Curbing Paper Wastage Using Flavoured Feedback

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ABSTRACT
In November 2009 the researcher embarked on a project aimed at reducing the amount of paper used by Queensland University of Technology (QUT) staff in their daily workplace activities. The key goal was to communicate to staff that excessive printing has a tangible and negative effect on their workplace and local environment. The research objective was to better understand what motivates staff towards more ecologically sustainable printing practises, whilst meeting their job's demands. The current study is built on previous research that found that one interface does not address the needs of all users when creating persuasive Human Computer Interaction (HCI) interventions targeting resource consumption. In response, the current study created and trialled software that communicates individual paper consumption in precise metrics. Based on preliminary research data different metric sets have been defined to address the different motivations and beliefs of user archetypes using descriptive and injunctive normative information.

Author Keywords

Human-Computer Interaction, Paper Conservation, Environmental Sustainability, Interaction Design, Printing, Social Norms, Feedback, Urban Informatics

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
The added mobility, ease of use and ubiquity of modern computing devices means that tools are available to track, reflect and intervene in our daily lives in real-time. HCI interventions tackling resource consumption, however, are still an emerging area of research, and real-time resource monitoring has only recently appeared in Australian households. Current implementations are simplistic, and the gap between effective interface design and what is deployed is vast (Pierce, Odom, & Blevis, 2008). There is a need to inform the design of computing devices that specifically grapple with resource consumption. Moreover, to Address HCI elements of computing devices that augment personal control while raising awareness of, and motivating people to, lower their resource consumption.

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To this end, the research reported on herein examines the development and deployment of software within an office environment providing regular targeted feedback that describes individual resource consumption. This feedback contains different metrics and comparison data on paper usage addressing the different motivations and beliefs of the office staff. The metrics applied offer an array of interpretations (e.g. printed paper usage in terms of trees cut down). Each interpretation communicates feedback while simultaneously attaching feelings to the information, be they playful, moral, serious or other. Currently three different information 'flavours' are offered: eco-metrics, financial/traditional statistics, and comparison based statistics. These information flavours seek to offer users a choice based on their attitudes and preferences towards receiving feedback about their printing behaviour. Not everyone holds the same beliefs, attitudes and motivations, and so the researcher concurs with He, Greenberg, and Huang (2009), in that no one interface will suit all people. The study's aim is to understand how to supply resource consumption information to participants in ways they view as relevant and useful, acknowledging that for other participants that same information may not prove useful or be considered legitimate or motivating.

The research reported here is work-in-progress and forms part of a larger program of research into strategies to connect people through real-time visualisations of resource consumption. The pilot study reported upon within this paper entwines ethnography informed research methods and software development principles. The chosen environment features a cross section of different areas of responsibility within business, ranging from upper and executive management to IT services, financials, accounting, and marketing. Expert user testing is currently underway and a subsequent rollout to around 120-160 staff is planned for late 2010.

The remainder of this paper is structured as follows. The next section reviews related research drawn from the literature surrounding human-computer interaction, environmental sustainability, interaction design and persuasive technology. This section is followed by the approach to the current research and some of the preliminary findings. Subsequently the methodology in use for this research is explained. A short discussion reviewing future work concludes this paper.

RELATED WORK
The HCI community has produced a range of solutions facilitating rich and immediate resource consumption feedback. The findings most reported by research focus on several key themes covered in the subsections below.

Resource Consumption Feedback

Feedback is inherently information and is offered to consumers at contextually relevant moments in time and space. The information provided at these moments has attributes or qualities that aid in understanding, accessibility and retention (Darby, 2006). Feedback in some form is available for almost all of the resources people consume in the course of their daily lives. Major sources of consumption can be readily measured by existing technology and infrastructure around us. The proportion, quality and granularity of the resource consumption feedback that reaches consumers though is often simplistic (Froehlich, Findlater, & Landay, 2010).

Progress is being made to introduce higher quality information of greater granularity and immediacy to consumers. Evidence of this trend is present in newer model cars offering detailed fuel econometrics, and the introduction of government sponsored campaigns to install real-time electricity monitoring in homes. Likewise the value of social comparison in particular settings rather than more traditional self-comparison to is underway.

Where a gap is often found though is in the translation of the consumption data to a readily accessible source of actionable information for consumers (Darby, 2006). More problematic still is even though a proportion of people understand the ways they consume, they still do not take up relevant pro-environmental behaviours to reduce their consumption.

Feedback Encouraging Pro-environmental Behaviour

Pro-environmental behaviour considers what motivates people to engage in behaviours beneficial to the environment, and how these motivations may be fostered within societies (Steg & Vlek, 2009). The current study follows the model of responsible environmental behaviour (a rational choice model) which views human behaviour as regulated by a systematic process of evaluating expected utility (self-interest). This model extends the more traditional attitude models by including the intention to act as well as situational factors (such as knowledge of issues and of appropriate action) in determining whether attitudes actually predict behaviour (Froehlich et. al., 2010).

To address this need for actionable feedback guiding pro-environmental behaviour, the results of numerous studies examining the facets of information that facilitate action are summarised in Figure 1. This taxonomy is by no means exhaustive, canvassing aspects relevant to the current research. Each box represents at least one theory (such as Abrahamse, Steg, Vlek, & Rothengatter, 2005; Darby, 2006; He, et al., 2009), or significant aspect of that theory.

The results of different forms of comparison, such as comparison in isolation, with anonymous or unfamiliar others, or with known counterparts, aid in understanding consumer design preferences. Designing HCI interventions that not only communicate effectively, but also persuade is a key requirement when addressing pro-environmental behaviour.

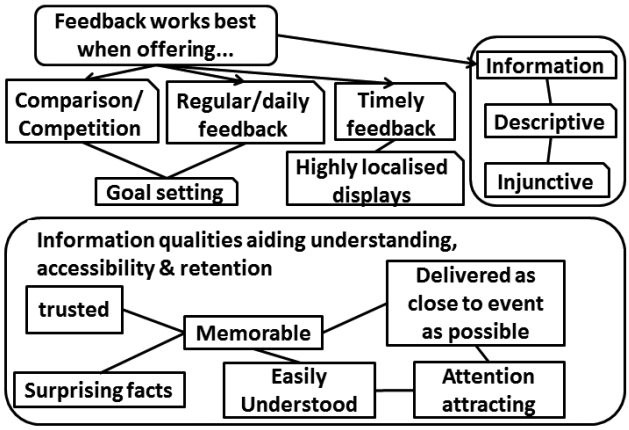

Fig. 1: Taxonomy of Feedback

Affecting Social Norms Using Descriptive and Injunctive Normative Information

The role that social norms play in predicting behaviour is well established (Reno, Cialdini, & Kallgren, 1993; Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007). Social norms can be divided into two types: descriptive and injunctive. *Descriptive* norms are essentially the perception of what is commonly done, and describe a standard that people attempt to adhere to (Reno, et al., 1993). Diverging either above or below the norm or mean is considered deviant. *Injunctive* norms describe what is commonly perceived as approved or disapproved activities (given a certain culture). For example, offering a graph showing an individual is below the norm paper usage (descriptive), accompanied by a smiling face communicating approval (injunctive), helps to prevent a return to the perceived norm (i.e. an increase in paper usage).

One Size Does Not Fit All in Interface Design

Interfaces are usually designed to offer accessibility to the largest possible audience (Satchell & Dourish, 2009). HCI often reports on issues relating to the usability and aesthetics of developed interfaces rather than the need for multiple interfaces (such as Dillahunt, Becker, Mankoff, & Kraut, 2008; Froehlich et al., 2009). Research it seems often applies a one-size-fits-all policy to interface development.

The difficulty encountered by a single interface is that users are rarely homogeneous in their motivations, attitudes and behaviours (Upham, et al., 2009). If it is accepted that people are motivated differently and likewise hold different behaviours and attitudes (Beebe, Beebe, & Redmond, 1995), it follows that interface designers need to develop a range of different interfaces addressing user needs (He, et al., 2009), or provide sufficiently comprehensive interface configurability.

USER STUDY

In the second-half of 2009, after discussions with the QUT Sustainability Group, a project aiming to reduce paper usage within a QUT office environment was initiated. A project plan was drawn up and the research team met with other key stakeholders to develop a set of design specifications for a HCI intervention targeting the printing habits of staff working in a selected office environment. The chosen office is a newly built five level

open-plan six-star energy rated building, boasting heavily trafficked communal lunch rooms and large meeting areas lit by natural light. The office is located within the QUT Kelvin Grove Urban Village and offers views of the surrounding campus and village. Each level provides desk space for around 120-160 staff, with job roles ranging from upper and executive management to IT services, financials, accounting, and marketing. The printing facilities for each level are four centrally located industrial multi-function centres.

From this point on the research conducted comprised of two major components, each working in tandem. The *first* was to discover the causes for paper usage within the professional work environment. The *second* was to develop an HCI toolset capable of communicating with staff addressing the causes.

In communication with key stakeholders a semi-structured interview questionnaire was developed to examine the attitudes and feedback preferences for printing consumption data. Staff were recommended by the key stakeholders, under the direction that the research sought to sample a cross section of staff roles and levels of responsibility within the work environment. 15 recorded interviews were conducted in November and December 2009. During this period the researcher was collocated within the work environment each Thursday conducting direct observations and gathering usage data and statistics directly from the four communal printers available to staff.

Emergent Printing Themes

Analysis of the interviews yielded three themes. Firstly, any printing conducted by staff was viewed as necessary, excepting accidents. Secondly, staff viewed different metrics as relevant or alternatively as unnecessary for feedback on printing behaviour. Lastly, staff viewed co-workers championing reduced paper use as a helpful reminder to be conscious of how much they were printing.

The second theme supported the need for differing interfaces providing meaningful resource consumption information for all staff. This theme also supported the need for persona describing the feedback preferences found in staff. These persona are still being developed and currently testing of the noted desires of interviewees is part of an expert user group evaluation underway.

The initial semi-structured interviews also revealed some interesting staff beliefs. There was a resounding feeling that sufficient information was gathered on paper usage for a team and individually by simply looking at the build-up of paper in the recycling pile. Also reinforced by the interviews was the feeling that there was a journey taking place, that printing was more than just an opportunity to get up from the desk and collect printing. The communal printing facilities meant that one-way, a journey to the printer could take 45 seconds, and on the way co-workers were encountered offering an opportunity to socialise.

Lastly, as examined by Pierce, Odom, & Blevis (2008) levels of individual and third-party control differ between environments. The observed and commented upon level of individual control and legitimate interactions available to staff using HCI based conservation interventions was limited as third-party control of job roles mandated certain printing activities. For example, some documents due to workflows required printing in triplicate.

The current research will, where possible, examine such mandatory printing workflows. Printing mandated by job roles (such as financials printing more during tax time) speaks to the previously mentioned belief of individual staff that, excluding accidents printing they conducted was necessary. Discovering if this belief is justified could prove extremely novel. For if staff are already actively minimising printing within their job activities, the need for a stronger focus on management practices and a collective effort to rethink printing policy may be justified. If however this perception proves false, there is a need to identify the culprit behaviours responsible for excessive printing.

SOFTWARE DEVELOPMENT AND EVALUATION

A software prototype was developed satisfying three main functional requirements. Firstly, to regularly parse and store exported print log data for the work environment in an SQL database autonomously. Secondly, to email individual staff, or staff groups using XML templates including real-time generated graphics with data driven explanations of printing activities (as shown in figure 2). Lastly, to generate exportable reports and metrics summarising print consumption data for dynamic time and personnel ranges. Email was chosen as the ideal communication channel as no other channel was deemed legitimate by all staff.

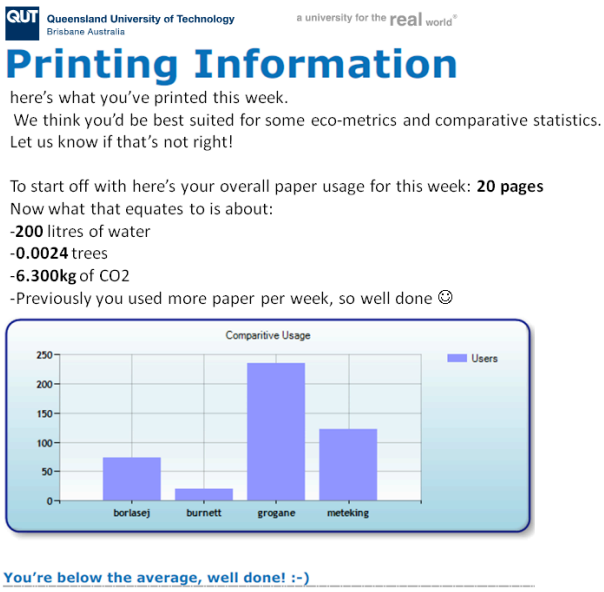

Fig. 2: Email with eco-metrics and comparative statistics

The software has gathered baseline data since November 2009. It is the view of the researcher that, given the design of this study, staff opting-out of participating actively should anonymously be used as a control group to account for variations and contributing to the validity and soundness of findings linked to behavioural change.

When considering the development of email templates sent to staff, the interview findings supported the need for multiple methods for communicating the same information. Where some staff viewed eco-metrics as valid or highly valuable as a method for tracking and curbing printing usage, others disagreed noting first that these metrics would not prove helpful to them, and subsequently explaining how they viewed comparative or financial metrics, as useful. When addressing the differing motivations and attitudes of users it can be seen that if a single interface is deployed without a degree of customisation or configurability its acceptance and perceived ease of use may vary.

Three templates currently being trialled in an expert user review: eco-metrics, financial/traditional statistics, and comparison based statistics. Each aligns with a different potential user archetype drawn from initial interview analysis. Expert users will over one month receive all three templates, and be asked twice for directed feedback on the templates and any behavioural observations. Undirected feedback may be offered at any time. At the conclusion of the month the print data will be examined for indicators of the impact of different templates. Focus groups will then be conducted to confirm any conclusions drawn from the data examination and to discuss novel trends. Follow up interviews with outliers or participants with interesting contributions will also be conducted.

FUTURE WORK AND CONCLUSION

This paper presented the preliminary research findings discussing experiences with HCI interventions addressing paper conservation in a professional work environment. This research addresses a gap in knowledge about targeted feedback on resource consumption and the need to better address individual preferences, motivations and beliefs. Additionally the novel interview findings relating to printing perceptions may lead to other avenues of investigation. The interviews conducted inform the design of the feedback provided to participants, whereas current designs often consider and employ a single interface to accomplish their goals.

The next step is to deploy the software across two levels of the chosen office building, encompassing over 120 staff. Beyond the introduction of accurate information on printing usage, the aim is to also explore the use of ambient devices placed within the environment. Ambient devices offer functional aesthetics unavailable on other platforms, and while being novel, ambient devices also afford lower cognitive load, as they may be cursorily or peripherally perceived (Mistry, Maes, & Chang, 2009). The rationale is to augment feedback accessibility by delivering timely information as close as possible to the event on attention-attracting localised displays.

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