Lessons Learned: A study on user difficulties with Parking Meters

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ABSTRACT

This paper presents a study on user difficulties with parking meters. Using known Human-Computer Interaction (HCI) concepts as a guide, we explore the reasons for these difficulties and propose recommendations for designers of parking meters to improve the usability and experience. This paper also considers the applicability of these learnings to similar technologies that are of interest to HCI.

CCS CONCEPTS

• **Human-centered computing → Usability testing** • *Human-centered computing → User models* • *Human-centered computing → User studies*

KEYWORDS

ACM proceedings, HCI, Public I.T., Usability Testing, Mundane Technologies. [1]

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1 INTRODUCTION

Since its introduction in 1935 in downtown Oklahoma City [13], the parking meter has become ubiquitous in the streets of many municipalities around the world. The function of parking meters appears simple: to enable motorists to pay for the right to park their vehicle in each space for a period of time. Despite this seemingly straightforward function, we commonly hear people complain about their frustrating experiences when using parking meters. We have also observed people having problems when using parking meters. Our casual observations seem to point to several usability issues associated with the design of these meters. This piqued our interest because it begged the question as to why something so simple appeared to be problematic during use - especially given these devices have been in existence for over 80 years.

We wondered what specific issues contribute to these problematic (and sometime frustrating) interactions. Can Human-Computer Interaction (HCI) concepts shed light on the design of these parking meters and the problems people encounter when using these meters? Can HCI offer ideas to how these apparently 'simple' technologies can be improved? So, we conducted an exploratory study of parking meters. This paper reports on our study of people using different parking meters situated in several municipalities in the North Shore of Sydney.

Besides trying to use HCI concepts to understand and explain the problems encountered by people when using parking meters, we also want to explore whether other factors contribute to people's overall experiences of use of parking meters. The findings provide some recommendations for designers of parking meters on how to improve users' experiences of parking meters. It also reveals the using parking meters can be potentially performative in nature, contributing to the overall user experience and usability.

But more importantly, investigating the 'troubles' with parking meters highlights a class of technologies that we believe deserves more attention from the HCI community – Public I.T. [4][1]. Just like the parking meter, it hints that some of these useful public technologies could be designed more thoughtfully and made more usable. And just like using parking meters, HCI researchers should also consider the potentially performative nature of people' interactions with this class of technology and find ways to include this in their design considerations.

2 RELATED WORK

Despite the ubiquity of the parking meter, and its length of service, we were unable to find significant amount of scholarly work on parking meters, especially efforts related to their usability. What we did discover were a significant number of engineering patents for parking meter technologies, (e.g. a combined parking meter/battery charger station [15] or an Automatic debiting parking meter system [6]). We did find several contributions that focused on technologies and themes that the parking meter shares, such as ticket vending and validation

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machines [4]. The rest are technological solutions, often through crowdsourcing, that are focused on finding or predicting an available car parking spot [9] and helping people to locate where they have parked their car [14]. Other contributions were broader, considering not just the technology, but policy implications for government [8]. The contribution closest to considering usability issues with parking meters involved the testing of a novel prototype that allowed users to reserve parking spaces in advance, however the contribution did not sufficiently unpack the experience for users using existing meter technologies [9].

Dourish et al., [2]. helpfully frames this group of technologies as Mundane Technologies. Dourish et al., [2] summarises mundane technologies as those which are ordinary, commonplace and form an unremarkable part of everyday life. The authors go on to suggest that to some, mundane technologies are "commonly associated with being boring". However, [2] ask us not to disparage such technologies, and challenge that view, suggesting instead that these technologies can offer "richly layered social interactions". We were skeptical that a technology such as the parking meter can offer "richly layered social interactions". This provided further motivation for the study we describe in this paper.

While we did not find papers that explored people's experiences with parking meters, Kristoffersen and Bratteberg's [4][5] ethnographic study of train passengers in Norway using a ticketless system - a technology that bears commonalities with the parking meter. They proposed that this system can be categorised as "Public I.T.". The study looked how people used ticketless system, located the at the central train station, to travel to and from the airport. After studying people's use and experiences with this one system, the authors concluded that despite the "simplicity and intuitive usefulness" of many of these types of technologies, they "actually seem quite disagreeable for people to use" [11].

Kristoffersen and Bratteberg's [5] twelve-month observational study generated several insights that challenge whether traditional HCI thinking applies to "Public I.T." devices. While the authors strongly agree with principles such as "affordance" and "feedback" being important concepts in designing interfaces, they suggest that the simplistic employment of these principles in the ticketless machine they studied was not appropriate, and that a more nuanced approach to designing Public I.T. interfaces is required [5]. One example they gave was related to the principle of visibility. They articulate a tension: at one level, they saw the benefits of increasing the visibility of the technology so that users can learn how to use the device by watching others. However, the visibility led to users feeling anxious (performance anxiety) and sometimes inept as they are watched by others. The authors suggest that this 'visibility tension' needs to be reconciled, and may require extending existing usability principles when designing "public display of private interaction" [5].

Whilst the ticketless system at the centre of Kristoffersen and Bratteberg's study [5] shared a number commonalities with parking meters, there are some key differences between them. Firstly, the interaction sequence for ticketless travel had few steps and offered limited functionality and input. Users would purchase their train fare with their credit card, which also doubles as their train ticket. The fare was calculated automatically based on the origin and destination points where the user had swiped their credit card. In contrast, parking meters offer users a few interaction styles and input options during the transaction process. For example, the choice of payment methods (coin or credit card) will alter how users select and purchase time for parking.

Secondly, the context of parking meters is different to that of the ticketless system in Kristoffersen and Bratteberg's [5] study. Whilst both exist in public spaces, the train station had staff on hand to assist people using the ticketless system. In the case of the parking meters we studied, there were no equivalent staff present to assist.

Kristoffersen and Bratteberg's [5] understandings of the usability issues of the ticketless system were built upon studying one system. The difficulties we observed users having with parking meters were seen in several different parking meter systems throughout the city. Given the differing interfaces of these parking meters, we needed to select a few parking meters that would be representative of the technology as a whole.

3 PARKING METERS IN ACTION: APPROACH

The study involved interviews with four participants, 3 males and 1 female (P1- P4) aged between 21-66. Each participant was individually driven to three different parking meters, and asked to complete a task whilst being observed. The participant would then be interviewed about their experiences. These three parking meters were selected because they are representative of the range of parking meters in use in this city.

Once the participant located the parking meter, they would be asked to select the least amount of time the meter permitted. Participants were told they could purchase the parking time using either coin or credit card. Participants were asked to think aloud, sharing their thought process and experience as they went about completing their task. Their interactions and comments were recorded by the interviewer. After the interaction had concluded, the participant was asked to further reflect on the interaction.

3.1 Parking Meter System Selection

This study only considered on-street parking meter systems. We did not consider off-street parking systems, such as those found in shopping centres. The three parking meters selected are described below.

3.1.1 M1: Multi-bay Parking System. The multi-bay parking system sees several parking spaces on a street given unique bay numbers. Motorists are required to park within the designated bay, marked by painted lines. The bay number is painted onto the sidewalk, immediately adjacent to the parking bay, and includes an arrow pointing to the meter responsible for the group of parking bays. Motorists can only use the meter attached to the group of parking bays they have parked in. They are unable to use a meter connected to a different set of parking bays. Motorists are required to enter the bay number of the parking space they have parked in, select the time they wish to purchase, and then pay, using either credit card or coin. Upon completion of the transaction, no ticket is printed – rather the time remaining for that bay is displayed briefly on the screen. Should the motorist wish to check, they must enter the bay number again.

3.1.2 M2: Pay-and-Display (number plate). The Pay-and-Display (PAD) system works in a similar way to the multi-bay system in that one meter can service multiple car parking spots, however the notion of numbered parking bays does not exist. Multi-bay parking sees purchased time linked to a bay number. PAD sees purchased time linked to a printed ticket. In the case of M2, this is extended to include the registration plate of the car which the user enters why purchasing a ticket, which is printed at the end of the transaction.

3.1.3 M3: Pay-and-Display. M3 works the same way as M2 in principle, except you don't enter your registration plate. This means time purchased is only linked to the printed ticket, not the ticket *and* registration plate number.

In the case of both M2 and M3, motorists are required to place the printed parking ticket face up on the dashboard of their parked car.

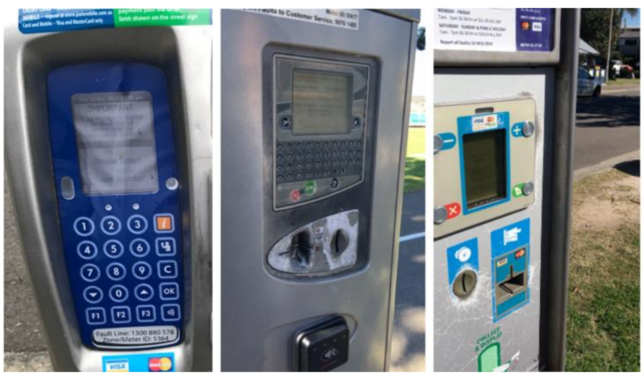

Figure 1: Selection of three parking meters (*Left, M1. Center, M2. Right, M3*)

3.2 Data Analysis

The audio and video recordings captured during the interviews were transcribed. We conducted thematic analysis on the dataset to identify salient themes pertaining to each type of parking meter (M1, M2, M3) [7].

4 FINDINGS

Overall, we found all our participants encountered some level of difficulty and frustration when using the parking meters under investigation. The study produced several findings, which have been grouped into three themes: Visibility, Ambiguity and Performance.

4.1 Visibility

Across all three machines, a lack of visibility was the most significant cause of difficulties for users. Problems because of a lack of visibility were experienced by every participant at some stage throughout the study. The issue of visibility is two-fold: 1) legibility issues either because of the environmental context (direct sunlight), form design (height of parking meter / angle of screen) or the contrast and brightness of the screen, and 2) visibility of functionality (e.g. how to select time).

To combat legibility issues, all participants were forced to either squint, bending over, or shade the screen with their hand to see the text on the screen (see Figure 2). The poor legibility of the instructions on the screen meant the participants had difficulty beginning the interaction. The reduced screen visibility hindered feedback to the participant, which in some cases led to errors, and increased the time taken to complete each task.

Issues with the visibility of functionality were seen in three participants, who were confused by the instructions on the screen, reporting that it was not clear what was being asked of them and what they needed to do next to complete their task. Participants dealt with this confusion through a process of trial and error, pushing different buttons and evaluating the outcome.

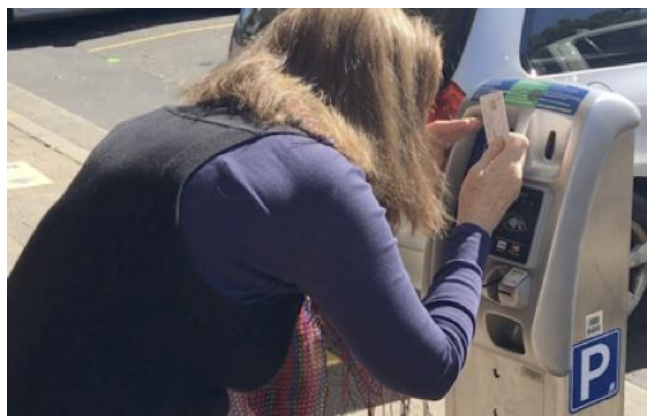

Figure 2: Participant bent over, squinting and shading the screen to try and read the screen's content.

4.2 Ambiguity

Participants found some buttons and their associated functions ambiguous. For example, one participant in the case of M1, believed she could use the numerical keypad (used to enter the bay number in the previous step) to enter their time selection. Using the keypad to enter time selection led to errors, which in turn caused more confusion for the user. There was no information on the keypad that specified when certain buttons could and should be used. Another example of ambiguity is seen Figure 3 where the buttons have dual meanings. Figure 3 shows a button with a label (white X on red background) printed on the device itself. There is however *another* label, presented on the screen *beside* the button which says "Help". These are competing messages: one may mean cancel, the other may mean help – and it is unclear to the user which one would occur if the button was pushed. There is also a difference in visibility between the two buttons. The printed label was more visible to the user than the digital label that was to supersede the printed label if present. In the case of one participant, he was unable to find the credit card button because none of the *printed* labels matched – and the poor visibility of the screen meant he hadn't seen the digital label. We also observed that participants became confused by the ambiguous feedback in messages. In the case of a user we observed, she received a message "card declined". She didn't know the reason for the decline, or how to fix it. Because of poor visibility, she had not seen that her card was not accepted and that she could only use Visa or Mastercard.

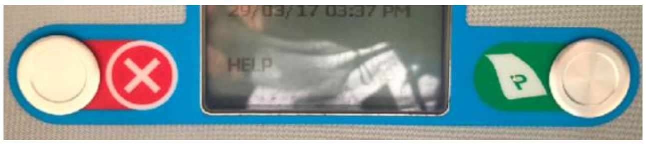

Figure 3: M3 – Example of Dual Message Buttons

4.3 Performance

During our interview with P3 whilst using M1, P3 stepped aside to allow another motorist (S1) to use the machine. We observed S1's interaction with the meter, and recorded the insights in this paper, despite S1 not being a participant in the study. Watched by the interviewer and P3, we discovered that as S1 encountered difficulties with the system they became increasingly embarrassed and flustered. This visible embarrassment was exacerbated by another motorist (S2) offering to assist S1.

5 DISCUSSION

This paper set out to understand why people had difficulties using parking meters. It highlights the value of contextual interviews. And as Kristoffersen and Bratteberg [5] found, efforts to understand a system's usability cannot simply rely on observational studies alone. Through the lens of known HCI concepts such as Nielsen's Usability Heuristics [10][11] and Norman's Design Principles [12], in combination with the insights gained from Kristoffersen and Bratteberg's study [5], we can begin to understand the source of these difficulties, and how one might begin to remedy them.

However, this study does have some limitations. The most significant limitation was its sample size. We acknowledge that small sample sizes make it difficult to gain generalizable insights, and can give disproportionate statistical weight to the insights of a single participant. However, this study did not seek to generalize its findings, but rather sought to explore and uncover the kinds of problems people face when using parking meters. The aim is to use these insights to guide further and more in-depth investigations.

The lack of visibility identified in the parking meters was the most significant cause of difficulty for users. The importance of functions and feedback being visible [12] is self-evident: a user will struggle to use a system if they can't 'see' critical interaction elements of the interface. The three meters we evaluated relied heavily on the screen as the primary mechanism for user guidance and feedback. This is unfortunate, as the legibility of the content on the screen was easily and significantly affected by sunlight and a limited viewing angle. These were compounded by small font sizes, poor user guidance, and ambiguous labels. However, in our opinion, designing larger displays to remedy visibility issues may not be the only nor best solution. In fact, the key components of the interaction, such as instructions, parking tariffs and feedback, need not rely on the screen at all. We see greater potential on redesigning the parking meter body and its various input devices. For example, instructions for the meter's use can be printed on the meter body, in a large font size and with high-contrast colors will reduce visibility issues due to direct sunlight. These instructions can be backlit, or written in luminescent ink in cases where the meter will be used at night. The mapping of the input controls can be enhanced by presenting these instructions alongside relevant input/output devices, as opposed to presenting them as a block – disconnected with the input controls they reference. These changes, combined with a reduction in the number of input devices, a simplification of the transaction process, elimination of buttons with a dual meaning/function, use of aural tones in concert with high-contrast LED indicators to provide feedback and user guidance, are perhaps some ways in which we can make parking meters more usable.

Whilst employing these known HCI concepts deals mostly with user difficulties of a cognitive origin, they don't address the social issues that were raised in our study, although they may go some way in reducing them. Our observations of performance anxiety, seen also Kristoffersen and Bratteberg's study [5], reinforces the argument of Dourish et al., [2] of a social dimension to these types of technologies, and should be considered by designers of technologies such as parking meters.

6 NEXT STEPS

This exploratory investigation reminds the HCI community about the need to consider the design for what appears to be a forgotten class of technologies. It offers great opportunities for HCI to rethink and reimagine ways to redesign an everyday public technology such as the parking meter. We plan on building a modular parking meter prototype to test some of our design recommendations, and explore the nuances of applying known HCI concepts to parking meters.

Finally, this study also reminds us that the parking meter is just one of the many other 'shared public technologies' that people encounter and use in their everyday lives. This offers great opportunities for HCI to be more involved in the (re)design of other shared public technologies, not only to ensure and improve their usability but also people's experiences when interacting with these technologies.

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