interfaces

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Health technology– An accident waiting to happen?

Prescribing IT for health
Harold Thimbleby

Standards and medical equipment
Chris Vincent

Disparately seeking healthy information
Elizabeth Sillence

Bringing the creative industries into HCI
Jeffrey Bardzell et al

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Authors should please provide a 70–80-word biography and a high resolution head and shoulders original digital photo. Photographers' credits will be printed if provided.

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interfaces

This issue of Interfaces explores HCI's role in the development of health technology, from Harold Thimbleby's very eloquent exploration of the scale and scope of the problems facing the development of IT for the health industry, through the standards explosion to the growing use of both medical information and equipment by older and untrained people.

The medical industry has been slow to adopt user centred approaches, and we still see design errors that we would expect HCI students not to make. Let's hope that the next time we address this issue in Interfaces we are not still pointing out the problems, poor designs and adverse events that have resulted but are promoting successful design in this area.

While health technology is anchored in risk, safety and rigorous processes, Gilbert Cockton and his workshop attendees explore the role of the Arts and design research in HCI at the more creative end of the spectrum.

Enjoy – and I look forward to seeing you all at the conference at Abertay in September.

Lynne Coventry

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View from the Chair

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Our community has evolved a range of ideas – such as gulfs, seams and flows – to understand what goes on in transition. Those of us with experience in performance arts know how vital it is to make impactful entrances, exits and scene changes

Transitions are the theme of the moment. Soon Interfaces will have a brand new look – one that will help our ideas fit into the mainstream of BCS, the Chartered Institute for IT. We are repeatedly (!) told that "change is the only constant", and the UK coalition government appear to be stepping up the pace of these changes, while driving down public expenditure on research and education. Meanwhile, at least two major if perplexing TV shows (Lost and Ashes to Ashes) concluded with the revelation that each had explored the transition between life and afterlife. We are all limbo dancers now!

I write just after the end of Create10, BCS Interaction SG's successful collaboration, over several years, with the Institute for Ergonomics and Human Factors' HCI SG. This year it was extended to three days, hosted in my own institution by Ingi Helgason and Michael Smyth, and the attendance rose to 125. The underlying theme, "Transitions", was evident in the personal stories of the many PhD students presenting and demonstrating work, in an excellent panel that explored education and practice and points in between, and, of course, in the creative approaches to interaction design in the keynote and full paper presentations.

Collectively, we have a lot for which to thank Ingi, Michael, John Bonner and others on the organising committee – a huge amount of work for starters, but also their bravery in playing with the format, pushing it, moulding it, understanding the needs of the interaction design community, both BCS members and those in other organisations (or none), all to search out a vision for the conference to ensure it is useful to both academic and practitioner. Whether it's cash, carbon or catty comments from the media, we can't take conference attendance for granted and organisers have to work harder and harder to create these memorable events.

We face the same challenges in our other events though we have enjoyed some inspiring moments in the last year, again thanks to hard work by volunteers such as John Knight, David England, Lachlan MacKinnon and local organisers for HCI2010, Jackie Archibald and Colin Cartwright. We look forward to a friendly, playful, vibrant week in Dundee in September before the conference itself undergoes transition – Linda Little and Lynne Coventry host HCI2011 in Northumbria in July next year, so expect the CFPs to flow sooner and build attendance into your 2010–11 budgets.

Our community has evolved a range of ideas – such as gulfs, seams and flows – to understand what goes on in transition. Those of us with experience in performance arts know how vital it is to make impactful entrances, exits and scene changes. As the BCS EGM hoohah fades to grey, we can get to work integrating our events, web channels and publications into the heart of the new BCS Academy. Your contributions can both provide substance for the Academy's archive but also achieve impact outside the HCI/ID/UX/UbiComp world into the rest of Computing (where our body of knowledge is sorely needed). I urge each of you to join the BCS Academy – it's free to BCS members, and, for those not in BCS, Academy membership subs are deliberately cheap.

We also have one extra huge thank you to say to Ingi – after several years of typically efficient and self-effacing work behind the scenes, she hands over management of our popular news service (BCS-HCI@JISCMAIL.AC.UK) to Ben Cowan. Yet another transition, yet the story continues.

Tom McEwan
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Is IT a dangerous prescription?

Harold Thimbleby

A hospital has a poster on the wall next to the reception desk: "Notice to ALL patients. The [...] NHS Trust is currently in the process of introducing a new Patient Administration System. It may cause a delay in you being seen..."

What is it that computers and IT do to us that we have an overwhelming urge to introduce systems that make the world a worse place? No doubt if the hospital was worried about the poor performance of the systems they are introducing, they would be told to spend more money on IT!

Simply: if a proposed solution does not work well, something is wrong with the solution and the process that led to it, or the process that failed to get rid of it – though if it was the very first time this had happened we might be excused on the basis of "exploring the unknown".

But we are not exploring the unknown. The UK has had the largest civilian IT project in the world trying to sort out hospitals with IT solutions. That hospital with the patient delays wasn't the first to be computerised! And in the US, some of the evidence is not just that IT slows handling patients down but that it increases fatalities. In one paediatrics ward, a hospital IT system doubled fatalities (Han et al, 2005) and, for reasons spelled out in the paper, this could hardly be a surprise to any experienced developer – essentially an absence of effective user centred design. Indeed, it is surprising that so few places are evaluating the effectiveness of IT, and one certainly wonders about its overall effectiveness. Perhaps, overall the hospital might be saving more lives, but at a cost to paediatrics? Nobody knows.

In their report on a series of radiotherapy fatalities (IAEA, 2001), the investigators say (on page 80) – with my numbers for reference, and "[...]" for omissions:

> (1) It is questionable whether the information in the instructions was sufficiently clear [...] there was no warning on the computer screen when [the user did not follow the exact instructions].
>
> (2) A single error in the method of entering data [...] led to the delivery of wrong doses to patients and to severe, and in some cases fatal, consequences [...]
>
> (3) An efficient system for detecting and correcting errors ***therefore*** needs to be in place: this implies a QA programme with sufficient double and independent checks. A comprehensive QA programme needs to be in place in any radiotherapy facility. In addition to the staff involved in the implementation of the programme, all hospital managers and administrators need to be made aware of this and of the consequences of not having it, as part of their training. (My emphasis.)

How does the report fail to put (1) and (2) together when they are on the same page? Surely the instructions could be clearer and surely the IT system itself could notice an error? Why is all the QA responsibility left to the users of the IT system and not, at least in part, to its developers? We will have more to say about this incident later.

In August 2006 a cancer patient died from an overdose of a chemotherapy drug. Unusually, this incident was studied in a root cause analysis (ISMP Canada, 2007; Thimbleby, 2008) that, unusually, was made publicly available. The root cause analysis was thorough, but it indirectly exposed cultural problems behind the issues with which this article opened: complex IT systems are not understood by the healthcare profession, and without any pressure to do otherwise, manufacturers continue to provide "solutions" that, like badly developed drugs, have unwanted side-effects, causing delays or increased rates of fatality, or financial loss (through hospital liability as well as through national costs as patients taking longer to recover put financial burdens on their relatives and communities). In effect, healthcare is subsidising sick IT, as we shall now argue in more detail.

The patient was using a mobile infusion pump to continually deliver a chemotherapy drug for her treatment. This arrangement allowed her to walk around. She presented at a healthcare centre to have her supply of the drug replenished. Having identified the patient, a nurse went to the pharmacy to get a new bag of the drug; the nurse was given a bag and a printed chit – the paperwork is reproduced in figures 1 and 2. The nurse's job was next to reprogram the patient's infusion pump to deliver the correct rate of drug for the next four days. (Presumably it could have carried on at the previous rate.) The cancer centre's protocol is that two nurses should independently calculate the rate, then enter it into the device. In this case, both nurses made the same calculation error: they forgot to divide by 24 hours in a day, and thus got an hourly rate that was 24 times too high: 28.8 mL per hour when

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5-Fluorouracil 5,250 mg (at 4,000 mg/m2) Intravenous once continuous over 4 days
Cis_5FU_Part2-HN-CC - Cycle - 1, Day - 1
Substitutions Allowed
Administration Instructions:
Continuous infusion via ambulatory infusion pump
(Baseline regimen dose = 1000 mg/m2/day = 4000 mg/m2/4 days)

Figure 1 The paper chit accompanying the drug bag. The figure accurately reproduces the text, line breaks and font. Human factors experts and typographers may like to note the poor spacing, the use of / (which can be confused for 1), inconsistent use of commas in thousands, and other legibility problems (the m2/4 is particularly problematic); see also figure 2.

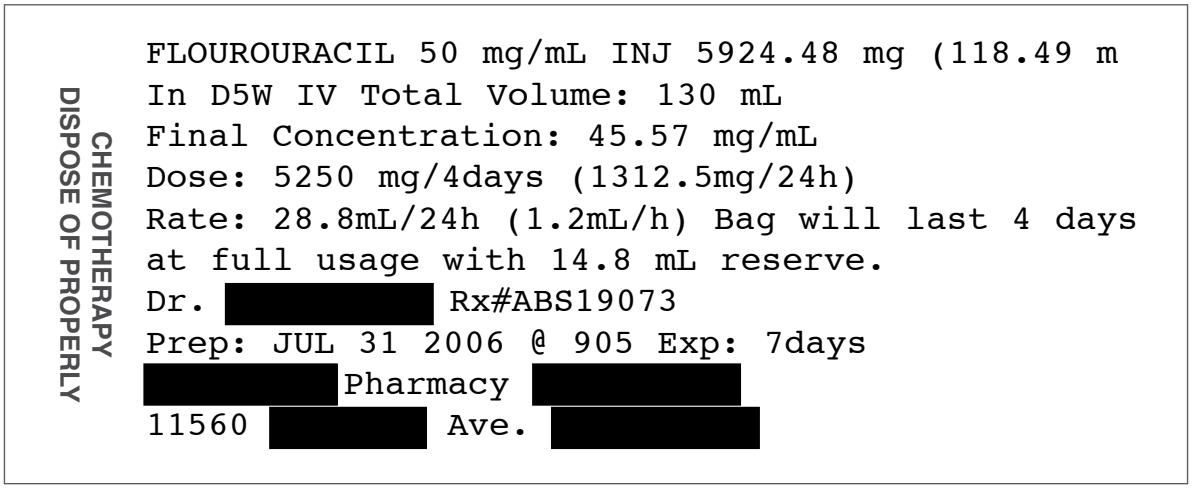

Figure 2 The drug bag label. The black regions are obscured in the root cause analysis to preserve anonymity. The figure accurately reproduces the text, including character spacing, line breaks and font (the text "ABS19073" – that S might be a badly written 5 – and the "905" were written by hand, and JUL 31 2006 was rubber-stamped). The first line ends "m" as the original label was not long enough to print more; possibly "L)" has been omitted. Note that the label refers both to days and to units of 24h. Since the patient can read this label, it might have been helpful to say, "Bag will last 4 days at full usage with 12 hours reserve", rather than "14.8 mL reserve", which in itself is not very useful information.

it should have been 1.2 mL per hour. However, their independent calculations agreed and thus their errors weren't noticed; moreover the incorrect number they calculated, 28.8 (in units of mL/24h), was written on the bag label, which itself would have misleadingly helped to confirm their calculations.

The patient left the centre, and returned later, surprised that their bag was empty several days earlier than usual. They had had an overdose from a chemotherapy drug delivered 24 times too fast, and unfortunately later died from the drug's effects. That is the story in brief, though it does not cover related issues such as the problem of managing an overdose from a drug when the hospital has no overdose protocol. Nor does it cover the social consequences on the nurses' lives, nor whether anybody learns the best lessons, rather than blaming individuals.

What we are interested in here are the specifically IT aspects of the situation, and whether IT helped or hindered. Unsurprisingly, the root cause analysis was not written by IT experts, so it ignores these issues. For example, the nurses made a calculation error. What type of calculator did they use? This isn't a clinical issue, so we do not know – but it might matter.

Please look at figures 1 and 2, which show the actual information given to the nurses. From these figures, work out what dose to give the patient. There are many questions: why are there two separate pieces of paper, and why

are they so complex, providing confusing details the nurses do not need to know. The patient name or identifier is not present on either label. The cancer centre knows the patient is using an infusion pump calibrated in millilitres per hour, so why isn't the correct value printed? Actually, the correct value (1.2mL/h) is printed, so there is clearly no statutory reason to keep it a secret to force the nurses to check it independently, but it was printed along with many inappropriate values such as 28.8mL/24h (which could be written more clearly as 28.8 mL per 24 hr).

Next, we can ask, given that for some reason the nurses are supposed to calculate a drug rate, what are they supposed to do? For clarity, figure 3a presents all the numbers and units printed on the labels; figure 3b presents just those that are required to perform the correct calculation. Apparently, the nurses are to perform the calculation based on the numbers 5250 mg, 45.57 mg/mL, and 4 days to get a rate in millilitres per hour. The correct calculation is (5250/45.57)/(4×24). To do this on a typical calculator without brackets requires this exact sequence of 22 keystrokes:

AC MRC MRC 4 × 2 4 M+ AC 5 2 5 0 ÷ 4 5 • 5 7 ÷ MRC =

There are three obvious problems with this: first is that the sequence of keystrokes bears little relation to the original sum. Calculators are hard to use! Secondly, calculators are different (even look-alikes from the same manufacturer), and while this is correct for one calculator, it may not be the correct sequence to use on a different calculator: it may give a different answer on another (for example, if its memory has to be cleared by pressing **AC** twice). Thirdly, any slip will simply give a different result, without reporting an error.

All numbers and units as printed	Numbers actually required by nurse
5,250 mg 4,000 mg/m2 **4 days** 1000 mg/m2/day 4000 mg/m2/**4 days**	5250 mg 45.57 mg/mL 4 days (answer 1.2 mL/h also printed)
50 mg/mL 5924.48 mg 118.49 m 130 mL **45.57 mg/mL** **5250 mg/4days** 1312.5mg/24h 28.8mL/24h **1.2mL/h** **4 days** 14.8 mL reserve 905 Exp: 7days 11560	

Figure 3 The numbers required for the nurses' calculation. Figure 3a (left column) shows all numbers and units taken from the labels (see figures 1 and 2); numbers required for the calculation are highlighted. Figure 3b (right column) summarises the numbers actually required for the calculation. Note that the label already shows the correct answer (along with incorrect answers).

The calculator has no idea what sum it is supposed to be doing; it can do anything, so it will happily produce any answer whatsoever (Thimbleby, 2000; Thimbleby, 2008).

The last point is not unique to calculators but pervades IT. We know that all humans will eventually make slips. With the calculator – and with the infusion pump the nurses were using – obvious slips like keying in too many decimal points are misinterpreted, and not even reported to the user as errors for them to notice and sort out. This practice of imagining that users are perfect pervades IT, and is reinforced with the unfortunately common attitude that only imperfect people make errors. Rather than design good systems, then, both IT and healthcare too often conspire to scapegoat the "bad" user rather than supporting them (as illustrated at the end of this article) – ironically in an area known to have continual opportunities for human error!

In fact, the calculation can be simplified, for instance to

AC 5 2 5 0 ÷ 4 5 • 5 7 ÷ 4 ÷ 2 4 =

But there is a Catch-22: calculators are for people who can't otherwise do calculations reliably, and almost certainly anybody who

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can convert (5250/45.57)/(4×24) into 5250/45.57/4/24 will have noticed that it's approximately 5250/45.57/100 = 52.50/45.57 ≈ 1.1 anyway. People like that won't have many problems with calculators or checking their results. User centred design would suggest that expecting users to do this task (especially when it could be computerised away) is unreasonable: why should nurses have to work out how to do sums to suit the IT rather than just do them anyway? Solving unnecessary technical puzzles takes time away from patients.

Given that calculators seem to be so hazardous, particularly for healthcare professionals, it seems that their use in hospitals persists merely because of misplaced awe of IT. As thirteen clinicians wrote in a refereed paper published in the Journal of the American Medical Association, "Computerized approaches are ideal for [eliminating error] because reliability can approach 100%, while methods that rely on human inspection will always miss some errors." (Bates et al, 1995). The sentiment is fallacious, on at least two grounds. Consider: the reliability of paper can approach 100%, but it obviously does not follow that an organisation using paper thereby becomes more reliable. It depends on how the organisation works, what and how procedures are "paperised". With computerisation, however reliable computers are themselves, any misunderstanding of the organisation's procedures will force users to employ workarounds and hence lower reliability. Indeed, the increased fatalities reported by Han et al (2005) were because users were forced into doing what the computer system required. Secondly, comparing computerised approaches with methods that rely on human inspection overlooks that computers themselves are programmed by humans who are equally subject to error – and possibly more so, since sufficiently skilled programmers necessarily understand clinical conditions less well than the experienced users of their systems.

Just because it is amazing that calculators work at all does not mean that they are amazing in hospitals. On the contrary, it is hard to see any sensible reason for allowing them

inside hospitals given how poorly designed they are (see Thimbleby, 2000). The drug bag has already got the right answer printed on it; why did the nurses have to use an unreliable process to recalculate something already known?

It seems that healthcare has become complicated, and that IT is seen as the way to handle this complexity. It is clear that this approach to healthcare is not working well. Whatever processes the pharmacy and the infusion pump automated, they were not the right things to automate, or at least to automate in this way.

Are there alternatives? In fact there are many different alternatives. Here are a few:

- Had the drug dose been 50 mg per hour (not 54.69), and had the pharmacy diluted it to 50 mg per mL (not 45.57) the calculation could have been done in one's head: 50/50 is 1 mL per hour. It's also very easy to estimate! Or the drug could have been supplied in a 100 mL bag (not 130 mL) to last 4×24=96 hours. Again, 100/96 is very easy to estimate: it's just over 1 (in fact, it is 1.04). I'm not sure we know the patient's weight to this precision, so these approximations are probably fine – certainly the cancer centre will not know the patient's weight to four significant figures, and there is no point providing the numbers to this misleading precision; all it does it make it more likely that the numbers will be misread or miskeyed.
- The pharmacy could have done the calculation (it evidently did) and entered it on the device themselves, rather than telling nurses to redo what it could do better.
- The pharmacy could easily have printed **IMPORTANT: 1.2 mL per hour for patient XXXX** on the drug bag.
- The pharmacy presumably has a record of the patient's last dose. It could tell the nurses to continue at the same rate. The infusion pump already knows this rate.
- The infusion pump – a dedicated device in a cancer treatment centre – could have known that a dose of this particular drug (fluorouracil) of about 50 mg per day would be fatal. Well, the actual device used cannot do that, but alternative products now on the market can do "dose error reduction" checks on drugs and dosage.
- The infusion pump could have used wireless, and been directly programmed from the pharmacy, perhaps with RFID tags or bar code checks to make sure it was being used by the intended patient.
- The nurses could have asked the patient, a strategy that would be even better if they did this routinely and taught the patient the parameters of their treatment.

And so on. Alternative approaches are not at all hard to imagine, and this is without wondering about alternative treatment regimes or even pharmaceutical developments (e.g., there is currently no antidote for a fluorouracil overdose).

We could improve IT (for example, see Thimbleby & Thimbleby, 2008; Thimbleby & Cairns, 2010). What is clear, however, is that the healthcare profession is not thinking about complexity and human error and how to sort them out; instead they seem to be buying into IT "solutions" to their messy problems. In an ideal world, developers would really understand the domain, the tasks and what users really do, and, in turn, users in the domain would, with the help of developers' insights, improve their processes: it is a two-way collaboration and takes many iterations. Unfortunately, IT loves complex systems, and often helps make them more complex and more inflexible. Particularly when the IT systems are developed and used by people who do not really understand what is going on.

The root cause analysis also did a human factors study of nurses using the infusion pump. Three out of five trained nurses, following the same protocol, entered incorrect data; all five were confused by setup; two out of five were confused by programming; three out of five were confused by the decimal point (which also serves as a mode change feature on the device!). This human factors analysis took just an afternoon's work, and it revealed major flaws in the user interface design and ergonomics of the infusion pump. A general rule is that if lots of people are making mistakes (here, 60% of them entered wrong data; 100% were confused by the device), there is something wrong with the system, not with the individuals.

To my mind, these empirical results raise important questions: why didn't the cancer

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centre perform any usability evaluation of the device before it was purchased? And, if such poor usability results can be found in only an afternoon, why didn't the manufacturer do this elementary work and correct the flaws as part of their normal iterative design of the product before releasing it to market? Why did the regulatory agency approve it? The answer does seem to be that people do not understand IT systems, and one infers that while hospitals and healthcare professionals buy into IT so uncritically, manufacturers will have no pressure or motivation to do any better.

The manufacturers have everything to gain by improving their devices and solutions. They have everything to gain by better understanding the real tasks and processes that healthcare professionals perform under difficult circumstances. Or so you would think, except that manufacturers have protected themselves with legal get-outs.

In the most notorious example of this, two hospital technicians went to prison in Panama for manslaughter after a medical device they were using killed patients through an overdose caused by an undetected error (McCormick, 2004; IAEA, 2001) – in my opinion, due to a program bug. The device manufacturer's web site (Multidata, 2010) says they make "easy-to-learn and user-friendly tools with the right functionalities for effective work in the clinical routine", but in their user instructions they say,

> It is the responsibility of the user to validate any RESULTS obtained with the system and CAREFULLY check if data, algorithms and settings are meaningful, correct or applicable, PRIOR to using the results as a part of the decision making process to develop, define or document a course or treatment. In particular, a USER SHOULD VERIFY THE RESULTS OBTAINED THROUGH INDEPENDENT MEANS AND EVALUATE ANY DISCREPANCIES CAREFULLY until the USER'S PROFESSIONAL CRITERIA HAS BEEN SATISFIED.
>
> Original emphasis; quoted in IAEA (2001, p47)

In other words, why use this sort of IT system in healthcare at all? Why doesn't the IT system itself also use some "independent means" to double-check its own results?

IT (computers and complex devices) have improved the world enormously – consider aviation safety – but only in domains that are well understood. Often IT has changed domains: businesses have been transformed by the web. If IT is to realise its potential in healthcare, the manufacturers have to better understand users' hugely varied tasks including the errors and workarounds, and the healthcare profession itself needs to work out how to change and adapt to make best use of computers. That is user centred design at its best, but it seems it will require much higher quality computer scientists and human factors experts than have so far been employed: it will take hard new thinking and new research, and a real dialogue between developers and healthcare professionals. Computerising what managers (or politicians!) think we are doing at present won't work and, as is already happening, it will lead to a stand-off: where manufacturers will supply what sells, but knowing that it won't work well. They will then have to protect themselves in legal frameworks that kill the spirit of user centred design before we've even begun to see the real transformation of healthcare we all want.

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From health informatics, through Autonomic Computing, to the future of HCI

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Health informatics poses several challenges to HCI, from the sheer scale of National Health computing systems, to the complexity of the information held, to the ethics of holding and distributing health care information.

Our recent project on post-operative Breast Cancer decision support [1] met all of these challenges. The particular challenge of post-operative decision support centres around the tension between an individual consultant's judgments and the requirement for the adoption of clinical protocols (local or nationally) in reaching decisions; the tension between autonomy and compliance. Autonomy is required as we are dealing with individual people who need to be involved in the decisions about their care. Compliance is required to ensure that local and national standards of treatment are being considered and choices documented.

In this particular context decisions support can come from two main sources; decision trees reflecting local and national models of treatment protocols. An oft-cited model is the Nottingham Index [2] that guides post-operative care decision-making dependent on a small number of factors concerning the tumour and the patient's status. Depending on these factors the patient will be allocated into one of four risk groups and certain treatment regimes suggested.

Another source is historical data where analysis can be performed of past patient data and the current patient's situation is compared. Again the patient can be allocated into a particular treatment regime. So we have two sources of data with which to triangulate possible decisions.

Autonomic Computing aims to support systems that are self-managing, self-healing and self-adapting

However, there are at least two problems with this approach. Firstly, as medical science and treatment progress we need to update our decision protocols to match current knowledge about how to treat tumours. Secondly, the treatments reflected in historical data may not reflect current approaches. So how do we maintain the currency of the decision-making support process?

One solution is to allow flexible but accountable adaptation in the system. In our project this was supported using the principles of Autonomic Computing [3]. Autonomic Computing aims to support systems that are self-managing, self-healing and self-adapting. They were originally intended for servers and embedded systems that could run with little user intervention once installed. However, the same principles can be applied to interactive systems that are supporting complex user activities where we wish the application or environment to be adaptable without requiring constant intervention by an administrator or the end-user.

In the case of medical decision support systems we separate out the functions supporting the decision tree management and the data mining management so that we can update them in an accountable way. In our particular system a scripting language, Neptune, is used to describe the meta-level management layers. Neptune is also used to describe the user interface so that decision models can be changed and the interface updated without re-building the whole system.

How does this impact on the future of HCI? Applications are becoming more complex and greater in size. Our interactions are becoming richer as we interact with more devices simultaneously, some of them visible, some of them hidden. This poses the same challenges to user interface engineers. How do we continue to improve user interfaces without rebuilding whole systems? How do we ensure that we cater for users evolving? We believe that Autonomic Computing offers one approach to these challenges by providing a federation of self-managing components with a high-level meta-language supporting the integration of those components. Some components will be domain-specific like the decision rule handing engine, or the health data-mining engine. Other components will be user specific, "mining" the user's data for patterns of behaviour to drive the evolution of interaction. Further components will be device and environment-specific, assisting the meta-level managers in adapting the use of devices, in an environment, to specific users and domains.

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When I get older

Interaction design for medical devices

Ann Blandford

In the UK, we are living in an ageing society, where the number of older people and the ratio of older to younger people in the population are projected to grow significantly over the coming decades [6]. A positive aspect of this is that many people are enjoying better health much later in life than their parents' and grandparents' generations did. However, longer life does not necessarily entail fitter life, and there will be a growing need for medical interventions to support the ageing population. This has implications at many levels, from the individual to the societal. For example, there will be growing demand for end-of-life care in all its forms: in hospitals, hospices, care homes and private homes, with a corresponding need for palliative as well as therapeutic care to be administered. More people will be reliant on a range of medical devices.

A second important trend is towards greater reliance on technology in healthcare, whether in personal health records, novel health technologies, integrated healthcare (e.g. where information from personal health records is used directly to make diagnoses and clinical decisions on therapies) or remote monitoring. The integrity of health information systems, the reliable exchange of information across different systems, and the usability of systems will grow in importance as there is more direct communication between systems, with fewer points of human intervention in which information is interpreted and validated.

A further trend is towards reliance on assisted living, and on finding ways to support people continuing to live in their own homes. Away from clinical environments, without 24/7 supervision, the ways that devices are designed for use by clinical professionals, lay carers and patients themselves will need more explicit consideration. Even within clinical environments, there is anecdotal evidence that devices are used in ways that they are not designed to be used. For example, patients may reset infusion pumps when they have stopped (and are sounding an alarm) simply because the patient has moved and obstructed the flow briefly. Nurses are too busy to respond quickly, and the protocol dictates that patients cannot be authorised to touch the devices, but the alarm noise is annoying and patients want the drug to be administered on time, so patients observe and then copy the nurses' actions, and check procedures with each other. There are likely to be even more (intentional and other) violations of intended procedures with devices as more of them move out of formalised care settings and into people's homes.

There are pockets of evidence that interaction design contributes to errors in programming and using interactive medical devices. For example, almost every clinician has personal stories of incidents, and the most serious are reported through national incident reporting systems (e.g. www.nrls.npsa.nhs.uk). However, perhaps surprisingly, the quality of the evidence linking system designs to incidents is low. Many incidents are not reported formally at all [10]; even when they are reported, that reporting is often not at the level of detail needed to understand exactly what happened at the interaction level [2]; and even where sufficient detail is provided about behaviours, there might be different explanatory accounts [1].

The landscape of research studying issues relating to the design of safe interactive medical devices is broad. Much of the work has focused on the design of next-generation computing solutions, i.e. systems that cope with the increasing complexity of devices and decision support technologies (e.g. [7]). There is also a growing body of work studying situated practices of clinicians with interactive systems. Much of this work

(e.g. [8]) considers the role of the medical record in supporting clinical work, and identifies requirements on the design of electronic health records. Other work (e.g. [3]) focuses on human factors such as the quality of team working, which contribute to system safety. However, little work has focused attention specifically on the design and use of the kinds of medical devices that are in widespread, routine use by a large number of people, with variable levels of training, and on which people's lives depend. Such devices include defibrillators, infusion devices, blood glucose monitors and vital signs monitors. Although these devices and the ways they are deployed and used are safety-critical, they have not been subjected to the same rigorous development processes as systems in aviation or control rooms; Cook and Woods [4] argue that this is because healthcare is too complex for the kinds of approaches to safety that have been developed for these other contexts. Similarly, incident reporting systems are less well developed in healthcare than in other safety-critical industries [1].

There is a growing awareness of the need to apply human factors techniques in the design of medical devices (e.g. [12]). While techniques that involve the (future) user in design and evaluation are necessary, they are not sufficient: when device behaviour is complex, user studies may not expose all potential difficulties [14], particularly when devices are used in diverse situations, by people with varying levels of training and different values and motivations.

Various design changes have been proposed, including the introduction of Dose Error Reduction Systems [13] and shifting responsibility for programming devices from nurses on the ward to pharmacists in the pharmacy. However, the introduction of new safety barriers can, paradoxically, often erode system resilience [9], and changes to working practices can introduce new vulnerabilities while removing known sources of error. There is a need to better understand device design and use, and how design influences individual and group behaviour. This better understanding should inform future design, policy, and procurement decisions.

In summary, there are at least three trends (an ageing population, greater reliance on individual and integrated medical technologies, and more care at home) that together mean that the design of medical devices will become even more important in the future than it is now. There is growing awareness that this is a problem (e.g. [5]), but surprisingly little, beyond general HCI principles of good design, is known about reliable interaction design, human error, or situated interaction around medical devices. This will be the focus for CHI+MED, a recently funded EPSRC Programme Grant. Please contact Richard Young, CHI+MED Manager (chi-med-project-manager@ucl.ac.uk), if there is relevant work that you would like to bring to our attention, or if you would like to be kept informed of programme developments. See www.chi-med.ac.uk for more information.

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Mind the gap

What interactive medical device manufacturers need

Chris Vincent

Recent alerts and recalls regarding the use of infusion pumps highlight the importance of an interdisciplinary approach to equipment design. HCI specialists are well placed to contribute and there are resources that allow developers to take account of the interaction between users, the tools that they use and the environments in which they live and work. HCI professionals need to make it easy for developers to adopt a user-centred approach and research is underway to establish current practice and future needs.

Each year, members of the UK health service perform approximately 15 million infusions. A small number (about 700) result in an adverse event [1]. Several mechanisms are in place to learn from incidents, protect patients from harm and maintain quality of care [2]. An area of potential concern relates to the users' inadvertent misprogramming of the device. These types of interaction error can be easily missed [3]. Much has been achieved in safeguarding the public and professionals from poor device design; however, there is still a need to understand where the medical device industry requires support and how HCI professionals can contribute.

For the majority of medical devices used in the European Union, patients, public and clinicians are protected by a statutory framework – the Medical Devices Directive [4]. This sets out essential requirements for audit, inspection, design, production, marketing, risk assessment and post marketing surveillance of a broad range of devices. The regulation comprises core essential requirements in addition to a series of optional harmonised standards. In terms of user interaction, the essential requirements are often non-specific, as in the two examples that follow:

> The devices must be designed and manufactured in such a way that, when used under the conditions and for the purposes intended, they will not compromise the clinical condition or the safety of patients, or the safety and health of users …

> Devices must be designed and manufactured in such a way as to remove or minimize as far as is possible: the risk of injury, in connection with their physical features, including the volume/pressure ratio, dimensional and where appropriate ergonomic features …

In the US, the Food and Drug Agency (FDA) is more prescriptive in requiring developers to demonstrate how human factors considerations were applied during product development. Consequently, there are several examples of manufacturers adopting a human factors approach [5, 6]. Following an extensive recall of infusion pumps, the FDA has announced an initiative to improve the safety and effectiveness of infusion pumps. In a recent white paper, cause for concern is raised regarding user interface issues, such as "confusing or unclear onscreen user instructions …" [7].

In the UK, there have been several alerts issued by the National Patient Safety Agency (NPSA). In 2004 a safer practice notice was

released, recommending interventions regarding procurement and equipment management. The resulting purchasing toolkit required buyers to assess usability and requested that user views are fed back to manufacturers [1]. Recently, a series of resources have become available, including guidelines regarding the design of electronic infusion devices [8].

International design standards, such as AAMI HE74, AAMI HE75, ISO/IEC 60601-1-6 and ISO/IEC 62366, recommend an iterative development approach involving phased design reviews and continual user input and evaluation. The cycle includes user research, conceptual development, generation of design requirements, design output (specifications), verification, validation, evaluation, deployment and post-market surveillance (as required by the Medical Devices Directive). Tools such as usability testing and risk analysis may be applied during multiple stages of the cycle.

Conceptual development and user research provides an understanding of the relevant domain. This includes reviewing process and procedures, market research, associated product complaints, adverse incidents, context of use and system constraints. Tools such as scenarios, storyboards, use cases, personas or task analysis may apply and practitioners can conduct focus groups, interviews or literature reviews. This informs usability requirements, for example "95% of first time users will be able to load a set and program an infusion within two minutes or less". There are several resources that can aid this process including usability heuristics [9] and formal risk management processes such as ISO 14971. While setting usability requirements is useful, it is not sufficient. The FDA, amongst others, is now asking: What about the 5% who fail to achieve this objective – are they putting patients at risk by not correctly programming the infusion?

Despite the volume of support available, there is still a genuine need to understand how developers apply tools, where there is an absence of resources, and how models of human capability can inform interface design.

How do manufacturers provide for the usability requirements that arise as a result of home use? Do issues like alarm fatigue present opportunities to improve design? Does experience with a legacy device type impact on the use of a new device type? Is there a sufficient understanding of how users react when distracted or when switching between multiple tasks? Do developers design interfaces that mitigate against likely sources of error and are there sufficient behavioural models to support this?

Interdisciplinary teams containing HCI specialists can contribute to many of these questions by recommending specific tools, techniques or measures and by providing clear and accessible advice that directly informs design decisions. HCI professionals can help the development team adopt formal methods to structure testing; they can also help produce tests that consider relevant human capabilities during the iterative process of prototyping, simulation and usability testing.

CHI+MED

Understanding how and why interface developers make design decisions is part of the CHI+MED research programme (http://www.chi-med.ac.uk/). It involves contributing methods that minimise the risk of human error and maximise patient benefit. Input from HCI practitioners and health care professionals is essential in understanding current practice and future needs, particularly with regard to interaction design. For more information, or to get involved, contact Chris Vincent at University College London Interaction Centre (UCLIC), c.vincent@ucl.ac.uk or +44 (0)20 7679 0694.

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Healthy people, healthy web sites

Elizabeth Sillence

It appears that most of us these days have consulted the internet at some point about our health. Whether it's facts and figures on asthma or advice about mumps or dieting, the information is out there. Of course as patients (or consumers of health information) the internet, although increasingly accessible, offers an unregulated source of health information and advice. Certainly medical reviews suggest that the quality of these sites is often a problem.

So, faced with a vast array of search results, how do people decide which web sites to click on and read? Here at the PACT Lab (Psychology and Communication Technology Lab) at Northumbria University we've been attempting to answer this question through our research on trust in e-health. Over the last few years we've been examining how consumers search for, engage with and act upon health advice online. Ultimately we are interested in the complex set of judgements and risk assessment processes underlying these trust decisions.

The potential risk associated with following health advice is considerable so what are the factors influencing consumer trust of e-health web sites? From our work so far it appears that consumers don't use the same kind of checklist as medical experts when it comes to finding a site they trust. In the first instance they are looking for a site with a credible design. A messy, cluttered site full of adverts and distracting swirls of colour gives people, short on time and eager for answers, the perfect excuse to click off and 'reject' the site. Of course, in doing so they may be missing out on top notch information provided by experts at the cutting edge of health and medicine but negative design trust cues are enough to lead people to dismiss the site outright.

Increasingly people are moving away from more regulated sites containing simple facts and figures. They want to know about the experience of illness – reflections, insights and practical advice from people who have been there – and to be able to share their own experiences with others.

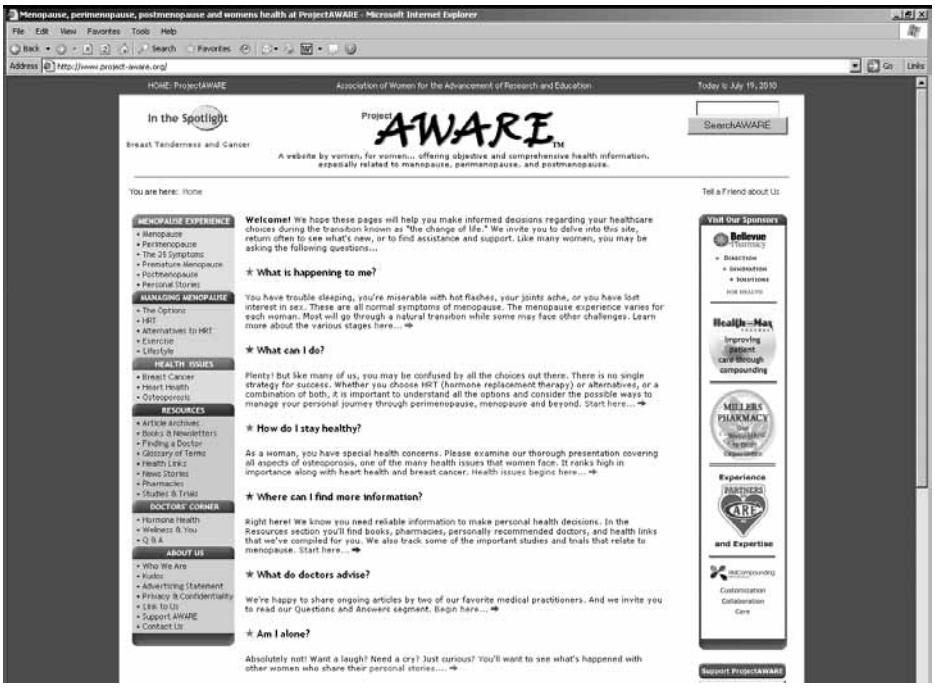
If, however, the design is credible then people start to become more careful evaluators of the actual content on the web site (if they have a personal, vested interest in finding out more, that is). People trust sites with accessible, clear information and value advice from "reputable, expert sources". Our participants were also looking for sites that were written by people similar to themselves and that were obviously aimed at "people like them". Sites that provided these social identification cues were appreciated, as was the inclusion of familiar sounding language and highly relevant or personalised content.

So trust develops over time and our early staged model of e-trust reflects that process: i.e. an initial rapid screening followed by a more careful selection and evaluation of sites. More recently, we have been unpacking the stages in our general e-trust model and examining the effect of adding threat-related variables. Here we are interested to see whether the sense in which people feel threatened by the information they read affects the way in which they trust the web site and their readiness to act on advice it contains.

We've also been directly manipulating design trust cues to see whether they have an effect on trust decisions and health behaviour. It appears that content irrelevant images and logos can influence the behavioural response to quality health-risk information. We found that heavier drinkers exposed to a positive cues version of a web site describing the link between alcohol and breast cancer reduced their drinking compared to the women who had seen the negative design cues version.

Health consumers, then, do not always choose the best quality health sites or follow the best advice. Indeed they can show a marked reluctance to trust advice they perceive to be inconsistent with their important prior beliefs. We've seen this in our study of advice giving on health discussion boards. Here the support group members have developed mechanisms for portraying their competence and trustworthiness and advice seekers seek out "very like minded" others to provide support for their pre-existing views. Thus they are more trusting of people with similar views and develop elaborate ways of subtly disregarding information and advice that is not congenial with their way of thinking.

Increasingly people are moving away from more regulated sites containing simple facts and figures. They want to know about the experience of illness – reflections, insights and



Top Example of a site with positive design trust cues that was liked by all participants. **Bottom** Example showing negative design trust cues.

practical advice from people who have been there – and to be able to share their own experiences with others. Patients' experiential information (PEx) is often sought by people using the internet to find out more about an illness or a health related topic. There is a vast array of this type of information available online, from single topic narratives, to blogs, discussion boards and videos. Sites vary in terms of their interactivity, so some are open to all with newcomers invited to contribute and share their own experiences whilst others are more "read only". Acknowledging the diverse types and quality of online PEx, we will be seeking to discover, over the next three years, how patients find and use PEx to inform health and life-style choices. Hopefully we will then be able to make some sensible recommendations regarding the provision and integration of PEx information in an online environment.

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The Arts and Design Research in HCI

Crowded House, Atlanta, April 2010

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In response to the "cultural turn" in HCI, the Arts have been an ever-growing presence in our field. We should now take stock of what the Arts can contribute, and how and why, and what the HCI community and its leaders need to do to more fully embrace the Arts to advance the leading edge of design research. So, at CHI 2010, we organized a SIG (special interest group) on The Arts and Design Research.

We have a broad conception of the Arts, spanning the visual, performing *and* liberal arts. The latter are less well established in HCI, largely restricted to workshops and alt.chi, but increasingly enjoying some success within papers managed by the Design subcommittee. Visual and performing arts are more in evidence at CHI, but they too are largely marginalised into 'non-archival' tracks with ever-changing names such as Interactive Experiences, Demos, or (in 2010) Media Showcase.

UK HCI is strong across the Arts. Nottingham University's Mixed Reality Laboratory has long-standing international excellence that includes outstandingly innovative collaborations with artists. HCI 2006 had a strong electronic arts focus through its location at QMW in London. The EPSRC-funded Leonardo Network (2004–2006, www.leonardonet.org) was associated with many pioneering workshops and conferences, building in particular on York University's Funology Programme, as well as on McCarthy and Wright's ground breaking *Technology as Experience*. Researchers outside the UK who have drawn on theoretical and critical approaches from the humanities are mostly closely associated with UK initiatives. The risk, however, is that this initiative becomes too much of a clique as a result. The CHI conference accordingly offers a major opportunity to grow humanities-influenced research within HCI. Our SIG was organised with this in mind.

We expected the usual suspects within the core Arts and HCI clique to attend, a few curious bystanders, as well as perhaps some established researchers who are interested in the Arts' role in HCI. Instead, there was standing room only at the SIG, with over 100 people attending. With a larger room, we might have been able to accommodate a larger audience. We benefited from active involvement from researchers with interests in New Media Arts, several of them associated with the ACM Creativity and Cognition conference (a look at their proceedings is strongly recommended, as the range of content covered is much broader than the conference's name suggests). However, much of the audience was not from any established HCI constituencies.

What's going on?

In the last five years new forms of cultural artifacts have emerged at an almost annual rate. Blogs, vlogs, mash ups, machinima, and tweets could be thought of as art forms if only as instances of "the shock of the new" [12]. These new forms complement and extend longer established 'expert' interactive digital forms such as computer games, internet art, interactive installations, desktop multimedia, and interactive fiction. Together, these expert and amateur cultural forms are an important focus for HCI research [1]. HCI's strong interdisciplinary basis requires that the study of such phenomena should benefit from existing relevant disciplinary practices, especially in literary and cultural studies where theorised 'readings' of such 'texts' are well-established valuable practices. These benefits are already being realised through a range of critical practices that can be collectively referred to as interaction criticism [2]. Such criticism uses essay forms that can draw on broad aesthetic theories that transcend art forms (e.g., text, image, performance).

However, there is more to the Arts (i.e., all disciplines of the liberal, cultural, literary, visual and performing arts) in HCI than criticism. Many constructive designers' practices originate in the Arts, e.g., sketching, storyboarding, scenario development, role-play and improvisation. Such techniques are shared with practitioners in more traditionally Arts-based domains such as film, theatre, television and literature. A small but growing body of work in HCI makes explicit use of Arts-based approaches to such activities, e.g., improvisational role-play using actors to inform designs for older people at every stage of iteration [16]. Literary techniques such as pastiche have been adopted in the creation of scenarios which draw on rich cultural sources. Increasingly new cultural forms such as machinima are being exploited [3].

Understanding developments and potential futures calls for disciplinary competences from the humanities, notably philosophy and the history of ideas. Without these, HCI is at risk from etiolated disciplinary borrowings, which stunt growth through poor exposure to both the philosophical issues underlying newly appropriated disciplinary matrices, and also their relation to the wider originating historical contexts. Too often a single philosopher such as Heidegger or Wittgenstein is chosen as the poster boy for a new HCI paradigm (or in the case of Descartes, its whipping boy). While stunted scholarship is not intrinsically

Is there one single HCI umbrella at all?

wrong, the failure to situate ideas within originating historical contexts brings forth distorting anachronisms that sever ideas from their original influences and motives. Such habitual amnesia even decontextualises HCI approaches that are barely a decade old [6].

Kicking off

In our SIG proposal (G. Cockton, S. Bardzell, M. Blythe and J. Bardzell: Can we all stand under our umbrella: the arts and design research in HCI. CHI Extended Abstracts 2010, ACM, 3163–3166), we seeded questions such as:

- What do the Arts specifically offer to HCI?
- Are CHI's contribution types appropriate for the disciplinary matrices of the arts and humanities, in particular, the theory and methodology contribution types?
- What are the formal and intellectual differences between a scientific report (i.e., intro, methods, results, discussion, etc.) and a scholarly essay?
- How much consensus is there about HCI's first, second and third waves that have brought us from human factors through human actors to human satisfactors? Do we have a shared understanding of the history of our discipline? Is there one single HCI umbrella at all?

Themes and issues from the SIG

There was a lively discussion at the SIG, which could easily have filled another SIG session. There were more questions than answers, but these now provide a better basis for taking debates and discussions forward.

Disciplinarity

Humanities researchers foreground epistemologies and disciplinary goals with a candour and reflexivity that is often missing in discourses that construct themselves as Science. This causes problems for Theory and Criticism within HCI, since many reviewers have limited or no understanding of the criteria by which essay forms should be judged. CHI undervalues scholarly discourses by constructing them as "Opinion Papers", condemning them immediately to some arbitrary subjective form. There is a need for more open discussion of epistemologies within the HCI community, with a level playing field for alternative standards of credibility. Alternative disciplinary values need to be recognised, mutually understood and valued for the distinct lenses on the world that they offer. Hostility and opposition to disciplinary alternatives needs to give way to better empathy.

Values

Epistemological values are not the only ones that create difficulties for the humanities within HCI. Novelty, curiosity and inventiveness are routinely undervalued relative to empirical rigour, leading to distortions across HCI wherever the new has more value than the true. Both technical inventiveness within HCI's engineering constituencies, and creativity with design and visual/performing arts constituencies are too often required to re-present themselves as systematic empirically grounded rigour, when the (scientific) truth is that's not where the coolest ideas come from. Creativity and inventiveness can establish their value independently without need for empirical validation. Many motives can be in play within HCI. Motivation to validate cannot always take precedence.

Marginality and institutional power

Not surprisingly, Arts-oriented researchers in HCI can often feel marginalised. Established disciplinary institutions within HCI shape the values in play within the reviewing process, as well as access to many resources. However, the establishment of explicit communities within the CHI conference has made access to conference resources more open and transparent. Interestingly, CHI 2011 will be the first to have an open call for communities. New communities within CHI can now emerge bottom up, without the need for SIGCHI patronage (embryonic communities were identified as a marketing device for CHI 2003, but have been an explicit part of the conference structure since CHI 2006). Design and Usability/User Experience were both given subcommittees within the new papers and notes process from CHI 2009. Life on the margins within HCI/CHI is thus neither inevitable nor permanent. As communities become established within CHI, resources follow, such as SV quotas via the ability of Subcommittee and Associate Chairs to nominate student volunteers. Even so, until a community becomes established across CHI, these resources will not be available, and students from marginal areas may feel (mistakenly perhaps) that they have less chance

The Arts and Design Research in HCI

Jeffrey Bardzell, Shaowen Bardzell, Gilbert Cockton & Mark Blythe

of becoming a student volunteer. This is often a major problem for students from disciplines that lack the financial resources of the major current HCI disciplines.

Consolidation, bridge making, and success strategies

There are many success stories with the Arts and HCI communities. The organisers have all had challenging CHI submissions accepted (and even lauded with best paper nominations and awards). Several attendees were also well established as critical and/or creative HCI researchers. There was a sense, however, that the scale of success within CHI and related venues is not well understood, either by those who continue to feel marginalised within HCI Arts constituencies, or by those outside these constituencies who would be surprised at the extent of success and influence of Arts perspectives.

Much successful Arts-oriented research requires authors to 'tone down' their positions to make them more palatable to less open-minded reviewers. While this inevitably dilutes the potential disciplinary contributions from the Arts, it does demonstrate the value of empathy and bridge-building between disciplinary communities. If Arts-oriented researchers can reach out to more narrowly focused empirical researchers, then hopefully the latter can develop more critical reflexive approaches to their work that will empower them to take on more demanding research challenges that would otherwise be obstructed by uncritical methodological and conceptual conservatism.

Early career researchers

Not surprisingly, if senior HCI researchers with an interest in Arts-oriented approaches remain unsure about the HCI community's ability to recognise and support excellence in theory, criticism, creativity and inventiveness, then this makes Arts-focused research a risky territory for research students and early career researchers. However, as researchers from a wider range of disciplinary backgrounds are drawn to Interaction Design research, the HCI community needs to reach out and support their new perspectives on interaction. A critical priority for the Arts community within HCI is to develop stronger support for research students and early career researchers.

Teaching resources experiences

Many HCI academics are now incorporating Theory, Criticism and Creative Arts into their undergraduate and postgraduate teaching. However, HCI textbooks have poor, if any, coverage for these areas, and are rapidly becoming over a decade out of date in their coverage of HCI. A further key priority for the Arts community within HCI is to develop teaching resources and to share teaching experiences.

Next steps

There are now well established communities in the Arts within HCI, some focused on visual and performing arts, others focused on critical and cultural perspectives from the liberal arts. There is some overlap between these interests, but there are also distinct differences, with the emphasis on creative works in the former, and on the development and application of theory and criticism in the latter. One immediate task for a theory and criticism community is to consolidate and communicate their current achievements, and to develop a research agenda for more fully demonstrating the value of the liberal arts within HCI.

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The women are here

Engaging young women with computer science

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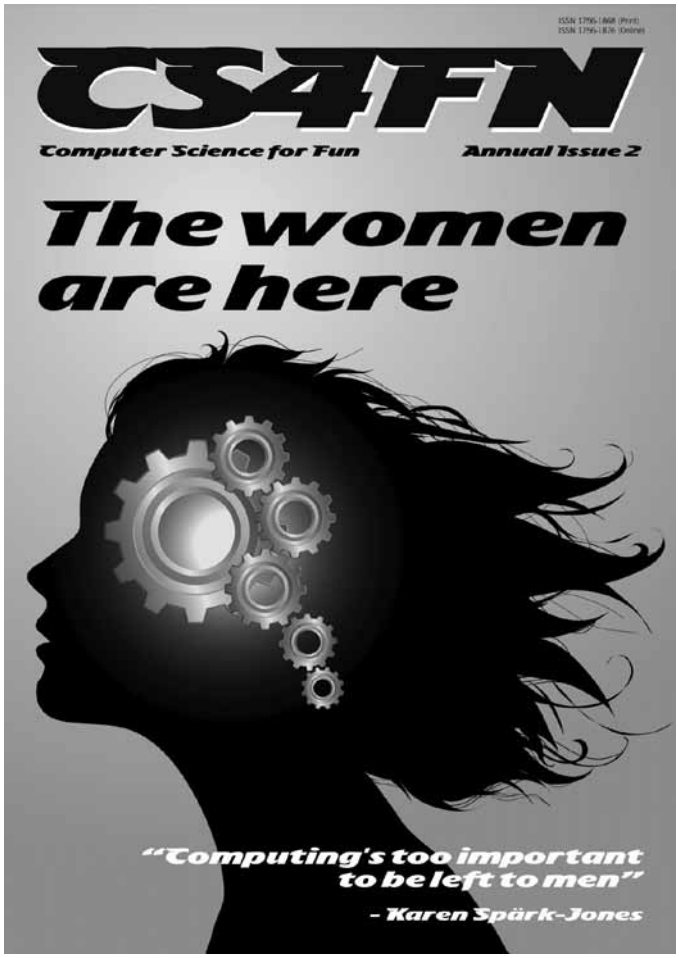
Since 2005, Computer Science For Fun (cs4fn) has been one of the UK's most prominent campaigns to engage young people with computer science [1]. We produce a magazine with a circulation of over 20,000 copies, a website (cs4fn.org) that attracts over 15 million hits every year, and we do live shows at festivals and schools that last year reached over 8,000 people. Our biggest success of 2010, however, is our 60-page booklet, produced in May, on the contribution of women to computer science.

Within a week of its initial release the entire print run of 15,000 copies had gone, in a combination of direct mailing to schools and follow-up requests for more by teachers. A further 1600 copies were downloaded from our website in the initial week as well. This response is the largest ever to a single issue of cs4fn. There is clearly a desire for high quality material that specifically engages young women with computing.

The cs4fn approach to engagement is a big part of its appeal, as it provides female students with the real-life possibilities of a career in computer science and HCI research, as well as female role models to inspire them. We write about real computing research in a style that appeals to young people's curiosity and imagination. HCI is key, with major stories in the 'women in computer science' issue featuring researchers whose work concerns interaction: from Ann Blandford's team's work on medical error to Kirstin Dautenhahn's on social robotics. There are also stories on the history of computer science, showing how women have been major players from the start. Readers (both male and female) see how computing is a way of accomplishing cool things across lots of disciplines. It's a way of making their best ideas and dreams a reality.

We have successfully applied this approach to other subjects within computing as well. Our 'Magic of Computer Science' spin-off project [2] uses card tricks to demonstrate key principles in human–computer interaction and mathematics, as any good magic trick is essentially an algorithm with a clever interface resting on top of it. Furthermore, each new issue of our magazine looks at a particular topic through the prism of cs4fn: past issues have looked at computer animation, mobile technology, ubiquitous computing and many other topics in computing research. For most school-age children, cs4fn is the only way they would hear about such deep issues in computing.

If you would like to know more about cs4fn and our publications, visit cs4fn.org, where you'll find PDF back issues and a link for ordering free hard copies. Our website also includes interactive games, activities and resources for teachers. If you're interested in using cs4fn for your own outreach activities, giving out copies at open days or giving talks to schools using tried-and-tested slides with support that we can provide, email us at cs4fn@eecs.qmul.ac.uk.



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My PhD

Understanding strategic adaptation in multitasking settings

Christian Janssen

Multitasking is becoming a prevalent aspect of our daily lives. For example, while typing this text, I am occasionally checking my e-mail. However, my eyes can only look at one of the tasks at a time. More generally, if each of the tasks that I want to perform uses the same resources (e.g., eyes, hands, memory), then performing multiple tasks concurrently requires some interleaving of attention (cf. Wickens, 2002). Within my PhD research, I am investigating how we decide to switch our attention from one task to another in situations where task interleaving is required. The aim of this work is to understand the strategies people use in multitasking situations (i.e., the pattern in which people interleave, and the factors that influence that pattern).

Case study: Dialling while driving

One case study that I have been investigating is dialling a phone number while driving in a simulated driving setting (Janssen & Brumby, in press). Using this set-up, we investigated whether people make use of the task structure of the secondary task (in this case a previously rehearsed phone number) to guide attention switching. The underlying hypothesis is that if a task can be decomposed into smaller subtasks, people will tend to switch attention after the completion of a subtask (cf. Bailey & Iqbal, 2008). Switching here, rather than in the middle of a subtask, is beneficial, as you do not have to remember at which step you were within the performance of that subtask. For example, if you want to check your email while typing a document, it is better to check your email after you have completed typing a sentence, rather than when you are in the middle of typing it.

In our dialling-while-driving study we investigated whether participants only interleave at subtask boundaries when the number of subtasks is limited and takes a relatively long time to complete. We found that participants strategically adapt their interleave pattern to their priority objective. If the objective was to dial a phone number as fast as possible, participants interleaved dialling for driving solely at the subtask boundary. However, if the participants' objective was to drive safely, while also dialling a phone number, they still interleaved at the subtask boundary, and added additional points of interleaving.

Cognitive models of human performance

To explain the difference in the adopted strategies, in the different priority conditions, I formalise human performance in cognitive models – computer simulations of cognitive processes. The use of cognitive models in HCI was heavily advocated by Card, Moran and Newell (1983). The development of a cognitive model requires one to specify a theory of human behaviour in terms of the cognitive, perceptual and motor mechanisms that achieve performance. In this way it requires a detailed understanding of the psychological aspects involved in the task. Once a basic model is in place, it can be used to generate predictions of performance in novel settings.

I use the novel framework of Cognitively Bounded Rational Analysis models (Eng et al, 2006; Howes et al, 2009). An important feature of this methodology is its capacity to explore performance of alternative ways, or strategies, for executing a task. Within

Christian has just entered the second year of his PhD research at the UCL interaction Centre. His research takes place within the EPSRC funded "interactions on the move" research program, of which Duncan Brumby is Principal Investigator. Duncan Brumby, John Dowell and Nick Chater are his supervisors. Christian received his B.Sc. in Artificial Intelligence, and M.Sc. in Human–Machine Communication, with a specialisation in Cognitive Modelling, from the University of Groningen in The Netherlands. He has a strong interest in understanding the adaptive nature of human cognition, and likes to study this in applied settings.

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the context of multitasking research, different strategies can in general be defined based on two aspects: (1) the amount of time that is dedicated to each of the tasks that one is pursuing, and (2) the amount of time that is spent on a task, before switching attention to the next. Whatever the applied strategy is, there are always trade-offs in performance. If more time is spent on one task, performance on the other task is likely to suffer. For example, in a dialling-while-driving context, the more digits that are typed in one sequence, the more a car will drift.

Observations of trade-offs in multitasking situations have been made frequently (e.g., Navon & Gopher, 1979; Norman & Bobrow, 1975), but required a lot of experimental work. In contrast, the modelling methodology that I use makes it possible to predict performance for several alternative, unobserved strategies. If there is a formal criterion by which performance can be assessed, then the strategy with theoretically optimal performance can be identified, and compared with human performance. In this sense, the modelling methodology extends the work on performance trade-offs, as the model allows one to assess (1) whether observed human behaviour is optimal, and (2) why it is (not) optimal, by comparing performance of the optimal strategy with performance of other strategies (see also Janssen et al, 2010).

The field of human–computer interaction promotes the use of mobile devices, and in effect encourages multitasking

Future work

The field of human–computer interaction promotes the use of mobile devices, and in effect encourages multitasking. It is therefore important that the field keeps on investigating human performance in multitasking contexts. As the field has its roots in psychology and computer science, it is in a unique position to integrate insights from both disciplines. It can keep human constraints in mind when thinking of new and improved technologies.

In my own work I am particularly interested to explore two aspects of multitasking more extensively in future research. First of all, I am interested in understanding how people learn to trade-off two (novel) tasks. Given that there are alternative ways of interleaving two tasks, how is the optimal way learned? What is, for example, the role of experience and feedback in performance?

Another aspect that I am interested in is individual differences in performance. Do people adapt the optimal strategy given their individual characteristics (e.g., their memory capacity, their typing speed, etc.)?

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My PhD

If you are a PhD student just itching to tell the world about your research or if you've enjoyed reading about some of the emerging areas of research that the My Phd column has recently discussed then we would like to hear from you. We are currently accepting one to two page summaries from PhD students in the UK and across Europe with a focus on being open and accessible to everyone in the HCI community.

If you would like to submit or would just like more information please contact Stephen Hassard using the contact information below.

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Interfaces reviews

Shailey Minocha

We have two book reviews for you in this edition of Interfaces. I hope you enjoy the reviews and find them useful.

About our reviewers

Xristine Faulkner is a Reader in HCI Education at the Department of Informatics, London South Bank University where she has lectured since 1990. She currently teaches HCI, usability engineering and social technology. She is the author of a book on HCI and one on usability engineering. Her current interest is in the area of social technology and especially interaction on forums.

Shailey Minocha is a Reader in Computing in the Department of Computing at The Open University, UK. Her research and consultancy activities have led to insights into factors that affect usability, user experience and user adoption of technology enabled systems. Shailey's website has details of her activities and publications: http://mcs.open.ac.uk/sm577

Please contact me if you want to review a book, or have come across a book that you think should be reviewed, or if you have published a book. I very much look forward to your comments, ideas and contributions. If you would like Interfaces to include reviews on a particular theme or domain, then please also let me know. Many thanks.

Shailey Minocha, The Open University, UK
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Gender and Information Technology

I am usually very wary of books with 'gender' in the title. As a socialist I think the priority is to put aside differences and concentrate on making the world better for everyone and the label 'feminist' always makes me want to back away out of the door. So although I was happy to review this book I did wonder just a little if bits of it would make me uneasy.

What can I say? If like me the term 'feminist' does not fill you with joy then actually this is a book for you. Mary bites the bullet and deals with the feminist issue straight away and she doesn't pretend it's a popular concept. She is all too aware that damage has been done to the task of working for equality for women by excluding anyone who wasn't a woman, and that some people switch off when they hear the word 'feminism'. She knows that equality for women is something that men need as well; in fact it makes their lives better too and is not something for them to oppose or to fear. So, a feminist movement should include everyone, not just women fighting for equality but society fighting for the equality of everyone no matter who they are. Her argument here is very forceful and convincing; she is certain she is right and she argues with that conviction. But she is never strident and hectoring; she never comes across as a crusading evangelist unable to listen to counter arguments – her argument remains calm, cool and collected – and often she lets the facts speak for themselves.

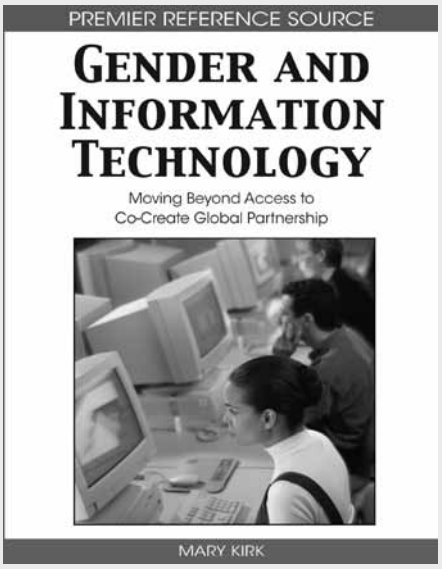
The first section kicks off with her particular view of feminism. She clearly understands my desire to back away from certain types of feminism and she deals with that reaction bluntly by addressing all of the 'myths' that surround the feminist cause and dispatching them. Her plan is to show that feminism is a response to a particular social system and that by shifting our world picture we not only deal with the inequalities caused by sexism but we deal with other issues too and make the world a place where everyone has the opportunity to take part without being browbeaten and ignored. She explains how dominator societies expect certain attitudes and cultivate certain ideas. It is these ideas and attitudes that create the atmosphere for sexism, which not only subjugates women but actually also subjugates those men who can't conform to the requirements set out by a dominator society. Her picture of a society that warps both men and women is not a pretty one.

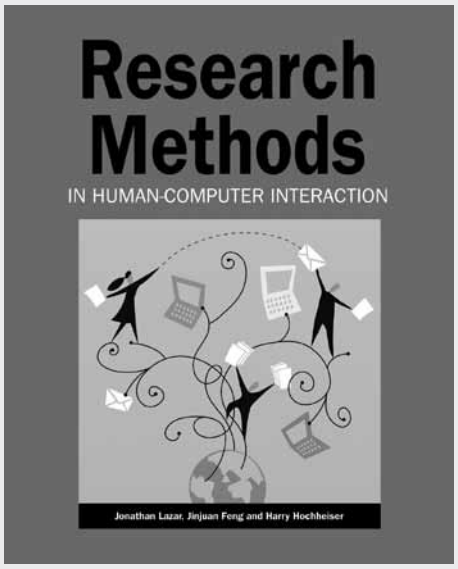
Chapter 2 deals with these issues in more depth looking how people are shaped into stereotypical roles by a dominator society. Finally, to end this first section, Mary considers the make-up of science, which again, from a dominator perspective, develops into a field that rather than encouraging women does completely the opposite. For Mary it is no wonder that women don't go into science because it is structured in such a way as to intend to preclude the inclusion of women. The real puzzle is as to why so many women do manage to ignore these strictures and make a life inside science and engineering.

Section 2 looks at social institutions within this dominator society. Mary takes the example of *Wired* to examine the role of mass media in supporting and engendering the dominator society. This leads naturally on to an examination of language and the male dominated IT culture. Chapter 6 looks at education and women's struggle for education and a place in science, maths and engineering. The section ends with a chapter on the global issues in IT and how the dominator society has meant that business has played a big part in some of the world's darkest moments.

Section 3 looks at how the world might be with a different social structure, that of partnership not domination. Mary looks at this new language of partnership and gives examples of how this might operate. She then takes each other social element in turn and shows the partnership equivalent of the dominator society. Hence, there are chapters on partnership technology, science and education; and partnership global IT businesses. The book concludes with ideas for future research, suggestions for a way forward and her own personal reflection.

I enjoyed this book immensely. It is very carefully and meticulously researched. It is often moving, touching and thoughtful but Mary isn't all doom and gloom – she has the most delightful sense of humour which bubbles through. Like many of us she is aware of the foolishness of prejudice and the brake it puts on people, so although she is angered by it at times the tone is more one of regret that humankind can do so much and yet hasn't learned even the most obvious and basic idea that actually everyone should be respected and cherished for who they are and by altering the way that we view each other we can make for





Gender and Information Technology: Moving Beyond Access to Co-Create Global Partnership
Mary Kirk
IGI Global
ISBN 9781599047867
2009

Research Methods in Human–Computer Interaction
Jonathan Lazar, Jinjuan Heidi Feng and Harry Hochheiser
John Wiley & Sons Ltd
ISBN 9780470723371
2010

a better, more economical society than we have at present. Our current society is not simply wasteful of talent and opportunity but deliberately so. We aren't talking about an accidental leak of resources; we are talking about the deliberate turning on of a tap which is encouraged to pour away opportunities and talent by the second.

I think this book will be very useful as a resource for IT students interested in gender and economics, and sociology students should find it useful too. I want my Social Technology students to consider it as it has very important things to say about how electronic communication operates for men and women. I recommend this to anyone who is interested in how society uses technology and how the very technologies themselves can be used to suppress the talent that in theory they are designed to engender. All in all, a thought provoking book that avoids the heavy-handed, high horse approach and instead sends you away to think about your own attitudes and prejudices. Mary treads an extraordinary line by combining rigorous research with personal reflection, experience and comment, so while mustering the facts she leaves the reader with the sense that a chat is taking place over her kitchen table and a cup of tea. As I say, getting that intimacy whilst at the same time retaining the rigour of research is no mean feat; and the book itself is an excellent ambassador for partnership language.

Reviewed by Xristine Faulkner, London South Bank University, UK

Research Methods in Human–Computer Interaction

The book *Research Methods in Human–Computer Interaction* is an excellent collection of a wide variety of methods that we have been applying in HCI research for a while but by referring to a number of texts and resources. The preface and the introductory section of the book discuss the role of the book in an HCI researcher's toolkit. The introduction to the book also explains the historical roots of HCI, how the discipline has been shaped and has changed over time, the inter-disciplinary nature of HCI, and the need to 'borrow' and apply methods from other disciplines, particularly social sciences.

Chapters 2–4 are on experimental design including statistical analysis. Chapters 5 and 6 cover two approaches from sociology: surveys and diaries. Chapters 7, 8 and 9 discuss case studies in HCI research, interviews and focus groups, and ethnography. Chapter 10 focuses on usability testing and the authors make the readers aware that usability testing or evaluation of the user's experiences with, and perceptions of, the user interface designs are a part of the HCI research approaches discussed earlier in the book. Chapter 11 focuses on the analysis of the qualitative data and methodological approaches and techniques such as grounded theory and content analysis. In chapter 12, automated data collection methods (e.g. web logs, keystroke and activity loggers) are discussed. Eye tracking and physiological tools are covered in chapter 13. Chapters 14 and 15 are my favourite chapters as they cover topics that are seldom covered in other HCI books and resources: recruitment of participants, dealing with institutional review boards or ethics committees, seeking informed consent from the participants, ethical concerns in conducting online research, and working with research participants with impairments (chapter 15 is the final chapter of the book).

Each chapter of the book has an excellent list of references to papers, books, and web resources. The summary and the research design exercises at the end of each chapter are useful resources for revision of one's understanding of the method or approach. The book will be a useful guide for HCI research students, academics and practitioners, and anyone doing user research. The writing style is very clear, conversational yet thorough, and each chapter is supported by a number of examples. However, I would have liked to see examples of situations where methods are combined in complementary ways – particularly usability evaluation techniques and techniques from social sciences such as reflective diaries, and online interviews via instant messaging or in 3D virtual worlds.

Harold Thimbleby has also reviewed this book in *Times Higher Education* and his review is available at http://tinyurl.com/355b6vv.

A companion web site of resources for instructors using *Research Methods in Human–Computer Interaction* can be found on the Wiley web site at http://tinyurl.com/2826dyz.

Reviewed by Shailey Minocha, The Open University, UK

Intercom

Interacting with Computers

Dianne Murray

The current issue of Interacting with Computers is a Special Issue on the topic of Measurement and Structural Models of User Experience, edited by Dr. Effie Lai-Chong Law and Professor Dr. Paul van Schaik. It is introduced with an overview article by the two editors presenting an Agenda for User Experience (UX) Research and Practice. The five selected papers address different concerns pertaining to UX, including measuring usability as a component of UX, impacts of sonic interactions on gameplay experience, experience narratives for measuring the dynamics of user experience, relationships between psychological needs and positive experience, and analysis of user-engagement in online shopping.

Although 'user experience' (UX) has become a fashionable term in human–computer interaction over the past 15 years, practical applications of this (multidimensional) concept still need to be further developed. Measurement models are essential to allow the UX concept to be measured accurately and to aid in activities such as the evaluation of interactive computer systems. Structural models of UX are needed to establish the structural relations both between components and the characteristics of users and computer systems in order to better inform the design of interactive computer systems. Some of the questions addressed in the Special Issue include the following. What is the relationship between usability and UX? To what extent and how can attributes of UX be measured? What is the role of and relationship between subjective and objective measures? What are the levels of analysis involved in studying UX? What is the role of time in UX modelling? What is the psychological basis of UX, in terms of motivation and fulfilling psychological needs? What are the practical implications of UX modelling? As usual, papers are available on ScienceDirect at http://www.sciencedirect.com/science/journal/09535438.

Recent accepted papers

The Science Direct page for IwC also provides access to papers still awaiting printed publication, although they are available to cite with a DOI, and can be downloaded in full.

Recently accepted regular papers are:

Cristina Manresa-Yee, Pere Ponsa, Javier Varona & Francisco J. Perales
User experiences to improve the usability of vision based interfaces

Jonas Moll, Yingying Huang & Eva-Lotta Sallnäs
Audio makes a difference in haptic collaborative virtual environments

Paul van Schaik
Using interactive 3-D visualization for public consultation

Sybille Caffiau, Dominique L Scapin, Patrick Girard, Mickaël Baron & Francis Jambon
Increasing the expressive power of task analysis: formal and empirical assessment of task models and tools

Editorial boards

I am happy to welcome these new editorial board members:

Dr. Jeffrey Bardzell, Indiana University, USA (HS Board)

Dr. Timothy Bickmore, Northeastern University, USA (ASEB)

Dr. Kasper Hornbæk, University of Copenhagen, Denmark (CS Board)

Dr. Effie Lai-Chong Law, University of Leicester, UK (CS Board)

Prof. Roderick Murray-Smith, University of Glasgow, UK (CS Board)

Annual board meeting

Our Editorial Board meeting at the CHI 2010 conference was very well attended by some 20+ old and new editorial board members, and those now part of the Founding Editors Board, in addition to Elsevier and Morgan Kaufmann managerial and publications staff. We reported on our greater integration with BCS and stressed that IwC is a society journal, not just for the Interaction group but also for the BCS, being identified now as one of the BCS stable of journals (see http://www.bcs.org/server.php?show=conWebDoc.1414). We discussed in some detail the future direction of the journal – how to differentiate IwC from other journals, both in existence already and in planning, and how to increase our visibility and status. We felt we should aim to be the best journal for new, future-focused work, new technologies and applications, the latest viewpoints and theories – and we should emphasise and publicise much more strongly our fast turnaround and speedy processing times leading to quick publication, and our very international and interdisciplinary nature. More input is needed on this, so an IwC blog for editorial board members is being set up for discussion. I am more than happy to receive input and comments from Interaction group members and any other interested parties so do contact me by email. As ever, we are constantly seeking new submissions, new registrations (especially of reviewers), and any proposals for Special Issues, so get in touch directly to discuss any papers you might like to submit to IwC, or proposals you'd like to make.

Calls and communications

Increased impact factor

Finally, the best news is kept till last: we have a greatly improved Impact Factor for 2009: 1.698, up from 1.103 and with a 5-year Impact Factor of 1.911, up from 1.174. We are ranked 7th out of 19 journals in our area. I am very pleased and extend my thanks to all editorial board members, reviewers and authors who have contributed to our success.

Latest news

Access Interacting with Computers via the Science Direct link and see, on the IwC homepage, the latest papers, most downloaded articles, up-to-the minute citation statistics and calls for submissions.

Dianne Murray
General Editor, Interacting with Computers
Email dianne@city.ac.uk

http://ees.elsevier.com/iwc/
http://www.sciencedirect.com/science/journal/09535438

CfP

CHI 2011

7–12 May 2011
Vancouver, BC

Submission deadlines

24 Sep 2010: Papers and Notes
8 Oct 2010: Workshops, Panels, Case Studies, Interactivity, Doctoral Consortium
14 Jan 2011: SIG meetings, Works-In-Progress, alt.chi, Videos, Student Design Competition, Student Research Competition.

www.chi2011.org

CfP

EuroSOUPS

European Symposium on Usable Privacy and Security

24 November 2010
Northumbria University, UK

2-page position papers are invited for a one-day workshop on the development of EuroSOUPS

Submission deadline

1 Oct 2010: Position paper deadline

www.cocolab.org/soups/eurosoups

CfP

INTERACT 2011

13th IFIP TC13 Conference on Human–Computer Interaction

5–9 September 2011
Lisbon, Portugal

Submission deadlines

10 Jan 2011: Full papers (abstract)
24 Jan 2011 Full papers (paper)
7 April 2011: Short Papers, Posters

www.interact2011.org

CfP

HRI 2011

6th ACM/IEEE International Conference on Human–Robot Interaction

6–9 March 2011
Lausanne, Switzerland

2011 Theme: Real World HRI

Submission deadlines

22 Sept 2010: Full papers, tutorial/workshop proposals
22 Dec 2010: Late breaking reports, videos

www.hri2011.net

BCS Interaction Group is served by regionally based sub-groups with representatives from a broad range of academic and industrial centres of HCI interest. The sub-groups meet informally every few weeks to progress work, and all participants are committed to promoting the education and practice of HCI and to supporting HCI people in industry and academia. For contact details of the people in each sub-group, please select from the following:

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Treasurer ***Corina Sas***
Membership Secretary ***Janet Read***
Communications Chair ***John Knight***
Competency Chair ***Dave England***
Research Chair ***Matt Jones***

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IFIP Liaison ***Phil Gray***

Vacant Roles

Offers of help always welcome

Webmaster/Web Developers
Student Representatives
Industry & Public Sector Representatives
Interfaces Magazine contributors
UsabilityNews contributors

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Relevant URLs

British HCI Group: ***www.bcs-hci.org.uk***
UsabilityNews: ***www.usabilitynews.com***
IWC: ***search for Interacting with Computers***
HCI2009: ***www.hci2009.org***
HCI2010: ***www.hci2010.org***

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Interfaces editorial policy is focused on promoting HCI and its community in all facets, representing its diversity and exemplifying its professional values by promoting knowledge, understanding and awareness to the benefit of all and harm to none. Editorial decisions are based on promoting these core values with the Editor being accountable to BCS Interaction Specialist Group and BCS for the content of the magazine. As such the Editor has the right to refuse publication with recourse to BCS Interaction Specialist Group and BCS in cases of arbitration.

The views and opinions expressed in Interfaces are strictly those of the relevant authors attributed to articles and do not necessarily represent those of BCS Interaction Specialist Group, British Computer Society or any associated organisation. Interfaces does not accept responsibility for the views expressed by contributors and unless explicitly stated (where authors are publishing at the behest of an organisation or group), authors are acting in a personal capacity and expressing personal opinions that may or may not represent the views and opinions of any organisation, employer, person or group attributable to them.

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