Introducing contactless technology into the financial self-service environment

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ABSTRACT

The use of contactless technology has grown; this led to a development to integrate it on an automated teller machine (ATM). This case study illustrates the importance of maintaining a holistic view of the entire system (including the physical interface, the onscreen experience, and the person using the technology), particularly when introducing new technology or interaction paradigms. It also demonstrates the benefit of multiple iterative rounds of ideation, concept creation and evaluation; without multiple cycles an acceptable solution would not have been found. Wider lessons are drawn for the design of hardware.

KEYWORDS

Contactless, self-service, user testing

Introduction

There is a growing trend towards using contactless technology at self-service terminals such as automated teller machines (ATMs). Contactless technology here means that the contactless card or NFC (Near Field Communication) enabled smart device such as a mobile phone or a wearable (or contactless token) is held close to, but not necessarily touching, a contactless reader.

The use of contactless technology in the financial self-service environment has grown rapidly in recent years. In a 2016 international study, 68% of financial institutions anticipated supporting contactless technology at their ATMs within the next four years (ATM Marketplace, 2016). The consumer interest in contactless transactions has grown as well. For example, in Australia (an early adopter of this technology), contactless card usage grew from less than 8% to 22% of all point-of-sale card usage in the period between 2010 and 2013 (Ossolinski, et al., 2014). Even Europe, which is often behind other regions in adopting new technologies, has seen a significant increase in the adoption of contactless and mobile payments (de Meijer, & Bye, 2011). In a recent survey, 23% of UK consumers and 9% of US consumers would like to withdraw cash at an ATM using a contactless card (ATM Marketplace, 2017).

There are many benefits to using a contactless reader at an ATM, instead of a conventional card reader e.g. it can be faster and offers significantly improved accessibility as the contactless token can be hand-held or on the consumer. These contactless benefits can offer a better user experience. Conventional card readers require card insertion into a slot, and later retrieval.

In some markets, contactless usage can also offer improved security. This is particularly true of regions like the US where the use of the magnetic strip on cards is still prevalent. Contactless technology enables higher levels of encryption and security than a conventional magnetic strip, as all contactless cards are EMV cards (which use a smart chip to securely store credentials and use cryptographic methods to authenticate with the terminal and processing network). So this enables

the US and other markets to be more resistant to fraudulent attacks such as card skimming (see chapter 2 of Bhargav, 2014).

The use of contactless technology also means that suitably equipped NFC-enabled smart devices (such as smartphones and smart watches) can be used to make payments and complete transactions, removing the need to carry cards. This is likely to increase in importance, particularly for consumers who use their mobile phones for their banking activities.

The problem

There are, however, some potential hurdles to overcome when using contactless technology in a self-service environment. Firstly, self-service terminals like ATMs are based on the principle of 'walk-up-and-use': people should be able to use these devices without any prior training, knowledge or experience. This can be rather difficult when people are being asked to use new technology, such as contactless tokens, that they may never have used before.

This unfamiliarity with the interaction pattern may be even more problematic with technology like contactless as the physical affordances can be somewhat abstract. Due to the nature of the contactless reader, there are no physical cues like there are with a conventional card reader. With a conventional card reader, the card is inserted into the reader, often accompanied by some electro-mechanical noise, and in the case of motorised readers that are commonly used in the UK, then returned to the consumer after being read. The contactless reader, meanwhile, has none of these physical cues. Therefore, the consumer is solely reliant on whatever feedback the system has been designed to provide. In our experience, both auditory and visual feedback are important, and they are needed in a timely manner otherwise people assume that the contactless technology is not working.

The unfamiliarity may be made worse by inconsistent and somewhat misleading messaging from the service providers, including banks and retailers, which in turn can lead to consumers creating mental models of the interaction that are oversimplified or even incorrect. Some banks have used the term 'tap' to refer to the action of using the contactless reader. Others have used the term 'wave'. For example, ANZ (The Australia and New Zealand Banking Group) in Australia, who were the first customer to roll this service out, called it 'Tap and PIN' (FS tech, 2014). They then followed up with the ability to use NFC-enabled mobile devices in their subsequent 'ANZ Pay' initiative (ANZ, 2017). When the technology was first rolled out in the UK, newspapers commonly referred to it as 'wave and pay' (see for example Brignall, 2012).

There are also certain technical characteristics of contactless technology that can create difficulties. According to the standard for contactless technology (EMVCo, 2011), the contactless reader must be able to read a token from a certain distance away (up to 40mm). However, in practice this read distance can vary based on the card type and manufacturing variability between units. Furthermore, the antenna position on cards can vary, with some cards having a small antenna wrapped around the chip, some going around half the card, and others having an antenna around the full extent of the card (Figure 1). This means that it will be easier to get a read with some cards (those with a larger antenna) than others. It also means that positioning the card correctly on the reader can be an issue. If the antenna is at one end, and the other end is presented to the reader, the card may not be read in a timely manner. The consumer has no way of knowing what shape the antenna is on their card. The contactless icon that is printed on the card does not usually demarcate the location of the antenna either; it is there just to show that the card is contactless-enabled. This may lead to further confusion as the consumer may attempt to align the contactless icon with the contactless reader.

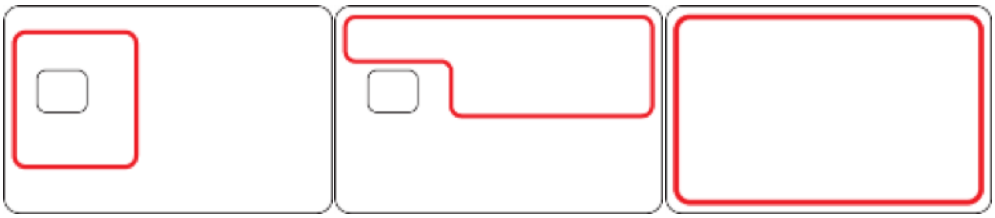

Figure 1: Examples of contactless antenna position

A similar problem exists with mobile phones, with antenna positions varying significantly between manufacturers and models. NFC antenna position is often unknown and can be anywhere on the back face of the device, or wrapped around the battery. Because these devices are larger than a card, the positioning problem becomes even more significant.

One of the key user experience challenges is knowing what action to use (e.g. tap, or touch and hold, or wave past the reader), and which part of the contactless token to aim for towards the ATM interface. This situation is exacerbated by the fact that the contactless card can often also be used with a conventional card reader. This potential dual use of the same card is particularly problematic when the contactless reader is in the path that the card is likely to take on being inserted into the conventional card reader. In this case, the consumer intends to insert the card into the conventional card reader, moves the card towards the slot, but before they have the chance to insert it, the card is read by the contactless reader. This inadvertent contactless read is potentially confusing for the user. This confusion grows if the software application is designed to only use one card reader at a time because this means that as soon as a contactless reader gets a read, the conventional card reader is disabled and the card cannot be inserted.

In our experience, this problem is by far the most common when a contactless reader and a conventional card reader are placed in close proximity; with the contactless reader just beneath and perpendicular to the conventional card reader slot (Figure 2). This is the situation that the authors had, and therefore several engineering solutions were explored to see what could be done to improve the usability of the overall solution.

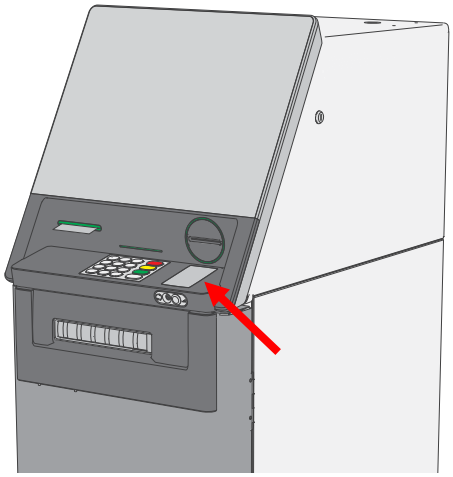

Figure 2: Illustration of ATM with contactless reader (arrow) below card reader

Investigation & analysis

As this was a complex system, with multiple factors contributing to the speed and responsiveness of the overall experience, different combinations of software application and platform had to be evaluated to ensure that a solution would work with all possible combinations.

Some of these factors include:

- Antennae position varying between cards and mobile devices, as previously discussed
- field strength of the contactless reader can vary between identical models of machine - probably due to build tolerance differences (e.g. position of internal metalwork in the ATM shelf might vary slightly).
- Type of feedback varies between implementations: some just use visual feedback, some use just an audible beep, some use both audible and visual feedback.

- Software architecture: variations in the system platform and application structure can mean that the timings and type of feedback change.

User test with NFC-enabled mobile devices

This first formative user test was conducted to understand likely user behaviour when using NFC-enabled smart devices, and to ascertain antenna position and read performance for different devices as this was not well understood or documented.

To begin with, a small-scale pilot test was conducted with seven participants and nine phones. Due to the lack of consistency of the location of the NFC antenna on mobile devices, it was difficult for users to know where it was on their phone and how it was to be used. If a user did not achieve a read straight away, the user moved or turned their phone around and then they successfully achieved a read. Most people tried using the top of the phone first. There was also confusion over how to enable NFC, and there was variation in different manufacturers in how this was achieved.

After this pilot test, it was clear that participants needed information on how to orient their mobile device. Additional guidance was developed, and then the extended evaluation took place with 17 participants, using 20 devices, including one wearable (an Apple Watch). The participants were initially asked to use their mobile device without any training or additional information. They were then all given the same informative graphics advising them to try holding the device in three different positions (Figure 3) and asked them to try again.

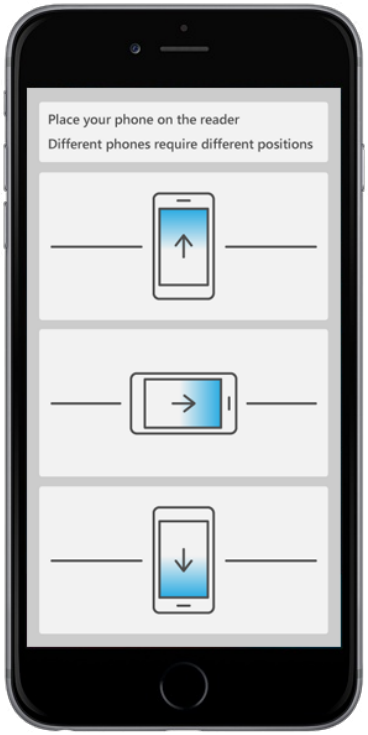

Figure 3: Orientation information

Most participants required the additional orientation information in order to complete the task. However, when given that information, the majority (16 of 17) successfully achieved a contactless read when given the additional orientation information. Figure 4 and Figure 5 illustrate some of the positions when using mobile phones and a watch, respectively.

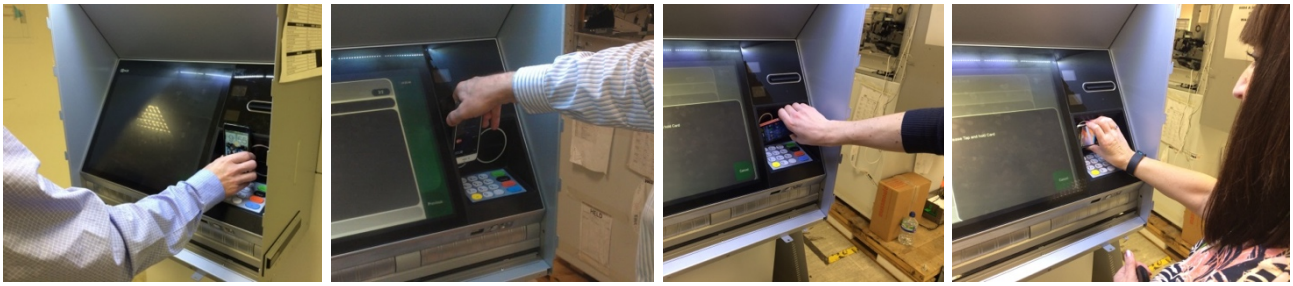

Figure 4: Participants using NFC-enabled smartphones

Figure 5: Participants using an NFC-enabled smartwatch

First proposal: Delay without feedback

Having understood more about the positional issues when using a mobile device, more work was needed to understand the inadvertent read issue with contactless cards, and to support engineering in evaluating possible solutions to this problem.

One of the early engineering proposals was to insert a delay into the software whereby, if a contactless token was read, then the system should wait a period of time (3 seconds) before accepting that token. This 3 second delay would allow users to insert a card into the conventional card reader if this was the intended action. The rationale for this was, if the user had not meant to read the card via the contactless reader, then they would be unaware of any issues.

This was evaluated by expert review by the authors. It was found to be unacceptable: the 3 second delay with no feedback made it appear that the reader had broken. It was not clear what to do next, and not clear why the card would not be accepted by the motorised card reader.

More detailed user test: Two contactless reader positions and three different cards

In this user test, multiple factors were investigated to try to better understand the problem. Two positions for the contactless reader were evaluated: on one ATM the contactless reader was further forward on the ATM shelf, and on the second ATM, the contactless reader was further back on the shelf. Placing the contactless reader further forward on the shelf was expected to make it easier to get a read: the contactless reader would be closer to the user so it would be easier for them to align more of the card directly over it. Three different contactless cards were used: one with a small, a second with a medium and a third with a large antenna, roughly equating to a weak, medium and strong read strength, respectively.

A total of 26 participants were recruited from staff members (23 male, 3 female). Participants were asked to complete two tasks: a) they were asked to use the contactless reader; and b) they were asked to use the motorised card reader (which allowed us to test if the card would be inadvertently read by the contactless reader). Experimental conditions were presented in a balanced order to alleviate learning effects.

With the contactless reader in the forward position, 24 participants experienced inadvertent reads. Conversely, only two participants experienced inadvertent reads when the contactless reader was positioned further back on the shelf. This difference was significant (χ^2 =21.043, p=0.000, using McNemar's test for paired nominal data).

All participants got successful reads of the contactless card regardless of the position of the contactless reader. However, four participants took multiple attempts to get a read when the contactless reader was further back on the shelf. This difference was significant (χ^2 =6.125, p=0.008, using McNemar's test for paired nominal data). Ratings for the ease of use (using a 7-point scale, where 1 was very bad, and 7 was very good) were also higher when the contactless

reader was in the forward position; this was also significant (t=-2.71, p=0.012, using Student's *t*-test)

In summary, when the contactless reader was positioned closer to the user, the contactless cards were read without problems and the ease of use was rated high. However, the majority of participants experienced the problem of inadvertent contactless read: particularly with the strongest card antenna, the contactless reader read it which then immediately disabled the conventional card reader. On the other hand, when the contactless reader was positioned further back, the inadvertent read was not such a significant problem but it was more difficult to get a contactless read.

Following on from this test, a solution was sought that would allow the user to insert a card into the conventional card reader even if the contactless reader had read it first.

Second proposal: Delay with feedback

In the next user test, we wanted to investigate the effect of a delay after the card was read by the contactless reader. During this delay, the user could insert the card into the conventional card reader and the application would continue with that card data. If the user did not insert a card during the delay, the application continued with the contactless data. This time the user was also given immediate feedback during the delay (an audible beep and a visual 'Please wait' message on the screen). As a control condition, one ATM did not have the delay, i.e. as soon as the contactless reader read a card, it would not allow the conventional card reader to be used.

Again, two positions for the contactless reader were compared: one ATM with the contactless reader further forward on the shelf, and another ATM with the contactless reader further back. There was also an additional ATM (with the contactless reader was in the further back position) which had the delay and also gave immediate visual and audible feedback to the user. The order of these experimental conditions was balanced. A total of 26 participants were recruited from staff members (18 male, 8 female).

When comparing the two contactless reader positions, again there was a slight preference for the contactless reader to be further forward on the shelf. This improved the perceived ease of use, and reduced the number of attempts required to get a read.

When considering the effect of the delay, when there was no delay (the conventional card reader was immediately disabled if a contactless read was detected), 17 of 26 participants experienced problems: the card could not be inserted into the conventional card reader. When there was the 3-second delay before the conventional card reader was disabled, all participants were able to insert their card successfully. This time they also had the added benefit of getting immediate feedback (a beep and a 'Please wait' message on the screen) to alleviate any confusion during the delay. Even if the contactless reader read the card first, the participants were unaware of any problems.

Additional user test: Similar solution but different software platform

This user test was conducted to evaluate a different software platform and a different application which meant that the solution was slightly different and had different timings. In this case, no immediate visual feedback was given (no 'Please wait' message), just an audible beep before the delay occurred. In addition, the delay time was reduced somewhat (approximately 1.4s) as the software architecture was modified from the previous version. Two identical ATMs were used in the test; the contactless reader was in the same position in both (Figure 6). The only difference between these two ATMs was the software build: one with immediate auditory feedback and a 1.4-second delay (during which the card could be inserted into the conventional card reader); and another with immediate auditory feedback but no delay (meaning that the card could not be inserted into the conventional card reader). Two cards were used in the test: one with a medium signal

strength and another with a weak signal strength. There were 30 participants (21 males and 9 females), again recruited from staff members.

All cards were successfully read by the contactless reader and the ease of use ratings were all positive for both software versions. Furthermore, the issue of inadvertent contactless read when the user is intending to insert the card was resolved: with the 1.4-second delay, all participants could successfully insert the cards into the conventional card reader. Without the delay, 29 of 30 participants could do it.

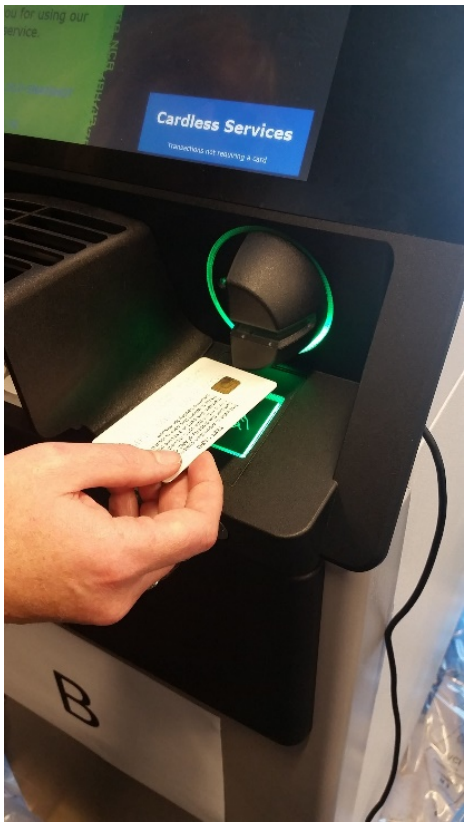

Figure 6: Participant using the contactless reader (with the conventional card reader immediately above)

Resolution of the problem

Through this series of user tests, an acceptable solution was found that allowed users to successfully complete the transaction using either a conventional or a contactless card reader. There were considerable technical challenges in making both card readers available at the same time but by carefully designing the user experience, these challenges could be hidden from users.

We approached the problem from three directions. Firstly, we wanted to find the best possible technical solution by experimenting with two different positions for the contactless reader. It became clear that the position further forward on the shelf had considerable benefits in terms of task completion and perceived ease of use. However, this position also increased the likelihood of the contactless reader inadvertently reading the card first, thereby disabling the conventional card reader. Secondly, we wanted to experiment with adding a delay which meant that even if the contactless reader read the card first, the user still had some time to insert the card into the conventional card reader if that was their intention. We discovered that the delay could help by giving the user time to make their intention clear before the ATM jumped to the conclusion that the user wanted to use the contactless reader. Thirdly, we experimented with the feedback provided for the user. It was unsurprising to discover that receiving feedback from the ATM is extremely important to users, but this series of tests gave us more information about the type of feedback that is useful in different stages of the transaction. Visual feedback on the screen is not necessarily useful when the user is focussing on handling their card around the card reader.

This work also enabled us to answer specific customer concerns on this very issue, and to demonstrate the suitability of the solution. This was of great help in repairing what could easily have become a damaged commercial relationship.

Impact and implications

This case study has wider implications than just the use of contactless technology in a self-service context. Firstly, it highlights the difficulty of introducing new technology and associated interaction styles without carefully considering the overall impact on the consumer and on other, seemingly unrelated functions. To the consumer, all these functions must appear as a cohesive, integrated experience that is useful and usable. Specifically, in the context of self-service banking, the main driver for consumers to choose ATM over other banking channels is ease of use, while the main

source of dissatisfaction is technical failures (Curran & Meuter 2005; Meuter et al. 2000). Perceived ease of use is also the most significant motivator for consumers' intention to continue using the SST (Chen et al 2009). So maximising ease of use and minimising the number of technical failures should encourage the adoption and continued use of SSTs.

Secondly, this case study illustrates the importance of iterative innovation with multiple rounds of ideation, concept creation, and user evaluation. Rejecting the entire solution of integrating contactless technology into the ATM would have resulted in significant financial penalties from customers who had already committed to the contactless technology. Furthermore, any revenue from this solution would have been lost until an acceptable solution was found. Through this iterative process, a pragmatic solution was found that had a minimal impact on development schedules and costs, while still mitigating the underlying issue.

Thirdly, this case study also demonstrates the importance of having usability and ergonomics professionals integrated into the development organisation as an active partner in developing new solutions. Without this tight integration, it is possible that the underlying issue of a confusing and conflicting user experience would not have been well understood, or a solution found to alleviate these effects, potentially meaning that useful technology (contactless readers) was not included in a product.

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