when the competing cash dispensers were deployed and subsequently advertised in the press.

As early as March 1967, Kneale was aware that at least three other banks were about to deploy 'small quantities' of cash dispenser by the end of the year [22]. Also that as a result of Barclays Bank financing the De La Rue dispensers, the

bank had gained exclusivity rights - something 'the manufacturer regretted'. De La Rue nevertheless provided Midland with 'basic information' that enabled a broad understanding of its machine (including the use encoding, mode of activation and the fact that De La Rue had doubts regarding the security of the machine).⁶

With no relevant experience from other sectors, Speytec embarked on designing the currency dispenser from first principles. As such, they were happy to liaise with the much better endowed NPL. The development posed a number of problems. For example, providing the machine with five power sources, designing an integrated circuit from components with different voltages and working around the lack of step motors (that is, providing indexing systems for continuing moving engines). Equally, weather proofing such components with metal alloys for the fascias, that were both light but still resistant to the UK weather and the effects of salt water (hence the reason to include the Hastings branch in subsequent trials) were new issues generally to the field of electronics.

Security remained an issue and in March 1967 the bank's Operations & Methods department working together with NPL's Autonomics Division demonstrated it was relatively easy to read and forge Speytec's activation card and even easier to break Chubb's soft plastic cards. Speytec responded to the NPL report by introducing two magnetic stripes on top of a plastic credit card sized token resulting in eight tracks, allowing for redundant security in a six figure PIN. A further security was hidden in an arrow apparently added to help point the way to introduce the card. However, this arrow was printed with a Carbon 14 dot placed at random but its position recorded and through the appropriate algorithm. Also responding to NPL comments and Midland's concerns on security, Speytec added a small needle that would punch up to twenty dimples into the card and thus limiting its use. The limit on reusability gave a degree control to the bank over the amount the card could issue. This meant that the bank would only issues card to those customers with a balance of £200 or more thus limiting the potential for overdrawing on the card.

Further trials at the NPL suggested that 'until a dispenser could be linked to a computer, there must always be a security risk'[22]. The desirability of interfacing a dispenser to the computer was in itself a mayor step forward given the asynchronous, stand-alone nature of first generation cash dispensers such as those by Chubb and De La Rue [5]. By September 1968 a total of £41,530 had been allocated to the project [23]. Midland then purchased 12 machines for field testing from Speytec at a total cost of £80,000 (of which £15,200 was granted to Speytec in the form of an interest free overdraft to be repayable from future profits).⁷ The first two machines were operational in October and the rest delivered

⁶ The same source informs of trials by the First National Bank of Arizona on a machine which accepted, counted and validated cash credits. No patent record was found of this machine.

⁷ Speytec machines were deployed in branches at Croydon, Glasgow (Clydesdale), London (Old Bond Street, Picadilly and Shaftesbury Ave),

⁵ This section, unless otherwise stated, borrows freely from interviews with Sean Newcombe on February 5, 2008 and John Donald on June 4, 2008.

by the end of December 1968.

While in operation, Speytec machines were technologically superior to those of Chubb and De La Rue. However, it was policy and user decisions rather than the elegance of engineering that led to the final outcome. Midland having stuck to the rather unconventional route of financing a small company to develop the system, began to consider moving the Speytec team to Burroughs. At the time, the Detroit-based manufacturer was the chief supplier of Midland's computer equipment [25]. In May 1969 the bank passed on all the results of its research to Burroughs engineers in the USA while Speytec became a division of its the UK subsidiary, Burroughs Machines Ltd.

An ultimatum of sorts was issued to the Speytec staff, essentially offering employment at Burroughs to the entire company, or if they preferred, to go off and do something completely different unrelated to their cash dispenser work. The Speytec team thus disbanded, although a few, such as John Donald, remained with Burroughs developing the RT2000 terminal (patented as GB1329964). The first two of these currency dispensing machines seem to have been made operational in Belfast in 1974 or four years after Burroughs had set up a mainframe computer for the local trustee savings bank [26].

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