

Living architecture: currencies between architectural pedagogy and time-based media performance

Ava Fatah Gen Schiek

Bartlett School of Architecture, UCL, UK

INTRODUCTION

The rise of pervasive computing (Weiser, 1991) and networked technologies has resulted in a hybrid structure of Mixed Reality Architecture (Schnadelbach et al., 2007; Benford and Giannachi, 2011) and Augmented Environments (Aurigi and De Cindio, 2008). This offers 'new tools' that may modify our perception, and even alter our bodies. Human bodies can be used for all sorts of cognitive purposes, not just to act on the world or co-create a personal world, but also to represent, model, and ultimately self-teach (Kirsh, 2013). Accordingly, human bodies can be used as simulation and modelling systems that make it possible to project to unseen things that would otherwise be more inaccessible. The rapid development of 'digitally mediated' interactions and the use of sensors designed around the body (such as in wearable tech) changes the way the human body relates to its -responsive and potentially interactive - surroundings. Arguably, this new development promotes new modes of engagement with older questions, it influences the way to prepare architects for new challenges in the field and calls for providing new tools and methods to be incorporated into the architectural education.

In this paper, I describe my research-based teaching for the unit 'Embodied and Embedded Technologies' on the Architectural Computation programme (MSc/MRes AAC) at The Bartlett, UCL. The unit consists of two modules exploring sensory environments and 'digitally mediated' interactions in Media Architecture and Urban Digital Interaction.

I present an attempt to foster new ways that extend beyond traditionally applied modes in architectural education and Human Computer Interaction (HCI), through integrating space, the body, digital media and computation in a module taught to students coming predominantly from architectural design background (Fatah gen. Schieck, 2012). The teaching adopts the design studio culture, which integrates: teaching, discovery (research), and application (practice). It draws on my research that intends to build a collective of researchers and practitioners spanning design, interactive technologies and media and the performing arts and applies a multidisciplinary approach where architectural space, the body and body movement, interaction design and performative interactions (Salter, 2010) come together. The teaching starts in term one with exploring the body as a design material in the 'Body as Interface' studio; and extends in term two towards the city context in the 'City as Interface' studio, which engages with the social agenda and the various aspects of participation in the networked

city. In the paper, I focus primarily on the ‘Body as Interface’.

Donald Schön’s concept of the ‘knowledge in action’ and Kirsh’s concept of the ‘thinking with the body’ provide a useful framework for interpreting my approach.

MEDIATED SPACE AND THE EMBODIED EXPERIENCE

Conceptual ordering, spatial and social narrative are essential to the way we design and experience buildings (Psarra, 2009). Buildings are defined through a thinking mind that organises and creates relationships between the parts and the whole and they are experienced through use and movement. We use our bodies to move, navigate and communicate, and change our posture relative to the space we are in, and the people around us.

At the heart of the 21st century, ‘interactive’ and increasingly ‘adaptive’ architecture will become part of our experience, forming an important shift in rethinking the public space and its social importance. With the new development, digital media extends into the physical and temporal aspects of architecture, creating visual and auditory interaction spaces. These spaces enable various types of embodied experiences as we interact within a shared space, which, in turn, may motivate new social interactions or disrupt the habitual nature of everyday interactions, creating new stages on which people can play out a variety of engagements. People are no longer limited to the role of the spectator or passive actor but are rather active in defining the emergent mediated collective experience.

Interactions with and through technology are performed with a variety of bodily situations, by being present at a location, for instance, or through movement. Research areas are merging, such as architectural design, HCI (Human Computer Interaction) and interaction design, which can be considered as a discipline of movement practice (Larsen et al., 2007). Several design approaches seem to emerge that support explicit bodily involvement by designers as part of the design process *“if one truly likes to design for movement-based interaction, one has to be an expert in movement, not just on theoretically, by imagination or on paper, but by doing and experiencing while designing”* (Hummels, Overbeeke and Klooster, 2007). In the learning environment, however, research into the design and development of digitally mediated environments and the way it is supported through full body interaction, is less considered in the academic arena.

As we find ways to incorporate digital media and computation in architectural teaching we need to rethink the role of architectural education. We need to develop new ways that extend beyond conventionally applied methods, which may in turn, challenge the traditional teaching model, and support re-inventing it as a mediated social and spatial experience. I argue that in order to capture, respond and regulate people’s experience, understanding the body and body movement, as a design material is key. The body sense of space is a combination of many sensory inputs including visual, kinesthetic, auditory and olfactory. In this sense, looking at the space-in-the-body (Laban and Ullmann, 1974) in addition to the body in space, postures and gestures will open up the possibility to better understand behaviour, and body movement and to develop new ideas and principles about spatial experience and interactions.

From the Human Computer Interaction (HCI) perspective, and as our experiences are increasingly mediated through tangible digital technologies (in different forms situated, mobile and networked), it is said that the theory of embodied cognition (Kirsh, 2013) offers new ways to think about bodies, mind, and technology. Accordingly, body movement can

literally be part of thinking, as a distributed and interactive process. Making a substantial change in the body might literally affect how we think; when we interact with the world we begin to simulate processes that shape our internal anticipations of how things may turn out. This is done through a form of implicit cognition buried deeply in our perceptual system. But it results in changes in how we mentally simulate the future. Moreover, by exploring how we think through things, designs may draw upon our embodied, distributed, and situated cognition, our ‘physical-digital coordination’. In other words, communication is not only media specific, but also body specific. According to Kirsh (2013), embodied cognition can provide us with new ideas and new principles for better designs as:

“(1) interacting with tools changes the way we think and perceive – tools, when manipulated, are soon absorbed into the body schema, and this absorption leads to fundamental changes in the way we perceive and conceive of our environments; (2) we think with our bodies not just with our brains; (3) we know more by doing than by seeing – there are times when physically performing an activity is better than watching someone else perform the activity, even though our motor resonance system fires strongly during other person observation; (4) there are times when we literally think with things”

In the following section, I describe my teaching approach, in the ‘Body as Interface’ studio, which focuses on the human body as a design material and builds on lessons from time-based performance pedagogy. I then outline aspects highlighted through students’ projects followed by qualitative feedback from this year’s students, before finally drawing conclusions about the light this approach throws on the nature of the body-based design process and the explicit bodily involvement by designers as part of the design process towards time-based architecture.

THE BARTLETT’S ARCHITECTURAL COMPUTATION PROGRAMME

The AAC is a one-year taught course in the field of Architectural Computational design, and has been running since 2005. The programme (MSc/MRes) engages with the main technologies by which tomorrow’s architecture will be designed and constructed. It perceives computation as a technology driving fundamental shifts in industry and society, and, more radically, one that can change the way we create and think. Students are educated to do research, in the context of industry and practice, to change the way built environment is designed, constructed, and inhabited. To this end, the learning of technical knowledge such as computer coding plays a stronger role than in many comparable courses, not only as a skill but as a framework for thought, which is supported by a broad theoretical understanding of algorithms and philosophies of artificial intelligence and related domains.

These digital tools and design environments provide, among others, increased levels of investigation at micro and macro scale that can be considered in parallel and at multiple accessible stages of the process, which in turn, increases the ability to abstract, a key skill in design (Morton, 2014). However, the focus in the design process on the coding and the computational framework of thinking, coupled with the reliance on visual reasoning and visual relationships of design elements, may raise a question as to whether design is thinking or doing. Furthermore, this could lead to over reliance on virtual digital tools with little understanding of what the digital model is expressing, in particular when it relates to embodied and time-based interactions. To train tomorrow’s designers – I argue, this framework needs to be balanced through a time-based embodied approach. Here, I believe, it is essential to support an iterative learning ‘loop’ of thinking, doing and feeling,



▲ Figure 1 Another example is related to the design, implementation and evaluation of technologically mediated interactions in the real world, for instance, through collaborative urban play and music making between two remote locations, 2012.

which is key to acquiring knowledge, and forms a fundamental part of the learning and reflective feedback (Schön, 1987).

In this respect, the design studio culture can give the students a hands-on opportunity to create spatial prepositions. Combining computational sketches, sensing and actuating mechanisms that are supported through embodied approaches, will offer an opportunity to learn from the artefact and to close the loops between the design and the outcome. The students are assessed formally, at the end of the process, by giving an audio-visual presentation in action through film, and multi media and a demonstration of a time-based installation activated through a whole-body experiential response.

RESEARCH AND TEACHING: EMBODIED DESIGN THINKING | THINKING WITH THE BODY

There has been interplay between my teaching and my research; an interesting aspect of the approach I present here (and also a challenge). One line of my inquiry explores Media Architecture (combining architectural space, interaction design and choreography) with the focus on the body and the dynamics of the moving body, and how this relates to the design of our affective experience, and digitally mediated situations. I explore this through my scholarly work, and design projects resulting in creative installations and publications. I engage with new modes of learning in architectural education through my studio teaching activities. I believe linking my research and teaching is valuable because it encourages the students to explore and present their own interpretations on the theme, which is an essential part of the whole process. Through engaging with my research the students gain first experience with embodying space and the use of different methods to translate this and create their own experimental interpretations. It is also important to bear in mind that teaching and research may require different kinds of spaces and they may not serve to enhance each other (Rowland, 2006).

The proposed approach, however, differs from traditional architectural education, in that the project is typically created and implemented in the real world setting, and requires applying a range of methods from interpretative-ethnographic to time-based experimental approaches. It emphasises the emerging nature of this new field, and encourages the

students to be active participants in the learning experience and shaping the final outcome.

I have been involved in the AAC programme since its inception, and my approach in developing the teaching is based on action research. I have observed throughout the years how students respond to the various computational methods and thinking-centered framework applied within the AAC course. This was coupled with my reflection on innovative work in the research group for developing an interactive dance-architecture (a conversation between dancers and dynamic digital simulation). The starting point, however, was prompted by the collaboration with a dance choreographer to carry out the first body-centred workshop (2008) and was reinforced after attending a week of intensive workshop and the exposure to a fascinating world of practice focusing on the moving body and the geometry of space through the lens of Rudolf Laban's principles. This training was an eye-opener, and have provided me with essential concepts and a main framing, which has to a great extent informed my approach and my understanding through 'feeling' space.

The 'Body as Interface' studio is supported by a variety of teaching modes, including the general course workshops (Physical Computing and more recently Robotics), seminars, and group tutorials. In the following, I explore the core workshop i.e. the 'Body as Interface' workshop.

THE WORKSHOP: EMBODIED AND EMBEDDED TECHNOLOGIES | BODY AS INTERFACE

With an emphasis on the body as a design material, the studio is supported by a body-centered training workshop aiming to encourage students to rethink the relationship between the human body, behaviour and its architectural setting in particular, as it is increasingly framed through time-based digital experiences. We apply a multidisciplinary approach where concepts of architectural space, body movement, performance, improvisation, and interaction design come together - drawing together, over the years, a broad range of collaborators in the field of dance and performance, visual arts, choreography and Human Computer Interaction.

The overall intention is to raise awareness of how kinaesthetic perception uncovers different properties than visual perception. These kinaesthetic properties, and the way they are encoded, make it easier to recognise the validity of interpretations that would be near impossible to infer from vision alone, if one did not also move the body (Kirsh, 2013). We utilise dance training methods such as Laban and Forsyth's improvisations techniques encouraging experiential learning through whole body interactions, curiosity, and participation. More specifically, the approach intends to open the body and mind, break routines and rethink various aspects that we take for granted. The premise is that to design for movement-based interaction only through movement, and through practicing the movement, the idea can actually be understood. By engaging the body to help cognise (Kirsh, 2013), the participant is able to understand the possibilities of movement better than observation of someone else doing it as she acquires participant knowledge.

Through practical physical exercises led by dance practitioners, students make good use of their different senses, as our senses pick up different information, and gain understanding of how we embody space and focus on practical aspects related to space orientation / gravity organization.

Aspects of movement and sensing space, in terms of its spatial content (space-in-the-body), are explored with the aim of developing a dynamic moving body, conscious of personal



▲ Figure 2 The Body as Interface workshop: Laban techniques. The students use their bodies to perform analog computation, and rely on the mechanical properties of their bodies - AAC 2010.



▲ Figure 3 The Body as Interface workshop understanding subjective space and proxemics (left and middle). Using Forsythe improvisation techniques help students to improvise and develop collaborative emergent performance (right) - AAC 2010.

space and aware of spatial relationships between bodies. Key elements of movement communication are introduced such as posture, gestures in conversation, and the notion of 'proxemics' and sensing 'proxemics', which represents the use of micro-space. In this respect, the interaction and perception in specific situations is framed through culture including the relationship, activity, and emotions present in a given situation (Hall, 1966).

To date, 8 different workshops were carried out. The workshop format has evolved over the years initially running for half a day (attended by 14 AAC students) with introduction to the main body-related concepts and has extended to a weeklong event (attended by 20 students from the AAC, the Place Centre for Contemporary Dance and the Slade School of Fine Art). The workshop combined, theory of body movement and perception, practical sessions and hands-on development and implementation of spatial propositions with simple digital manifestations.

Following the workshop, each student starts working on his/her own studio project building on the design material generated during the various exercises and the experience of the dynamic body in space. The students attempt to create their own experimental interpretations manifested through time-based installations. Body movement and spatial representation were explored through a variety of studies using different methodologies. One of the projects, for instance, created an installation that explores spatial interaction projected on a 2D plane and looked at how different types of the perceptual categorisation of space by different people would produce different ways to occupy and relate to the architectural space.

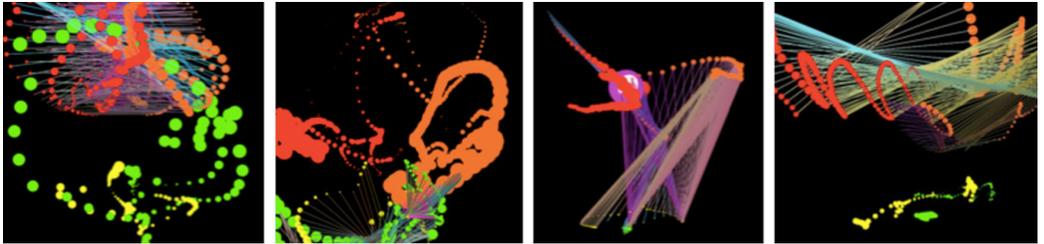
It attempts to find ways to represent the personal kinesphere [i.e. the space surrounding the body or the movement space], and to explore the relationship between space awareness, perception and body movement; how people relate to their own space and how they relate to other people.

One study tested the possibility of changing the eye location to a different part in the body, and how this affects the way we move in space

Another study explored designing sensory relations with the surroundings. It draws on



▲ Figure 4 adaptable space generation - spatial perception and bodily action operate interdependently (developed in an interactive project using computer vision and processing - AAC 2010).



▲ Figure 5 what if the human eyes are in a different location? How would this affect the way we move in space? This idea was tested with the use of a mobile phone and a camera that was mounted on different positions to provide vision mechanism for a moving body -AAC 2015



▲ Figure 6 a way of looking at the role our haptic and kinaesthetic senses play in experiencing tangibles (above) - AAC 2015 and the production and visualisation of different body signatures through spatial drawings in 3D space using hands and feet by 4 different people (using Kinect for depth sensing and processing programming language - AAC 2011)



▲ Figure 7 experiments with whole-body time-based interactions with museum objects (depth-sensing camera captures the person's posture and position in space - AAC 2011)



▲ Figure 8 what if the human eyes are in a different location? How would this affect the way we move in space? This idea was tested with the use of a mobile phone and a camera that was mounted on different positions to provide vision mechanism for a moving body –AAC 2015

gestural data to explore the rich, interpersonal, non-verbal communication we read, and perform every day and the role our haptic and kinaesthetic senses play in experiencing tangible digital objects in space.

Playful interactions through full-body manipulation of museum objects was developed using depth-sensing camera to capture the person's posture and position in space.

Finally, an interesting example, exploits full body movement with different ranges of interactions in order to develop a new tool for motion studies, where the outcome depends on the speed of the moving body. This was achieved through a reflective process of 'thinking with the body' using the hand, partial and full body motion over multiple iterations performed with the bodies of the students themselves.

In summary, the students' work demonstrates aspects of gaining higher awareness of 'Experiential Bodily Knowing' (Larssen et al., 2007a) and understanding of the importance of the body, how it relates to its own space and to its surroundings. Going through bodily activities enabled them 'as designers' to perform movements, which can extend beyond their bodies to the objects they interact with, and into the way they design time-based interactions with digital prototypes and spatial interfaces. I believe, this offered valuable insights into how interaction with new environments, or interfaces, can frame the design of future experiences.

THE LEARNING EXPERIENCE

An important aspect of the teaching approach presented in this paper, is that students are encouraged to be active participants in shaping the learning experience. We achieved this by framing the students' core experience around the body combined with the expression of movement, and exploring how our bodies create relationships with things around us and how the design of mediated experiences might 'feel' like.

My initial observations indicated that this approach has helped the students 'feel' the relationship between the body, space and mediated interactions and 'think' more critically about it, instead of relying on passing knowledge. It provided tools for design that extend our understandings of bodily aspects of 'technology supported' interactions and offered the students a deeper understanding of the role of the body and the space generated through body movement and the dynamic spatial relationships between bodies, which in turn, helped shape their project development and its direction.

This year, the students were asked to provide feedback through email about the learning process and their experience during the 'Body as Interface' workshop and to outline aspects that influenced the development of their studio projects. Five students responded (out of 8 who were registered for the studio). These comments must be considered only as preliminary and a part of an early development process, however, they proved to be very useful in helping us to develop appropriate techniques for future workshops, and the teaching in the studio overall.

Students' feedback indicated that they have particularly enjoyed the body-focused collaborative activities as it challenged the way they used to do things and provided them with a new lens to view body-space related relationships:

"The body class was inspiring to me largely in its success in getting me out of my comfort zone... it gave me a good understanding of the ways in which we can use our bodies within defined spaces and the discussions we had made me think about the ways that architecture and sculpture are only relevant in terms of the human body... The body as interface is a concept about which I had not thought in the ways we were encouraged to do through these sessions. I found it a positive and thought-provoking..."

Other comments highlighted the importance of being in the action, rather than only observing it: "It was also interesting how computation can be so physical and human. How we explored the space was also liberating, it is generally a rare occasion that we get to play games with our body." In this respect, it was important from the teaching point of view that we provide our students with the opportunity to engage in 'real fun', whilst practicing the new concepts and skills.

The role of the so called the 'feel dimension' (Larssen et al., 2007a), as a particular kind of dialogue between bodies and things, was highlighted, where people have different possibilities for action depending on their bodies, which in turn, opens up a new design space of movement-based interactions that so far has not been thought of as the usual material for designers. Here, 'Experiential Bodily Knowing' is realised through moving: "The exercise of walking backwards... helped me observe different behaviour on each person if their eyes are not in front of their faces and how different spatial assemblage it was versus when people walking forwards."

Special mention was dedicated to the exercises that emphasised other senses in the body (beyond vision), which helps consider, not just how a design or a technology might look, but more importantly how we might ‘feel’ or ‘hear’ it:

“I have learnt that sound is a means to understanding space almost as powerful as vision, even if its understanding remains normally underestimated. There are some effects that are necessary to accomplish a certain degree of embodiment and interaction that cannot be achieved only by visual means. Sound has an enormous potential, it is a very vast field not easy to master and not directly understandable, but despite all these challenges it is worth trying to work with it.”

Finally, comments stressed the value they discovered from enacting a set of rules during the emergent behaviour exercise of the ‘body as interface’ workshop, which resembled the computational techniques the students are introduced to in the Masters programme, in particular, in the computational modules: “it was a magnificent representation of some of the ideas that we just started studying this semester, such as cellular automata that have simple rules, however produce amazingly complex structures.”

An important aspect, which emerged during the session, is related to how the students worked together to ‘perform’ an ‘improvised’ piece - what looked like a highly choreographed and rehearsed time-based performance piece - by following very simple local rules between two or more body points that generated a global outcome of dynamic moving bodies with complex spatial relationships between them (a kind of living architecture). This has provided a strong framework for ‘unintended’ collaboration. Here, working on the various body-space exercises individually and collaboratively became a game that they enjoyed and consequently this increased their level of collaboration (Figure 4).

CONCLUSION

Schön (1985) has outlined some of the dilemmas presented by the expanding horizon of knowledge within the architectural field. He identified a dilemma facing architectural schools as they start to identify the growing importance of new fields of knowledge to the education they must provide: “architecture may try to incorporate them in a way that imitates the technical education in other fields, thereby turning its back on the tradition of the architectural studio. Or, out of a wish to remain true to a certain view of that tradition - and to the image of the architect...architecture may turn its back on the rising demands for technical education” (Schön, 1985, p. 86).

The rise of pervasive media and networked technologies calls for an approach to designing the physical and digital environments as an integral whole and of a coming together of Architecture and Interaction Design. Key to this interdisciplinary integration is the body in space (with its social protocols, conventions and attached values).

In this paper, I presented an embodied perspective to view the contribution the synergy, between time-based performance media, architecture and interaction design, may provide towards an inclusive architectural pedagogy.

Incorporating computation and digital media into architectural teaching raises educational issues of how to infuse it into the process. In the AAC programme computational methods are critical component of the learning experience. The teaching in the ‘embodied and embedded technologies | Body as Interface’ studio presents an attempt to re-balance this through its emphasis on the body and body movement as a material for design,

and with the intention of helping students understand and gain awareness of important aspects and design principles within an evolving field of knowledge on the cutting edge of the research. Here, the focus is on how the human body relates to its subjective space, body movement and space perception and how this may affect the way it relates to its responsive surrounding and potentially to future adaptive and interactive environments.

I outlined a discussion about the significance of this approach as an architectural pedagogical tool and described the proposed methodology, which suggests a time-based design process promoting a body-based dialogue and exercises that enable students to observe, think and feel space and spatial interactions and in order to understand the critical relationship, create their own learning experience and generate rich and varied responses within time-based architecture. I argue that re-introducing the human body as the main focus will open up more possibilities to capture, understand and react to the human experience as it is mediated through digital technologies and promote the use of experiential learning as a key strand of creative exploration within the design studio.

The paper identified pedagogic issues that influence how students conceptualise the synthesis of body movement, technology and design work and raises a question of the extent to which research could and should 'inform' teaching. Crucially, it highlights factors such as participation, collaboration and understanding curiosity and the role of discovery as fundamental aspects in teaching and learning.

ACKNOWLEDGEMENTS

Special thanks to Katja Nyqvist (dance maker & choreographer, University of Roehampton), Janine Harrington (performer, choreographer), Armando Menicacci (musicologist and dance researcher, Châlons sur Saone, France) and Christian Delecluse (Architect & Interaction Designer, Ecole Spéciale d'Architecture, France), for their invaluable contribution. Thanks to Professor Alan Penn for inspiring discussions during the early stages of the process. I would like to acknowledge the efforts and participation of the MSc Adaptive Architecture and Computation of the 2008-2015 tutors and student cohort.

REFERENCES

- Aurigi, A., and De Cindio, F., 2008, *Augmented Urban Spaces: Articulating the Physical and Electronic City*. Aldershot: Ashgate.
- Benford, S. & Giannachi, G., 2011, *Performing Mixed Reality*, The MIT Press.
- Bianchi-Berthouze, N., Cairns, P., Cox, A., Jennett, C. & Kim, W.W., 2006, On posture as a modality for expressing and recognizing emotions, *Workshop on the role of emotion in HCI 2006*.
- Bassanese, S. & Rodeghiero, B., 2014, Affective experience in space. A case study for systems thinking in architecture. In *Proceedings 2nd AAE Conference 2014 Living and Learning*, Sheffield, UK.
- Body as Interface workshop: MSc Architectural Computation (formerly: Adaptive Architecture and Computation), 2008-2015, at The Bartlett, UCL: <http://www.bartlett.ucl.ac.uk/architecture/programmes/postgraduate/space-syntax-msc-mres-architectural-computation>
- Bullivant, L. (ed.), 2007, *Architectural Design, 4dsocial: Interactive Design Environments*.
- Dourish, P., 2001, *Where the Action Is: The Foundations of Embodied Interaction*, MIT Press.
- Fatah gen. Schieck, A., 2012, Embodied, mediated and performative: exploring the architectural education in the digital age. In M. Voyatzaki, C. Spiridonidis (eds.), *Rethinking the Human in IT-Driven Architecture*. ISBN: 978-2-930301-53-2
- Fatah gen. Schieck, A., & Moutinho, 2012, *ArCHI-Engaging with museum objects spatially through whole body movement*, Mindtrek 2012, Finland.
- Fatah gen. Schieck, A., O'Neill, E. & Kataras, P., 2010. Exploring embodied mediated performative interactions in urban space. *Workshop on Designing for Performative Interactions in Public Spaces, UbiComp 2010*, Copenhagen.

- Fatah gen. Schieck, A., 2008, Exploring architectural education in the digital age. In Proceedings Education and Research in Computer Aided Architectural Design in Europe eCAADe 08 Architecture 'in comutro': integrating & techniques, Antwerp.
- Gibson, J. J., 1979, *The Ecological Approach to Visual Perception*. Lawrence Erlbaum Associates Publishers, Hillsdale, NJ, USA.
- Hall, E.T., 1966, *The Hidden Dimension*, Anchor Books.
- Hansen, L. A., & Morrison, A., 2014, Materializing movement—Designing for movement-based digital interaction. *International Journal of Design*, 8(1).
- Klooster, S. & Overbeeke, C. J., 2005, Designing products as an integral part of choreography of interaction: the product's form as an integral part of movement. DSForM, 1st European workshop Design and Semantics of Form and Movement, New Castle, UK.
- Hummels, C., Overbeeke, K. C. J., & Klooster, S., 2007, Move to get moved: a search for methods, tools and knowledge to design for expressive and rich movement-based interaction. *Personal and Ubiquitous Computing*, 11(8).
- Kirsh, D., 2013. Embodied cognition and the magical future of interaction design. *ACM Trans. Computer-Human Interaction* 20 (1)
- Kirsh, D., 2010, *Thinking with the Body*, in (eds.) S. Ohlsson R. Catrambone, Proc of the 32nd Annual Conference of the Cognitive Science Society, Austin, TX: Cognitive Science Society.
- Laban, R, with Ullmann, L. (ed.), 1974, *The Language of Movement: a Guidebook to Choreutics, Plays, inc.* Larssen, A. T., Robertson, T., & Edwards, J., 2007a, Experiential bodily knowing as a design (sens)-ability in interaction design. In Proceedings 3rd European Conference on Design and Semantics of Form and Movement.
- Larssen, A. T., Robertson, T. & Edwards, J., 2007b, The feel dimension of technology interaction: exploring tangibles through movement and touch. In Proceedings TEI 2007, ACM Press, New York, NY, USA.
- McCullough, M., 2004, *Digital Ground: Architecture, Pervasive Computing, and Environmental knowing*. MIT Press, Cambridge, MA.
- Merleau-Ponty, M., 1962, *The Phenomenology of Perception* trans. by Colin Smith, New York: Humanities Press.
- Morton, D., 2014, Visualising the unbuilt: design investigation in architectural pedagogy, Augmented Reality creating live investigation in architectural studio learning. In Proceedings 2nd AAE Conference 2014 Living and Learning, Sheffield, UK.
- Psarra, S., 2009, *Architecture and Narrative: The Formation of Space and Cultural Meaning*, Routledge.
- Rowland, S., 2006, *The Enquiring University*. Milton Keynes: Open University, Press/Society for Research in Higher Education.
- Salter, C., 2010, *Entangled: Technology and the Transformation of Performance*, The MIT Press.
- Schnädelbach, H., Penn, A., and Steadman, P., 2007, Mixed reality architecture: a dynamic architectural topology, In Proceedings Space Syntax Symposium 07, Istanbul, Turkey.
- Schön, D. A., 1985, *The Design Studio: an Exploration of its Traditions and Potentials*, London: RIBA Publications for RIBA Building Industry Trust.
- Schön, D.A., 1987, *Educating the Reflective Practitioner*, Jossey-Bass, San Francisco
- Weiser, M., 1991, The computer for the 21st century, *Scientific American*, 265(3).