Converging at The Source: Art, Science + Technology © Sara Diamond, June, 2012

My talk today proposes that art + science (including the human sciences), and its correlative art + technology research has both an important and dynamic history in Canada and a critical role to play in our present times. Never before has the alliance of art, science and technology research and creation held such an imperative - the stakes are high for all three domains. I have chosen to discuss this topic both because it is a preoccupation, because of where the SOURCE is situated – at The Banff Centre, with its history of Media Arts's New Media Research and the Banff New Media Institute which ran from 1995-2010, of which I was the founding director until 2005. At points in the talk I will touch on the Banff history and provide you with some excerpts from the book that Sarah Cook and I edited ***Euphoria and Dystopia: the Banff New Media Institute Dialogues***.[i] The book examines the major trends in new media practice and research during the period of 1995-2005, with consideration of earlier roots and later history. I am going to run a slide deck in the background that provides an overview of the BNMI and its larger themes. While Banff is the site of the book the practices and discourses described in it hale from an international perspective and set of practices. The other reason that I have chosen this topic is that Science is under attack. Its defence of curiosity, of speaking uncomfortable truths, of providing evidence and demanding action on the basis of evidence is increasingly vulnerable to contingent political and religious forces. Art acts as a different kind of evidence. As goes science, so goes art.

The reasons that underlay the creation of the BNMI retain persistent relevance in this decade. Fundamental to the ethos of the BNMI was the concept that artists and designers should both be advanced users of technologies and inventors of technologies. Believing that "all forms of technology are designed," it sought to provide cultural, humanist and post-humanist perspectives on technology research and development-design from the perspectives of human culture and respect for the natural world.[ii] We hoped to facilitate artists' access to and understanding of not only standard digital tools but to the art and science edges, where access was far more difficult to attain – virtual reality research laboratories, sensor technologies, biotechnology, and nanotechnology. The BNMI was created as a space for action-driven dialogue and practice, a "third space."[iii] As the ethnographer Mark Muller states a third space acts as "the border or boundary region between two domains – two spaces – is often a region of overlap or hybridity."[iv] Dialogues across differences and within differences are even more powerful than those within, according to Muller, when these occur between, not within groups.[v] Hence, The BNMI grew into a cross-disciplinary home for the creative arts and design professions, for humanists, social scientists, computer scientists and engineers, mathematicians, physicists, biologists, chemists and medical researchers. With this interdisciplinary blend The BNMI could be prescient about the direction of new media – able to predict and at times to construct emerging practices. By 2004 the Banff New Media Institute Co-Production catalogue indicated over two hundred and ten co-productions, and the A.R.T. (Advanced Research Technology) laboratories comprised of a CAVE, with related visualization and virtual reality software, a collaboration laboratory and a mobile engineering and physical computing laboratory and supported research under the direction of Dr. Maria Lantin.

Anthropologists and ethnographers use the concept of the "boundary object"[vi]; these are transformational concepts and artefacts that join one world of understanding to another. In most instances, boundary objects are material gifts, but in cross-disciplinary dialogue, these gifts can be terms, maps, prototypes or other semiotic artifacts. These symbolize the boundaries or edges where new knowledge is produced. The BNMI's sites of production of this boundary condition included art works, body-and location-storming activities, parties, hikes, charrettes, chance encounters, Gerhard Fischer notes that boundary objects are able to adapt to all groups: "They represent the domain concepts and ontologies that both define and reflect shared practice".[vii] Original objects are reinterpreted through this process (for example terms like, "wearable" "technology") unsettling assumptions about both original terms (wearable technology bridges engineering, material science, fashion design, sculpture). The BNMI could be described as trafficking in the economy of boundary objects. Equally, the work of art, science and technology inhabits this third space.

The post-war era in the West rigidified specialization, creating barriers between disciplines and, with this, a separation of the arts and sciences. Yet science is now deeply interdisciplinary – in fact research excellence for nations is in part judged by the breadth and complexity of their researchers' collaboration networks. – The very post-war specialization that led to a segregation of art and science has now led to recognition that contemporary science requires that these highly specialized disciplines combine to solve complex questions. Science is also moving towards art and design, a notable change from the 1990s when artists chased science. Paola Antonelli, Curator of Design at the Museum of Modern Art in New York City, and creator of the *Design and the Elastic Mind Exhibit*[viii] proposes that the earlier twentieth-century conversation between design and science in the 1960s has returned to the foreground in this century and has become focused. She argues that this is, in great part, a result of technologies that offer scientists the freedom to use their imaginations, particularly in the realm of biosciences, biotechnologies, green and clean technology and nanotechnologies, opening their minds to the views of artists and designers.

There are seven reasons why we should consider art + science + technology collaboration:

1) Art brings new approaches to solving "wicked" contemporary problems.
2) Art brings innovation in philosophy to science and technology and vice versa.
3) Art brings innovation in methodologies to science and technology and vice versa.
4) Artists will invent different kinds of tools. Artists will redirect tools. And, artists will change the methods through which tools are invented.
5) Science offers rich material for art-making. A critique of science becomes meaningful through engagement.
6) Collaboration between artists, scientists and technologists begins to emerge not only transdisciplines but hybrid forms of institutional culture.
7) Art practice needs new forms and locals for its distribution.

1) Wicked Problems

Here are three instances of projects that walk the line between scientific instrumentalism and aesthetic achievement:

- A memory scaffolding for Alzheimer's patients' draws from years of practice in autobiographical research, cognitive science and engineering – creating virtual worlds that allow users to reconstruct memories of their home. A different simulation allows therapists to experience the perception of being lost in an eerily familiar yet unknown space. Cognitive scientist Guy Proulx and engineer Brian Richard and visual artist Judith Doyle and patients, collaborated because of a shared interest in memory and emotion.

- A self-cleansing living architectural system is chaotic and responsive, combining shape metal alloys, living substrates, the twenty-four hour clock and the rise and fall of human uses of a space, suggesting new self-managing forms of interior design, yet exuding a sublime lace-like and mesmerizing half life (Philip Beesley)?
- A data visualization of genomic processes allows for new discoveries in gene sequencing, requires the invention of a new visual software system, and doubles as an elegant and revealing patterning tool and an abstract painting (Ben Fry)?

2) New philosophy

From its inception the Banff New Media Institute concerned itself with the developing language and considering the implications of new technologies as well as the creative investigation and applications of technology itself.

Anne Cauquelin, a French sociologist of culture, warns against a turn to *"techo-doxique"* forced in the name of technology onto art, resulting in cold technological aesthetics, a set of practices that could obliterate the aesthetic history and variability of art and its embodied references. She argues for a science and art engagement that is "*kinesthésiques, tactiles ou polysensorielles that can 'permettant d'éprouver le sentiment de la presence de l'autre, et de contrebalancer ainsi la dureté des temps*" and that does not reproduce the separation of nature and culture.[ix] This commitment to this particular approach can be constituted as a call for a much broader need for engagement of art with science in its broadest variance.

This is a goal worth considering while we consider the tensions between art and science that produce a rich ground for dialogue:

1) Artists have posed important ethical concerns that critique technologies as well as use them, and insist on a culturally diverse or relativist approach to the use and even the design of technology. Yet engineering, cognitive science, artificial intelligence drive towards universality. The pragmatic role of artists in proposing new applications that are inclusive is of significant importance. Examples include Mongrel's "socially engaged software" that provided a Black cultural tool set to search for Black cultural identity on the Internet.
2) Art and science have different, long-standing relationships to failure. As Paul Godrey-Smith suggests, the scientific method embraces failure as a means to progress and establish the line between the potentially true and false—that which has failed.[x] Art eschews failure. In the 1960s scientist Billy Kluver, at Bell Labs opened the door for artists to work with scientists and co-founded EAT (Experiments in Art and Technology) with Robert Rauschenberg. He did not expect that art and technology projects would immediately produce new technologies. Rather, he hoped to inspire each field towards relevant creation in its own domain, demystify the workings of technologies and, in time discover new expressions: "What I am suggesting is that the use of the engineer by the artist will stimulate new ways of looking at technology and dealing with life in the future."[xi] He argued for a willingness to accept failure in order to find ultimate success: "The artist's work is like

that of a scientist. It is an investigation which may or may not yield meaningful results; in many cases we only know many years later."[xii] This view does challenge the art world's requirement for successful new works. Kluver's refreshingly optimistic modernist view has been tempered by science and technology studies and decades of critical postmodernism, yet the experimentalist tone and sense of emergent potential still offers an exciting opening for cross-disciplinary pedagogy and research.

3) The philosophical bases of art, science and technology are different. As Jean Gagnon states in his essay in our book,

   "We know since Gaston Bachelard and Thomas S. Kuhn, that reference of the terms of scientific theories vary depending on theoretical contexts or *paradigms* to use Kuhn's terminology. This is the relativistic and constructivist position whereby social constructs, economic and technical factors inform the construction of scientific theories. This points to the constructed character of reality itself."

   The story of science and its philosophy can be told as a narrative of the invention of the tools of discovery. One could also tell the story of art-making that way.

   Yet, the tenants of scientific realism still dominate much of science and propose that there is a universal shared world of perception that is a common sense, and discovery manifests this world through shared understanding.[xiii] The aim of science is to accurately describe reality. The empirical world, including its invisible dimensions and its description through analysis thus becomes of paramount importance. The rationalist roots of scientific realism suggest that perception leads directly to action, and presupposes the alignment of reality and image.

   Naomi Barad a physicist and a philosopher of science observe in *Meeting the Universe Halfway* that there is not a one-to-one relationship between the ontology of the world and its discovery, as is claimed by 'the traditional realist'. [xiv]The 'common-sense' view of Nature is continually entangled in the theoretical and experimental practices that mark its description, as is human society.xv Yet science still makes meaning of the sometimes-invisible material world and we must pay equal attention to empirical research, as it produces ontological knowledge. The complex navigation between the empirical, material and experiential world – including the body - and its mediation through instruments is the space of art practice and critical theory, with our own struggles with authenticity, essence and surface.

   Scientific discovery grounds itself in prior knowledge, and citation is its most valuable form of currency (with patents coming in second), deepening the value of the opus cited. It provides continuity and credibility while empowering the source. Since the early twentieth century, artists have appropriated images, found objects, texts and ideas to underscore the constructed nature of these, to offer a critique, or to find inspiration in a fragment. The original is reified and abandoned, while the credit and power move to the artist making the appropriation. This is not citation.

Artists also appropriate scientific theories, such as complexity, making use of the theory's conceptual framework as a metaphor rather than as a mathematical methodology. Sometimes the creative interest is in the text alone, not the theory behind it. Some scientists question artistic license when artists use theory out of context, or in ironic ways. Scientific aesthetics can reify realism or historical abstraction, while the art world moves on in a constant reappraisal of form and artistic language.

These divergent approaches can lead to clashes between the worldviews of science, when it seeks truth and art, when it seeks the contingent, contextual or metaphorical. [xvi]This can result in mutual dismissal, or it can be of value to research, as these productive frictions provide fundamental debates about the nature of reality.[xvii] Thus, collaboration can result in variable or effectively overlaid methodologies.

If science offer a space of inquiry to artists, so art continues to reframe fundamental questions. Theoretical physicists have had little exposure to continental philosophy. Yet, in part through their relationship to artists physicists are beginning to value Gilles Deleuze, who proposed that it is only if we "rethink time" that we will be able to transform our future and ourselves. He argued that, "Through memory, concepts, art and philosophy, we can move backwards and forwards through the flow of time; we can think other durations, and we can disengage perception from the apparatus of prompted actions."[xviii]He suggested that time could be an explosive force, not glue. Neurobiologist Francisco Varela concurs. He describes "…the rich texture of the present, its "thickness" (retention, nowness, protention); and "the multiscaler hierarchies of temporal registers that underlies the flow of time".[xix] Mark Hansen in New Philosophy for New Media notes the abilities of artists' works to "compel us to confront the rich temporal depth, or affective bodily spacing, that underlies our complex experience of time". [xx]

In this decade, scientists hold variants views of reality and its analysis as contradictory and chaotic, with different worlds – episteme and ontology – side by side. New trends in science acknowledge phenomenology, complexity theory and emergence. There is recognition that complex systems are difficult to predict. Abstraction and synthesis are perceived as the new real. Contradictory views within science allow elasticity in aesthetics and provide fertile ground for artists and designers who choose to collaborate with scientists.

3) New Methods

Artists, designers, scientists and engineers derive their approaches from different training and ways of working, with much differentiation within their own disciplines. Artists work in relatively speculative ways, drawing from technical methods and experiential, process-based methods as well as on studio critique. Artists embody, manifest and make material. They challenge "common sense" – the teleological assumptions of willful design leading to predictable outcomes that is fundamental to engineering. Many scientists and social scientists also work speculatively and then add experimental tests of proof, mixing quantitative iteration with qualitative assessment. Art can learn from these methods. Designer Anthony Dunne argues that such a convergence of design and science allows design to engage with science as a research-methods discipline (brainstorming, sketching, scenario building, etc.) and to take up a critical and ethical position in relation to science, technology and invention.[xxi] The same can be said for art. Leaders of the HCI community Bill Buxton and Saul Greenberg place extraordinary value on the methods of art and design to break a scientific gridlock of discovery.[xxii] They express the concern that there is a crossroads in the process of discovery – human ingenuity needs to be privileged once again. They want to break the model of incremental research.

Further than inter-disciplinary work, in which different fields address separate problems inside a common framework, transdisciplinary research involves a stronger "interpenetration of disciplinary epistemologies" (Michael Century, 1999). Effectively, this means new fused horizons become possible — such as the fields of data visualization, social media, mobile experience design, wearable computing/design — beyond or transcending paradigms existing within single disciplines.
This excerpt from Joanna Berzowska speaking at Outside/Inside in 2004 captures the interplay of disciplines in conceptualizing "memory" and the role of artistic method:

> Joanna Berzowska: Sara [Diamond] and I were talking about how important the idea of memory is when we invest in fashion, when we buy clothes. But we actually purchase a lot of manufactured memories when we purchase clothing… all of these digital technologies, whether it's mobile phones or other things that we embed into and onto our clothes, or wear on our bodies really do allow us to amass this ever increasing amount of information about everything about the world and ourselves -- predicated on the assumption that we forget everything, which eventually is true, but it's also predicated on the assumption that we want to remember everything. And I don't think that's necessarily true. So I've come up with this graph, this memory classification system. On one axis we have things we remember and things we forget and on the second axis there are things we want to forget and things we want to remember.
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> So this brings me to my project which is called "memory rich garments." What does this mean – other than just cigarette smoke and stale perfume? Well actually cigarette smoke and perfume can be quite meaningful in itself, but it's basically the idea that clothing is an extremely intimate thing. It's right against our bodies. This idea of evidence – that all of our worn objects carry evidence of our identity and history. Then digital technologies, on the other hand, allow us to manipulate that evidence. To shape it and to edit that evidence. To reflect not only on things that we think are more or less meaningful, but also perhaps poetic or personal or subtle aspects of our identity and our history. And from the more computer science point of view there is the idea of the history of use – how has your clothing been used? By yourself? And by others? Do you want to display this history of use? Sort of like the hit counters in web pages. So, these garments can sense where, when and how they were touched or groped and then they can display that, either through a simple change in colour or illumination.

4) Tools

How can we develop tools that are both human-centric in their interface and application and post-human, in their attention to sustainability (such as solar powered mobile devices)?

In his history of science and studies of the emergence of techno-culture, philosopher-sociologist Bruno Latour has shown the ways that scientific and technical invention are "black-boxed" – that is, represented as finished, whole products whose inner working, or mode of development, cannot be seen. Society naturalises inventions and science appears as a free-floating enterprise, operating as an engine outside of society, "without people as carriers".[xxiii]The mystified and invisible processes of invention make the intentions and ideas behind each new stage of technology appear as absolutes. Olga Gotiunova, speaking at Skinning our Tools: Designing for Context and Culture in 2003 explains changing attitudes towards technology:

> Within the philosophy of technology, technology was regarded more or less as a kind of a black box closed system. Though created by humans, it has its own logic. It's impossible to change and it controlled humans from outside. This kind of very pessimistic and deterministic thought can be found in Heidegger and in some Frankfurt School[xxiv] writings on analysis of how technology influences a society. Closer to 1970s and in the 1990s, there appeared this idea that we can actually alter the development of technology, because it's shaped by human factors, and it becomes a black box only afterwards when it's already done. I think our interest in software, and all software art, is a part of this movement. It is also part of this larger change of focus that yes; you can basically influence the technology in the moment of its creation and also alter it afterwards. It's not some alien force driving you.

Identity, individual and collective, fragmented, conjunctural, or enduring was articulated and theorized in almost all events of the BNMI. Identity formed a theme in its own right with specific gatherings created to explore issues of its relation to new media. Technologies are actors; they are not neutral. Technologies are material forces that enable and facilitate the behavior of their users. Technologies are engineered with assumptions about the identities of their users implicit in their design, as well as in the affordances of their components. These assumptions about users are active at every layer – in content produced for or by the technology, at the interface layer, in the software that runs on machines, right through to machine code and platform engineering. Assumptions in turn act back on users to construct the ways that they perform through and with the technologies, hence shaping their identity. This may seem to be a mechanistic approach. In fact, users are also disruptive, finding applications for technologies that defied these assumptions. As well, design has embraced usability, and user participation, broadening the personas represented by machine interfaces. The BNMI sought ways to excavate the identity forming mechanisms of technologies, looking at broad social impacts as well as the ways that individuals and groups used and adapted technology. At the second Bridges summit in 2002 Cheryl l'hirondelle developed the concept of CREE++ - an object oriented software that would emulate the CREE world view.

Simon Pope provides a critique of the free software and open source movements and their competitiveness, questioning their utopian images, he starts out:

> I was presenting a piece of work that is called *Ice cream for everyone.* To give you some idea of why the idea of open-source / free software crosses my career path: I started to make ice cream with a colleague of mine several years ago. Having reverse-engineered some proprietary food products we decided to, in our terms, open the source code for that ice cream. At the launch of this project when we were giving away ice cream in a pub in the east end of London[xxv], Richard Stallman came up to me and said, "Of course this is not open ice cream. This is free ice cream."

Artists bring different aesthetics to the creation of technology. For example, in a hard-hitting critique of the underlying philosophy and aesthetics of artificial intelligence artist Warren Sack, at Simulation and Other Re-enactments (2004) argues for a shift from individual experience to hybrid group experiences and expressions. He argues that contemporary technology systems require an aesthetic that allows the emergence of new common and collectively constructed shared experiences and identities rather than a focus on individual cognition.

5) Science offers rich material for art-making

There are many reasons why artists are drawn to science – new materials, issues of philosophy and studies of perception as these two examples will show The first is Sha-Xin Wei at Outside/Inside: Boundary Crossings, 2004:

> If I have an orange in my hand and I give it to you and I ask you, "What colour it is?" It is a trick question. You say it's orange in this light. If you take it into green light, it will look black to the photometer; it will look black because green light doesn't have orange in it. So, scientifically, it's black. If you let people walk into a greenish room they will think that orange is still orange in colour. What's real is really a power of imagination as far as physics and that's part of this gap that we might be talking about. We are interested in the extent that technology is a performance.

This excerpt from Theodor Krueger at Living Architecture (2000) captures why science provides such dynamic opportunities for artists. He is researching with NASA:

> The thing that I am getting a little bit more excited about here – and I think is the human half of the equation – is the notion of adaptability. A lot of that comes from physiological adaptation I have become familiar with and working within the zero gravity environments...Perceptual adaptation – most of you probably know those studies. There are persons that reversed their visual fields, flipped these upside down, right, left, reversal. Surprisingly people found that after a time the world didn't look upside down. There is no image that would be upside down, which is interesting, because there is no image there.

6) Transdisciplines and hybrid forms of institutional culture

Euphoria & Dystopia chronicles the development of studio-lab or collaboratoriums as Michael Century named them through the last century and of which BNMI was one. These have taken many forms, from artist-run centres to large cultural institutions to university based laboratories.

As the BNMI grew, other institutions that linked artists' initiatives in new media with theory and exhibition were also emerging around the world. Some of the most comprehensive are ZKM in Germany, with its focus on virtual reality and exhibition; V2 with its artistic labs; the Dutch Electronic Arts Festival and its workshops and publications; Le SAT in Montreal, as an art + technology centre, took many years to be able to achieve funding, InterAccess in Toronto, and Ars Electronica, featuring its festival, awards and commissioning programs. In the last decade this wave of collaboration between art, science and design and technology has now moved into university curriculum and research institutes such as Hexagram, in Montreal, Canada, straddles Concordia University and Université de Québec and supports multiple researchers in new media. Hexagram's large-scale science initiatives are driven by artists, architects and designers. It is almost a decade old. Now a success story, it required many years to begin to show results. University art + technology and art + science labs are growing: the famous MIT Media Lab, and the Media Lab at UIAH in Helsinki with its Crucible Studios, the bioArt Lab at University of Windsor, OCAD U's Digital Media Research and Innovation Institute; SmartLab UK, ALiVE in Hong Kong, the Digital Media Reseach and Innovation Institute at OCAD U or the California Institute of Telecommunications and Information Technology (Calit^2) that build on historic experiments such as those at the University of Illinois National Centre for Supercomputer Applications where Donna Cox a leading visualization artist has worked for many years.

We have also seen the success of large scale networks such as the GRAND National Centre of Excellence in Canada ($23 million in funding for five years). The BNMI co-led two major networks that were funded by Heritage Canada and engaged university and commercial partners in Canada and abroad. Am-I-Able research brought together research in social networking, architecture, fashion and design with wearable and smart technologies. These fields of research were applied to learning, health, leisure and sports, and the arts. Projects included ground breaking work in fashion and technology and museum navigation systems as well as design methods. The Mobile Digital Commons Network (MDCN) occurred over three years and provided analysis of the scope and potential of mobile networks, content and technology. MDCN focused on creating location-based, context-aware pervasive games and learning experiences for wilderness and urban parks – testing genres for future mobile entertainment.

There is an opportunity for media arts centres and artist run centres to participate:

1) NCE GRAND will create an artist-in-residency program that will connect artists with labs. Media arts centres could be partners;
2) SSHRC is revamping its Research/Creation program and there may be opportunities for specific collaborations with the social sciences. Media art centres can partner with or even lead a SSHRC partnership grant that explores art and technology or art and science or art and social science;
3) Create a scientist in residency program like the ICA London has done or like Intermedia did in Vancouver in the 1960s
4) Join networks that explore art and science, perhaps in collaboration with the Subtle Technologies

Festival in Toronto.

5) Collaborate with universities as Le SAT has done in Montreal to create an art + technology or art + science program.

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[i] Completed in 2012 and available through http://www.banffcentre.ca/press/39/euphoria-and-dystopia/ or http://www.riversidearchitecturalpress.com/

ii BNMI Program brochure, 2002.

[iii] Homi Bhabha, The Location of Culture (London: Routledge, 1994).

[iv] Mark J. Muller, "Participatory Design, the Third Space in HCI," Handbook of HCI (Mahway, NJ: Erlbaum, 1993),1-32, 4.

[v] See Muller.

vi Star, S.L. & Greisemer, J.R. (1989) Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39. In: Lynch, M., ed. Social Studies of Science 19. London; New York: Sage. pp. 387-420., p. 388.

vii Fischer, G. (2004) Social Creativity: Turning barriers into opportunities for collaborative design. In: Proceedings Participatory Design Conference, 2004, Toronto. New York: ACM.pp. 152-161. p. 157

[viii] Paola Antonelli's *Design and the Elastic Mind* (New York: Museum of Modern Art, 2008).
[ix] Anne Cauquelin, *L'Art du Lieu Commun: Du bon usage de la DOXA* (Paris: Editions du Seuil, 1999).
[x] Godfrey-Smith, P. (2003) *Theory and Reality: An introduction to the philosophy of science*. Chicago: Chicago University Press.
[xi] Kluver in Packer and Jordon 33.
[xii] Kluver 33.

[xiii] See Godfrey-Smith, P. (2003) *Theory and Reality: An introduction to the philosophy of science*. Chicago: Chicago University Press for a thorough overview of the history of scientific philosophy.

[xiv] Barad, K. (2007) *Meeting the Universe Half Way: Quantum Physics and the Entanglement of Matter and Meaning*. Durham and London: Duke University Press, p. 41.

[xv] See Kember, S. (2003) *Cyberfeminism and Artificial Life*. London: Routledge for a closely related discussion of artificial life, gender constructs and concepts of nature.
[xvi] See Gadamar, H.G. (1960) *Truth and Method.* New York: Crossroads.
[xvii] See Law, J. & Mol, A., eds. (2002) *Complexities: Social Studies of Knowledge Practices*. Durham: Duke University Press.
[xviii] Deleuze, G. (1989) *Cinema* 2*: The time-image*. Translated by H. Tomlinson & R. Galeta. London: Continuum.
[xix]Varela, F.J., Thompson, E. & Rosch, E. (1993) *The Embodied Mind: Cognitive science and human experience*. Cambridge, MA: MIT Press.
[xx] Hansen, M. B. N. (2004) *New Philosophy for New Media*. Cambridge, MA: MIT Press.
[xxi] See Anthony Dunne & Fiona Raby's *Design Noir: the Secret Life of Objects*. (Basil, Boston, Berlin: August/Birkhauser, 2001) and the citation of their work in Peter Hall's essay "Critical Visualisation" in Paola Antonelli's *Design and the Elastic Mind* (New York: Museum of Modern Art, 2008) 120-131.

[xxii] Greenberg, S. & Buxton, B. (2008) Usability Evaluation Considered Harmful (Some

of the Time). *CHI 2008 Proceedings, April 5-10, Florence*. Florence: ACM, pp. 111-120

[xxiii] Latour, B. (1998) *Aramis: The love of technology*. Boston: Harvard University Press. p133).

[xxiv] The Frankfurt School (German: *Frankfurter Schule*) refers to a school of neo-Marxist interdisciplinary social theory, particularly associated with the Institute for Social Research at the University of Frankfurt am Main in the pre-Hitler era. Many of these theorists felt that traditional Marxist theory could not adequately explain the turbulent and unexpected development of capitalist societies in the twentieth century. Critical of both capitalism and Soviet socialism, and compelled by the pervasiveness of capitalism, they considered culture, psychology, philosophy and ideology as well as economics and politics and hence their ideas were embraced by twentieth century cultural theorists. Walter Benjamin is one of the most cited of the Frankfurt School. He was murdered by fascists. Other members were Max Horkheimer,Theodor Adorno, Herbert Marcuse, Erich Fromm , Friedrich Pollock, Leo Löwenthal and Jürgen Habermas.

[9] The Foundry, Old Street, London