

# Presence in Blended Spaces

## Abstract

Mixed reality technologies have been around for over ten years but it is only with the proliferation of smart phones and tablet (computers) that mixed and augmented reality interaction is reaching the mass market. There are now enough examples of mixed reality interactions that we can begin to abstract principles of design and principles of user experience (UX) for these new spaces of interaction. In this paper I develop the notion of mixed reality as a blended space. Mixed reality is a blend of a physical space and a digital space. The term 'blend' here is borrowed from blending theory which is a theory of cognition that highlights the importance of cross domain mappings and conceptual integration to our thought process that are grounded in physically-based spatial schemas. The concept of a blended space is developed by recognizing that physical space and digital space can both be described in terms of the objects and agents who inhabit the space, the structure of the objects' relationships (the topology of the space) and the changes that take place in the space (the volatility, or dynamics of the space). The blended space will be more effective if the physical and digital spaces have some recognizable and understandable correspondences. The issue of presence in this blended space is then discussed and it is suggested that traditional definitions of presence are inadequate to describe the experiences that blended spaces offer. Presence is considered as interaction between the self and the content of the medium within which the self exists, and place is this medium. Blended spaces mean that people have an extended presence; from their physical location into digital worlds.

## 1. Introduction

Mixed reality comes in a number of forms, spanning the reality spectrum described by Milgram, et al [1] from digitally enhanced physical spaces to physically enhanced digital spaces. An example of the former would be a vineyard covered with sensors supplying data about moisture and other growing conditions of the vines. An example of the latter might be the guitar interface to the game Guitar Hero. In the middle lie many combinations of physical and digital objects and spaces, from QR codes on buildings providing information to GPS triggered events on a smart phone, to augmented reality overlays using GPS and compass information to a mixture of maps with real-time video of the physical location integrated into the map [2].

However, designers have very little advice on how to design for engaging user experiences in mixed reality. The concept of presence could be useful here as if we feel present in a medium we feel engaged with the content and do not notice the mediating technology. This is presence as the 'illusion of non-mediation' [3]. Most research and reflection on presence concerns either tele-presence or presence in the real world. Presence can be seen as 'the subjective experience of being in one place or environment even when one is physically situated in another' [4], but in the case of mixed realities this may not be the case. We want people to feel present in the blended space.

Floridi [5] criticizes the view of presence as the illusion of non-mediation in a detailed philosophical paper. He argues that you cannot define something as complex as presence by what it is not and by the failure of someone not to notice something. He rejects this 'epistemic failure' concept of presence and instead introduces the idea of local and remote observation and the need to establish a level of abstraction at which to describe some phenomena. Presence is then the 'successful observation' of entities in our surroundings. This view creates the concepts of forward presence ('being there') where a person is able to interact with entities in an extended space and backward presence ('being here') where an entity is able to observe something distant but cannot influence it.

Certainly this idea of being able to extend the self into distant spaces across the Milgram spectrum is a characteristic of mixed reality environments. However the idea of mixed reality suggests more than just being able to bring distant things closer. Mixed realities can bring together many different types of experience and many different sorts of content. Steve Benford and his colleagues have been looking at mixed reality for some years [6] and more recently talk about hybrid spaces and how people move through trajectories of hybrid experiences [7]. Wagner et al [8] also discuss this need to recognize that people are not simply present, they move through different experiences and engage in rich, new social phenomena.

In this paper we look at people who are increasingly inhabiting hybrid, or blended spaces — spaces that mix the physical and the informational, or digital spaces. People are having new experiences brought about by the different layers of experience that are evolving as the digital and real worlds are increasingly intertwined. People move through these spaces and through layers of experience. They are present in a blended space.

In order to explore the idea of blended spaces and the impact that these places have on presence we need to establish some common ground for talking about space in general. We do this through a discussion of physical space (Section 2) and digital (information) space (Section 3). We then use blending theory [9] to develop the idea of blended spaces (Section 4). Blending Theory (BT) is a theory of cognition and has been applied to human-computer interaction [10] and more recently to mixed reality spaces [11]. This paper explores the practical and philosophical issues of developing blended (reality) spaces and how people might feel present in a blended space; a space that has properties that emerge from the blending of the real and the virtual. In Section 5 we return to the concept of presence and discuss how the (user) experience of blended spaces may make use of presence in all its many forms. Section 6 provides a brief conclusion.

## 2. Physical Space

There are many, many perspectives on the concept of physical space ranging from discussions in Computer Supported Cooperative Working (CSCW) and Human-Computer Interaction (HCI) literature, to presence research, to architecture, to urban studies, to cultural geography, to semiotics, to sociology, to anthropology, to environment, to psychology, to art, to general philosophy. Each of these disciplines highlights different aspects of the concept, often at very different scales, from cities, to communities, to the design of offices and individual or collaborative experiences. Finding ones way through this literature is difficult and is compounded by the inescapable fact that writers explore the concept within their own cultural and historical setting.

In the world of CSCW spaces and places of interaction have been discussed since the mid 1990s. Harrison and Dourish [12] presented an early distinction between space and place that was revisited by Dourish 10 years later [13]. In this later paper he draws on a number of accounts of cultural geography to look at the social construction of space and on the relationships between technology, mediated practice and spaces of interaction. He highlights the nature of the modern world with the multiple interrelated spatial systems and infrastructures and how these open up new ways of working and how people come to understand spaces through the practices of space. Drawing on Michel de Certeau's work [14] he distinguishes strategic practices of space (characterized by design) and tactical practices of space. The tactical practices of space are concerned with how the space is used; the production of spaces through use. This idea of the production of space is also developed by Henri Lefebvre, a Marxist sociologist writing in the 1970s [15].

Heidegger is frequently cited in discussions about space, focusing on his ideas of being and of dwelling [16]. However, many of his examples are very pastoral and nostalgic and do not extend easily to places that mix digital and physical experiences. Heidegger's contribution to the philosophy of place and technology is ambivalent in that he seems to favour older technologies over the modern, but at the same time recognizes that technologies bring forth and reveal the sense of being. Thus we could argue that presence in mixed reality is something rather different.

Heidegger was a phenomenologist who focused on the experience of being. Other phenomenological treatments of spaces and places are found in the works of Tuan [17] and Relph, both writing in the 1970s. The interaction between people who populate a space, and the objects in a space can result in a variety of interpretations of that place. Examples such as the sense of place experienced by skate-boarders in a city park compared with the sense of place experienced by shoppers or office workers are often cited. Relph's monograph [18] takes an explicitly phenomenological and holistic stance towards appreciating places. He defines three components of 'place identity', the physical setting, the activities afforded by the place and the meanings and affect attributed to the place.

Gustafson's conceptualization of place [19] draws on empirical work in the form of an interview survey to identify three poles that can be used to understand places. Self concerns the individual's life-path, emotions, activities, and identification. Environment concerns the physical environment, distinctive features and events the type of place and its localization. The characteristics of other people in the place characterize the third pole. Jorgensen and Stedman [20] developed their view of place based on interviews with Swedish second home owners, again highlighted issues of self, the activities and the emotional attitudes towards place. Turner and Turner [21] take these characteristics of place and use them to look at people's reactions to photorealistic virtual reality representations of real places, concluding that a framework based around the physical, the activities, the affect and the social interactions is an effective way of understanding places. Benyon and his colleagues use a similar structure in their 'place probe', aiming to understand the characteristics of place that people find important, again for the purpose of creating photorealistic representations of places [22].

In architecture, Norberg-Schultz provides a structural view of place in terms of landscape, settlement, space and character [23]. He discusses Kevin Lynch's conceptualization of the city in terms of landmarks, nodes, edges and districts [24]. Norberg-Schultz goes on to explore other spatial concepts such as enclosure, extension, figure-ground, boundary, centralization and proximity. He offers a nice quotation from Heidegger "the boundary is that from which something begins its presencing" ([23]. P13). He goes on to discuss character in detail and how architecture makes a site a place, though he emphasizes the structure of a place is not fixed but changes with time. However it is the 'Genius Loci' (the spirit of a place) that does not get lost.

Another architect, Gordon Cullen explains his Townscape Theory in terms of concept of optics (serial vision), place and content [25]. Optics concerns the unfolding experience of walking through a space. The concept of place is concerned with one's emotional reaction to the position of their body in its environment. Cullen states that "the human being is constantly aware of his position in the environment, [...] he feels the need for a sense of place and [...] this sense of identity is coupled with an awareness of elsewhere" (page 12).. Content is defined by the fabric of towns: colour, texture, scale, style, character, personality and uniqueness. These fabrics are used to create the individual elements of the urban space and "to create symmetry, balance, perfection, and conformity" (page 11).

David Canter takes a more psychological view and describes a faceted theory of place that aims to integrate an environmental psychology perspective with one coming from architecture [26]. Building on the work of Markus [27], he argues that form, function and space are the key features most associated with people's experiences of buildings and other spaces. They combine the individual, social and cultural perspectives. His theory of place is a theory of situated activities. Pulling these ideas together he identifies four key facets – function, objectives, scale of interaction and aspects of design – to develop a rich view of places. The function facet considers the centrality of certain functions to certain parts of the

overall place. The objectives focus on the individual, social or cultural perspective being taken. The scale of the place refers to the environmental scale and whether one is considering immediate, local or distant relationships and the design facet considers the form, function and spatial relations of a place. The interaction of these facets produces different typologies of places.

Canter uses his theory to look at the work of Christopher Alexander [28] who sought to capture the experience of spaces as a set of over 250 architectural patterns. Each pattern describes a solution to a classic design problem, or design situation. The patterns are heavily biased to a particular view of being (the timeless way of being) capturing what Alexander believed to be good design solutions. Smyth et al have also looked at the idea of 'patterns of place' [29], based on a semantic differential approach (also used by Brian Lawson to understand the characteristics of places such as pubs, [30]). In trying to get a rich description of people's experiences of places they identified activity patterns, physical patterns and patterns of meaning and affect. As with Alexandrian patterns, the patterns make use of other patterns in a network structure referring to other patterns to create a pattern language for design of spaces.

In museum design, space syntax has been used to explore design options with the aim of optimizing the complex relationships between the curated objects, the gallery spaces, the museum as a whole, the movement through the museum and the presence and experiences of people in that space [31]). Spatial interactivity is seen as important as technological interactivity. Indeed space syntax is a very general way of looking at spaces that focuses on the key features of spatial integration, choice and depth [32]. The approach is to strip away the different types of room, or building and instead focus on the structure in terms of how closely integrated the different spaces are and how deep the structure is in terms of its connectivity. Looking at where people need to make choices if moving through the space is another tool in the analysis. Space syntax is claimed to offer real insights into spaces and the social consequences of spatial layouts such as the UK riots in 2011 [33]. In developing creative office spaces, Davenport and Bruce appeal to the concept of 'ba' [34], a Japanese term for place (or space) where knowledge can be effectively created.

This brief review of some of the ways that philosophers and designers have thought about physical spaces is intended to set up a discussion about how we should conceptualise it for our purposes. As Dourish [13] comments, the technologically mediated world is not separate from the physical world, but is rooted in everyday life. Looking back over these various accounts we finish up with a description of physical space that focuses its structure, the dynamics of the space and the people in the space. In terms of its structure we recognize that there are various objects in the space that are spatially related to each other. At the scale of cities these would be the Lynchian concepts of nodes, edges, landmarks and districts, at the scale of houses these would be rooms. Adding in the form and function of the place gives an analysis of patterns of designing for particular purposes, and for particular emotional or socio-cultural experience. Describing the relationships between the components spaces leads us to look at the topology of the space. How local or distant the objects are from one another

and the direction that they lie in. Thus in addition to the objects in the space (the ontology) and the topology, we need to consider the dynamics of the space, since spaces change over time and objects move (volatility) and the people in the space along with their cultural and social setting, the meanings they make and the activities they undertake (agency).

### **3. Digital Space**

The term digital space is intended to cover the whole range of graphical, functional and social representations that exist in media such as virtual reality, spreadsheets, databases and so on. It is often synonymous with the term information space, but of course information may be in non-digital form. Digital space is the space of bits rather than atoms. It is the intangible but infinitely transmittable and transformable. The digital space concerns data and how it is structured and stored. It concerns the content that is available and the software that is available to manipulate the content. The digital space is the medium through which people engage with digital content [36].

There are many different views on digital spaces and many different people who are interested in digital space from different perspectives. Database people look to how digital data can be organized and structured to represent some domain or 'universe of discourse' [37]. People who are interested in virtual reality look at the digital space quite differently, focusing on motion, navigation and the representation of people as avatars [38]. Software engineers focus on the objects, methods and delivering functionality [39].

For our purposes the digital space consists of all the information content in whatever form (text, sound, haptics, video, animation) it takes. Others call this the information space (e.g. [40]) and focus on information architecture; the design of information spaces. Just as real world architects have to understand client needs and design appropriate structures to enable those needs to be realised, so information architects have to abstract some aspects of a domain and choose how this should be presented to people [41].

The first thing they must do, then, is to specify an ontology. An ontology is 'a designed conceptualization of some activity' [42]. It describes the objects, their relationships and the structure of a domain. An observer, or analyst defines the objects in a domain that are of interest and the relationships between those objects. The complexity of a domain results from the ontology. The ontology will effect how often things change (the volatility of the space) and how the objects in the information space are structured (the topology). Deciding on an ontology for some activity is deciding on the conceptual entities or objects and relationships that will be used to represent the activity. There is a wealth of research on conceptual modeling dating back to the early days of artificial intelligence, database theory [37] and now popular in work on the Semantic Web [43].

The ontology concerns deciding what objects are in the domain and how those objects are structured and related to one another. It is critical and will affect all the other characteristics of the information space. For example if an information

architect is designing a clothes shopping web site the ontology would include objects such as 'women's tops', 'men's tops', 'women's trousers', 'women's jackets' and so on. This is the ontology, the way that the physical space and the physical objects are conceptualized. Quite often the information architects of web sites come up with quite strange ontologies, which is why you may find it difficult to find certain objects on web sites. For example in one well-known clothes shopping site, the term 'Levi's', is not recognised by the search engine, nor does it appear under any other category such as 'Jeans'. The designers of this site have not included 'Levi's' in their ontology, so no-one can find them! Benyon [40] discusses information architecture and web site design.

Choosing an appropriate level of abstraction for this is vital as this influences the number of entity (or object) types that there are, the number of instances of each type and the complexity of each object. A coarse grained ontology will have only a few types of object each of which will be 'weakly typed' – i.e. will have a fairly vague description. This means that the objects will be quite complex and there will be a lot of instances of each type. Choosing a fine grained ontology results in a structure which has lots of strongly typed, simple objects with a relatively few instances of each. In a fine grained ontology the object types differ from each other only in some small way, in a coarse grained ontology they differ in large ways [36]. In the case of the clothes store, the information architect could have chosen to conceptualize the clothes using a much courser grained ontology such as 'Women's wear' instead of identifying women's tops, women's jumpers, etc.

The size of an information space is governed by the number of objects, which in turn is related to the ontology. A larger space will result from a finer grained ontology, but the individual objects will be simpler. Hence the architecture should support locating specific objects through the use of indexes, clustering, categorisation, tables of contents and so on. With the smaller space of a coarse grained ontology the emphasis is on finding where in the object a particular piece of information resides.

The information architecture of a digital space will also impact on the topology of the space, on the distance between objects and on the direction relations between object types and instances. For example the ontology affects the next and previous relations between instances. Is the next item next in chronological order, alphabetical order or some other structure? How close is a particular instance to the current location, or how close, and in which direction do I need to go to get to a different type of object in the space?

A second key characteristic of digital space is the volatility. Volatility is concerned with how often the types and instances of the objects change. In general it is best to choose an ontology that keeps the types of object stable. Given a small, stable space, it is easy to invent maps, or guided tours to present the contents in a clear way. But if the space is very large and keeps changing then very little can be known of how different parts of the space are and will be related to one-another. In such cases interfaces will have to look quite different.

The third characteristic of digital spaces concerns people and artificial agents. In some spaces, we are on our own and there are no other people about – or they may be about but we do not know about them. In other spaces we can easily communicate with other people (or artificial agents) and in other spaces there may not be any people now, but there are traces of what they have done. The availability of agents in an information space is another key feature affecting its usability and enjoyment.

The final aspect of the digital space concerns the technologies, both hardware and software, that are used to access and deliver the (information) content. The technologies for content provision, consumption and manipulation have a huge impact on the digital space. For example displays may be large or small, colour or monochrome, touch-enabled or not. There may be speech as part of the medium as input or output. There may be music and other forms of non-speech sound. There may be gesture recognition, tangible interaction or haptic feedback. There may be video, animation or 3D representations. And there will be different applications, software for the production, consumption manipulation and transmission of content.

#### **4. Blended Space**

The proposal, then, is that we are creating spaces that blend the physical and the digital. We want to go beyond mixing realities and develop a user experience that makes people feel present in a blended space. This idea of a blended space has been proposed before [44], and blending theory has been applied to the design of specific devices and applications [45]. The proposition here is that blending theory can be applied to the concept of a blended space itself.

Blending Theory (BT), or conceptual integration, is a theory of cognition that builds upon and further develops the idea that we think and reason through a complex network of mental spaces (domains) and conceptual projections from one domain to another. Most importantly BT ties in with the ideas of metaphor, which is a mapping from one domain to another and hence to the ideas of Lakoff and Johnson ([46], [47]) and their philosophy of ‘experientialism’ or cognitive semantics.

Lakoff and Johnson argue that all our thinking starts from the metaphorical use of a few basic concepts, or ‘image schemas’, such as containers, links and paths. Most importantly these are bodily-based and spatial schemas that therefore provide further support for an embodied view of cognition. For example, a container has an inside and an outside and you can put things in and take things out. This is such a fundamental concept that it is the basis of the way that we conceptualize the world. A path goes from a source to a destination. A link is something that connects two objects. The key to experientialism is that these basic concepts are grounded in spatial experiences. There are other basic image schemas such as front-back, up-down and centre-periphery from which ideas flow.



Tim Rohrer goes one stage further by highlighting the importance of culture and the social setting of activity;

“...three natural kinds of experience—experience of the body, of the physical environment, and of the culture—are what constitute the basic source domains upon which metaphors draw” ([48] p. 14).

BT builds on the idea that metaphors are much more than a simple mapping from one domain to another by recognizing that blends have a new emergent structure. Take the idea of a window as it appears in a computer operating system. We know a computer window is different from a window in a house. It shares the idea of looking into a document, as you might look into a house, but when you open it, it does not let the fresh air in. It is only ever a window into, or onto, something. Moreover it has a scroll bar, which a window in a house does not.

The contribution that Fauconnier and others have made (e.g. [9]) is to point out that what we call ‘metaphors’ in design are really blends. A blend takes input from at least two spaces, the characteristics of the domain described by the source and the characteristics of the target that we are applying it to. So for example, a computer window takes elements from the domain of house windows and elements of the functioning of a computer trying to get a lot of data onto a limited screen display.

For metaphors and blends to work, there must be some correspondences between the domains that come from a more generic, or abstract, space [49]. So, for example, the metaphor ‘the ship ploughs through the waves’ works, but the metaphor ‘the ship ran through the forest’ does not. In the second of these there is not sufficient correspondence between the concepts in the two domains. Of course the generic space is itself a domain and hence may itself be using metaphorical concepts. This process works its way back until we reach the fundamental image schemas that are core to our thinking.

Imaz and Benyon [49] have applied the concepts of BT to HCI and software engineering. They argue that designers need to reflect and think hard about the concepts that they are using and how these concepts affect their designs. They emphasise the physical grounding of thought by arguing that designers need to find solutions to problems that are ‘at a human scale’. Drawing upon the principles of blends suggested by Fauconnier and Turner in [9] they present a number of design principles. These include designing to preserve an appropriate topology for the blended space, allowing people to unpack the blend so that they can understand where the new conceptual space has come from. There are principles for compressing the input spaces into the blended space, aiming for a complete structure that can be understood as a whole and for keeping the blend relevant and at a human scale.

Bringing the ideas of BT together with the discussion of the physical and digital spaces leads to a conceptualization illustrated in Figure 1. We have a generic way of talking about spaces – ontology, topology, volatility and agents. This is the

generic space of spaces and places that is projected onto both the physical and the digital spaces. The correspondences between the physical and the digital are exploited in the design of the blended space. The job of the designer, then is to bring the spaces together in a natural, intuitive way to create a good user experience and where appropriate to create a sense of presence in the blended space.

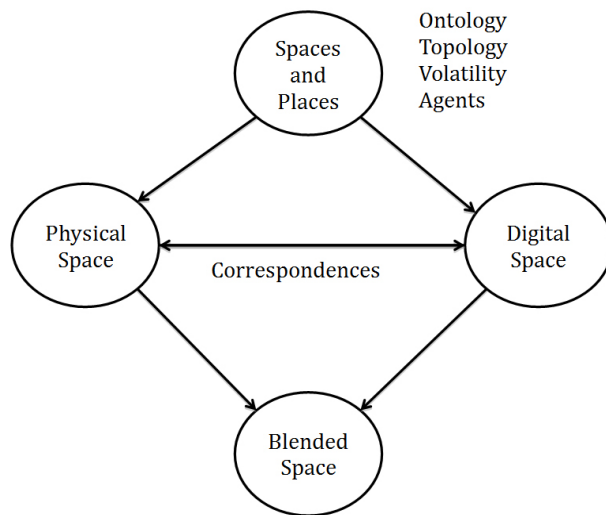


Figure 1 Conceptual blending in mixed realities

One other consideration is important in the design of blended spaces. The physical and the digital rarely co-exist. There are anchors, or touch points where the physical is linked to the digital, but there are many places where the physical and the digital remain separate. QR codes or GPS are examples of anchor technologies that bring the physical and the digital together. An iPad running some augmented reality software will take a person into a blended space for the period that they are looking at or through the device, but the connection is lost once they turn to talk to a friend when they return to the physical space, or make some adjustments to the software when they move into the digital space. Thus people move between the physical, the digital and the blended spaces as in the idea of a hybrid trajectory [7].

The blended space encompasses a conceptual space of understanding and making meaning and this is where the principles of designing with blends play their part. People need to be aware of both the physical and the digital spaces, what they contain and how they are linked together. People need to understand the opportunities afforded by the blended space and to be able to unpack the blend to see how and why the spaces are blended in a particular way. People need to be aware of the structure of the physical and the digital, so that there is a harmony; the correspondences between the objects in the spaces.

One example of a blended space that we have concerned creating a fictional narrative of Robert Louis Stevenson's (RLS) last day in Edinburgh. Using QR codes to link the physical and the digital spaces, the narrative took people through some of RLS's favourite place in Edinburgh and provided relevant sections from his writings about the places. Thus the ontology consisted of the physical locations and the writings of RLS about those locations. The technological medium used the QR codes and a smart phone to deliver the content and the topology was dictated by the physical topology of Edinburgh. The digital topology mirrored this. It was a very non-volatile place and the digital space did not include other people.

In another design, for a poetry garden in Edinburgh, we have used the topology and the volatility of the space to guide the design. We have proposed a digital space that we believe will provide a suitable blended experience. QR codes at the entrance to the garden allow people to pick up and carry a poem on their smart phone. The poem changes daily to cater for the shop and office workers. Directional 'sound showers' in the quiet areas of the garden provide poems read by famous people. A 3D QR sculpture provides a challenge to align a scanner with the sculpture in an appropriate way and augmented reality (AR) provides an anchor to personal video of poets reading their poetry, seemingly sitting in the garden.

The design of the poetry garden aimed to maximise a blended topology, fitting the different ways into the digital space into the physical space of the garden. The aim of the blended space is provide a new experience that is well designed and balanced because of the relationships that the physical and the digital space have. The AR projection fitted into the stone seats near the pond, the sound showers went into the sheltered areas, the sculpture on the main grassy area, carry a poem used QR codes and these were located near the entrances to the park. The design accommodated the volatile nature of the space through natural and rapid methods of access to the content, and the QR sculpture added collaboration between people as they tried to line up a QR reader with the sculpture as it would only act as a QR code from a certain angle

## **5. Presence and Place in Blended Space**

What is the impact, then on presence in blended spaces? In the new hybrid, blended spaces and environments where digital images commingle with real objects the sense of presence will become increasingly multi-dimensional and distributed. You may feel closely in touch with someone who is miles away at the same time as feeling attachment to the place you are occupying. Simply putting on a pair of glasses will soon take people into a blended space with interactive digital content incorporated into their being instead of it being mediated by a tablet device. Implants will be incorporated into people enabling them to directly sense new aspects of the world such as radiation, air quality and so on. Synesthetic experiences will allow new ways of perceiving. People will add layers of their experiences, as sound photos, video and animations onto physical locations. Curators will bring historical artifacts and experiences into the present day. Artists will create fantastic displays with mixed reality spaces.

The key to creating successful blended spaces is for designers to have a clear vision of the sense of presence, the experience, that they are trying to create for people. Simply layering digital content onto a view of the world (as most AR applications do now) will not create a sense of presence. Carefully crafted mixed reality experiences such as those developed by Benford and his colleagues [52], however, will develop the sense of immersion and belief required to feel present. Similarly the 'media spaces' crafted by [53] will potentially offer people a sense of presence in their historically blended place. Benford et al. [52] do provide a number of design guidelines for their particular type of blended space; the spectator interface. There are certain types of spectators that can be identified and certain types of activity and movement through the space; their hybrid trajectories. But these will not translate to other blended spaces where designers are trying to evoke different feelings.

Design guidelines for blended spaces come from the principles of designing with blends [10]. These concern understanding the correspondences between physical and digital spaces, focusing on the ontology, topology, volatility and agency in the spaces. Design for suitable transitions between the physical and digital spaces and design at a human scale. Designers need to make people aware that there is digital content nearby, to steer them to that content and to enable them to effortlessly access and interact with the content. Designers need to create narratives that steer people through the different spaces and that exploit the characteristics of the physical and digital spaces. Designers should aim to avoid sudden jumps or abrupt changes that will lead to breaks in presence. They should aim for multi-layered, multi-media experiences that weave threads of the physical and the digital into blended fabric for people to engage with. Designers of blended spaces need to be clear and explicit as to the type of experience they are trying to design for and what features of the spaces they expect to produce feelings of presence. Presence can then be measured using physiological, behavioral and subjective measures derived from the design criteria.

In the case of blended spaces, then, neither of the classic definitions of presence ([3], [4]) seem to capture the essence of the presence that is being sought. In blended spaces people should be aware of the blends, but should be experiencing something different. We want people to feel present in a blended space and to understand that the blend is a mixture of real and digital. We do not want an illusion of non-mediation or of sense of 'being there', in another location. We want people to feel present in a blended space.

Riva, Waterworth and Waterworth [54] argue that there is an essential evolutionary need for a sense of presence. Presence is the result of an evolved neuropsychological process that allows people to differentiate between the self and the other (the environment). Presence is attention to the non-self, the external world that is needed for survival in addition to emotional appraisal of events. In short, people need to know what is real and what is not if they are to survive. People usually interact with their environment through some technologies, even if those technologies are shoes and shirts, spectacles and hammers. When technologies are perceived as part of self, people will feel a strong presence in them. They argue that when the technology that mediates the

interactions with the environment appears to disappear — feels part of the self — there is no effort of action or effort of access to information in the environment. In Heidegger's terms things are ready-to-hand. Thus technology allows people to extend themselves. Ijsselsteijn and Riva [55] focus on presence as distal attribution, on the interplay between internal presence (personal presence) and external presence enabled by technologies (tele-presence).

A key feature of presence is the ability to interact and be able to modify the environment, not simply observe it. Riva argues that presence is the 'intuitive successful action in the environment'. Fiordi [5] says something similar. The emphasis on action is important as it brings with it the concepts of volition and intention into a discussion of presence. People want to bring about some change in the environment, to enact some change. In Riva, Waterworth and Waterworth (2011, [56]) they bring these arguments together arguing that presence is the missing link between cognition and volition. Presence locates itself in an external and cultural space and can act in it. Presence provides feedback to the self about the status of its activity and 'tunes' its activity so that it is intuitive, or non-mediated.

Rather than seeing people as living in an environment, O'Neil and Benyon [36] see people as being in a medium. This medium is necessary for our human abilities to think, communicate and interact with others, because the medium holds ideas and concepts for us. A medium must exist in order to make ideas physical so that others can interact with us, whether the medium is words, objects or interfaces. The stuff of the world, including our bodies, has the capacity to be formed and reformed by physical manipulation, in order to represent ideas. In doing so, the stuff of the world holds concepts for us, relieving us of the need to keep them in our heads. This allows us to perceive them, recognize them and reuse them as and when we need. The stuff of the world is able to act as a medium through which we can communicate and interact because it is malleable and responsive to physical transformation. In addition people are physical beings that can act on it taking advantage of the physical laws of cause and effect. This allows people to 'off-load' cognition into the environment and mark the world around us, creating content in the medium, giving form to our thoughts and experiences. In marking the world we no longer have to think. Instead we can perceive. The 'invariant repertoire of behavior' [57] that a medium affords us can give an idea the kind of stability that the mind cannot and thus embed the medium with content.

With ideas out in the world formed by a medium we are more readily able to engage with them not just in an intellectual 'present-at-hand' way but in a 'ready-to-hand' way; where the medium disappears allowing us to act directly with the content of the medium. The mediation of ideas by the stuff of the world allows us to engage with those ideas physically through our bodies.

Presence, then, is interacting directly with the content of media. But it would be wrong to see this as a single medium. Interactions are multi-layered, built upon one another, and there are many mediums. As soon as I have accessed a medium's content and incorporated this, my new extended self can interact at

the next level of abstraction in that medium. However, I might then access and incorporate some other medium's content thus extending myself in another direction. This may happen physically such as when I move to feel present in a particular place, or it may happen conceptually such as when I have a conversation with another person. In blended spaces people are existing in multiple media simultaneously and moving through the media, reflecting on some and incorporating others, in and out of physical and digital spaces.

This view of presence as interaction with the content of media shares ideas with many recent and older accounts. In Waterworth and Waterworth's terms [58] there is no effort of action, or of access to information if there is a strong mediated presence. Whilst this suggests technological mediation, O'Neil and Benyon's view is that the media is all the stuff in the world whether technological or not. Views of presence that foreground being able to act in the environment which suggest physical action, are replaced by the ability to add, change and manipulate content. Whereas accounts of presence tend to look at the environment of the self as a single technologically mediated entity, O'Neil and Benyon's view recognizes the multi-layered and multi-faceted view of presence that seems to characterize blended spaces.

Thus presence does not require sophisticated computing equipment. At its most basic, the blind person's stick is an example of a technology, or a medium, that allows the person to reach out and be present of a more distant world. Tele-presence allows us to reach beyond the confines of our body. Of course if we do have sophisticated computing technologies, then we can be present on Mars, controlling a remote vehicle, or as a surgeon feeling present when undertaking a remote operation. All manner of simple media such as eye-glasses, hearing aids and so on extend our natural presence away from the confines of the body. New media make us present of certain attributes of the world and allow us to be present of things that our five senses would not allow us to be present of.

Mearleau-Ponty [59] distinguished the objective body from the phenomenological body and it is this person-in-mediums that corresponds to the phenomenological self that helps to explain how we can feel present in digital environments such as virtual worlds. Furthermore, to be present is to be in a place. Place is the medium in which we make ourselves as has been recognized by many writers such as Mearleau-Pony [59] and Heidegger [19]. Until now this meant a physical place, but with blended spaces comes a new sense of place.

## **6. Conclusions**

The concept of blended spaces aims to take the design of mixed reality experiences to the next level of understanding. By understanding the generic space of spaces, designers can look for the correspondences between the physical and the digital spaces and develop the anchor points that bring the spaces together. There needs to be an understanding and appreciation of the ontology, topology, volatility and agency in both the digital and physical space and an understanding of the technologies and media available in both the

physical and the digital. A sensitivity to these characteristics will enable a designer to create a great blended space.

People will be present in these blended spaces, engaging in experiences. They will move between and within blended spaces. They will move up and down the layers of experience. Support for navigation of spaces is a critical aspect of designing spaces. How people come to understand what they can do in blended spaces, what they can feel and how they can express themselves will depend on the designer's skill in allowing people to conceptualize the blend. Principles from blending theory points to integration as a key feature; "integrated blends is an overarching principle of human cognition" ([9] p.328). This integration can be achieved by applying principles from BT such as 'pattern completion' which involves designing to take advantage of people's previous knowledge and experience and 'web' that aims to have appropriate connections and its associated principle of 'unpacking' that people can understand where the blend has come from.

In investigating a semiotics of information spaces Benyon and O'Neil [36] draw on de Certeau's ideas that people walking in the city create the city. 'the mouse clicks, scrolling, button presses and sliders, ... the swipes, taps, pinch and spread and other gestures in our multi-touch interfaces are the way we create the blended space'. The information architecture —the ontology, taxonomy and topography — allows realization through movement within and between the information artifacts. People create meanings as they negotiate and contribute to the information space. Brought together with the architecture of, and the people in the physical space affords the production of space. People use the rhetoric of physical and digital spaces to be present in a blended space.

The degree to which people will feel really present in the blended space is a measure of the quality of the user experience; of the naturalness of the blended medium, the appropriateness of digital content and the spatial and aesthetic characteristics of the physical space.

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