Supporting Shy Users in Pervasive Computing (Full Proposal)

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Track Record

Dr. Dan Chalmers (BEng(Hons), PGCertHE, MSc, PhD) is a Lecturer in Informatics, working within the Software Systems group. Prior to that he worked for Ericsson Ltd as a Software Engineer and Imperial College London as a Research Associate. He was coordinator on the EPSRC UK-UbiNet network grant, and worked on the LinkMe project while at Imperial. He has been on the programme committees of MPAC, CAMS and MDM, and has reviewed papers for IEEE Distributed Systems On-Line, Pervasive, Middleware and MobiCom among others. He is on the committee for the UKCRC Grand Challenge in Scalable Ubiquitous Computing[5], and currently a co-investigator on the EPSRC WINES2 "Pervasive Computing Support for Market Trading" and "Shaping an International Grand Challenge Community for Ubiquitous Computing" projects.

Dan's research interests focus around context awareness and the way in which system behaviour impacts the user experience in pervasive computing. In particular, how knowledge of context (including resource limits, location, trust, and other physical and social aspects of context) can be used to modify system behaviour[6], affect data display and configuration of systems.

Dr. Geraldine Fitzpatrick (BInfTech Hons, PhD) is a Senior Lecturer and Director of the Interact Lab. Prior to this, Geraldine worked as a User Experience Researcher at a business-technology consultancy company in London, and as a Research Scientist at the Distributed Systems Technology Centre in Australia where she led the Enterprise Work Practice group. Geraldine serves as an associate editor of the CSCW journal and has served on committees of conferences including co-chair for ECSCW, associate chair for ACM CHI and CSCW, and Pervasive among many others. She has a published book and over 50 refereed publications in diverse areas such as CSCW/groupware, HCI, and pervasive computing.

Geraldine works at the intersection of technical and social science disciplines to understand how to design user-centred technologies, with particular expertise in social interaction and collaboration. She has been/is engaged in a number of pervasive computing projects, including the recent Equator IRC. Of particular relevance to the current proposal are projects to do with co-located interaction around large screen displays [4], studies of distributed collaboration and awareness using event notification in a software development group [11], and studies of interaction in mobile outdoor learning contexts. Fitzpatrick's monograph [10] puts forward a framework for understanding and designing social interaction in distributed and co-located contexts including issues of self-presentation and mutual awareness.

Dr. Susie Scott (BA, PGCertHE, MA, PhD) is a Lecturer in Sociology at the University of Sussex, and previously worked as a Research Associate and Teaching Associate at Cardiff University. Her research into the social and cultural dimensions of shyness has been groundbreaking in presenting an alternative to psychological approaches, and has been supported by an ESRC-funded doctoral studentship, ESRC postdoctoral fellowship and British Academy funded study. Susie has published a well-received book, Shyness and Society[26], as well as eight refereed journal articles and twelve other short articles and review essays. Susie is particularly interested in the ways in which shyness emerges situationally from social contexts of interaction, the mutual (mis)perceptions of shyness and non-shyness in others, how self-defined shy people devise performative strategies for managing their shyness, and how non-shy others respond to shy behaviour[24, 25]. In addition, she has explored the methodological, practical and ethical implications of researching shyness, the medicalisation of shyness as an individual pathology, and its social representation as a cultural epidemic. Susie's wider research and publications have been within the fields of Symbolic Interactionist social theory, self-identity and performance, and medical sociology.

Dr. Ian Wakeman (BA, MSc, PhD) is a senior lecturer in the Department of Informatics at the University of Sussex and formerly a research fellow at UCL. His current research interests are focused on support for user policies within pervasive environments, and how to make trust relationships explicit in the technological foundations of pervasive computing systems. His previous work has been in the area of programmable networks and congestion control of video over packet networks. He has been the Principal or Co-Investigator on five successful EPSRC projects and the BT funded Alpine programme. The EPSRC projects included: investigating support for adaptive applications; understanding mental models of networked applications, in collaboration with UCL; an investigation on the design and implementation of programming languages for active net-

works; an exploration of how to use natural language policy management; and developing support for third party computation within the network. He is currently the Principal Investigator on the Utiforo WINES EPSRC project, examining how trust can be modelled for ad hoc markets. He has over fifty publications in refereed journals and conferences.

Mr. Eric Harris (Named Research Fellow) Eric Harris is both a research fellow in the Interact Lab as well as technology facilitator working within InQbate. Eric designs and builds devices and installations, which support new forms of human computer interaction and is particularly interested in bringing his ubiquitous computing expertise into the InQbate space. Eric comes from an industrial background of robotics and machine vision where he filled both technical and operations director positions within a blue chip packaging company. Most recently his work at Sussex University, sponsored through the EPSRC funded Equator project, has been the investigation of both hardware and software toolkits, used to enable experience builders to create their own arrangements of both existing and emerging technologies. He is also interested in the deployment and use of wireless pervasive devices to see how they might embellish user experience within augmented realities.

Dr. Darren Reed (Named Research Fellow) Dr Darren Reed has worked as a Research Fellow in the Science and Technology Studies Unit (SATSU), University of York, and will soon also take up a Research Fellow position in the Interact Lab at the university of Sussex to look at social interactions in online environments such as Second Life. He comes from a sociology background and has extensive experience working in HCI and technology design and evaluation. His PhD was an ethnomethodological analysis of "newsgroup" interaction that used the analysis to reflect back on the conceptual foundations of EM and CA. Over the past few years Darren has looked to combine Science and Technology Studies and Human Computer Interaction and has split his time between Sociology, Psychology and Computer Science. His interests include mundane interaction with technologies in broad social contexts that incorporate peoples histories experiences and expectations. Darren has been working in a variety of including: Inclusive Design - an area interested in promoting the design of everyday technology devices that are attractive and can be used by older people. Transport management and information systems. Assistive Technology, especially the development of common place technologies such as the telephone to support isolated elderly individuals. Currently he is interested in the use of the concept of "performativity" as a means to understand the ongoing interactions between people and technologies.

1 Introduction

We propose to investigate how to use pervasive computing technologies to support shy people in their interactions with other people, through the development of case studies in education, situated group communications and public interactive art-works. Our research aims are to understand how to:

- Identify social and physical factors which can give rise to feelings of shyness in settings that use pervasive computing, so appropriate computational models of these contexts can be developed.
- Develop information and relationship models and implementations that manage personal and context data to control presentation of self and mediate interactions.
- Develop interface models that facilitate interaction, self-presentation and social presence, to mediate and mitigate the effects of shyness in performative settings.
- Better understand the sense of performance anxiety and shyness arising from the connectivity and the forms of interaction provided by pervasive computing.
- Consider the ethical implications of manipulating the presentation of self through technology and incentives for technology use.

We are therefore addressing the following themes, as identified in the WINES3 call: context awareness; information management and provenance; security, privacy and trust; human factors; and ethical and societal issues.

Shyness is a current topic of interest to sociologists and psychologists. We take as our starting point the work of Scott [26] who argues that rather than individuals being inherently shy or not-shy [7], shyness emerges situationally from the context of interaction. Here, context includes the task at hand, relationships with the people directly engaged and any audience, reflecting the presentation-as-drama approach of Goffman [13]. The trigger for shyness is a feeling of *relative incompetence* at the interaction required in a given social situation, whether actual or anticipated [26]. If the situation is repeated the same feelings recur, so that people can be labelled or identify themselves as "shy". Shyness may also manifest itself publicly or privately (where a person appears gregarious but is experiencing stress) [21, 34].

The internet and computing have created new modes of interaction which often do not give rise to the sense of performance and exposure leading to shyness. These modes provide convenient and safe ways to interact through text or avatar, thus allowing users to mask a perceived problem with self-presentation [27]. Further, these forms of interaction require explicit use of the self-presentation mechanism and users can clearly see and understand how they are presented to others in the environment.

Pervasive computing presents new opportunities for people to interact socially and to present themselves, e.g. [3]. However, current research prototypes in pervasive computing tend to assume extrovert engagement in quite public situations, only modifying visibility according to traditional security concerns. This expectation of certain forms of participation excludes those who feel uncomfortable with such extrovert models of engagement, so that these new tools fail to truly "disappear into the environment" [32].

In comparison to text based systems, pervasive computing environments offer more complex, fragmented and often passively-captured forms of self-presentation and interaction, e.g. through sensors that can be worn or are in the environment, through movement tracking, and so on. Users may not even be aware of the many ways they are "present" in an environment nor what is recorded about them and, if they are aware, they may be uncomfortable about how much information is available and to whom. How should the shy person manage their self-presentation and interpret feedback and cues in such contexts of interaction, as opposed to the face-to-face situations of everyday life or text mediated communication of traditional computing? How does any user better understand how they are perceived in an environment where they leave traces of presence, actions and interactions?

Pervasive computing should be constructed so that both shy and extrovert aspects of personality can feel comfortable engaging in these environments, making interaction enjoyable and constructive for all concerned, rather than attempting to "cure" shyness. Various techniques can be applied to make pervasive computing both blend into the world and provide a sense of protection from the stresses of face-to-face performance. Possibilities include: making use of asynchrony, e.g. to provide time for thinking and editing responses; providing choice of interaction mode e.g. shared whiteboard rather than video; exploiting possibilities for obfuscation [9] and mediating detail of data [6] to adapt interactions to device limitations, context and privacy constraints; providing more subtle or private indications of engagement; providing reassuring feedback [23] with indications of what is revealed to whom; supporting a sense of belonging [30] and appropriateness. Ideally these approaches can help create a sense of safe isolation when required – so the exposure, both actual and apparent, of the user can be modified to suit their preferences.

A key strength of the project approach is its interdisciplinarity: combining software systems research on infrastructure and models; interaction design research on self-presentation; and sociological research on the experience and causes of shyness and ethics surrounding this research.

2 Research Objectives and Questions

Context Awareness The context of interaction varies more widely with pervasive computing than in other forms of computer mediated communication. Some aspects of the setting will be outside the user's control. In order to support responses to contexts which trigger shyness, contexts in which group membership is experienced, and the sharing of captured data, we shall need to examine context sensing, processing, dissemination and application. There is much work existing in this area (and we shall re-use technology where appropriate), but relevant context is often particular to applications and so to the design of artifacts to be used. In addition, context helps us to understand observations and interventions used to understand shyness.

As Fogarty discussed in [12] context sensing from simple sources can provide surprisingly good estimates of human situations, which can learn by matching sensor inputs to user actions, gradually automating actions when contexts are understood. This study focused on the appropri-

ateness of interrupting another, and we note how bad people were found to be at estimating whether another could be interrupted. Similarly, people often misinterpret shyness as rudeness or aloofness [26], or simply overlook the shy person. If context information is shared it may be possible to indicate affective state to trusted others, such as teachers, and so improve the interpretation of behaviour.

While it may be an advantage to carefully monitor environments, care must be taken not to make people feel overly observed – it intrudes on their privacy and may well lead to feelings of shyness. Our context awareness mechanisms shall therefore apply our experience in privacy [31] and seek to provide, rather than collect, information; and to store context-annotated data with visibility constraints arising from models of identity, group membership and mediated presentation.

There will also be boundaries to appropriate context sensing, which need to be better understood. For instance, physiological responses to shyness include increasing heart rate or body temperature, e.g. when blushing [8]. Observing such conditions may reinforce feelings of shyness in some users, and certainly dissemination of such personal data must be well controlled and understood by the user. Hence questions of context awareness must also be related to questions of ethics and understanding.

Information and Relationship Models Shyness arises from a sense of frustrated sociability rather than contented isolation: people report wanting to participate in group activities but fearing that they lack the necessary skills and will make an embarrassing mistake [26]. The inhibition that results is due not to performance anxiety per-se, but to concerns that their individual contributions to a group activity will be identified as less competent than those of other members. Technologies that would enable users to contribute to collective tasks while retaining a sense of inconspicuousness and anonymity would therefore meet the needs of many shy people.

Can a mechanism for nurturing collective identity, shared interests and contexts be developed in order to support strategies of hiding, selective disclosure [15], obfuscation [33] and the presentation of alternative identities? Answers to this may build on work in establishing and using privacy and trust in pervasive computing [31, 1]. The use of dynamic and personally specified social groups (rather than those requiring strong membership arrangements) for scoping the exposure of information maps well to established work on situations which cause shyness.

Modifying timing, modality and detail are all possible techniques for controlling presentation to reduce the sense of exposure. However the techniques used must be consistent if they are to be acceptable. It is therefore important to provide tools for applying appropriate modifications and for the underlying mechanisms to ensure consistency [6], possibly using histories of the user's own interactions and those of anonymous others.

Can we define a mechanism to support sharing of context and exposure-constrained data through a pervasive computing environment? This problem builds on existing work for collecting context data and using it to tag stored data, notes and messages. Data may be carried by users' devices and environmental devices; for instance creating a pervasive diary, with more sophisticated sharing behaviour than a typical blog. The visibility of data and its tags therefore needs to be easily defined but also adapt as the scope of the "known world" expands over time. Once data becomes public it cannot, generally, be made private again. For the shy user this can create a greater than normal tension over revealing themselves through wireless networks and public computing infrastructure. More generally, data on interactions with others has no single clear "owner", so requires us to address the problem of conflicts in information ownership. Answers to these issues may build on work on contextual mediation [6] and distributed data storage and sharing [11, 28].

There has been work on obfuscation of context, particularly location, such as Wishart's [33]. This work ranges from simple access controls, via preset levels of inaccuracy and generality, to fine grained control over many aspects of context. The motivation is generally based on roles that 2nd parties take: spouse, family, friend, colleague etc. Wishart's approach describes such preferences matching interaction conditions to obfuscations over particular information. The technique will be interesting to consider with wider issues, where roles / people / situations are not known in advance; where interactions are with an environment or conducted by an environment on a user's behalf; where consistent obfuscations are required; and where obfuscation may be temporal rather than in the values reported.

Interface Models Modes of interaction; hidden and subtle interfaces; and presenting context, location, identity, data and messages in a context- and shyness-aware manner are vital complements to the systems models. If interaction with the environment can help to avoid the sense of physical or virtual proximity and visibility this should help to reduce the sense of exposure and "stage fright" which triggers shyness [25, 26]. It may also help if attention or a desire to interact can be signalled, or if participation can occur in the background. Investigations on this topic will build on prior experience in shared interactions, e.g. [11, 4].

Can we extract general models of the relevant parameters of interaction and presentation? We shall examine physical closeness, virtual closeness, synchrony, the lifetime of data, history of interaction and group membership, settings of use both brought by the user and found in the world [13].

The idea of contextual mediation was presented by Chalmers in [6]. Here context was used to guide selection of the most appropriate media and to ensure a consistent application behaviour by setting goals and monitoring resources. Meanwhile Fitzpatrick examined how interaction spaces, temporal coupling and spatial coupling were perceived and enabled interaction with partners [10]. We propose to develop these techniques, not only to manage receipt of interactions, but also to mediate the presentation to the world. Mediation will be performed on outgoing data, to form an appropriate and consistent presentation to the partner, with context and social relations driving the behaviour preferences.

There has been some examination of tools to support identification of *familiar strangers* in day to day life and to try and reduce the barriers to expressing emotion in urban settings. An interesting example is [20], where there

is no attempt to take away the *stranger* status, but to give places greater meaning by the association with these people. It would be interesting to explore whether all users, shy and gregarious, would find such devices useful. Does anonymity or control over disclosure provide insulation? Does a sense of belonging without needing to interact have social benefit?

How do we best represent group membership, mediation and obfuscation? Metaphors of space, relationship, realism and personification of representations will be important to consider, such as the work in [2]. Interfaces should facilitate the understanding what types of data and control are most effective in different contexts, possibly exploiting the incidental affordances of the technologies such as "seams" [18] to manage their presentation. The experience of these metaphors may allow reusable models and languages to be developed to describe interaction designs.

The Experience of Shyness How are shyness and issues around self-presentation experienced by people in pervasive computing contexts? Understanding this can provide input to the design of mechanisms to attenuate feelings of self-consciousness. This work can also build on understandings about self-presentation and awareness already explored with CMC and CSCW technologies [23, 11] and on understandings of shyness in everyday contexts [26].

Goffman's dramaturgical theory [13] focused on face to face, offline interaction, and although more recent sociologists have applied his concepts to more conventional forms of CMC (such as email or personal web-sites), their relevance to ubiquitous computing is less clear cut. If an environment is less contrived as a "computing area", for example by the absence of a monitor and keyboard, then do users feel more or less vulnerable as performers? On the one hand, it is easier for them to blend into the background of a situation, but on the other, there is no physical screen to hide behind, no *backstage* area in which to rehearse the presentation of self [25]. There may be greater ambiguity in terms of which version of the self is most appropriate to present, because of the lack of immediate, visual feedback from other users on how a collective performance (such as a group task) is progressing. Goffman's notion of performance teams [13] is crucial here, for the shy user is less certain of who is on their side: with whom must they coordinate their roles, on whom to call for help, and how far do the boundaries of the team extend? Without the use of conventional online displays, typing, and emoticons to communicate the more subtle nuances of group interaction, it may be more difficult to display signs of flustering and calls for help. This in turn may lead to feelings of "stage fright" or performance anxiety, whereby the individual fears appearing foolish, being "exposed" as incompetent, or otherwise attracting negative attention.

Team-mates may in fact be quite inclined to provide "protective face-work" [14] to conceal the individual's lack of poise, but this cannot work unless there are clear lines of communication between them. The physical design of these performance spaces is also important. Goffman [13] distinguished between two main aspects of the *front-stage* arena: the setting and scenery, which are fixed in place, and the personal front, which is carried around by each actor. In the case of pervasive computing, the technical equipment can be incorporated into the actor's personal front rather than being a part of the background scenery (as for example a traditional computer would be). This means on the one hand that it is easier to disguise the way in which one is staging one's own performance, but on the other hand, that it is more difficult to read the same cues from other people. Does this make it more likely that group members will interact to gain greater physical proximity, and to explicitly negotiate a shared "definition of the situation" [29]? Or does it mean that shy users become even less confident in their own ability to perform, and so lurk unhappily on the margins? We can then investigate ways of designing these spaces so that they contain some more obvious "props" or physical features on which actors can lean to communicate more clearly, such as writing implements, pointing devices, visible personal devices, or areas within a space identified by screens, lights etc.

Underlying all this is the need to better understand how the personal and social issues behind shyness map onto the pervasive computing sphere. The research aims to support people so as to reduce or avoid the negative aspects of shyness (anxiety, self-consciousness, frustrated inhibition), thus enabling them to behave as they would like - without denying them their personality. This in turn would protect such users from being disadvantaged or threatened by their environment, while also seeking wider benefits from context aware, dynamic, adaptable systems supporting social interactions.

Understanding and Ethics There may also be new insights into issues around privacy, trust and virtual personal space which will arise from investigating shyness, with its focus on the personal and social rather than the commercial and legal. For example, how do shy users define the parameters of a "safe" (socially comfortable) zone, in terms of levels of sound, lighting, co-location and personal space? What levels of reciprocity are expected in social situations and will it be acceptable for a shy person not to share presence to the same extent as others?

If we are providing techniques to manipulate the presentation of self, it is important to explore the question of what tools, and what degrees of manipulation are socially acceptable. Having established what is socially acceptable, this project shall also examine how make explicit the benefits and drawbacks of engaging with these technologies.

Relationship to Other WINES Projects The research issues that will be addressed, and the inter-disciplinary approach, match the interests of the Grand Challenge in Ubiquitous Computing [5], particularly the experience and engineering perspectives. In addressing pervasive computing, and taking the grand challenge approach, we naturally have a relationship with much past (in particular the Equator IRC of which Fitzpatrick was part) and ongoing work, both in the UK and internationally.

The Utiforo project (UCL, Southampton, KCL, Sussex) is investigating the role of trust within ad-hoc market places, such as auctions and book fairs, and is attempting to instantiate pervasive computing support for such environments. As members of the project we shall obviously be building on the work on defining and understanding trust in compu-

tational systems in this project.

The City-Ware project (UCL, Bath, Imperial) has explored supporting the establishment of *common ground* between people, by identifying common communities, but leaving the social interaction itself to people [17]. How such mechanisms interact with differing presentational needs will be interesting to establish.

Summary of Research Questions

From our research objectives we have identified a series of *research questions* below. For each of these questions we have identified which group's researchers (SoftSys, Interact, Sociology) will focus on that issue, although in each case there will be interest across groups in the questions and in the answers. These questions also serve as a preliminary identification of papers to be produced.

Context (All) In what contexts are feelings of shyness triggered or removed? What aspects of context provide meaningful cues for modifying modes of interaction, presentation of self and presence in social groups? How do the capabilities offered by pervasive computing enable or constrain these contextual cues for interaction, presentation and presence? These questions cut across the three research groups, each interpreting context through the lens of their methods and tools: a social / personal human view; a presentation and communication view; and a systems model of sensing, processing and communicating context. Each of these views builds on past experience in context awareness and understanding how situations affect behaviour. Together these views integrate into a combined model. Toolkits based on these models will support the questions below on mediation, interactions and the experience of shyness.

To meet our aim of mediating interactions according to relationships with others we have identified two questions: firstly we must solve problems relating to identity, groups and relations between people and groups; secondly we must better understand self-presentation and how to mediate it.

Identity, Groups and Relations (SoftSys) What models and tools will support the development of systems of identity, group membership and relationship description to support interactions? We will be building on past experience in managing identity, group membership and trust. We shall explore the trade-offs between expressibility, complexity and usability. The answers will take the form of models of identity and groups. These models will enable expression of policies to control data exchange with other people and devices, and facilitate understanding of the social environment.

Mediation (Interact) What concepts and tools will support the development of systems which mediate interactions and the presentation of self in a system? We have identified time, detail, representation and modality as having potential for creating a sense of protection, but different users will want to apply different techniques as appropriate to their context. We shall produce a system for specifying the mediation of interactions. Expressibility, handling unexpected contexts, unknown others and resolving conflicts must be balanced with usability. The resulting techniques and tools will provide underlying support for the exploring the interaction questions, and require insight from the possibilities afforded by the pervasive computing infrastructure.

Interactions (Interact) When users are face-to-face what are the appropriate interface models to support their interactions? How does the use of pervasive technologies change the relationship with physical spaces? How do pervasive technologies and persistent traces of multiple activities change the nature of being "distributed" across space and time? How do people exploit the possibilities of pervasive technologies to manage their presence? We will be building on past experience in situated interactions, computer mediated communication and computer supported cooperative work. The answers to these questions will be in the form of models and toolkits.

Shy Social Situations (Sociology) The aim of better understanding the causes and experience of shyness is addressed in the following questions, which shall be explored pre- and post-intervention in each study. What are the social models of expected behaviour and ways in which people wish to / can manage their performance? We will be building on past experience in understanding the causes and effects of shyness in performative situations. The resulting understanding shall inform the collection and identification of context, mediation requirements and interaction models.

Ethics and Understanding (Sociology) We aim to explore the ethical issues arising from this research and how potential users can best understand and engage with these systems, so that the benefits can be best realised and disadvantages removed or avoided. What are the ethical implications of manipulating interactions? We will be building on our past experience in understanding appropriateness (as perceived) and studying people's beliefs. The understanding gained forms an input to all the above models, to focus research on desirable outcomes; the outcomes of the other questions similarly provide a focus for the ethical studies which must respond to the possibilities arising. This question shall be addressed through all work packages.

3 Work Programme

To explore the questions posed above we propose a series of studies in three themes, each theme gradually building in scope, complexity and adventure across a series of work packages. These each consider situations where social interactions using pervasive computing give rise to feelings of performance anxiety and exposure, leading to shyness. They provide grounded scenarios in which the research questions can be explored and across which commonalities can be identified and synthesised to produce generalisable models and tools. The themes are:

1. **Class participation** We shall examine common lecture, seminar and laboratory style classes, but also classes undertaken in "smart spaces" and out-of-class interactions with course material. Of particular interest are week-one classes, where much of the establishment of roles takes place.
2. **Social and situated groups** We shall examine group relationships and interactions arising in workplaces, student groups, conferences and other shared experiences. We are particularly interested in situated equivalents to- and pervasive augmentation of- social networking websites.

3. **Public interactive art-works** We shall examine people's responses to exhibits in public places, particularly those which display awareness of the people engaging with them or require interaction to fully experience the piece, and how to make such works accessible to all.

Methodology In each theme the work packages will build from an observation-led study, focusing on questions of context awareness and the experience and causes of shyness through to a series of interventions, which allow the questions of identity, mediation, interaction, understanding and ethics to be explored iteratively via a range of different interventions.

In each of the work packages we will use a quantitative observation schedule, supported by video, sensor data and logged computer interactions, to record interactions. We will also record qualitative data in the form of observational field-notes about interactions, who seems to be shy or reticent, and the way in which participants respond to each other. Where possible, participants will be debriefed on the purpose of the study after participation. They will then be given a short questionnaire to ascertain whether or not they would self-define as a shy person in general, whether / how the session exacerbated any feelings of shyness, and how they felt that they behaved – in terms of reticence, vocality and peer interaction.

The mapping between research questions and work packages is illustrated in table 1. In each case the results of the intervention feeds into the next iteration of that theme, the understanding of shyness, and the development of more general cross-theme models, patterns, tools and guidelines. Through an iterative approach, sophistication and participant numbers can be grown. The sequencing of work packages is illustrated in figure 1. In each work package we shall explore what information and devices are available to apply in the situation, paying particular attention to tools for people to manage their self-presentation, feedback and interactions. We shall consider which contextual cues may trigger configurations and policies to adapt systems to the user's needs. Studies with potential users can then be used to explore possible uses and issues, in particular to manipulate their self-presentation and interactions. These studies then inform the design of sensing, underlying software and user interfaces.

Class Participation We shall look at common lecture, seminar and laboratory style classes and also classes undertaken in "smart-spaces", but in particular at first-week classes, where much defining of roles and social relations takes place. Common activities such as "ice-breaker" games and group problem solving with reporting-back to the class are of particular interest. These studies shall be centred on classes at the University of Sussex, rather than schools, since students have well developed personalities and can give their own consent to participate and we have more control over course content and delivery. Each study may have multiple instances, across various classes and terms, in order to account for cohort variation and to provide significant participant numbers (over 100 participants, at least 20 self-identifying as shy). Given the spread of courses and students that the investigators usually teach this target is quite achievable. Discussions and feedback from students will inform the ethics and understanding questions in all iterations. This theme will be led by the SoftSys group.

Learning styles [16] and group dynamics are often considered in educational literature. That online fora support shy users, who prefer not to participate in class discussions (Kolb's *reflective observers*), is well established. Sociological studies have shown that "shy" students, particularly women, tend to be overlooked in the classroom because they are less vocal and more reticent about asking for help [22]. Consequently, shy people are vulnerable to feelings of social exclusion and invisibility.

WP1.1 In year 1, patterns of interaction will be observed in classes and e-learning systems in which no intervention has been made, in order to establish a baseline for comparison and being to understand contexts in which shyness occurs. The output will be a baseline dataset of responses to situations. From this we expect to derive a model of situations causing shyness; and models of context and relationships which are significant.

WP1.2 In year 2, a pair of complementary interventions will be tried, across various classes and two teaching terms. Firstly, the use of signalling devices: to signal a desire to participate, to annotate personal records of the class, to allow communal participation, and to signal affective state. Secondly, access control and mediation for online course materials, including forums, which may be accessed through PDAs etc being mediated according to preferences and group awareness. In the first case the intervention is the introduction of new pervasive computing technologies, in the second it is the introduction of underlying systems and / or novel interaction mechanisms to better support shy users.

These interventions inform the questions on context awareness (annotated signalling), identity, groups and relationship models (through the online materials in particular), mediation and remote interactions (the signalling systems could combine face-to-face and remote, depending on the approach of the users). The outputs will be descriptions of the models developed, and the design of artifacts used in our interventions.

WP1.3 Finally, we shall address the problem of supporting face-to-face interactions and more complex stored histories with pervasive computing. The intervention in this case is the use of shared devices, data and displays combined with access through personal devices. These will be used for the construction and exploration of course material and solving problems being mediated according to preferences and group awareness. To achieve this we will develop models for collecting data on sessions and controlling access to such data over the duration of the course. This intervention builds on prior experience to refine and extend our understanding of the causes and experience of shyness, context awareness, identity, groups and relationships, mediation face-to-face interactions (participation) and remote interactions (accessing stored data).

The outputs will include a system for controlling presentation and interaction through context awareness and group relationships, and a study of how this affects user behaviour.

Social and Situated Group Communications Social groups can include support networks, friends, families, workplaces and be based around shared experience situated

in real and virtual spaces. Areas such as CMC and CSCW have had long standing interests in supporting social groups however, the technical interventions to date have largely been based on some form of online tool requiring explicit interaction via groupware, messaging, video or social networking web sites. The maturing of pervasive computing opens up very new and challenging possibilities for supporting social groups with potentially more implicit, continuous and multi-faceted streams for presenting self and interacting with others.

In this theme we shall examine patterns of communication and presentation amongst social groups who may have both face-to-face and remote interactions. The three studies combine to give more general answers to questions of manipulating visibility and interactions, and together offer a greater range of users than one alone. We shall map out the range of shy-behaviour strategies in relation to different types of pervasive data and in different social and physical contexts.

WP2.1 There are many groupings in the university: through departments, research groups, projects, classes and social interests, although new arrivals often find it hard to identify all the appropriate groups. At present many of these are manifested through email and regular meetings. Being physically co-located but locally mobile gives us opportunity to explore the ways in which physical presence and interactions can be appropriately captured and communicated to account for shyness. It also allows for capturing individual-level data, e.g. associated with activity in a private space, but also group-level data, e.g. activity in the shared labs. Where possible we shall correlate and contrast our results with observations of presentation in other channels, e.g. Facebook, outside our control. The study lends itself to a long-term approach, with an initial set-up in year 1 then as a background activity, but evolving and evaluating periodically, considering identity and mediation tools later on.

The primary outputs of this study will be around understanding of shyness, ethical issues and remote interaction. The results will be presented as papers describing observations and models developed.

WP2.2 Research conferences are a familiar study setting, e.g. [19], and have relevance to this project as well. Conferences may have some initial remote contact, followed by an intense period of face-to-face contact (which can be quite daunting for the shy), and then longer term remote contact based on identification of shared interests. In the first iteration intervention will be limited, but studies of behaviour can be performed (as for the first phase of the classroom theme). In the second iteration we shall deploy technology, for instance based on bluetooth phones or smart conference badges, to facilitate in-place interactions; and support the remote interactions with mediated networking, conference blogs etc. These two iterations naturally fit the timing of the colloquia organised within the project, but the investigators have well established links with other conferences making extension of these studies possible.

The primary outputs of this study will be in context awareness and experience of shyness in year 1, and around interaction and group models in year 3. We expect to produce both conceptual models and software and systems to support interactions.

WP2.3 There are many social groups amongst students on a campus, arising from shared accommodation, shared courses, membership of clubs and chance friendships. The formation of many of these links happens in "freshers week", which can be an intimidating experience for those who experience shyness as there will be few familiar faces and an unusual opportunity to redefine ones self-presentation. This first week typically has many unusual activities taking place, and we plan to contribute to these in the third year, through on-line and public displays of location, movement and interaction, organised as a game. In this each individual will be able to manage their presentation and detail of representation, drawing on past experience [4, 11]. This will provide interesting explorations of the relationship between physical spaces and interaction; individual vs group effects on presentation; and variation in presentation and engagement in different contexts. In order to prepare for this in the second year we shall recruit a number of students who self-identify an experience of shyness during their early time here; explore their experience of freshers week and their ongoing interactions; and involve them in the design of these new technologies. This will be through a mix of methods including cultural probes, diary studies and social network maps.

The primary outputs of this study will be in understanding the experience of shyness, ethical and understanding issues in year 2; and software and systems to support context awareness, mediation and interaction in year 3.

Public Interactive Art-works We are considering installations in public spaces and where interactions with the piece verging on "performance" are expected of the audience, such as museum and gallery exhibitions that have interactive displays, and pieces which display an awareness of the environment and / or the people nearby. While these can, of course, be ignored by visitors it would be valuable to discover ways of enabling those who do so on the basis of shyness to participate as they would like. Shy people may feel intimidated about performing in front of an audience, particularly if they are unsure of what will happen, e.g. if they press a button, will there be a loud noise or a sudden movement that startles or frightens them, with subsequent embarrassment.

Sociological and social psychological studies indicate that embarrassment can be caused not only by individual behaviours but also by interactive behaviour, audience provocation and bystander behaviour. Thus gallery visitors may feel vicariously embarrassed or inhibited by what other people around them do. We therefore seek to develop technological devices that not only mediate shyness but also help to prevent embarrassment, or at least attenuate its effects.

There will be three deployments of public art-works, each supported by design workshops and small scale trials and possibly extended by re-deployment of the piece in new locations. The multiple iterations will allow us to examine different uses of pervasive computing in artwork, and to develop the sophistication of our responses to shyness. These work packages lend themselves to producing anonymised data sets, and we hope to be able to make records of movement, interaction and reactions available to

other researchers as part of our outputs.

WP3.1 We will deploy an observational study of an interactive piece in the first year. This may include sophisticated sensing and monitoring, but will offer few alternative experiences. The purpose is to better understand people's experience of shyness and analysing these for shyness triggering contexts, and will result in data sets and observational records.

WP3.2 In year two we will present a study based around a piece that offers virtual / remote and real representations. This will allow us to consider what people are willing to do in-person and remotely, consider these two broad forms of context; and how the artwork may mediate the remote experience of the local, and vice-versa. The outputs from this study will include supporting software and papers describing results.

WP3.3 Finally, the most complex approach of a study based around a piece that offers different on-site interactions. In this the artwork may be accessed directly, via public displays / kiosks, or via more personal technologies, such as phones or PDAs. The artwork itself may be physically distributed, so that many people can interact with part of it at one time. This iteration will allow us to more fully explore the possibilities of mediation and relations in public and flexibility in what is local and remote in interactions.

On-site support of the pieces understanding of what is possible and how this may be an advantage can be used to address questions of experience, ethics and understanding.

Through our artist and gallery partners we aim to develop engaging, well presented and widely accessed pieces, so these studies will give greater generality to support the university based ones. Brighton also has the Brighton festival in May each year, which has an open-access fringe umbrella, which we shall target as the venue for the art-works, thus maximising potential wider dissemination of our work.

WP4: Panel In support of all of the themes we will recruit a panel of self-defined shy people through Internet fora and support groups dedicated to shyness, social phobia and social anxiety. This sampling technique was used by Scott [24, 26] to great effect, insofar as those who would feel intimidated about taking part in a face to face interview are surprisingly forthcoming and willing to participate in computer-mediated communications. A forum will be set up, which the recruited participants will be invited to visit and register with. Small scale studies, prototyping exercises, questionnaires and on-line interviews will be used to better understand the possibilities and desires of self-defined "shy" and "non-shy" people, making use of the scenarios to be explored in the other work packages.

This activity will be led by Sociology, setting up in the first year then running throughout. While the *pervasive* experience here would be more imagined than real this forum approach would provide useful baseline data and feedback through investigators acting as moderators, facilitators, and helps us to capture a wider range of people than the studies alone could.

WP5: Colloquia The project will include two interdisciplinary colloquia, whose organisation will be shared by the team. One will be earlier in the project, sharing initial findings and supporting the experience of others and engaging with the ethical debate. The later one will form part of our dissemination, while remaining inclusive. We will invite attendance via mailing lists such as UK-UbiNet, British HCI mailing list and by associating with other events as a workshop-at-a-conference.

WP6: Coordination & General Outcomes As the project develops we shall identify reusable concepts, techniques, tools and results that arise from the various studies – while these will initially be particular to shyness in pervasive computing, they will also have more generally applicability for management of self presentation and interaction for different types of people across a range of contexts. In order to strengthen these findings we shall identify those outputs which may be of benefit to other researchers and practitioners and make software available for download and concepts available through papers. There will also be a need to identify scope for validating findings across case studies and identifying where the study scenarios influence the context and make the findings rather more specific. This will be an ongoing process achieved through regular collective project management meetings and periodic consolidation of results during the summers.

4 Project Management

Responsibilities, Phases and Communication In order to facilitate clear responsibility within the project each of the themes will be led by a research group, with the associated RFs responsible for supporting implementation. The themes are naturally centred on the research interests and approach of the leading group, but cross-cutting research questions are intended to foster an interdisciplinary approach giving different perspectives on the questions, as illustrated in table 1. The research questions will be tackled by PhD students under the guidance of faculty in the research groups identified for those questions. In this way each PhD student is exposed to the various themes and research group methodologies. By addressing the issues in multiple instances different approaches can be explored, and answers to the research questions built from preliminary and narrow to more general and sophisticated. Figure 1 indicates the flow of the various work packages and the key events associated with them.

We will have formal biannual project meetings, with further monthly or weekly meetings with appropriate people to manage particular deliverables or questions. The main meetings will give direction to the overall activity, forming relations between the questions and studies carried out in the three research groups, and providing an opportunity to host external presenters of mutual interest. These meetings may also be used to undertake group design work with partners or panel members. The various events surrounding the studies will also provide an opportunity to work together, and we anticipate cross-research group invitations to relevant research seminars etc.

There is risk in each of the research questions we have identified. This is being managed by an iterative approach, building from less risky observation and simpler technology to more complex studies; by the cross-over and re-enforcing nature of the studies in the three themes; and by the close working afforded by the project being based at one univer-

sity.

Research Conduct and Ethics Planned interventions will be submitted for approval by the university ethics committees. In addition, the research team will adhere to the Research Ethics Framework of the ESRC and the British Sociological Association's code of ethical practice. In line with these we shall ensure that participants are given an appropriate explanation of the research; that consent (and any limits to consent) to use data (including observer notes, video, sensor data and computer logs) is freely given; that data is stored securely; that any publications arising from data protect participant anonymity; and that no harm is done to participants. In many cases anonymity will be built-in to the data collection process. In some cases the explanation and consent may be handled after a covertly observed intervention, to remove any alteration of participant behaviour (the *Hawthorne Effect*). Where studies are being conducted in public it may not be feasible to undertake individual explanations or gathering of consent, in which case covert observation may be required and anonymity ensured. Although shyness is a potentially sensitive and personal issue, we do not anticipate that the experiences of being observed in public settings or filling in the questionnaires will evoke any unwanted or uncalled-for self-knowledge. Where studies are likely to prompt more introspection, self-disclosure and the revelation of personal information an informed consent form and disclaimer statement will be provided.

5 Dissemination & Beneficiaries

The outcomes of the project will be disseminated through publication and presentation to academic audiences in computer science, engineering, HCI, and the social sciences. In addition to our own colloquia, we will target leading conferences in these areas, such as CHI, CSCW, Middleware, MobiCom, Pervasive, UbiComp and ASA Couch-Stone (Symbolic Interactionism); and journals such as CSCW, HCI, Personal and Ubiquitous Computing, Pervasive Computing, and Theory, Culture and Society. Where appropriate, anonymised data sets, software and design of hardware and artifacts will be made public through a project web site. The art installations will naturally engage the public with this research and we shall prepare appropriate supporting materials for this.

The outcomes of this project will include data sets, models, toolkits and observations which will benefit academics researching pervasive computing, social interactions, software systems and shyness. Pervasive computing is an area of significant economic potential, and it is hoped that our findings will inform practitioners so that pervasive computing may better support people in their work, learning and leisure.

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		Research Question (DPhil/Group Focus)			
Theme (Lead Group)	Study	Context (All 3)	Identity, Groups, Relationships (SoftSys)	Mediation (SoftSys)	Interactions (Interact)
Class Participation (SoftSys)	WP1.1) Observation	Sensing & identifying	Derive models	Derive models	–
	WP1.2) Signalling devices & mediated record	Sensing, indexing data, interpreting	Identity & relationships	Visibility & online access	Local, not foreground
	WP1.3) Shared & personal devices	Sensing, identifying & logging	Identity, groups & access to data	Mediating contributions	Control mediation, identity & recall; remote support after
Social & Situated Groups (Interact)	WP2.1) Workplace social networks	Identifying	Identity	Mediation	Online & situated
	WP2.2, WP5) Conferences	Identifying & applying (year 1)	Group identity	–	Co-located groups (year 3), remote interaction pre & post
	WP2.3) Freshers week	Sensing & identifying	Personal & group identity	Mediating visibility	Both co-located and on-line via place & displays
Public Interactive Art-works (Sociology)	WP3.1) Observing interactions	Sensing & identifying	–	–	–
	WP3.2) Art with remote mode of interaction	Local / remote	Traces of interaction	Local / remote mediation	Local / remote modes
	WP3.3) Art with multiple local presentations	Sensing & identifying	Situated identity & public groups	Mediating interaction & exposure	Mediated participation
All		Understanding the causes and experience of shyness; ethical considerations and understanding use shall be addressed through all nine studies by observation, interview etc. (Sociology)			
WP4) Panel (Sociology)		WP4 provides input to the design process and understanding across other work packages and all research questions.			

Table 1: Mini-Project – Research Question Coverage and Responsibilities

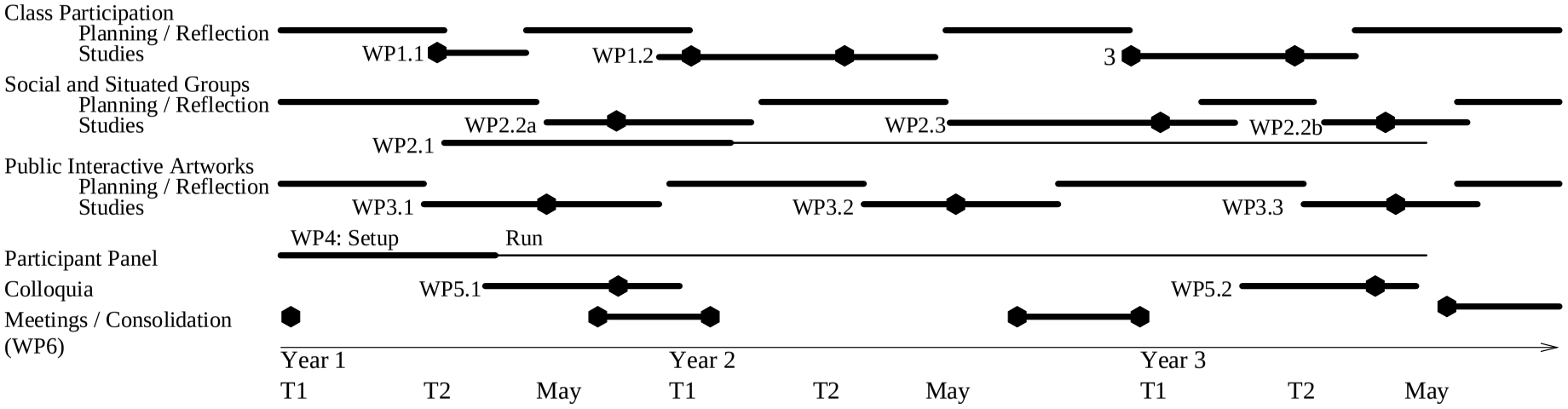

Figure 1: Work Plan