Pervasive Computing in Time and Space: The Culture and Context of 'Place' Integration

Sally A. Applin
Centre for Social Anthropology and Computing
School of Anthropology and Conservation
University of Kent Canterbury, UK
sally@sally.com

Michael D. Fischer
Centre for Social Anthropology and Computing
School of Anthropology and Conservation
University of Kent,Canterbury, UK
m.d.fischer@kent.ac.uk

***Abstract*—We consider some possible broad changes that may impact society as a whole as a result of widespread integration of full-spectrum deployed pervasive computing technologies. Our approach considers design challenges for successfully developing and integrating pervasive technologies into culture and society. This is particularly challenging, since pervasive technologies as services are most successful when transparent, invisible, overlooked, unacknowledged and seemingly forgotten by the very groups that embrace their usage and development. We suggest a heuristic for understanding pervasive technology from an anthropological/social perspective, along with a reminder that humans create, shape and use the technologies that affect them. In particular, we look at the impact on social relations in a poly-social world where people must develop means to blend their own realities with those of of others. In conclusion, we remind those developing these technologies, that although we will eventually become wedded and intertwined as cyborgs within this new environment, it may have a positive outcome, creating new social group models for human interaction.**

I. Introduction

Pervasive computing is well integrated into our culture, not at its beginning or just starting to creep into our culture. Pervasive computing nodes facilitate conduct of the most minute and mundane elements of our lives, often with limited awareness on our part. Indeed, limited or targeted awareness is intimately tied to the effectiveness of pervasive technology. If people had to pay much attention to pervasive technology, they would not be capable of navigating the layers and layers of interdependent technosystem services required to maintain their way of life.

What is new are the ways we interact with people and systemic services. Integration of personal mobile technology, in combination with networked computational support, is radically changing the scope of how individuals interface to these services while simultaneously remaining unaware and unconcerned of underlying technologies. In addition, with the many aspects of material life that are leveraged, there is an increased scope for manipulating time and space. This greatly increases our capacity to utilize social relationships and networks.

Pervasive technology is about both creating transparent services and the human empowerment that those services can provide. The capacity for people to be able to enhance the physical planet in ways such that it might almost become sentient is very powerful. It is also a phenomenally complex process stacked upon many other complex processes forged by the massively distributed computing power of people. People and the environment have become increasingly intertwined in such a way that the environment can sense and respond to them. This leverages cyborgism, not as dystopic or dehumanizing, but as enabling. The sensored planet, the physical network, and the pervasive technologies that will enable us towards that type of sentience form a clean slate with which to reinvent design, and to incorporate the pervasive aspects of invisible, temporal, elegance.

Within the realm of pervasive computing, several components have emerged: 1) enterprise systems that control large scale transportation, warehouse and other systems that service society as a whole; 2) mobile devices that create the ability for people to reach each other almost everywhere instantly whilst on-the-go; 3) applications that extend the ability of enterprise systems to exploit mobility, creating geolocative services that integrate 'pervasiveness' as a prominent fabric of society, and 4) forthcoming sensors that will enable the physical environment to become 'smart' and anticipate the needs of people interacting within it.

The choices that are available for people to interact with technology alter their perception of space, time, architecture and understanding of social groups. Some people may use mobile technology to augment their current social experience, simultaneously checking into a representational space on foursquare (a location based mobile platform) whilst physically occupying a real life environment. Others extend physical space when they connect to a network and interact with mobile devices during wait cycles in airports, stores or public transit.

As a society the benefits of a clear, transparent, ubiquitous and responsive design provide us with a platform from which to evolve into larger more functional social groups, to save resources and to more thoughtfully integrate our sense of place within ourselves. Concepts such as Dual, Mixed, Blended and Augmented Reality (AR), and their subsequent technological implementations, go some way towards defining the base levels and identifying the ontological principles for the creation of what will effectively be a new world. What will be critical is the capacity for people to construct, relate and integrate multiple unique configurations of these under the control of ordinary users. Innovations will have greater success to the extent that people are able to use them to enhance their ability

to inject and extract value from their personal networks and to set up new complex forms of exchange with others

Developers will benefit from understanding, at least in part, the nuances that humans exhibit when interacting with each other within groups and within networks, in order to prepare for the eventuality of multiple relationships and orientations within the real world, and all virtual spaces. The potential for change is incalculable as Internet technologies become more connected to the world through sensors and are able to uniquely adapt to and be adapted by the the people who use these. Although people have always, through their culture, occupied blended (intelligent) realities, the capacity for large scale integration of ad hoc arrangements as a resource for living greatly expands the range of new technologies and new ways of life to be developed.

II. Places

Physical spaces are gradually shifting, with the aid of pervasive technology, from being mainly locations or destinations (with space in-between), towards the notion of being places that 'host transitions.' These are becoming temporary containers to house the body whilst the mind is occupied in the alternate destinations of the pervasive world of the network.

In his book, *non-places, introduction to an anthropology of supermodernity*, Marc Augé writes:

> The word "non-place" designates two complementary but distinct realities: spaces formed in relation to certain ends (transport, transit, commerce, leisure), and the relations that individuals have with these spaces. Although the two sets of relations overlap to a large extent, and in an case officially (individuals travel, make purchases, relax), they are still not confused with one another; for non-places mediate a whole mass of relations, with the self and with others, which are only indirectly connected with their purposes. As anthropological places create the organically social, so non-places create solitary contractuality [1:94].

If we expand a bit on Augé's work of 1995 and adapt it to the expansion of mobility in technology, the 'non-place' can be defined as the space that is formed in relation to certain ends within the network. In the early days of communications, transportation and the transportation of messages were intertwined; early telegraph lines ran alongside railroad tracks. For our purposes, we are extending 'non-place' to the network, which contains commerce, leisure, communication, and forms of non-embodied 'transportation.' The greater the extent to which communications technology is pervasive and people connect to those networks, the more engaged they become in 'non-place' and the more 'solitary contractuality' they have within the place that they are physically in at that moment.

Thus, the pervasiveness of communications technology provides a mechanism for people to take physical space for granted in a different way than before: to cerebrally occupy a 'non-place', whilst their bodies are simultaneously established in a physical place.

A example of this involves the use of Twitter, a 'real-time information network' service based 140 character messages transmitted to other users of its service through a stream' or 'feed.' Users of Twitter can follow others and have 'followers' that keep track of their 'Tweets.'

Twitter provides an especially good example of pervasiveness and the associated 'non-place' of communications technology that is found at conferences and gatherings, particularly in the technology industry. Many conferences now create a Twitter hashtag (#) code for themselves, in order to allow Twitter users to reference the event by tagging it for others. The hashtags can be collated by a simple search within the Twitter application, that reveals all comments tagged by attendees or followers from each conference.

In the past year, Twitter has become more and more prominent at conferences. The channel of chat and 'non-place' activity is a hive during any given random conference session. Some conferences project the back-channel of Twitter on stage behind the speakers, which can have unintended consequences. There is a well-known example of this phenomenon involving Microsoft researcher danah boyd, during her November 2009 Web 2.0 Expo talk [2]. The conference organizers erected a screen behind boyd to broadcast the hashtag Twitter stream feed while she was speaking. For reasons beyond her control, boyd was unable to have her usual set up for speaking, and as a result, from early on, her talk did not go well. The Twitter stream reflected this. The more she spoke, the more critical comments populated the feed about her speaking. It was as if she was no longer a person in a real 'place' but had been subsumed by a group watching her, that was now so absorbed in the activities of its non-place' that boyd the person had become an afterthought. Even though the audience was physically there, in seats, watching her speak, it became easily disconnected as each audience member entered the 'non-place', lost their social bearings, and engaged in a 'solitary contractuality' with themselves as they typed and read the Twitter feed with other audience members in the 'non-place.'

Augé adds,

> A person entering the space of non-place is relieved of his usual determinants. He becomes no more than what he does or experiences … Perhaps he is still weighed down by the previous day's worries, the next day's concerns, but he is distanced from them temporarily by the environment of the moment. Subjected to a gentle form of possession, to which he surrenders himself with more or less talent or conviction, he tastes for a while, like anyone who is possessed, the passive joys of identity-loss, and the more active pleasure of role playing [1:102].
>
> Pervasive technology runs our supermarkets, trains and society. There is a "non-place" imposed on the individual as they take a ticket from, or pay money to, the various machines set up to collect payments for food, parking, travel etc. Identity is surrendered with each transaction requiring identification, but is removed again as the individual disengages with the machines.
>
> What he is confronted with, finally, is an image of himself, but in truth it is a pretty strange image. The only face to be seen, the only voice to be heard, in the silent dialogue he holds with the landscape-text addressed to

> him along with others, are his own: the face and voice of a solitude made all the more baffling by the fact that it echoes millions of others...The space of non-place creates neither singular identity nor relations; only solitude and similitude [1:103].

The irony here is that as pervasive technologies create isolation in the physical world, the feeling of isolation becomes a driver for the embracing of social technologies that unite people in the 'non-place' world against that which they dislike in the physical world.

In these instances, the groundwork has been laid that for the idea of supermodernity, the 'non-place' is reached through an attentiveness to the technology in our time which is currently the most socially pervasive: mobile device interaction. The previous argument and indeed, quotes, support the notion that pervasiveness begets supermodernity, which in turn begets social isolation, which begets fragmentation which begets participation in social networks which begets social connection whilst simultaneously creating a side effect of disregard for physical space participation during the connections.

Although many people have mobile devices, not everyone does, and those who have mobile devices aren't necessarily wired to them at all times, even though it may seem that they are. At any given moment, as people are interacting with mobile devices in the 'non-place' they are intersecting and/or colliding with others in 'place', who may not own such devices. The widespread distribution of mobile technology is getting us closer to being a society with full blown pervasive technology, but we aren't there yet. People still balk as they dodge those unaware 'non-placers', even while they are connecting with their own devices.

This is not a promising case for pervasive technologies (or at least not a happy one). Our goal is to understand how to create a successful scenario that incorporates pervasive technologies successfully into social awareness, expands social networks for individuals and increases the capacity to benefit from these. In other words, pervasive does not necessarily have to mean 'taken for granted' nor does it have to create the assumption that fragmentation and social isolation (at least in the physical space) will follow. We'd like to examine pervasive technology as it moves towards its next incarnation, for woven within ubiquitous mobility, will be the bloom and pervasiveness of our forth layer: sensors and Contextually Relevant Inscribed Knowledge (CRIK). In this case, CRIK refers to that information that is delivered or 'served' to a person in the context within which they are located, and that is related to that context. An example of CRIK would be AR, a layer of information that uses geolocation to sense context and deliver relevant content, or the 'smart meters' that regulate household power usage and communicate data information to an offsite monitoring organization.

This instance is where things have the potential to be interesting and hopefully positive for society rather than dystopic. Sensor technology (also referred to as the Physical Internet) is forecasted to be the next pervasive technology that will embed itself into 'place', thus permanently altering the physical space into a hybrid of concurrent 'place' and 'non-place.' Sensors enable appropriate CRIK, opening much greater potential for new abilities and subsequent user-created services that can permeate people's lives, through each person, their social network and those of others.

If we examine the current state of the distribution of pervasive technology, we discover that it permeates some areas, and barely covers others. In the areas that it permeates, it comes in the form of systems that have either been absorbed into the culture wholly (as in the case of automobiles), or in parts as in the case of Radio-frequency Identification (RFID) and other types of pervasive system technology, the kind that gets our products, services and selves shipped around the globe, but not necessarily through any awareness on our behalf that such systems exist at the level of technical complexity that they do. Even the laser eye that opens the supermarket door automatically, is a pervasive technology. At this point, in most of Western society, there is a non-verbalized expectation that doors in certain contexts will open automatically for those treading close to their thresholds. In certain environments, people have learned cues as to which doors are 'automatic' and they won't push open a door, they expect it to sense their path and gain them entry. As this type of service by sensors and actuators becomes pervasive, human expectation, and some level of fusion with the systems that support sensors, will become more and more intertwined.

To smooth the transition for society into a sensor services economy, conflicts within a culture with regard to adopting and adapting new technologies must be resolved by those developing and deploying pervasive technologies. Technological practice that is 'marked' (e.g. unabsorbed) cannot be pervasive. When technologies become 'unmarked' (e.g. absorbed) into the 'unawareness' of daily life in society, there is a successful technology acceptance.

The precipice that we are all about to plunge into in our future is that of a pervasive society where 'non-place' becomes the new 'place' and there is no 'downtime' from the network, or its ability to serve us. This can be a societal asset, freeing us up for other endeavors.

III. The Internet, Space and Time

The Internet has modified our experience of both space and time, within its domain rendering time as asynchronous and spatial locations as ubiquitous. A new heuristic for experience blends physical and virtual space in personal, asynchronous time. When the internet was composed of fixed servers and clients, these two views of space and time were contextually moderated. With the advent of pervasive technologies, ubiquitous mobile devices and the like, new capabilities and lived experiences are leading to a convergence of those views. Many people believe that this will increasingly draw us towards a common world culture. We posit that unmoderated this will reinforce fragmentation: the convergence of views of time and space reinforces local cultural logic by removing many of the constraints imposed by these views in a global context. However, fragmentation need not be negative, indeed it is likely to be positive if one values individual agency while retaining group values.

The Internet was developed as a framework and architecture with a fairly specific intent for how the world would interact

within its constructions. We suggest that the world has found a way to imbue itself within, around, underneath and on top of the Internet and that furthermore, those adaptations lead to new ways to use the Internet, which then lead to new ways of using the Internet, etc. Thus, the convergence of the Internet is not represented by a single use case being adapted by more and more people in the same way. It is convenient to conclude that as technologies become more widespread and available, world culture will share more resources and ideas and thus become convergent. This is misleading. The convergence of the Internet supports divergence and fragmentation: as each person uses an Internet adaptation in a new way (capability), and shares that adaptation, it creates more potential for others to create and share new adaptations and capabilities. Convergence of capabilities is not a convergence of cultures. People express themselves and have diverse opinions even within their own cultures on how to use or construct communications with these capabilities.

IV. Contextually Relevent Inscribed Knowledge: Relating the World

In developing pervasive technologies, trying to map the Internet to the real world is a complex process. As people use the Internet, they are increasingly mixing their online 'non-place' behavior with their real life 'place' behavior. This has resulted in new forms of behavior transference that include detachment, impatience, fixed linear knowledge, and an expectation that other people will respond with not only the depth of data of a computer connected to the Internet, but also with its immediacy.

We propose that the cultures and behaviors of humans are increasingly actively permeating Internet-based applications [3]. This is leading to the development of, user created, applications that are culturally transcending the hardware and software platforms that support them. This creates a different kind of cultural world map, complete with the richness and diversity of the former analogue world prior to the Internet's widespread development.

Hardware usage models are reasonably standardized across most platforms, operating systems, and global cultures. This creates a set of increasingly standardized capabilities that enables the real world to be represented and manipulated, and thus mapped to hardware. People adapt capabilities to achieve goals that extend beyond the capabilities' context of origin.

Software uses and integrates the capabilities of hardware to create new capabilities that end-users can then deploy to build experiences. There are now many of these 'capabilities' deployed on the Internet, enabling end-users to create new capabilities for themselves and others [4]. Because so much of Internet content (and capabilities) is now created by end-users, the diversity of human culture is being replicated inside the system that once was formalized and controlled. In this way, the human cultural experience, and all of its messiness, cannibalizes software and creates a localized cultural experience: a real world 'place' within the 'non-place' of the network/ Internet. This is evidence of 'real world' mapping to the Internet and may explain the rapid growth and popularity of 'Social Computing', as humans carve out spaces for their cultures within software frameworks.

V. Human Relations and the Network

Although historically, people have had standards to facilitate analogue interaction and communication, they have not typically related to each other using formal logic protocols similar to those found in the machines on the Internet. In their own way, people have changed the landscape of their life (and their world in the process) by creating hardware, software and the relevant associated protocols required to use them. People adapt their world, rather than struggle to adapt 'as is' to changes thrust upon them [5].

The Internet is the latest human 'landscape changing' adaptation. Initially the Internet was adapted as a means of personal communication through email. Public news feeds. FTP sites and 'bulletin boards' were early tools for sharing information. As the Web became more widespread, and as software became more available for humans to contribute personal data, more and more humans came online and interacted with each other by playing games, trading information, and sharing advice as well as stories. They also created personal content within the context of those activities, thus contributing to the creation of 'virtual worlds', 'virtual societies', avatars, and broader applications for human self-representation, societal affiliation and direct communication. The Internet environment is slowly surpassing the analogue structure of fantasy, books, radio, film and television, by containing those elements within its structure and making them malleable. We suggest that the Internet as a human adaptation changes the landscape of life by generating new behavior patterns that have unexpected consequences. These new behavior patterns are revealed as some people spend more time on the Internet than with each other, and/or may have behavior that changes as a result. New consequences infiltrate daily life as a by-product of the cognitive, physical, and social systems that humans switch between as they communicate with others.

The network space that humans have begun to occupy poses some interesting paradigms for human group formation, culture, and the associated expressions through the usage of the new technologies' various user experiences. With the addition of sensor networks, a future Internet (the 'Internet of Things') based on Dual Reality (a condition by which things are both happening in grounded reality (real life) and the network), Mixed Reality ("...anywhere between the extrema of the *virtuality continuum*.")[6], Augmented Reality (AR), and other technologies, will allow for a more synchronous, albeit networked, simultaneous human experience. The future Internet will not only encompass a single person and their laptop, computer or mobile phone, but will reside as an intermediary between whatever virtual and 'real' (culturally constructed and experienced) worlds a person happens to be multiplexing at any given time. Because of this, within the context of the Future Internet, using terms like 'Augmented reality', 'Dual Reality', 'Blended Reality', and 'Mixed Reality' ('Virtual Reality' is omitted for lacking interactivity with other worlds) may be limiting in scope. Those terms do not currently address the multiplexing scenario that is commonplace amongst groups of people using the Internet simultaneously, each with a different multiplexed set of 'mixed' realities. The complete set of those multiplexed 'mixed realities' connected through the social networks that they reside within, we refer to by the name of

PolySocial Reality (PoSR)[7]. These rapidly compounding realities create great potential for confusion. In many cases a major part of the context for interpreting a given person's behaviour is not observable by others.

An example of an elementary kind of PoSR is on Facebook, (a social network for people to connect with each other and share information). Each person's Facebook homepage is in many respects unique to them, even though all the components are partially shared with others' Facebook homepage as well. Each person's page is mainly composed of the primary messages and/or media of their 'friends', and includes comments on those messages and/or media from their 'friends.' The secondary comments can occur even if those commenting are not Facebook 'friends' of the first person. In addition, these secondary comments reveal insights about their Facebook 'friends' that would not normally be revealed. In this way, Facebook can both create an elementary PoSR and simultaneously contain a mechanism for moderating some of the confusion.

More advanced forms of moderating PoSR will be needed to avoid individuated fragmentation in the Future Internet. Within a sensor/actuator connected environment, humans will be generating data in the physical world that will simultaneously interface with any one of multiple environments. This means that one action in the physical space, could trigger results in numerous applications such as Second Life (a virtual world), Facebook, foursquare (an app based on using a physical location to update status within a network), Twitter, Massive Multi-player Online Role Playing Games (MMORPG), geotracking apps, or any one of many others that haven't yet been implemented such as direct input to health records or some type of family notification program. The complexity of the multiplexed realities for an individual, scale well beyond these examples. Technological solutions must be found to ameliorate this complexity. In augmented environments, information is sent to mobile devices within these multiplexed environments. In more elaborate intelligent environments,sensors/actuators can provide sufficient information for each person in the group to understand more about each other's current context.

In March of this year, the Color app was released by Color Labs, Inc. Color is a start towards locally contained, software based PoSR. Color works by enabling anyone who is running the app on their GPS enabled smartphone, which acts as a location sensor, to share photos taken with anyone else in their geoproximity. Color contains several different views. One is called the multi-lens, which enables the user to see all videos and photos being taken on any phone running Color in their geoproximity. All photos are automatically loaded onto each participant's phone. Simultaneously, there are other views in Color that allow for interaction. There is an 'elastic-network', which is the place where the image icons/avatars/photo representations of the persons in the geoproximity who are participating in the Color (pop-up) network can be viewed. There is also something called the 'thread view', which is a running update of photos being taken by those in the 'elastic-network' who are nearby. There is also a way to post on photos and communicate with those in one's geoproximity (elastic network). This app enables a PoSR in that there are multiple people on multiple channels creating multiple realities that are replicated on multiple devices, within a local geo area that is defined by each device. It's exhausting just describing it. The civil order issues alone here, while irrelevant to this paper, are seemingly insurmountable: too much information is available to too many, potentially unscrupulous, 'others.'

Another app that was also launched in March of this year, is TweePlayer. TweePlayer calls itself the first Digital Video Recorder (DVR) for conversations. In this model, the user can collect multiple conversational viewpoints that are created simultaneously or asynchronously by any participant at an event, and replay all of the ones from the same event to get a multiple replay perspective of what people have to say about each event. As a user play back a video from an event, they can play the conversational viewpoints along with it. In this way, the PoSR happens in collection, and in replay as multiplexed events are shown on different devices.

At present, though, the closest that technology gets to the PoSR model in mass commercial use at the moment is when a geolocal app uses the mobile phone as a single sensor. If one has set up the foursquare app to both post their location data to Facebook and Twitter that is an example of a one-to-one-to-multiple model, where the human activates the phone-as-sensor by carrying it to some location, which is then transmitted to one point, foursquare, which then distributes it to other applications. The phone can have its sensor location on, however. Indeed, GPS (global positioning system) records can now be used as subpoena evidence, even when a phone has not had its 'location', 'turned on' by the user. While other programs can sense location on a mobile device, current devices are not simultaneous in usage.

VI. Space and Time

The developers of geolocal and geospatial (LBS and LBMS) apps often conceive themselves to be mapping data from the Internet onto the real world. However, from our anthropological point of view, they are incorporating data that represents features considered significant from both old and new human conceptions of the world, and inscribing it onto digital maps. For a growing class of users, their conception of 'reality' is increasingly consonant with what appears within hardware, software, geolocal maps and apps, presented to them from both old and new frameworks. In this way, developers and users are designing, albeit, changing, both the world, and the human perception of it, not just representing it in abstract terms [8].

In the asynchronous nature of social computing, time has become a threshold or window rather than a 'moment to moment', conception. The shift from the synchronous oral communication used during most of human history to asynchronous Internet communications is rapidly underway. Humans have more asynchronous capabilities on the Internet and seem to be using them. This has impacted how people conceive and experience the nature of time. Time has become more personalized, and each person’s experience of time has become paramount. Needing to be 'somewhere' in order to utilize communication has become moot: one can be anywhere in space, that there is a signal and use time asynchronously.

Broadcast technologies, beginning with the telegraph, promoted capabilities that modified conceptions of space, making some of its aspects irrelevant. With the advent of the mobile Internet, space has become modified, and humans are now able to move within communications spaces in a new physical way. Thus, the Internet has become ubiquitous within time and space as the potential to communicate, collect and share information is now 'everywhere.' Furthermore, with contextual geolocal services and their extensions into AR, the property of pervasive ubiquity has begun to function as an 'extension of the self' as those services quietly serve, sense, and deliver information in a similar way to the 'self.' In other words, making time and space personal and unique, creates an 'inner ubiquity' alongside that found in geospace. With ubiquitous communications, people are simultaneously in specific physical 'places' and network space 'non-places.' In summary, people now navigate a world which is based on free variables in human constructions, rather than specifically based on space and time.

We use the term "Geolocomotion" to describe the way that people navigate through space using using the capabilities of geospatial technologies to monitor and control movement in context. Geolocomotion is based on contextually relevant instructions, that are sequentially delivered by a combination of the network and specific geospatial applications. Geolocomotion has a particular unique characteristic in human navigation in that it utilizes a Polynesian, or radial type of navigation model. In this model, one turns/moves only as things come up in context. A Polynesian sailor navigates by turning the Vaka (a Polynesian voyaging canoe) when the stars orient across the bow in the right way to reach an intended destination. The Vaka may be turned again as another star orientation appears. Most targets for the Polynesian sailor (islands) have a low horizon, which makes it difficult for them to steer towards an island as a fixed target because the variability of wave height can impede their vision. Stars are higher than waves, and in a fixed location that has a predictable rotation. The Polynesians developed a system of navigation for the Polynesian sailors by which they turn the Vaka as the stars align for their particular intended direction. In this way the world appears to come to them. The usual combination that humans use of both rectangular navigation and radial navigation is compromised [9].

Lifton [10] discusses the 'vacancy problem' in relation to users of virtual worlds both with respect to their (lack) of presence in their local 'reality' when engaged in a virtual world and the paucity of the virtual world when users are not engaged. He proposes that Dual Reality potentially addresses the 'vacancy problem' by making both the place (local reality) and the non-place (virtual reality) interoperable in some respects by mapping information from each to the other using real, or virtual, sensors. This is also a useful concept for discussing social and cultural issues arising from the increased use of technologies to support the user experience for augmented, mixed and blended realities. Lifton does not fully address the social element and aspects of Dual Reality. In part, this results from the rather 'fixed' locations that he is linking, and by his restriction of the social component to those people in the lab who share both aspects of the dual reality. The introduction of mobility via phones and other devices to the context will require a generalisation of Dual Reality.

Although there are a number of mobile applications that incorporate augmented and mixed reality, there are serious issues even with the simple case of Dual Reality involving one locally mobile person. At its most serious, it is potentially dangerous. One study relating accidents and mobile phone use concluded that using a mobile phone while driving, increased the risk of accidents for up to 10 minutes following use [11]. It is reasonable to assume that maintaining attention to two separate, if interlinked, realities could be, at the very least, distracting. One way to partially alleviate this is by focusing more on linking the virtual world to the local one, with local effects from virtual events through appropriate actuators.

The problem becomes compounded when we consider that once we have truly dual realities, these will in fact rapidly become compounded, as people begin to simultaneously engage in multiple dual realities, or introduce their own sub-dual realities within a virtual world. The latter introduces new development concerns, because either only the virtual aspect of the sub-dual reality can be represented in the virtual world or we find ourselves having to implement both the virtual aspect and a virtual representation of the other-local physical aspect.

Descriptively, some of this could be subsumed under present concepts of Mixed Reality or Blended Reality, but as Lifton notes, these do not address the same issues as Dual Reality. Dual Reality relates to interoperability between the two realities through sensors and actuators, not simply by rendering one in the other. Furthermore, once we start to consider two or more people interacting in contexts where they share one common virtual world between them, together with different local realities and possibly additional virtual environments, dual or not, interoperability becomes very complex. To avoid both physical danger as a result of local vacancy in the worst case, and to maintain effective and engaged relationships, sufficient information about the experienced reality of all the participants must be exposed to each other, and must become a part of their own experience of reality.

PoSR builds on a modification of Lifton's definition of Dual Reality [10:16]: "An environment resulting from the interplay" among two or more dual realities. "While each [reality] is complete unto themselves, they are also enriched by their ability to mutually reflect, influence, and merge into one another." Unlike the base Dual Reality concept, resolving/moderating a PoSR does not necessarily require additional exotic hardware to create interoperation, people engaged in social activity will create conventions if no other resources are made available. However, an underlying sensor and actuator flow within a PoSR architecture may support a moderated, mutually consistent, environment in the case of two or more people. Moderation is not just a rendering into a composite reality, but results in a new reality, that is simultaneously mutually consistent with each underlying reality. These viewpoints or projections on a PoSR are consistent, not equivalent or equal. Due to differences in knowledge, the field of sensory awareness and other factors, two people will not experience a PoSR in the same way (just as two people in the same location do not experience exactly the same reality), but their experience will be based on compatible viewpoints on the same PoSR.

VII. Space-Time Communications

The new model for communications is one of creating experiences of physical and derived multiplexed communications spaces in personal, asynchronous time, using new capabilities created by the self and other humans within many cultures. This encourages a greater fragmentation of world culture. Convergence implies similar organization and greater synchronicity, which requires either severe constraints or enormous resources to implement. When constraints are reduced and personal and asynchronous preferences are supported, divergence and desynchronization follow. A pervasive, ubiquitous asynchronous service structure will support synchronic interaction between cultures.

Geolocal services as ubiquitous asynchronous services for conceptualizing the world that combine old ways of navigating with a 'blended reality' experience. Humans now navigate a world where spatial location has the potential to be both 'place' and 'non-place.' For example, in Yelp (an app that connects people to locations in their community for reviews of services and businesses) 'place' refers to a physical location, whereas in the Twitter app, the virtual non-location refers to 'non-place.' Foursquare is an app that allows for 'place' and 'non-place' to exist simultaneously and contains both physical location and virtual non-location referents in a 'blended reality.'

In this way, location can nominally be 'non-place' using a logic where it is 'place' and vice versa. Geolocal apps create conceptual frameworks within which people are able to reconcile these potentialities of location equaling 'place' and 'non-place' for particular purposes, and to rapidly shift between, and even integrate, these. This frees people to adapt their interpretation to more closely correspond to old or new group specific cultural beliefs as they see fit.

The continuing development of pervasive technologies, including mobile technology, sensor based responsive environments and integrated AR, will further asynchronicity and diversity in global cultures as people adapt and create their life experiences within their own personalized time and space.

VIII. Cyborg Services

When the pervasiveness of mobile devices becomes saturated and integrated into the society, there will be no 'non-place' vs 'place' for people.

For the past century, the cyborg has been a popular image in literature and cinema, and over the past thirty years it has emerged as a heuristic for theorizing about modern humans embedded in technological landscapes. A position long held by Donna Haraway [12:149], it extends back at least to Fritz Lang's 1927 classic film *Metropolis*, and perhaps to L. Frank Baum's *Wonderful Wizard of Oz* in 1900. If we are not yet cyborgs, we increasingly use cyborg services to enhance our senses, augment our muscles, expand our knowledge and increase our skills. But beyond this we are greatly expanding our already substantial capacity to mobilize other people, their knowledge and their skills. We argue that as individuals we are becoming cyborgs through these processes, and as such, are generally accepted only by the networks of people with who we form social groups. Robin Dunbar [13] proposed a group size limit of 100-230 as the number of people an individual can maintain stable interactive social relations with based on core cognitive ability. Subsequent empirical research [14;15] suggests that Dunbar was a bit low, finding a limit near 290 individuals with a median result of 231. Pervasive technologies capable of increasing this limit would represent a major advance for humanity as the capacity of people to organize more transparently would reduce substantially inefficiencies of materials, energy, information and effort found in large organizations. The transition of the cyborg as individual to social cyborgs as members of supergroups is a possible endpoint of the changes we have described.

We are not advocating a society of drones. We are suggesting that pervasive technology can offload tasks, freeing cycles otherwise spent, and perhaps expanding the group size limit for stable interactive social relations, thus increasing the overall capabilities of the societal group.

In addition to cognitive limitations as proposed by Dunbar, space and time are major limiting factors for group formation. Historically groups had to come into regular physical contact in the same place and time to maintain stable relationships. When individuals can concurrently interact with individuals directly, regardless of time and space not only can larger groups be maintained, but far more focused groups representing much more targeted purposes. For example, the innovation of Facebook was not just a new kind of portal, but the capacity to multitask interaction. With a single message an individual can interact with everyone they are in contact with. Smaller groups can be formed easily, and complex interlocking organizations emerge. Similarly Twitter has introduced many innovations. For many, Twitter takes the place of Really Simple Syndication (RSS) as a means of aggregation. By making a query to a vast group of similarly interested individuals, a list of resources can be derived in little time. Layers above this, such as Flipboard (a personalized social network content aggregator magazine) collect focused aggregated content from resources, and permit people to surf on an ocean of social relationships, investing more intimacy across vastly more individuals by multitasking each investment in intimacy.

So how does the social cyborg serve as a tool that can help direct the design and deployment of pervasive technologies? It breaks down to something like this: If you want your technology to become pervasive, you have to pay attention long enough for people to stop paying attention. You also have to provide a product. In the case of pervasive technology, the product that is being offered is a form of service.

Previously, services were sold to individuals. There were, of course, many social drivers for many services. People bought those services that they felt reflected their status, that they thought their associates would approve of, and that served their material and social needs. Today we must recognize that services are sold indirectly to groups, their real customers. While individuals still make most purchases, they share experience and information pervasively within their direct networks and through interconnection with vast groups. When the immediate groups an individual participates in reflect more of their core interests and beliefs, a small number of failed services can have a devastating effect, and likewise successes

spread quickly. The technological ecosystems is both immediate and powerful in its effects.

IX. Conclusions

Pervasive technology is about creating transparent services and the resultant empowerment bundled alongside these. It's hard to persuade someone to invest in something inherently transparent, but once someone goes towards a door with an armful of groceries, the automated sensing door becomes an easy favorite. The more invisible it is, or unaware we are, of pervasive technology, the easier it becomes to create more of it. This isn't a clandestine proposition, it has to do with how humans absorb their surroundings and use them as they navigate society. Well developed pervasive technologies create a bit of 'non-place' without the associated isolation.

The issues surrounding pervasive technologies are complex and fascinating. The capacity for people to enhance the physical planet in ways such that it might almost become sentient is breathtaking and awe inspiring. It is also a phenomenally complex process stacked upon many other complex processes forged by the massively distributed computing power of people in human societies that serve us today. To become integrated with our environment in such a way that it senses and responds to us, leverages cyborgism to be not as dystopic or dehumanizing, but as enabling. Humans and their ancestors have adapted and created systems for its survival, propagation and expansion for millions of years [16].

The key things to remember when developing these systems is that one is designing an invisible service that functions best when it is forgotten. This is the purest vision of ease-of-use in design, and the one most envied and aspired to. The sensored planet, the physical network, and the pervasive technologies that will get us there, have a clean slate to reinvent design, to that of invisible, temporal, elegance.

As a society, the benefits of clear, respondent design, provide us a platform from which to evolve in to larger, more functioning social groups, to save resources, and to more thoughtfully integrate our sense of place and non-place within ourselves also at a transparent, ubiquitous level.

Concepts such as Dual, Mixed, Blended and Augmented Reality, and their subsequent technological implementations, go some way towards defining the base levels and identifying the ontological principles for the creation of what will effectively be a new world. What will be critical is the capacity for people to construct, relate and integrate multiple unique configurations (PoSR) under the control of ordinary users.

Innovations in Dual Reality, Mixed Reality, Blended Reality, and AR will have greater success to the extent that people are able to use them to enhance their ability to inject and extract value from their personal networks and to set up new complex forms of exchange. That is, success will be proportional to the extent that those innovations empower people to be makers, not just consumers.

Dual Reality, Mixed Reality, Blended Reality, and AR and other multiple realities depend on the capacity to support complex interactions between and impacts of these (PolySocial) realities. This creates interoperability between virtual and physical, ideational and material, representations and objects and culture. Going forward, this knowledge should be beneficial to any developer wanting to understand, at least in part, the nuances that humans have when interacting with each other within groups and within networks and to prepare for the eventuality of multiple relationships and orientations with the real world, and all virtual spaces.

The potential for change is incalculable as Internet technologies become more connected to the world through sensors and are able to uniquely adapt to and be adapted by the the people who use them. Although people have always, through their culture, occupied a blended reality, the capacity for large scale integration of ad hoc arrangements of these as a resource for living greatly expands the range of new technologies and new ways for life to develop.

References

[1] M. Augé, *Non-places: introduction to an anthropology of supermodernity*, translated by John Howe. London: Verso, 1995, pp. 94-102.

[2] d. Boyd, *spectacle at Web2.0 Expo...from my perspective*. 2009, Nov. 24. [Online] Available: http://www.zephoria.org/thoughts/archives/2009/11/24/spectacle_at_we.html

[3] M. D. Fischer, S. Lyon, D. Zeitlyn. "The Internet and the future of Social Science research," in *Online Research*, N. Fielding and R. Lee, Eds. London: Sage, 2008, pp. 517-534.

[4] D. Fensel, et al., *Spinning the Semantic Web: Bringing the World Wide Web to Its Full Potential*. Boston: MIT Press, 2003.

[5] E. T. Hall, *Beyond Culture*. New York: Basic Books, 1976.

[6] P. Milgram and A. F. Kishino, "Taxonomy of Mixed Reality Visual Displays," *IEICE Transactions on Information and Systems*, E-77-D(12), 1994, pp. 1321-1329. [Online]. Available: http://etclab.mie.utoronto.ca/people/paul_dir/IEICE94/ieice.html

[7] S. A. Applin, and M. D. Fischer, "A Cultural Perspective on Mixed, Dual and Blended Reality," in *Workshop on Location-Based Services in Smart Environments (LAMDa)* © ACM *IUI 11*. doi: 10.1145/1943403.1943509 Feb.2011.[Online].Available: www.dfki.de/LAMDa/accepted/ACulturalPerspective.pdf

[8] R. Happel. *The importance of place - GPS and photography*, 2007. [Online]. Available: http://www.wildportraits.com/gps.aspx

[9] M. W. Makemson, "Hawaiian Astronomical Concepts," *American Anthropologist*, vol. 40, no. 3, p. 381, Jul.-Sep. 1938.

[10] J.H. Lifton, "Dual Reality: An Emerging Medium," Ph.D. dissertation, Dept. of Architecture, MIT, Cambridge, MA, 2007.

[11] S. P. McEvoy, et al., "Role of mobile phones in motor vehicle crashes resulting in hospital attendance: a case-crossover study," *BMJ*. [Online], vol. 331(7514), p. 428, 2005. [Online]. Available: http://www.bmj.com/content/331/7514/428.full.pdf+html

[12] D. J. Haraway, *Simians, Cyborgs, and Women: The Reinvention of Nature*, New London: Routledge, 1991.

[13] R. Dunbar, *Grooming, Gossip, and the Evolution of Language*, Boston: Harvard University Press, 1998.

[14] H. R. Bernard, et al., "How Much of a Network does the GSS and RSW Dredge Up?" Social Networks 9: pp. 49-63., 1987.

[15] H. R. Bernard, "Honoring Peter Killworth's contribution to social network theory," Paper presented to the University of Southampton, 28 Sept. 2006.

[16] M. D. Fischer, "Cultural dynamics: formal descriptions of cultural processes," *Structure and Dynamics*, vol. 3:2, 2008. [Online]. Available: http://www.escholarship.org/uc/item/557126nz