Supporting Remote Problem-Solving with Ubiquitous Computing: Research Policies and Objectives

Peter Tolmie, Antonietta Grasso, Jacki O'Neill, and Stefania Castellani

Work Practice Technology Group, Xerox Research Centre Europe,
6, chemin de Maupertuis, 38240 Meylan, France
+33 4 76615050
{*name.surname*}@xrce.xerox.com

ABSTRACT

As an introduction to the UbiComp 2004 workshop on 'Giving Help at a Distance' this paper pulls together many of the features of the perspectives upon research and design adopted by the various workshop authors and distills from them a common set of policies and objectives applicable to research in this domain.

INTRODUCTION

There are numerous circumstances – the use of technology and/or devices; medical emergencies; practical way-finding; training and learning; and so on – where problems that have arisen may not be open to resolution by the in situ party alone but require additional assistance from other parties at remote locations. Existing methods for overcoming these problems still centre largely upon bringing other parties (for example technicians, doctors, etc.) to the site of the problem (or in some cases taking the object to them); or else providing conventional telephone support where the in situ party can phone up a remote expert for advice.

In the case of actually bringing the expert to the problem the cost of such resolutions is frequently high in both terms of the provision of such a resource and the loss of time, productivity, etc., for those encountering the problem.

Telephone support in these circumstances is cheaper, but presents other issues regarding making the problem properly available to the remote expert and finding ways to guide those in situ to an effective resolution.

The question then arises as to how these interactions might be better supported by new developments in technology. Do mixed reality and ubiquitous computing technologies, for instance, offer a clear way forward? And, if such avenues are indeed promising, what implications does that carry for the way in which research and design might be directed in this area in the future?

SCOPE OF RELEVANCE

The breadth of the topic here is huge and there are several possible dimensions to how one might characterize the need for remote assistance. One dimension, for instance, could be the range of different scenarios in which requirements for remote help might arise. This could cover everything from calls for help relating to accidents or failures, to less pressing calls for advice, and everything from the provision of troubleshooting and the support of diagnosis, to remote repair and maintenance.

Another dimension could be that of relevant domains such as: software troubleshooting; medical equipment troubleshooting; printer and MFD troubleshooting; telephone equipment troubleshooting; PC hardware troubleshooting; TV troubleshooting; router and network equipment troubleshooting; car troubleshooting (especially by the roadside); electricians; plumbers; washing-machine repairmen; police; remote medical units; vets; water companies; gas companies; and so on. Just the handful of papers presented in this workshop are indicative of the scale of the domain: scientific analysis; product development; the textile industry; libraries; healthcare; travel agents; florists; naval technologies; civil engineering projects; vehicles; and input/output device repair. One could even expand the scope still further to all circumstances where there is a need to share information and/or artefacts across distance for the purposes of solving problems as they arise.

Evidently there will be discrete concerns within the practices of different kinds of remote problem-solving that will defy ready to hand generic solutions. However, the common nature of the problem – supporting the communication of information about how to resolve some difficulty between two or more individuals who cannot for some reason be co-present – does propose some common *policies* for investigation and design. And the findings and techniques that might accrue to the pursuit of such policies may well offer the possibility of some significant and fruitful synergies between those addressing the problem from different perspectives.

POLICIES OF INVESTIGATION

One of the prime concerns that underpins what kinds of policies of investigation should be adopted is the extent to which help-giving technologies should be designed to fit with people's existing and future practices. Beyond this, issues attach to just how one should proceed with any such investigations.

We adopt the strong, but increasingly prevalent view that a) understanding of people's practices is essential; b) that such understanding is informative even when designing for future states; and c) that ethnographic methods are those best suited to acquiring such an understanding.

People have tried and tested and *orderly* ways of going about providing assistance to one another and, at least since the invention of the telephone, they also already have orderly ways of providing help *at a distance*. This order will not be just swept aside by technological innovation. Instead technological innovation will need to be made at home in current practice [15]. Without understanding current practice, then, one relies upon serendipity for utility and success.

It is further the case that the order within work is constituted in the *doing* of the work [1][8][9]. Only by observing the doing of the work will one be able to properly uncover the orderliness within practice. Ethnography is therefore a critical component of investigation.

Adopting these policies at XRCE has already revealed to us clear issues regarding matters such as just how people oriented to a common 'troubled' object of some kind resolve the fact that the object is not mutually directly available. There are current ways of handling this that might be seen to have direct relevance for how one might design supporting technologies. Many of the other authors at this workshop can be seen to have adopted similar policies of investigation. Crabtree [4], Evans et al [5], Fitzpatrick [6], Fraser [7], and O'Neill et al [14] will all explicitly or implicitly propose proceeding this way and the other papers clearly recognise this need to attend to actual practice. And, of course, many other researchers, especially in the CSCW domain, have been contributing findings on the basis of such policies of investigation for some years now [2][10][11].

POLICIES FOR DESIGN

Policies for design in many ways extend out of the above policies for investigation. Thus, one policy is that critical design issues should be uncovered through study of existing work practice. Only by understanding the characteristics of remote help-giving and the pursuit of such help, and how such problem-solving activities are constituted collaboratively, can one begin to understand just what problems one *should be designing for*.

The issues that arise out of these understandings are not discrete in their relevance but rather can have import across the whole of the design process. One policy for design might then be giving serious attention to how to capture and record information *at the site of the problem* so that this order of information can be effectively relayed to remote experts. For ubiquitous computing this could translate to a need to attend to what current practice might imply regarding where technology might be best embedded and what might be best sensed. It would not be coherent to wire and sense everything even if one could, and understanding where these technologies might be best placed to support *human* practice is critical. Even where feedback is provided to auto-diagnostic systems the issue will still remain as to how such information is made intelligible and worked with by humans. The only exception here would be something like remote system guidance for troubled objects to undertake self-repair without any need for human interaction at all.

Another policy relates to the need to attend to what features of *the interaction* between remote agents might be best captured and supported. Understanding how interaction is currently organised - what features are evidently taken for granted and what features present troubles, demands for clarification, or callings to account – will be tremendously informative for how one might facilitate the communication and 'help the help-giving' with new technological resources. It will also be informative regarding what works well at the moment and is therefore best left alone.

Beyond this there lay issues regarding not just what might be best displayed to interactants in problem-solving interactions, but just *how* information regarding the problem and its solution might be best displayed. In other words one needs to take as a policy the need to attend to designing *appropriate* representations of this information to support the interactions of users and remote experts. An important point here is just how far such representations should go. Representations clearly need to provide sufficient key information (that is, neither too little or too much) for the interactants to arrive at the kind of mutual understanding needed to underpin remote help. More than this, the *way* in which representations are provided must allow for appropriate mechanisms for the interactants and the system to be duly accountable within such collaborations. It is no good having a system where the interactants are forever needing to wonder why certain things look certain ways, why certain things are happening, and just what it is that the other person is doing. However, it is an open question as to how far a representation should go towards producing a facsimile of some troubled object. The quality of representation required in the car driving scenario proposed by the SACARI team [18] is clearly appropriate and Fitzpatrick [6] points out that the quality of resolution can matter in certain clinical situations, but this does not indicate this would be optimal for all of the situations such a technology might cover.

Throughout all of the issues here observations of current work practice are well worth attending to. From the papers in this workshop alone we can see that there is a range of methods currently adopted by those engaged in this kind of problem-solving. For instance, there are:

- Methods for describing, representing and formulating problems by those who encounter them [4][14].
- Methods for situating problems in an ongoing sequence of events [5][14].
- Methods for articulating, eliciting, translating and refining problem descriptions by remote parties, often in the context of resolving distinctions between technical and non-technical vocabularies.

This nearly always entails collaborative work and is therefore governed in itself by the methods people use to produce intelligible talk in interaction [4][5][6][14].

- Methods for resolving a lack of situational information [5][6][7][14].
- Methods for proposing solutions [6][12][14].
- Methods for providing directions and instructions, often by remote parties for objects they cannot actually see [5][7][12][14].
- Methods for *following* directions and instructions that have been given from remote [5][6][14].
- Methods for enacting the physical characteristics of objects currently out of reach [7][12][14].
- Methods for extending the cohort of problem-solving parties [4][6][7][14].
- Methods for enacting solutions and providing feedback [12][14], and so on.

Whilst many of these methods can be seen to be bound up with resolving the problem of a lack of mutual access to the same object, the fact that these methods are already constituted to provide for intelligible interaction suggests it would be foolhardy to presume that alternative methods for supporting this order of problem-solving could simply overwrite existing and evolved practice.

Specific design solutions to the issues these imply are as numerous as the domains they pertain to but again the papers in this workshop expose some common concerns regarding what design should be attending to:

- Providing means to resolve distinctions in expert and non-expert understandings [3][4][5][18].
- Providing means to access *relevant* situational information [5][6][7][18].
- Providing the means to access relevant historical information [6].
- Providing the means to present problem-solving information in situationally coherent ways [5][6][7][12][17].
- Providing the means to appropriately represent people's ongoing activities in relation to an object [7][12][17].
- Providing means to clarify and/or enhance expert instructions and directions, including through gesture [5][12][17].
- Providing means for there to be visual as well as audio resources and in particular the shared visualization of problems and their context [3][5][6][7][12][18].
- Providing means to reduce interactional overhead (where features of the interaction are devoted to resolving other problematic elements such as a lack of mutual access to the same object) [5][6][12][14][17].

Whilst this tenor of interest may not cover the whole scope of existing practice comprehensively, it clearly captures many of the methodological features noted above, even if agreement on just what solutions should look like is less apparent.

CONCLUSION

The policies and objectives outlined above will be either implicitly or explicitly handled in the range of papers to be presented in this workshop. However, other issues are also going to be discussed here. One such issue is how mixed reality and ubiquitous computing technologies in particular might be used to provide a solution to some of the problematics that arise in this domain and a number of the papers presented here are relevant to this issue [3][7][12][13][18]. And, as Fraser points to in his paper, this should certainly not be the limit of our technological vision [7]. Other technologies such as grid technologies may also have something to offer to some remote problem-solving concerns. Furthermore, it may be appropriate to consider whether other bodies of research, such as that one can encounter in the more solely VR oriented 'presence' literature may have insights to offer for how support might be provided for remote problem-solving [16].

Another issue pointed out by Fitzpatrick [6] is the actual ins and outs of how, where, and for who such technology might be successfully implemented and whether it is best for such technologies to be presented as technologies for problem-solving alone. In Serrano's example of virtual innovation groups [17], for instance, the technology provided to support their interactions could be construed to be a resource for the routine resolution of problems as well.

Nonetheless, beyond all this, it is critical to preserve a sense of the scope of the domain. It remains a matter of discovery, in forums such as this, as to how important distinctions might be between things like: technological support for remote interaction between experts or where an expert may need to guide an 'unskilled' person remotely; two-party or multi-party interactions; or even the import findings here may have for when individuals must solve problems on their own with only remote machine-based resources to turn to.

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