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User Experience of Intelligent Buildings; A User-Centred Research Framework

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Abstract
In order to truly understand 'user' experiences of intelligent buildings, a research and development framework must be developed that takes into account the discontinuities between AmI and previous technologies, as well as producing rich and detailed knowledge of the 'user', embedded in the historical, socio-political and cultural context of his/her life. In addition, the mechanics of 'creative misuse' of technology must be better understood, in order to extrapolate from past technologies to 'intelligent agents' and their use in intelligent buildings. This paper represents an initial attempt to formulate such a framework, with particular reference to understanding the distinguishing features of intelligent buildings, and how they could influence 'user' needs, attitudes and behaviour.

Introduction
Longitudinal studies of consumer behaviour have shown that the motives of behaviour change little over time, but the mode of provision and enabling technologies frequently do change. For example people always want to communicate, whether it's by face-to-face, fax, email, telephone or SMS messages. This understanding enables the generation of innovative propositions for new products and services primarily inspired by consumer observations rather than by iterative technological improvements.
Social and person-centred research into the effects of new technologies has developed incrementally over the past twenty years or so. That is, each new technological development has required an adaptation of existing R&D methods in order to produce useful research and to design appropriate services. Part of this adaptation has been to include a progressively richer understanding of people into the R&D process, from the early 1990's focus on 'usability' through Jordan's [1] Pleasures Framework and similar approaches, to more recent, more fluid methods such as Sanders' [2] Experience Design approach. Similarly, the actual level of involvement of non-expert people in the design process has also increased incrementally, from using them as 'consultants' to test the usability of a ready-designed product, to involving them in every step of the design process, to allowing them to lead the design process.
When conducting AmI research therefore, we need to examine whether or not these methods have been or can be developed in an appropriate way to cope with the new parameters of AmI environments, both in terms of the nature of the technology and in terms of the new interactions possible between people and AmI technology, whilst also taking into account the needs, goals and dreams of people outside of these interactions.
These are exciting times for 'user' centred researchers. Not only do we have the opportunity to study people's reactions to an almost entirely new technology (and its subsequent appropriation), but also we have the opportunity to expand our field beyond current limits, to include other fields of study that proffer a deeper understanding of humans. This deeper understanding is critical for the development of relevant and appropriate AmI environments; it is no longer excusable to concentrate on the 'usability' of the 'interface' and hope that this will pass as 'customer understanding'. People will live as they have always lived in an AmI environment, therefore the technology will have to adapt to them rather than designers relying on users' having to become familiar with the technology in order to fulfil a need that they have. AmI is pervasive, and because of this pervasiveness, our approach to 'users' or 'customers' will have to change.
In order to research people's reactions to AmI and associated issues, it must also be understood that a 'fluid' method of investigation is required, one that presumes very little in the way of

static 'user' or system characteristics. This paper is an attempt to evaluate existing theories, methods and tools in order to identify those that are most appropriate for the study of people in a pervasive and invisible computing environment.

Definitions

A mutually agreed definition of AmI will be key in providing a reference point for the context of the study and to inform the generation of research questions. There are many possible definitions available to select from and three are offered here as a starting point for discussion. The first is from a system/technology perspective:

"Ambient Intelligent environments can be characterized by the following basic elements: ubiquity, awareness, intelligence, and natural interaction. Ubiquity refers to a situation in which we are surrounded by a multitude of interconnected embedded systems, which are invisible and moved into the background of our environment. Awareness refers to the ability of the system to locate and recognize objects and people, and their intentions. Intelligence refers to the fact that the digital surrounding is able to analyze the context, adapt itself to the people that live in it, learn from their behaviour, and eventually to recognize as well as show emotion. Natural Interaction finally refers to advanced modalities like natural speech- and gesture recognition, as well as speech-synthesis, which will allow a much more human-like communication with the digital environment than is possible today" (Kuniavsky, 2004[3]);

The second from a more people oriented perspective:

"People living easily in digital environments in which the electronics are sensitive to people's needs, personalized to their requirements, anticipatory of their behaviour and responsive to their presence" (Phillips, 2004 [4]);

The final, prescriptive definition offered is from the ISTAG [5] vision statement:

"When convergence is achieved, humans will be surrounded by intelligent interfaces supported by computing and networking technology that is embedded in everyday objects such as furniture, clothes, vehicles, roads and smart materials - even particles of decorative substances like paint. AmI implies a seamless environment of computing, advanced networking technology and specific interfaces. It should be: aware of the specific characteristics of human presence and personalities; adapt to the needs of users; be capable of responding intelligently to spoken or gestured indications of desire; and even result in systems that are capable of engaging in intelligent dialogue. Ambient Intelligence should also be unobtrusive and often invisible and interaction should be relaxing and enjoyable for the citizen, and not involve a steep learning curve."

It is clear from the above that the key elements of AmI fall into two categories: 1) the dynamics of the interaction; and 2) the factors that govern the nature and quality of that interaction. It is useful to consider these two aspects and the categories within them as a guide for shaping the proposed research i.e. we can identify the features of AmI that distinguish it from previous technologies, thereby enabling us to better identify appropriate research methods.

Interaction Dynamics

The overall flow of interaction is envisaged as iterative and continuous and can usefully be described as having five stages (see fig 1). First, the detection of a human or life presence entering the Ami space, this could involve methods such as heat fluctuation monitoring or movement detection. Then once a presence is established, there will be a process of identifying the individual or the presence type, group or category which can then be matched to relevant data, for instance personal profile or more general data about personality type or group membership etc. The next step is to understand the immediate needs of the individual, possibly

through detection and analysis of speech, gestures, expressions etc. The results can be combined with personal data and matched to service availability in order to meet the assessed need. Once a service has been delivered or offered, the Ami environment will be required to assess the appropriateness of the offering by detecting further needs, service rejection or a rating of appropriateness. The interaction can then be evaluated and conclusions drawn leading to possible further service offerings and new profile data relating to the group, individual or category. Finally there will be a need to detect the withdrawal of a specific presence from the Ami environment.

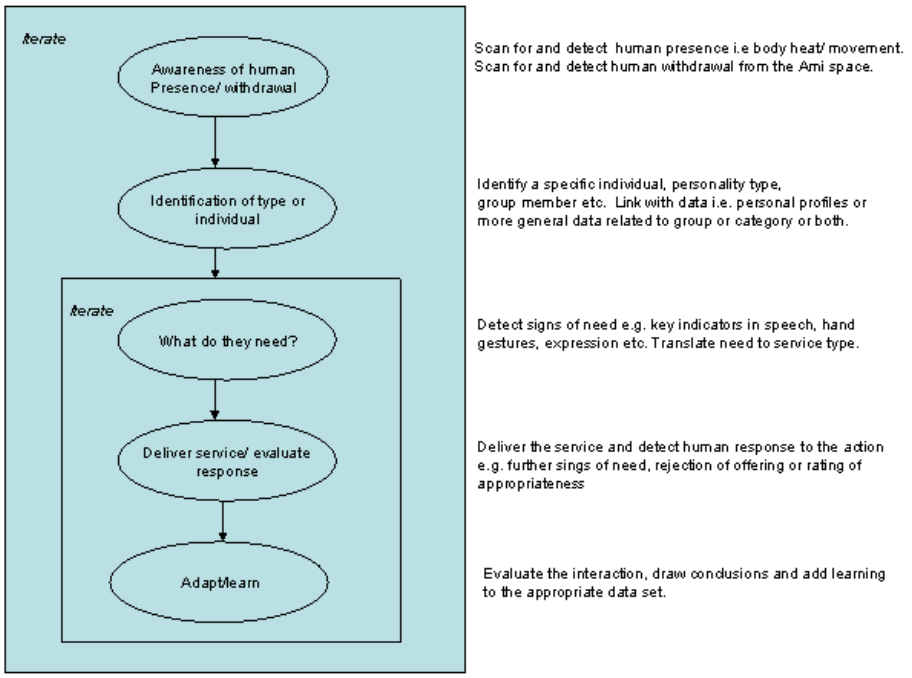


Fig. 1 Interaction dynamics of intelligent space

However, when we add the features of networked intelligent spaces to this dynamic the situation becomes far more complicated. Many more processes then become possible, including the transfer of information about the individual from one space to another, 'communication' between networked appliances etc.. The transfer of information raises several privacy issues, discussed elsewhere in this document.

Nature and quality of interaction

The definitions use terms such as 'ubiquitous', 'natural', 'sensitive', 'intelligent', 'unobtrusive', 'invisible', 'relaxing', 'enjoyable', 'easy to learn' and seamless to describe the desired human experience of being in an AmI environment. They characterise AmI as slipping naturally into supporting our existing life patterns and activities rather than challenging us to change the way we do things or providing us with wholly new experiences. They also expresses our desire to rethink our relationship with technology; a need that is not driven solely by the technical possibilities offered by AmI. Our growing frustration with technology may be linked with social issues such as work/life balance, information overload and the increasing speed and complexity

of daily life. The advent of a new wave of technical advance gives us the opportunity to step back and look at how we choose to investigate and define human beings and our needs in relation to the possibilities offered by technology.

For an AmI environment to live up to the aspirations expressed in the definitions, it would be necessary to consider these qualities at each of the five stages of interaction (Fig 1.) In the context of this project these qualities become broad guiding principles governing the nature of interaction, and may require further define and agree about what these terms mean in relation to the services and interactions available within a specific AmI environment.

What Makes Ami Different?

AmI is a concept rather than a single technology. It is constructed from the possibilities offered by multiple technologies working in unison. While many of the challenges that AmI poses have been considered to some extent in other fields and/or in relation to specific singular technologies, there are a number of factors about the total AmI vision that are distinctive. Our focus here is the distinctions that impact on the task of evaluating theories and methods for researching and understanding user needs. Two issues stand out clearly in this respect:

1. **Anticipation** – In some ways AmI could be described as a meta-environment – its design and construction will need to embody the tools to anticipate the needs of the entities within it's domain. Traditional requirements gathering approaches start from an assumption of the user as the 'driver' of the technology, for instance by seeing the user as selecting the services that she/he requires. The task of eliciting the requirements for this anticipatory, meta-environment will have to consider complex new issues such as what constitutes a signal to offer or provide a service, what, data should be collected and held about each entity and what is common and what is unique to the individual entity. The desire that the nature and quality of these interactions should be should be 'natural', 'sensitive', 'intelligent', 'unobtrusive' etc also affects the approach to gathering requirements. The traditional mantra of "what do users want?" is transformed to "how do users think and act as they go about their daily lives?" In an AmI space service offerings may be based on such things as rhythms or patterns of behaviour, body language, voice pattern recognition etc., which suggests that we may have to look beyond mainstream approaches and consider methods from different domains such as ethnographic, observational or pattern recognition approaches.
2. **Adaptation/learning** – The AmI environment must also recognise and assimilate new events and changes in pattern – constantly learning and improving on intuitive service delivery. Some form of natural human feedback may be required to help build optimum anticipation of needs. Sophisticated observation and analysis techniques will be required to understand, design and realise an initial learning environment which can be populated with entity profile data and trained by continuing user behaviour and human feedback. The AmI space will never become a complete or static system, it will be in constant flux, aiming to anticipate the needs of the entities within it. Satisfying user requirements becomes an issue of meeting targets (hourly, daily, weekly) for successful anticipation of service delivery. Chosen approaches will have to address issues such as recognising new, out of the ordinary events, how and what to record about them, and how existing pattern data should be adapted or assimilated into the AmI. Again observational techniques may be useful, and also knowledge from the domains of Artificial Intelligence and Learning.

Relevant Research Questions

Because we have begun to understand, from the definitions above, the nature of AmI technology, we can now begin to formulate research questions that are appropriate and useful with regards AmI. These need to be identified in order to in turn identify the methods that can (or could with some adaptation) answer these questions. That is, will the level of explanation

offered by different methods be both appropriate and sufficient? Many researchers now advocate collecting data on both a macro and micro level, in order to give a rich picture of the situation under examination, and to be aware of the effects of what would otherwise be termed as 'confounding variables'; variables not identified in advance and hence not examined, therefore making their effects unquantifiable. There has also been a re-conceptualisation of qualitative and quantitative data to actually be the same thing, given the dynamic nature of social systems (Byrne 1997)[6]. The list of useful questions generated so far is shown in the table below – but it is envisaged that this list should be a dynamic and evolving aspect of the proposed collaborative research.

Level of Analysis	**Research Issues**
Predictive/ Visionary	• What are the existing technologies that AmI could successfully replace? • What are the most likely initial applications of AmI? • What attitudes currently exist towards AmI? • Are there any historical parallels to be drawn between AmI and past technologies?
Individual	• What prevailing social norms will be challenged by AmI? • What are the personal drivers towards the uptake and usage of AmI? • What are the personal barriers against uptake and usage of Ami? • Is there/will there be a gender split in the use and appropriation of AmI technology? • How will AmI change personal behaviour, both in and outside the home? • When and under what circumstances does an AmI environment create value for human beings? • Under what circumstances is an AmI environment not appropriate?
Household	• How will the use of living space change under AmI conditions? • Who in the household is 'in charge' of AmI functionality, and what implications does this have? • What are the dynamics of a new household member/stranger entering an AmI household? • How is the boundary of a 'household' defined in an AmI environment? • What are the environmental impacts of AmI households?
Community	• What are the drivers for increased connectivity through AmI to the surrounding community? • What are the barriers to the above? • What are the effects of the above? • How will the use of communal public space change through the use of AmI? • How will team behaviour change in an AmI environment?
Societal	• How can reasonable and effective social barriers be maintained in an AmI environment? • What factors are involved in the broad social acceptance of AmI? • Privacy, security and trust issues • Will AmI bridge or exacerbate the 'Digital Divide', or will it create a new one? • What legislation needs to be in place before the widespread deployment of AmI technology, in order to protect society, the community and the individual? • What might be the negative effects of AmI on individuals, households, communities and society at large?
Technical	• What happens when different aspects of the AmI system fail?

	• What technical support should be available? • What aspects of the technology are open to misuse, and how likely is this misuse? • What are the health issues related to being continuously immersed in a wireless environment? • What effects do different interface types have on user acceptance and usage of AmI technology?

Evaluating Existing Practices

Existing practices are described in full in the appendix of the report. By existing practices we mean meta-theories from the field of the social sciences, 'human-centred' research and design methodologies, methods that enable designers to consider the user, and various tools that can be applied both to gather data and for design purposes. Obviously there are many more useful research tools from other fields, however those mentioned will suffice in enabling us to define evaluation criteria for the study of AmI.

In order to evaluate these existing practices, to determine their relevance for AmI, we need to think about the assumptions implicit in each approach, about both humans and technology. We also need to determine the types of information that can be gleaned from each method, and in turn, whether this information is relevant for AmI environments. The evaluation criteria so far discussed consist of the following questions (this list was the result of a brainstorming session between Chimera staff):

- Does it examine the past, present or future? – that is, does it gather information relating to past events, the present moment or future expectations, dreams and goals?
- Are any static characteristics presumed? – given the fluid, dynamic nature of AmI technology, it is important that any method we use doesn't presume that things will stay the same. This question asks whether the method presumes any fixed states, both for the technology and for people.
- Are the findings generalisable or relative? – that is, does the method presume a degree of human homogeneity or does it allow humans to be unique, and hence render the findings less generalisable across people and situations? AmI itself 'recognises' the digital signature of each unique human, therefore it is important that this uniqueness is also acknowledged by the research methods used.
- Does it presume goal-directed activity? – Interaction with AmI technology is more incidental and random than interaction with any other previous technology; people have on the whole interacted with technology in order to achieve goals. AmI will just 'co-exist' with us, and we are not always exhibiting goal-directed behaviour. Any method used for the study of AmI should be able to describe and explain these 'incidental' interactions in a coherent manner.
- What can it predict? – That is, what types of predictions can it make in terms of future behaviours, future acceptance of technologies etc. Predictive power is important for AmI research given the current stage of technological development, however we must be aware of any assumptions that these predictions are based on.
- Appropriate stages of R&D process? – At what stage should this method be applied – before the technology has been developed, or when making changes to existing products and services? As AmI is currently under development it is important to be clear when, during this development, each method can be used.
- What level of user involvement? - INVOLVE (2004)[7] refer to three levels of user involvement; consultancy (where the user is consulted about his/her

reactions to a particular product or service for evaluation purposes), collaboration (where the user is part of the research and design team) or user control (where the user designs, undertakes and disseminates the results of a research project).
- What stage of user involvement? – At what stage of the method/process does the 'user' become involved?
- Fixed human interface presumed? – Does the method presume a fixed point in time or space at which people are interacting with the technology, and does the method focus on this point of interaction?
- Is there a visionary element to the method? – Does the method allow participants to be creative in their ways of thinking about the technology, either in terms of future developments or current use?
- What sort of framework is necessary to define the symbiotic relationship between humans and technology in an AmI environment?
- Does the method aim to identify user requirements in advance, or does it allow for the technology itself to identify these requirements as it 'learns' from the user? AmI is a learning environment, learning from the user as the user moves around within it. How necessary, under these circumstances, is it to gather requirements in advance?

How to use evaluation criteria.

Chimera have developed a matrix that allows us to see 'at a glance' which of the ready existing methods and tools are appropriate for the study of intelligent buildings (see Appendix I). This matrix, whilst appearing fixed and non-dynamic, is still under development itself, that is, there may be additional criteria that we have not yet identified that are important in deciding which methods and tools to use under different circumstances.

It is also important to develop an over-arching methodological and theoretical framework within which this research can be conducted, and so far, Chimera has drawn on several different approaches to produce a provisional research framework.

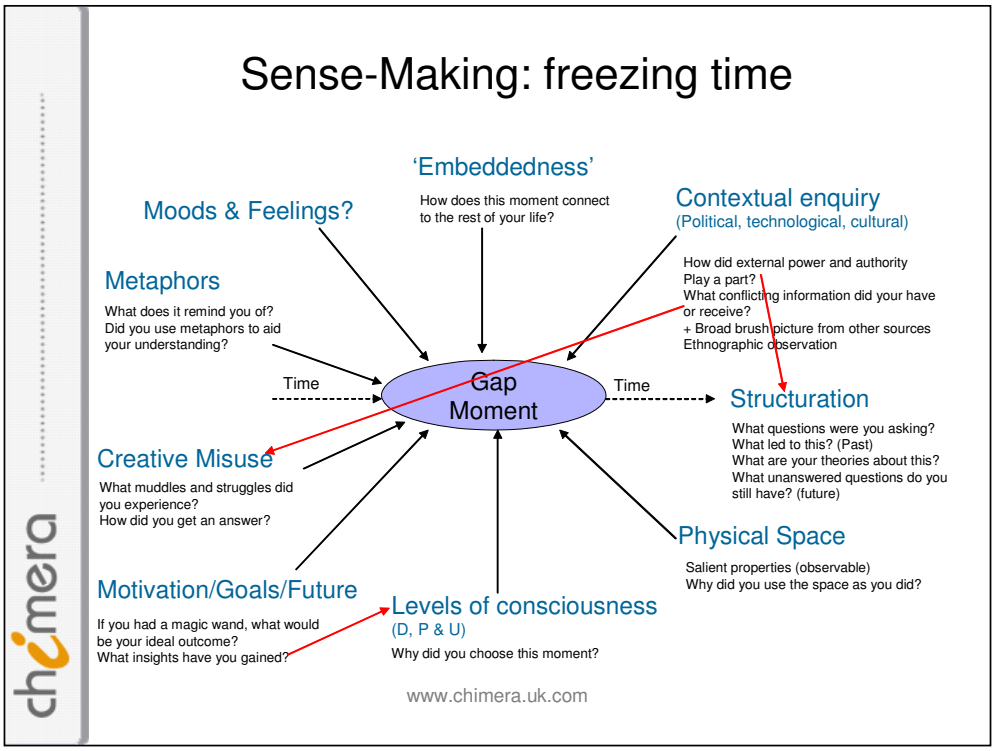
An Appropriate Research Framework

The above investigations have led researchers at Chimera to formulate the following tentative format for methodologies for the study of AmI environments. It must be noted that the following diagram illustrates initial thinking in this area – this methodology has yet to be applied. In short, for a methodology to be appropriate for AmI it has to;

- Allow for the fact that reality is constantly changing, and that people have different realities.
- Not assume static or generalisable characteristics of human beings
- Not assume goal-directed activity
- Provide a rich description of specific moments
- Allow for the 'embeddedness' of each moment in the time-space continuum of the individual, that is, the method must take into account personal, social and cultural variables that affect how an individual responds to an AmI environment at any given moment.
- Allow for visionary exercises (leading to the design of products and services) to be conducted based on the research findings.
- Not over-emphasize the importance of requirements capture before the development of products and services.

The initial proposed framework can be seen in the diagram overleaf. The diagram shows a moment in time during which an individual is immersed in an AmI environment, either real or

simulated through the use of prototypes. It also shows the types of information, relating to that moment, that need to be collected in order to answer the research questions defined earlier in this report. By combining elements of Structuration Theory (Giddens 1981)[8] with Sense-making techniques (Dervin 2000 [9]– see Appendix II for brief explanations of these approaches), we are in effect collecting a detailed snapshot of a particular moment, whilst at the same time being aware of the nature of the embeddedness of that moment. That is, we are situating the snapshot in a personal, social, cultural and political time line, which means in turn that, through iteration of this technique, we can understand on a deeper level the effects of environmental variables on an individual's responses to AmI environments.



Creative misuse of AmI environments

Coupled with this deeper understanding of people, there must also be a recognition that people do not always use technologies for the purposes for which they have been designed. The term 'creative misuse' is used to describe the unexpected or unpredicted ways in which people use ICTs. That is, these uses were not anticipated by the designers, and therefore the ICTs in question were not designed for that purpose.
When trying to understand the mechanics of creative misuse, Haddon (2003)[10] formulated the following table, showing different levels of user innovation, and relating to historical ICTs:

Table 1: Types of Innovation

Types of Innovation	**Examples**
Design and re-design of ICTs; improving existing or developing new applications	Technical hobbyists and early microcomputer projects, including their role in writing early

	games
The creation of new practices using ICTs, the creation of content, the establishment of patterns of interaction	Early radio broadcasting by radio hams; on-line communities or other grassroots initiative
More widespread creative design	Club and personal web-pages
New patterns of use, new practices	Using the early telephone for social purposes; emergent SMS practices

As well as this type of 'innovation', Haddon points out that there is also another way in which people innovate, and this is done in order to control ICT use. There are several behaviours that demonstrate this type of creative misuse, from parents' strategies to control both the internet and the phone use of their children, through children's strategies to avoid parental controls, to controlling personal accessibility through ICT, e.g. by sending incoming mobile calls direct to voicemail. All of these strategies represent behaviours either not originally predicted by the service designers, or seen as somehow the 'wrong' way to use ICT, for example children barring their parents' calls to their mobile. It must also be remembered that these behaviours are all designed to limit the effects of ICT on a particular household or individual. When the ICT becomes a part of the environment, be it within a household or in a public space, how does this affect both the ability and the need to control it?

Table 2: Managing ICTs in everyday life

Ways of Managing ICTs	**Examples**
Attempting to control other's use of ICTs	Parents controlling children's use of TV, the phone, the Internet.
Resisting that control	Children's parent management strategies:
Managing contactability	Giving out mobile phone numbers; dealing with unwanted or disruptive incoming calls
Managing mobile calls	Interacting with co-present others and with the caller
Making ICTs aesthetically fit it, displaying ICTs, personalising ICTs	Locating of TVs and other ICTs in the home, adorning PCs, decorating mobile phone covers

(From Haddon 2003; Cost269 conference paper)

From Table 1, we can see how some ICTs; those that are open to reprogramming, freeware etc., are more open to creative misuse than others, a good example being early computer games that were recorded on cassette tape and thus could be easily duplicated and passed to friends. Similarly with other early forms of computer games, easily re-programmable due to the open source code, people could alter the structure of the games themselves, and in fact there is plenty of evidence to suggest that this was widespread practice.

AmI technologies appear to be more difficult to 'customise' than the early ICTs mentioned above. However, one of the ISTAG recommendations for the FP6 report on AmI (op.cit) was that "AmI should be controllable by ordinary people", that is, in order for this technology to be socially acceptable it has to be under the 'user's control to a large extent. Altering the technical aspects of the services however, seems much more difficult for non-experts. However, if we look at some of the practices surrounding mobile phones we can see how people could, if they chose to, become 'unavailable' to the AmI environment. In much the same way as children switch off their mobiles when they don't want their parents to ring, so it could be that they could 'lose' the ID tags that identify them, at least temporarily, in order to avoid detection when entering or leaving the household.
There are several different aspects to ambient intelligence environments, and the following sections will examine each aspect in turn in order to identify the potential for creative misuse and/or 'user innovation'.

Personalisation and Customisation

Several of the ISTAG scenarios talk about customising of a particular service by the 'intelligent agent' and not by the person, thereby in effect giving control of the service to the agent. That is, the agent 'learns' a person's preferences, habits etc. and sets things up accordingly, for example by adjusting the room temperature and lighting when the person enters. This kind of customisation makes two basic assumptions about people; 1/. That their preferences won't change, and 2/. That this customisation will make life easier for them. The first assumption is easily disprovable – people's preferences are constantly changing. The second assumption does not take into account the stress of living in an AmI environment, as yet unquantifiable and unspecified. The main question then, is how annoying, or even boring, will this sort of personalisation become to the individual, and how will they react to this annoyance? Is there potential for creative misuse, maybe in the deliberate misleading of your 'agent' so that it sets things up differently, just to make some changes in your normal environment?

Monitoring presence and movement

Monitoring presence is almost an essential part of an AmI environment within a household – that is, the environment needs to know who is present so that it can adjust according to preferences etc. Yet it is possible that this could be seen by some as intrusive, especially given the networked environment; if your house 'knows' where you are what's to stop it passing this information through the network? If we look at the ways in which children make themselves unavailable to their parents via their mobiles, by switching their phones off and claiming the battery was flat, sending incoming calls direct to Voicemail, etc. we can see that there is much potential for household members to behave in similar ways to prevent detection by the rest of the household, for instance if a teenage child arrives home much later than allowed, or brings friends home whom their parents disapprove of, or even if a parent of teenage children wants a little peace and quiet after work before announcing their presence to their offspring.

Health monitoring services have pioneered the development of movement monitoring technology, with the aim of preventing hospitalisation in some cases where people want to continue living independently despite being relatively infirm, however some 'problems' with this technology have already been documented (Millenium Homes project[11]) as follows:

1/. The habit, especially prevalent amongst the older population, of turning everything off when they retire to bed in the evening – which also switches off the monitoring devices.
2/. The form of interface used – for any element of 'user control' to exist, the interface must be easily used and understood – this is not always the case with health monitoring technology.
3/. The 'stigmatizing aesthetic' of the various control boxes etc. – they actually look like medical equipment!

Co-presence via ICT

This refers to the ability to 'video-conference' with someone not physically present, yet completely visible, either on a 'video wall' or a large screen. Video conferencing itself has a long history, and developers have struggled to find a suitable 'application area' for this technology, that adds value to a purely audio channel. Two of the ISTAG scenarios contain a video wall (one in a household and one in a hotel room) and both are used to communicate with family members – however what does the visual element add to this type of communication? It is worthwhile remembering that there is an argument that pornography drives new media development (as proven by the home video industry, or the development of interactive CDs) – this could well be the case with video conferencing, particularly if this service were offered in hotels – does this count as 'creative misuse?'

Speech Recognition

Speech recognition software has improved dramatically over the last two years or so, and in the ISTAG scenarios, a person's speech pattern is also another form of unique ID, and therefore could also be used for security purposes. New user interfaces are also required for the new AmI services – some of these will inevitably involve speech recognition at some level. With regards creative misuse, it is equally possible that people will attempt to 'trick' the speech recognition software, in the following ways:

1/. To impersonate another household member in order to gain access to their personal data or their permissions to use certain services.

2/. To change your voice so that the software doesn't recognise you, simply as an 'experiment' to try and change the software's 'behaviour'.

Conclusions

At any given moment in an AMI environment, the user may or may not be exhibiting targeted, goal-driven behaviour, they may or may not be reflecting on their actions, and they may or may not be enjoying themselves. They also may not be enthusiastic about the technology surrounding them, nor require any technological assistance or 'agent' intervention. Any method used, therefore, needs to take a snapshot of user experience that can capture these, as well as other, more socially/culturally influenced, variables.

Framework development so far has been highly speculative in terms of attempting to evaluate the appropriateness of the chosen theories and methods, however the 'snapshot' approach to research is becoming more popular, as technology development becomes progressively more human-centred, and the limits of more quantitative research methods are highlighted. The framework as developed so far could also incorporate research methods from other fields not yet explored, for example human geography (to investigate how people use public space) or anthropology, to examine cultural (including gender) influences on behaviour within a given space. Repeated snapshots taken over time and between people, if properly analyzed, can reveal deep structures in culture, society and behaviour, that is, they can reveal patterns that would otherwise be indiscernible (Giddens 1993 [12]).

Whilst writing this document, the inappropriateness of some of the language used in the HCI domain has become more apparent, the word 'user' being the most outstanding example of this. It is also suggested, therefore, that alongside a new research framework, a new vocabulary is developed, that better reflects our deeper understanding of the people and processes involved.

Despite the fluid nature of AmI technologies, it is also clear that this fluidity may be currently over-estimated. Consider the outlandish claims made for the Internet over the past ten years – i.e. that it will completely transform commerce, private and public lives, change the nature of communities, and lead to the creation of a 'cyber-intelligence' – none of these have really happened. Part of the reason for this is the conceptual distinction between real and virtual worlds – in actuality this distinction does not exist but rather, the two overlap and intersect to such a degree that it is impossible to draw distinct boundaries. The same can be said of AmI, i.e. that its very embeddedness will determine its use, and indeed, that the technology itself has further broken down the boundaries between the real and the virtual. Therefore, a detailed understanding of how people will behave in intelligent buildings has to be based, in the first instance, on how people behave in existing buildings now, regardless of the technology surrounding them. If that technology then causes their basic needs to change (as well as the behaviours that attempt to fulfil those needs), then visionary exercises are needed in order to understand how and why they might change.

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Appendix I: Evaluation grid for existing methods

Method	**Past, present or future? (Say, Do or make?)**	**Static Characteristics presumed? (Human or technical)**	**Goal-directed activity presumed?**	**What can it predict?**	**Appropriate stage/s of R&D Process**
SUNA	All – use of knowledge about the past to write present scenarios that predict future service use	Yes – in order to write scenarios to guide service design.	Yes		Requirements capture to beginning of design process
UCPCD	All (as above)	Yes – as above	Yes		At any point
Interaction relabelling	Present and future (say and make)		Yes		design
Design for Extreme Characters	Present and future (say and make)	Yes – human (extreme but static human characteristics)	Yes	Diverse usage of new services and products, creative misuse.	design
Pleasures framework	All	Yes - both	No	Reasons for acceptance of new technologies	At any point
Personas	All – as per scenarios	Yes - both	No		At any point
Cultural probes	Past and present	No	No		
User experience probes	Present	No	No		
Experience design					

Method/tool	**Level of user involvement**	**Stage of user involvement**	**Fixed human interface presumed?**	**Visionary element?**	**Generalisable or relative?**	**Requirements capture?**
SUNA	Collaboration	1/. User needs identification 2/. Product/service evaluation	No	No	Generalisable	Yes
UCPCD	Consultancy	1/. User needs identification 2/. Product/service prototype evaluation	No			Yes
Interaction Relabelling	Collaboration/consultancy	At concept development stage	Yes	Yes		No
Design for Extreme Characters	Consultancy or none	No	No	Yes		Yes
Pleasures framework			Yes	Yes		Yes
Personas	Consultancy		No	Yes		Yes
Cultural probes	Collaboration		No			Yes
User experience probes	Collaboration		No			Yes
Experience design						

Appendix II – Theory Descriptions

Sense-Making (Dervin)

Dervin's Sense-Making methodology is drawn form the discipline of Communication Studies but is also applicable to the design of software systems and services. It is centred on generating an understanding of how people make sense of their world in the course of their everyday lives and looks for both human universals, in terms of common patterns of sense making, and individual or group characteristics. The approach can be described as both quantitative and qualitative and challenges philosophical assumptions about the nature of reality, the nature of human beings and the nature of observing predominant within the social sciences. Emphasis is always on understanding 'process' rather than 'end state', leading to a more flexible and sustainable approach to design. A key element is the Sense-Making interview which involves circling phenomena such as an event or interaction with multiple accounts from different actors. Each is asked to reflect in detail on issues such as their personal effort to understand the phenomena, the emotions they felt, their personal interpretation of its meaning, difficulties with the medium, their ideas and theories about what would be ideal etc. Close attention is also paid to physical, social and cultural context and links are sought between the different data. Through a comprehensive view of both the internal and external world of human beings in relation to specific phenomena, patterns of sense-making are elicited that can inform the design of intuitive and sustainable software products and services.

Structuration Theory (Giddens)

Giddens' Structuration theory puts no emphasis on the effects that the world has on people, nor on the effects that people have on the world, but rather, examines the process of interaction. Giddens states that people bring their own structures to bear on present circumstances, these structures arising from the past (personal and social). Present circumstances can also change these structures, hence again, the emphasis is on the process rather than the end result. Giddens also believes that by taking repeated 'snapshots' of this process over time, deep structures of behaviour and attitude can be revealed that would not otherwise be discernible through more traditional research methods.