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Studies of intra-action: Informing design for palpability

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Extended Abstract

Pervasive computing offers attractive, in some cases critical, support in a range of settings. The work of emergency response personnel is one such setting [5], and one important issue that could benefit from pervasive computing support is illustrated by emergency medical personnel thus:

> *after an accident with many people injured, we try to attend to those most in need of treatment while monitoring the status of others. Failure to notice critical changes in patient conditions can be fatal, but noise, darkness, rain and smoke limit what we can see and hear, and victims are covered with blankets.*

These difficulties were described during discussions between researchers and emergency professionals embarking on a joint project to explore the architectural requirements for pervasive computing in emergency response (PalCom: A new perspective on ambient computing http://www.ist-palcom.org, [6]). When asked – somewhat naively – why they do not use biosensors and alarms to assist in the monitoring of victims, the professionals pointed out that biosensors and displays might improve visibility and audibility of vital signs from a distance, but they would require additional time and work to set up. Moreover, wired displays and power sources would impede the transport of victims, and alarms would add to the chaos of the situation, overwhelming staff rather than alleviating the risks of missing significant changes in patient conditions.

The researchers described how wireless biosensors and wearable displays could be used to direct alarms more effectively, for example by highlighting the data of victims that a particular member of staff is responsible for. This would allow the professionals to selectively tailor and expand their range of attention. However, subsequent discussions revealed more deep-rooted difficulties. The main concerns chime with studies of everyday practices of using wired biomonitors and alarms in hospital settings. First, although alarms seem to demand urgent action, they can often be ignored safely. Ignoring alarms is skillful work [4] and it depends on knowing the relevance of thresholds built into the alarm system to the specific situation. For emergency trauma injuries few of the standard thresholds are useful. If they could be adjusted individually, it would be difficult for the medics to judge the relevance of one alarm in relation to other alarms. Second, responding to or skillfully ignoring alarms are accountable and collaborative rather than individual, private responsibilities [15]. People make inferences about the meaning of action or inaction in response to alarms. While this can be negotiated in hospital settings, where patients, doctors, nurses, and visitors have opportunity to talk and learn, in an emergency situation selectively attended alarms could increase the trauma for victims and confuse rather than support collaborative efforts. Third, wireless connectivity makes the connections between people's injured bodies, the sensors and the displays where sensor readings are shown invisible. For medical personnel it then becomes difficult to engage in localization, orientation and recognition of significant sensor alarms [16]. If an alarm sounded, showing critical readings on a medic's wearable display, how would s/he find the victim in question? How could s/he be sure that erratic readings are due to changed patient condition and not a failure of power or network? Even worse – how could s/he avoid the risk of false positives – where good signals are received when the victim's actual condition is deteriorating? Personnel argue that they cannot accept these uncertainties and that although problematic, their current practice of monitoring embodied symptoms through physical examination is best.

This example highlights a key cause for the difficulty of realizing the potential of pervasive technologies: The complexity and invisibility of their processes, states, resources and connections make it difficult for people to notice, inspect and break down what is going on and understand it [6]. Breakdown is usually seen as the result of malfunction or failure. However, breakdown is also a constructive, in fact, crucial activity in using technologies confidently and creatively. Drawing on phenomenological philosophy, Winograd and Flores describe breakdown as 'the interrupted moment of our habitual, standard, comfortable 'being-in-the-world' ([18] p. 77). Flows of activities in which equipment is taken for granted or 'ready-to-hand' can be interrupted by malfunction, but also by a change of perspective. People become interested in the components, states, processes, affordances of, and connections between, materials, technologies or environments and make them 'present at hand' or 'palpable' when they experiment, analyze, or explore other uses. The word 'palpable', in its sense of 'plainly observable', 'noticeable, manifest, clear' (http://dictionary.oed.com) captures key aspects of what happens during breakdown.

Balancing complexity and invisibility with 'break-down-ability' or support for making computing palpable poses great challenges for designers of pervasive computing technologies. Everyday users come to these technologies with different computer 'literacies', a variety of purposes, and in diverse physical and social situations. In addition, component based, mobile, pervasive computing allows people to use geographically distributed, embedded and autonomic devices and services, sustained by invisible, 'grid'-like infrastructures of connectivity, location information, or data services. Not all services are benign and there is a risk of – again often invisible – breaches of security and privacy.

The response within the pervasive computing design community has two main strands. First, one can seek to design systems that anticipate or sense people's needs and eliminate as far as possible the possibility of failure. This should make pervasive computing effective, sturdy and efficient. Approaches include autonomy [12], context-awareness [9], self-healing [14], information appliances [13], protecting people from complexity and countless choices whose consequences only few would be able to fathom. Furthermore, designers may aim to make interaction intuitive, e.g. through tangible interfaces [17]. These strategies are attractive. However, they underestimate the challenges and opportunities complexity and invisibility pose.

The second strategy seeks to identify and address these challenges and opportunities. Belotti et al. [3], for example, insightfully highlight the challenges of 'making sense of sensors' in the absence of GUI-supported interaction tools. Drawing inspiration from the analysis of interaction between people, they focus on problems of addressing embedded systems, of understanding and taking action, coordinating mutual attention and alignment, noticing and addressing accidents. They seek to inform design by sensitizing designers to the challenges of human-computer interaction in environments saturated with interoperating and interdependent devices and services that sense human action. In a similar vein, but drawing on Weiser's work for concrete design inspiration, Chalmers [7] addresses these issues through 'seamful design', revealing system 'sutures' (for example, between areas where location information is or is not available). Dourish, who calls for 'accountable' computing, pioneering the use of reflection to support human-computer interaction [10] is working with a group of researchers to explore, for example, how people might be supported in understanding security [8] and privacy [11] in pervasive computing environments. Anderson et al. [1] explore the need to make autonomic computing accountable. They articulate how autonomy undermines the little 'natural' accountability that systems have (by way of deterministic behaviours), and show how difficult it is to build useful accounting procedures into autonomic computing. Most notably they argue that appropriate or 'recipient designed' accounts are required to answer everyday users' key question of 'why that now?' in ways that are relevant and understandable in specific use situations. Anderson et al. show that contemporary advances – e.g. agent based reasoning or context information – deliver only paltry progress towards enabling appropriate, recipient designed accounts in computational systems. They recommend in-depth participatory engagement with prospective end users to allow designers to better prepare satisficingly appropriate accounts.

My work builds on this research. As a member of an interdisciplinary team I carry out studies of everyday practice to inform the design of an open architecture that supports people in making computing palpable [6]. Like many in this field of research, my colleagues and I come to it through ethnographically informed participatory design projects, in our case with, amongst others, healthcare and emergency response personnel, who express a strong desire for pervasive computing. However, for reasons I elaborate in Parts 3 and 4, we shy away from notions of human-computer 'interaction' and 'accountable' computing. Instead, we focus on human and material agency and 'matereal' methods of 'intra-action' [2] – deliberately mis-spelt to highlight that people break down, experience and shape reality through engagement with material agencies in a continuous intertwining of cause-effect, action-reaction, documentation-interpretation. Matereal methods are ways of noticing, acting in line with, and creating order in human-matter intra-action. Part 3 and 4 show that palpability is an effect of intra-action, not something designers could design *into* technologies. However, I argue that we can design *for* it in Part 5.

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