A case for Number Entry

Sarah Wiseman
UCL Interaction Centre
University College London
London, WC1E 6BT
s.wiseman@cs.ucl.ac.uk

Anna L. Cox
UCL Interaction Centre
University College London
London, WC1E 6BT
anna.cox@ucl.ac.uk

Duncan P. Brumby
UCL Interaction Centre
University College London
London, WC1E 6BT
d.brumby@ucl.ac.uk

Abstract
The field of text entry has long been focused on purely alphabetical text entry, concentrating on language typing tasks and paying little attention to the task of number entry. Not only does number entry often require a different interface from text entry, it is also subject to different errors and phenomena from text entry. Number entry occurs in many domains in the real world and for this reason this paper argues that more attention needs to be paid to this niche area of text entry.

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Introduction
The study of text entry has long been focused on the task of continuous writing of words, be it composition or transcription. However, the requirements of text entry have changed and diversified since the early days of studying office workers copying text[1]. Text entry nowadays considers not only how people enter words and letters but also how they enter numbers and digits. Just as admin workers are required to type at a particular rate of words-per-minute, job adverts now may require a "keys-per-minute" skill level from potential data entry workers. This is not the only career that requires number entry; it is also the case that in areas such as retail, accountancy and medicine people are required to enter numbers in a fast and accurate manner using a computer input device. It is important that HCI understands number entry so as to be able to design appropriate input methods that support fast and accurate input of numbers.

In order to make text entry easier, there have been many design improvements to the input devices that

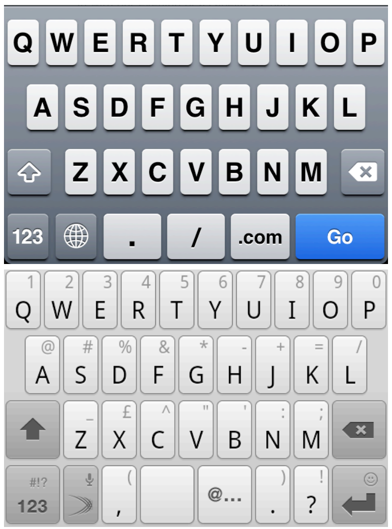

Figure 1. Adapted keyboards on the iOS and Android mobile phone interfaces

we use, often by reducing the number of key presses required for certain actions. If we consider the mobile phones before touch screens were common, predictive text made it much easier to enter words on a number pad interface. As shown in figure 1, shortcut buttons are added to the keyboard of modern touch screen phones to meet the current task's needs; for example giving the user a ".com" button when entering a URL or the '@' key when typing out an email. The method of typing itself is also changing with the introduction of keyboards that rely not on finger taps but finger swipes[7].

In contrast, the number pad that is used in many number entry tasks has largely remained unchanged since its conception and has not enjoyed the kind of innovative design shortcuts used to support text entry. There are however changes being made with the advent of touch screen phones. For example the iPhone has implemented a variety of new number entry methods, from number pads to scroll wheels. In particular, sticky keys on calendars seem a good idea; most meetings tend to start on the hour or at half past the hour.

To determine how effective these alterations are for aiding number entry, more needs to be known about the mental processes behind the number entry task. The field of text entry has learnt much from the works of Salthouse[3], culminating in a series of transcription typing phenomena, which provide benchmarks against which cognitive modelers can test models of typing. Equally the phenomena can be used to recommend ideal transcription typing conditions with regard to the amount of text look ahead required for optimum typing or the likelihood of errors occurring with certain letters.

Again, this amount of information is not available for those investigating the number entry domain, and therefore the recent design decisions do not have phenomena to be tested against, nor do we have any way of predicting what an ideal interface might look like for the number entry task.

There is a small amount of research going on in the number entry field, mainly with a view to informing medical design. For example, there has been research into how interfaces can be designed to catch particular errors that medical workers may make[4] and investigations into which interfaces help users to focus on reading the number they are entering[2]. More generally, there have been attempts to model the process of entering spoken numbers and applying the Salthouse phenomena[3] However, this research is not yet at a stage of maturity to have a positive impact upon number entry systems in a way that may make serious errors far less likely and thus save time, money and potentially lives.

In this paper, we discuss two of our pieces of ongoing work in the field of number entry, with an aim to understand both the process and the potential errors that people make when entering numbers. We feel that these particular pieces of work represent important first steps into understanding number entry; the first describes the creation of a number entry error taxonomy, which aims to classify and understand the errors that occur when transcribing number. The second piece of work describes our research into the numbers being used in hospitals and what we can learn from this data about real world number entry tasks.

Number Entry Error Taxonomy

The number entry error taxonomy (NEET) was created as a method of classifying number entry errors depending upon their potential underlying causes[5]. The NEET provides both a label for an observed error and also links the error to others similar to it so that patterns may be noted.

Some examples of errors within the NEET mimic common errors found whilst typing any sort of text, for example the transcription or anagram errors, omissions and insertion of digits. However, some of the errors are unique to the number entry domain.

Two particularly interesting examples of number specific errors are the "Zero for decimal" and "Decimal for zero" errors. These error classifications were necessary due to the large number of errors resulting in a zero where there should be a decimal place and vice versa. After investigation it was discovered that this error was likely to be caused by the design of the number entry interface, which had switched the positions of the decimal point and zero key when compared to most calculator interfaces. This 'switched' design was later noted being used on certain designs of infusion pump in hospitals.

In the above example, the NEET was useful because it provided insight into a potentially dangerous number entry interface design. In the near future we plan to conduct further work that will hone in on the causes of certain number entry errors, the taxonomy could work as a tool both for researchers analysing experimental data and for designers aiming to avoid error-inducing interfaces. Despite its current number entry focus, this could be expanded upon to be of use to the text entry community as a whole.

Digit Analysis

The second strand of our work reported here is an analysis of digits that are entered in naturalistic work settings. The aim is to learn more about the digits and numbers actually being used in certain tasks, specifically within the medical domain[6] Based upon the information that certain letters have different frequencies in typing tasks and consequently have different error rates, we investigated whether digits have different frequencies in a medical setting.

The data was gathered from infusion pump logs and analysed. This evaluation showed that there were indeed very different distributions of digits being used. The digit 0 occurred over three times as often as the next most common digit, 1. The digits 2 and 5 also occurred more frequently than the average expectancy. The number of times that the number 999 was used was also very high.

This information not only means that studies into how digit frequency affect error rates would be useful, it may also provide design suggestions. For example, making the common patterns of digits easier to enter, perhaps using a scroll wheel as with the iPhone time entry method, and making more likely number "sticky". One could even accommodate the 999 number entries by providing a max button that infuses at the fastest rate possible.

In addition to these design implications, this analysis has a secondary use in experimental design. Previous experiments involving number entry in medical settings have used randomly generated numbers[2,5]. However we now have a set of numbers that are more realistic and adhere to real world digit distributions, thus allowing us to study frequency effects within number entry experiments.

Discussion and Future Work

The two pieces of work described in this paper show that our work in the area of number entry can already inform certain device designs. It also highlights the amount of work yet to do. We wish to attend the workshop: to gain input from others who are interested in these issues.

The NEET needs refinement so that it is able to predict error cause with more certainty. This will occur as more number entry error experiments are performed and more data gathered. The digit analysis work proved interesting with regards to infusion pumps, it now needs to be applied to different fields within medicine, for example GPs' records or pharmacy prescriptions. In the future it could easily be extended outside of the medical domain to other fields such as finance.

These are not the only lines of work necessary to understanding more about the process of number entry. It is not clear how our understanding of number will affect our ability to type numbers. Future work will look into how people read numbers and memorise them, and how magnitude information held by the numbers can be utilised to aid memorization and checking.

The ultimate goal is to produce number entry interfaces that are less error prone and will eventually prevent serious errors occurring. By attending this workshop we hope to both raise the profile of number entry interfaces within text entry, and also to gain feedback and inspiration from experts in this field, with the aim of developing potential collaborations.

References

1. Gentner, D. and Larochelle, S. Lexical, sublexical, and peripheral effects in skilled typewriting. *Cognitive Psychology 20*, 4 (1988), 524-548.

2. Oladimeji, P., Thimbleby, H., and Cox, A. Number entry interfaces and their effects on error detection. *Human-Computer Interaction–INTERACT 2011*, (2011), 178–185.

3. Salthouse, T.A. Perceptual, cognitive, and motoric aspects of transcription typing. *Psychological bulletin 99*, 3 (1986), 303-19.

4. Thimbleby, H. and Cairns, P. Reducing number entry errors: solving a widespread, serious problem. *Journal of the Royal Society, Interface 7*, 51 (2010), 1429-39.

5. Wiseman, S., Cairns, P., and Cox, A. A taxonomy of number entry error. *BCS Conference on HCI*, (2011).

6. Wiseman, S., Cox, A.L., and Brumby, D.P. Designing for the task: What numbers are really used in hospitals? *CHI Work In Progress*, (2012).

7. Zhai, S., Kristensson, P., Gong, P., and Greiner, M. Shapewriter on the iPhone: from the laboratory to the real world. *Proc. CHI*, (2009), 2667-2670.