

Sustainability in an Imaginary World

Detailed Description:

1. Objectives

This project aims to design and evaluate an innovative, multimedia experience for engaging various publics on the social and cultural dimensions of sustainability. It is centred on what we call “the sustainability labyrinth”: a digital art installation that presents participants with interactive moments, prompting them to choose among multiple possible paths. Using audio cues, video sequences, and tangible objects (water, stones, refuse, human touch), the labyrinth will be designed to blur the real with the virtual, and to evoke a sense of possibility, wonderment, reflection and agency.

Before stepping into the labyrinth, participants will complete a registration and brief questionnaire about their conceptions of sustainability. This will provide a participant baseline as well as enable us to personalize key elements of the experience they are about to have. As they move through the labyrinth iteratively, individually and in groups, they will leave behind traces of their choices. And with every completion of a path they will leave an imprint of their subjective assessment of sustainability in the form of a Q-sort. These, along with a series of interviews taking place over set intervals, will allow us to start charting responses to the following research questions:

1. What kinds of choices do participants make in regards to sustainability when these choices are based not on *facts* but on *experience*? Do choices change as participants move through the labyrinth iteratively or in groups?
2. Does the experience translate into thinking about the world-at-large? What image of sustainability emerges from engaging with the labyrinth? Can this image be generalizable to something like the “social imaginary” – a *common understanding* of the relations, meanings and practices that make sustainability?
3. Is the experience captivating? Does it inspire noticeable changes in stance regarding sustainability? Do participants report changes in their sense of *possibility, agency and self-efficacy*?

Assembling answers to these questions will improve our understanding of how the public understands sustainability; whether engaging the public on the basis of aesthetic experience instead of factual representations leads them to evaluate their relations to the world and others in a different manner; whether it increases their sense of agency and self-efficacy; and whether it creates a motivation to further pursue ideas and activities associated with sustainability. These will contribute to a better scholarly understanding of how sustainability fits in the social imaginary, and will also make an important contribution to expanding the communicative techniques with which we are able to engage the public on the ideas, processes and policies associated with sustainability.

2. Context

This project responds to an increasing sense that the urgency of sustainability is not being matched by progress on the ground (Latour, 2013; UNEP 2012; Worldwatch, 2013), and the consequent need to reconsider some of sustainability’s fundamental dimensions. Although many remain committed to something like the substantive definition of sustainability offered by the UN (1987) (i.e. meeting the needs of the present without compromising the needs of the future), it has been recently suggested that sustainability should be viewed as an essentially contested concept (Connelly, 2007; Ehrenfeld, 2008; 2009; Jacobs, 2006). Since sustainability is constructed *in practice*, it inescapably involves social, economic and political dimensions and raises normative and ethical questions related to the nature of the

world we want to create. It is a situated, context-sensitive notion that needs to be debated and redefined for each place and time; its meaning a temporary and spatially explicit conceptualization of what exists and what matters, something to be realized through social processes of articulation, verification, and institutionalization (see for instance Berger & Luckmann, 1989; Latour, 2004). Such a reconceptualization marks a shift from a “substantive” to a “procedural” notion of sustainability (Miller, 2013), where sustainability is seen not as a desired end-state but as an emergent property of negotiations amongst interested parties (Robinson, 2004; Robinson & Tansey, 2006).

The procedural notion of sustainability builds on key insights of the scenarios approach to futures studies: the future is not pre-determined but is to a significant degree a function of choice and behaviour; uncertainty defined in probabilistic terms is not a good way to conceptualize the future variance of systems characterized by volition and intentionality; and there is therefore no single baseline, or most likely future. Instead there are multiple baselines, which are to some degree incommensurable with each other and which are strongly determined by the exercise of intentionality, within the context of particular environmental or political constraints. As such, how we conceive of, and practice sustainability should be seen as an emergent process of ‘co-production’, in which scientific and other ‘expert’ information, providing indispensable views of our best current understanding of physical and social processes, is combined with values, preferences and beliefs from affected communities (or stakeholders). This gives rise to a collaborative understanding of possibilities and preferred outcomes. In this sense, a procedural approach to sustainability provides a powerful justification for the development of participatory processes of community engagement in which non-academic research partners and citizens can be involved directly in the formulation of research questions, the development of alternative scenarios, and the interpretation of what sustainability might mean in a particular context (Caswill & Shove, 2000; Robinson et al., 2011; Salter et al., 2010). As Dobson (2006, p.224) puts it, “‘participation’ in the widest sense [...] is what shapes the contours of sustainability itself”.

Whereas many current efforts to engage the public on sustainability remain committed to a top-down science communication paradigm, otherwise known as the “information deficit model” (Blake, 1999; Brossard & Lewenstein, 2010; Bucchi, 2008; Burgess, Harrison & Filius, 1998), our suggested framework foregrounds the significance of experiential engagements with the constituents of sustainability. It builds upon a widening variety of research perspectives that note the crucial role played by participant worldviews, values, and individual and collective identity in the formation of attitudes toward sustainability and the development of an intention to act in relation to it (Crompton, 2010; DeLuca, Sun & Peoples, 2011; Innes & Booher, 2010; Kahan et al., 2012; Leiserowitz, Kates & Parris, 2006; Smith & Snyder, 2011; van Kerkhoff & Lebel, 2006). To this we wish to add an emphasis on an imaginative engagement with sustainability, substituting linear infocentrism and a focus on individual behaviour with a holistic approach to communication characterized by: (1) an appeal to the felt, resonant, imaginative aspects of the lifeworld; (2) the integration of interactive, context-specific participatory modalities; (3) the emphasis on collective ways to articulate and advance sustainability.

Importantly, this emphasis on imagination is not strictly instrumental, but represents a real shift in worldview: when we look at the world, instead of an objective space filled with discrete classifiable entities, we see a conceptual space populated by conflicting inscriptions, incommensurable modalities, and refracting social constructions. It is a world rife with potentialities, which are best seen as dynamic and contingent cultural forms, not objective or factual categories. It follows that this project does not aim to disseminate information about sustainability or garner data concerning possible planning priorities. Rather we are interested in exploring issues of imagination, identity, narrative, and worldview in order to foster a reflexive relationship between participant, self, world, and other; and we are interested in exploring how such elements connect to sustainability. In other words, instead of seeking to *inform* the

public about sustainability we seek to evoke *experiences* that expose and perhaps make malleable certain epistemological and ontological conditions critical to expressing and evaluating the transformative socio-political dimensions of sustainability. In designing such evocative experience we will be drawing from two fields that have already shown their capacity to shift the discourse of sustainability from infocentric to more holistic modes of communication.

Scenario Analysis - Scenario analysis was first popularized by Royal Dutch/Shell in the 1970s as a strategic planning tool for investigating possible futures (Wack 1985a, 1985; Schwartz 1992). A key characteristic of such approaches was their recognition that predictive approaches to long-term socio-economic futures were problematic in principle, and that it might be helpful to think in terms of multiple incommensurable baseline futures, which could not be meaningfully reduced to variants of each other. Scenario analysis was initially a qualitative, narrative-based exercise that focused on the construction of plausible alternative stories about the future (e.g. Svedin et al., 1987). Coinciding with the rise of computer modeling techniques in the 1980s, researchers and practitioners in sustainability-related fields such as Integrated Assessment and Land Use Planning began to develop quantitative, probabilistic future scenarios. These quantitative scenarios were less focused on the development of comprehensive narrative storylines, and more focused on predictions of impacts from forecasted trends in variables such as atmospheric CO₂, or land use development.

While examples exist of attempts to integrate the qualitative and quantitative approaches to scenario analysis (see e.g. IPCC, 2000; Millennium Ecosystem Assessment, 2005; Carmichael et al., 2004; Robinson et al. 2006), tensions between the two approaches persist. Advocates of qualitative scenarios focus on their ability to foster creative future visions (Siebenhuner and Barth, 2005), while advocates of quantitative scenarios focus primarily on their ability to derive measurements of future conditions, providing empirical means for comparing alternative future scenarios (Yohe et al., 1999). Much of the current work on scenario analysis in climate change and sustainability research takes a more quantitative approach (Salter et. al 2010). However, both approaches retain the multiple baseline perspective that differentiates scenario analysis from predictive forecasting.

Scenario visualization provides an example of the current focus on quantitative scenarios. Visualizations are increasingly used to explore the implications of alternative worlds as they offer a powerful means of communicating complexity in intuitive and comprehensible ways (Sheppard, 2012). Much of the recent work on scenario visualization has focused on quantitative/predictive forecast scenarios, driven, at least in part, by the parallel development of digital visualization and computer modeling techniques in the 1990s and early 2000s (Sheppard and Salter, 2004). While embracing the focus on articulating multiple alternative incommensurable scenarios, we identify two drawbacks to this specific approach. First, uncertainty remains largely invisible in the visual presentation of possible future scenarios. Second, sufficient levels of data to support fully-fleshed experiences are rarely available, yielding scenario visualizations that are typically fragmented and impoverished, unable to leverage visualization's power and immerse the participant in a rich experience of predicted consequences. In other words, despite the explicitly fictional status of scenario visualization, such practice fails to take advantage of the full range of visual expression because of a tacit commitment to being 'data-driven'. In response, this project seeks to build on the progressive tradition of scenario analysis, but explore scenario visualization work that is more explicitly grounded in the qualitative, fictional nature of futures research.

Art - Our approach to scenario analysis crosses paths with another dimension of sustainability engagement. The arts, once heavily courted by environmental movements, have seen enthusiasm wane as their increasing involvement has not yielded the transformative impact once anticipated (Bachmann, 2008). This may be due to circumstances similar to those described above, where the arts have failed to

wield their full imaginative or expressive capacity within a relationship to sustainability by assuming the linear, instrumental task of converting facts into values. Science provides the data and the arts are asked to make people care.

One problem with such an approach is that it likely neuters what may be fundamental to the potential of artistic engagement. Social change agendas turn to the arts based on a belief in their transformative potential – their capacity to communicate alternatives, difference and otherness, to free us, even if temporarily, from present rationalistic understandings of self and world (Murdoch 1967; Marcuse, 1978; Bateson, 1979; Scarry, 1998; *Bourriaud, 2002*; Dieleman, 2008). Described as ‘ontological reflexivity’ by Dieleman, this capacity to illustrate present rationalities as constructs rather than absolutes invites an imaginative engagement with difference, novelty, or improvisation into what may have been considered firm reality. Such ontological reflexivity, however, is necessarily dependent on a conception of the arts as *epistemic*, that is to say, a way of knowing the world, a methodology for exploring, understanding, and building human realities. Therefore, artistic engagement whose substance is overly defined by prior ‘facts’ likely jeopardizes its own epistemic status. Assuming the role of turning scientific facts into public values, the arts lose themselves as a genuine means of exploration.

Similar to the expressive freedom sought for scenario visualization work, the goal of the present research project is to find ways to connect artistic languages to pressing issues of sustainability, without constraining their full expressive, imaginative range – without, in other words, losing the epistemic dimensions of creative inquiry in the name of more substantive engagements with sustainability. Rather than trying to bring the idiom of art into the factual world of sustainability, we suggest sustainability be realized as a deeply imaginative project in its own right. This invites a genuine exploration of sustainability using various aesthetic languages. In this project we aim to start with questions and seek possible ‘truths’ via beauty, rather than starting with ‘truths’ and trying to make them beautiful.

Digital Media - Our project suggests that an important bridge connecting scenario analysis and artistic vocabularies is new digital media. New interactive technologies can combine sophisticated modeling capacities with compelling interactive repertoires, can create continuities between several spaces and screens, are flexible to design and modify incrementally, and can be deployed modularly and in different sites. The process of designing the interactive components of the project draws from existing research in human-computer interaction (HCI) that focuses on the experiential dimensions of interactive technologies (Dourish, 2001; McCarthy & Wright, 2004; Wright, Wallace & McCarthy, 2008), and from recent investigations into the capacity of interaction design to provoke politically significant experiences (Bardzell et al., 2012; DiSalvo, 2012; Obrist & Fuchs, 2010). We aim to add to current, promising work in this area (e.g., Blevins, 2007; Blyth et al., 2010; Dourish, 2010; Gordon & Manosevitch, 2010; Gordon, Schirra & Hollander, 2011) additional interactive vocabularies, developed by exploring immersive, hybrid or multi-modal experiences within the context of sustainability. We are particularly interested in exploring the performed, symbolic and imaginative relations between interacting within hybrid virtual-non-virtual environments and conceptualizing (and relating to) sustainable futures. In this vein, we will be asking how interactivity may produce experiential continuities, homologies and contrasts by deploying various narrative structures (cf. Murray, 1997); by creating rhetorical associations between ‘source worlds’ and their virtual representations (Bogost, 2007); by creating dialogical or, inversely, conflicting representations of the world (DiSalvo, 2012); or by provoking and channeling other emotional resonances (Norman, 2004).

3. Methodology – Tool/Design Process/Evaluation

Research Tool – Our proposed research hinges on the development of a highly specialized research tool

in the form of a physical art installation composed of standard equipment (curtains, screens, projectors, cameras, monitors, wireless headphones) integrated into a cohesive experience through digital applications (location sensors, media controls) and artistic vocabularies (script, staging, lighting, video, animations, music, and soundscape). From this we will create a labyrinthine structure that translates sustainability into interactive visual, tactile, and auditory metaphors. Consonant with the known importance of localization in public engagement (Sheppard, 2012), engagement with the sustainability labyrinth starts with a playful ‘registration’ – collecting personal information that includes biographical details, features of worldview, and a range of cultural preferences. This content will then be used to personalize participant encounters in the labyrinth. Following registration, each participant will enter the labyrinth wearing a wireless headset that reports location through RFID tags. This will enable the labyrinth to use location, along with explicit choices made at interactive stations, as a way to cue different audiovisual elements (music, soundscape, voices). The labyrinth knows who participants are, where they are, and what they are doing (through motion capture of gestures). And what they do has consequences. While these consequences are primarily generated in digital form (to maintain traceability), in order to facilitate interactivity they will also affect non-digital elements (i.e. water, human touch).

Design Process – Building the sustainability labyrinth requires a unique integration of art, technology, and sustainability. Its development maintains ontological agency for artistic languages while engaging ‘real world’ concerns in pursuit of a more robust interaction between arts, humanities, and sustainability. We propose a recursive model of collaborative creation in order to optimize the benefits of emergent, interdisciplinary interaction without frustrating the capacity of specific expertise or losing cohesion. Devised theatre techniques will bring disparate fields together in a collaborative development phase. Roundtable sessions will develop and finesse key areas of exploration: What sustainability themes? What metaphors carry these themes? What images, sounds, and interactive possibilities animate them? What digital tools carry such animations? What collaborators are needed to help create the piece? These questions will feed back on each other as different possibilities and obstacles arise. Group discussions will be punctuated with more streamed work, allowing specific expertise to work in a focused manner. These streams will regularly rejoin, allowing various findings to revise larger development paths. Such a development process should capture the richness of collaborative development while supporting specialized investigations into the project’s various frontiers.

We expect the development of the research tool to occupy the majority of year 1. Prototype testing will begin early in year 2 with full public engagement at the mid-point of year 2. The labyrinth will be free and open to the public and a special effort will be made to attract a variety of demographics (see the knowledge mobilization section). Individuals will be free to wander by, wonder what the experience is, and drop in to try it out.

Evaluation – Our evaluative framework will be developed collaboratively in response to two difficulties associated with measuring media effects: first, how do we evaluate the effects of interactive media on active participants, instead of the more passive audiences of non-interactive media? (Bryant & Thompson, 2002, p.364; Gauntlett, 2011; Hermes, 2009). Second, how do we measure and evaluate the relations between interactive experience, the imagination and political subjectivity? These difficulties are especially important since our approach seeks to evoke experiential – felt, resonant, imaginative – engagement with sustainability, the effects of which tend to exceed the grasp of methods that focus solely on observable behaviour. In light of this, and in accordance with the project’s research questions, our evaluative framework will provide a balance of ‘externalist’ and ‘internalist’ techniques, allowing the correlation of observable behaviour with participant reflection and expression. It aims to capture three interrelated outcomes:

1. *The way participants interact with and within the labyrinth.* Data on participant movement will be collected by deploying locative (RFID) sensors, and data on participant choices will be collected digitally as the media displays react to participant gestures through motion capture. Engagement dynamics would be correlated and mined for meaningful patterns, which could then be reflected in realtime back to users in the labyrinth, and also stored for evaluation purposes.

2. *The way interacting with the labyrinth affects participant views on sustainability.* At the end of each complete navigation of the labyrinth participants will be asked to complete a Q-sort, which consists of ordering and prioritizing different statements about the nature of sustainability and its relations to various social and cultural phenomena (such as certain cultural metaphors, views on science and technology, political actors and institutions, etc.) In accordance to Q methodology, these orderings (Q-sorts) would then be available for statistical factor-analysis, providing the project with a mechanism for aggregating and generalizing outcomes across several research subjects, in a reproducible and therefore reliable manner (Brown, 1980; van Exel & de Graff, 2005; Webler, Danielson & Tuler, 2009).

3. *The way the engagement may affect participants' attitudes towards, and willingness to further engage with sustainability.* Participants will be asked to complete short pre- and post-engagement surveys aimed at evaluating whether navigating the labyrinth has changed participants' worldviews, attitudes towards sustainability and willingness to act on it in both individual and collective modes. Randomly selected participants will be asked to reflect on their experiences and provide short, clarifying statements in accordance to a phenomenological approach to researching lived experience (Smith, Flowers & Larkin, 2009; Van Manen, 1990). This would allow us to start answering questions about the ephemeral and lasting impressions left by the labyrinth, correlating specific interactive affordances with reported effects, and charting the ways in which these effects reflect on the larger social and political contexts within which interacting with the labyrinth takes place.

Conclusion

This project reflects our belief that the challenge of sustainability calls upon us to rethink the very terms in which it is conventionally presented, and, accordingly, to formulate new methods to engage more diverse publics in more expansive ways. In this sense the sustainability labyrinth suggests a unique opportunity to enrich the practice of scenario analysis through a deepened artistic license and the freedom to foster imaginative explorations of possible worlds, and to connect artistic practices related to sustainability to more empirical methodologies without losing their expressive and imaginative capacities. Combining the insights and techniques of scenario analysis and the arts into an innovative, meaningful and resonant multimedia experience will allow us to start charting the place sustainability occupies in the social imaginary. It allows us to ask, what do we mean by sustainability? How do the meanings we attribute to sustainability change as result of interactive aesthetic experiences? What elements in particular invite reflection on sustainability as a collective, future oriented project? How do we create dynamic public engagement processes that are flexible enough to respond to, and incorporate participant feedback? What new paths for bolstering political self-efficacy open up as result?

In a broader sense, this project proposes the idea that sustainability represents a way of being, of relating, of imagining and of acting in, and on the world. This is what we intend to capture by the notion that the challenge of sustainability is not to prove the world more real, but more imaginary – a world ripe with opportunity, brimming with potentialities, and in need of collective care. We cannot be sure what we will find since at its core this project aims to promote emergent, interactive public participation. In this sense the project performs what it seeks to interrogate. The promise, however, seems well worth the risk. We expect to learn much about how our approach to sustainability may be conceptualised, instantiated and deployed, and provide a framework with which it may be extended into future projects and venues.

List of References

- Antle, A. N., Bevans, A., Tanenbaum, J., Seaborn, K., & Wang, S. (2011). Futura: design for collaborative learning and game play on a multi-touch digital tabletop. *Proceedings of TEI*.
- Bachmann, G. (2008). Gatekeeper: A Forward. in S. Kagan & V. Kirchberg (eds.) *Sustainability: A new frontier for arts and cultures*. Frankfurt: VAS.
- Bardzell, S., Bardzell, J., Forlizzi, J., Zimmerman, J., & Antanitis, J. (2012). *Critical Design and Critical Theory: The Challenge of Designing for Provocation*. Paper presented at DIS 2012, June 11-15, 2012, Newcastle, UK.
- Bateson, G. (1979). *Mind and Nature. A Necessary Unity*. New York: E.P. Dutton
- Bendor, R. (2013). 'Towards Emergent Public Engagement on Sustainability.' Report on Cross-Channel Evaluation. *Greenest City Conversations Project*. Vancouver, BC.
- Bendor, R., Haas Lyons, S., & Robinson, J. (2012). What's There Not To 'Like'? The Technical Affordances of Sustainability Deliberations on Facebook. *Journal of eDemocracy*, 4(1), 67-88.
- Berger, P. L., & Luckmann, T. (1989). *The social construction of reality: a treatise in the sociology of knowledge*. New York: Anchor Books.
- Blake, J. (1999). Overcoming the 'Value-Action Gap' in Environmental Policy: tensions between national policy and local experience. *Local Environment*, 4(3), 257-278.
- Blevis, E. (2007). Sustainable interaction design: invention & disposal, renewal & reuse. In M. B. Rosson & D. Gilmore (Eds.), *Proceedings of CHI 2007* (pp. 503-512). NY: ACM Press.
- Blyth, M., McCarthy, J., Light, A., Bardzell, S., Wright, P., Bardzell, J. & Blackwell, A. (2010). *Critical Dialogue: Interaction, Experience and Cultural Theory*. Paper presented at the CHI 2010, Atlanta, GA.
- Bogost, I. (2007). *Persuasive games: the expressive power of videogames*. Cambridge, MA: MIT Press.
- Bourriaud, N. (2002). *Relational Aesthetics* (translated by S. Pleasance and F. Woods). France: les presse du reel.
- Bowie, F., Fels, S. & Hibbert, M. (2010). Flow: An Interactive Public Artwork. *ACM Multimedia*, pp. 1373-1382.
- Brossard, D., & Lewenstein, B. V. (2010). A Critical Appraisal of Models of Public Understanding of Science. In L. Kahlor & P. A. Stout (Eds.), *Communicating science* (pp. 11-39). New York & London: Routledge.

Brown, S. R. (1980). *Political subjectivity: applications of Q methodology in political science*. New Haven: Yale University Press.

Bryant, J., & Thompson, S. (2002). *Fundamentals of media effects*. Boston, Mass.: McGraw- Hill.

Bucchi, M. (2008). Of deficits, deviations and dialogues: Theories of public communication of science. In M. Bucchi & B. Trench (Eds.), *Handbook of public communication of science and technology* (pp. 57-76). London; New York: Routledge.

Burgess, J., Harrison, C., & Filius, P. (1998). Environmental communication and the cultural politics of environmental citizenship. *Environment and Planning A*, 30, 1445-1460.

Carmichael, J., Tansey, J. & Robinson, J. (2004). An integrated assessment modeling tool, *Global Environmental Change*, 14, 171-183.

Caswill, C., & Shove, E. (2000). Introducing interactive social science. *Science and Public Policy*, 27(3), 154-157.

Connelly, S. (2007). Mapping Sustainable Development as a Contested Concept. *Local Environment: The International Journal of Justice and Sustainability*, 12(3).

Cornish, L. M. (2013). *Can 4D Visioning foster community responses on climate change?* Unpublished MSc. Thesis, UBC, Vancouver.

Crompton, T. (2010). *Common Cause: The case for working with our cultural values*: WWF- UK.

DeLuca, K. M., Sun, Y., & Peeples, J. (2011). Wild Public Screens and Image Events from Seattle to China: Using Social Media to Broadcast Activism. In S. Cottle & L. Lester (Eds.), *Transnational protests and the media* (pp. 143-158). New York: Peter Lang.

Dielemann, H. (2008). Sustainability, Art and Reflexivity, in S. Kagan & V. Kirchberg (eds.), *Sustainability: A new frontier for arts and cultures*. Frankfurt: VAS. DiSalvo, C. (2012). *Adversarial design*. Cambridge, Mass.: MIT Press.

Dobson, A. (2006). Citizenship. In A. Dobson & R. Eckersley (Eds.), *Political theory and the ecological challenge* (pp. 216-231). Cambridge, UK; New York: Cambridge University Press.

Dourish, P. (2001). *Where the action is: the foundations of embodied interaction*. Cambridge, Mass.: MIT Press.

Dourish, P. (2010). HCI and Environmental Sustainability: The Politics of Design and the Design of Politics. In O. W. Bartelsen & P. Krogh (Eds.), *Proceedings of DIS 2010* (pp. 1-10). NY: ACM.

- Ehrenfeld, J. (2008). Sustainability needs to be attained, not managed. *Sustainability: Science, Practice, & Policy* 4(2).
- Ehrenfeld, J. (2009). *Sustainability by Design*. New Haven: Yale University Press.
- Gauntlett, D. (2011). Media Studies 2.0. *Theory.org*. Available from <http://www.theory.org.uk/mediastudies2.htm> (last accessed Oct.6, 2013).
- Gordon, E., & Manosevitch, E. (2010). Augmented deliberation: Merging physical and virtual interaction to engage communities in urban planning. *New Media & Society*, 13(1), 75-95.
- Gordon, E., Schirra, S., & Hollander, J. (2011). Immersive Planning: a conceptual model for designing public participation with new technologies. *Environment and Planning B: Planning and Design*, 38, 505-519.
- Hermes, J. (2009). Audience Studies 2.0: On the theory, politics and method of qualitative audience research. *Interactions: Studies in Communication and Culture*, 1(1), 111- 127.
- Innes, J. E., & Booher, D. E. (2010). *Planning with complexity: an introduction to collaborative rationality for public policy*. London & New York: Routledge.
- IPCC (2000). *Special Report on Emissions Scenarios*. Cambridge University Press. Jacobs, M., (2006). Sustainable Development as a Contested Concept, in A. Dobson (ed.), *Fairness and Futurity: Essays on Environmental Sustainability and Social Justice* (pp. 21-45). Oxford University Press.
- Kahan, D. M., Peters, E., Wittlin, M., Slovic, P., Ouellette, L. L., Braman, D. & Mandel, G. (2012). The polarizing impact of science literacy and numeracy on perceived climate change risks. *Nature Climate Change* 2, 732–735.
- Latour, B. (2004). *The Politics of Nature* (translated by C. Porter). Cambridge: Harvard University Press.
- Latour, B. (2013). *An Inquiry into Modes of Existence. An Anthropology of the Moderns* (translated by C. Porter). Cambridge: Harvard University Press
- Leiserowitz, A. A., Kates, R. W., & Parris, T. M. (2006). Sustainability values, attitudes, and behaviors: A review of multinational and global trends. *Annual Review of Environment and Resources*, 31, 413-441.
- Marcuse, H. (1978). *The Aesthetic Dimension: Toward a Critique of Marxist Aesthetics*. Random House.
- McCarthy, J., & Wright, P. (2004). *Technology as experience*. Cambridge, Mass.: MIT Press.

Millennium Ecosystem Assessment (2005). *Ecosystems and Human Well-being: Scenarios* (Vol.2). Washington: Island Press.

Miller, T. R. (2013). Constructing sustainability science: emerging perspectives and research trajectories. *Sustainability Science*, 8(2), 279–293.

Murdoch, I. (1967). *The Sovereignty of Good over Other Concepts: The Leslie Stephen Lecture*. Cambridge: Cambridge University Press.

Murray, J. H. (1997). *Hamlet on the holodeck: the future of narrative in cyberspace*. Cambridge, Mass.: MIT Press.

Norman, D. A. (2004). *Emotional design: why we love (or hate) everyday things*. New York: Basic Books.

Obrist, M., & Fuchs, C. (2010). *Broadening the View: Human-Computer Interaction & Critical Theory*. Paper presented at CHI 2010, Atlanta, GA, USA.

Robinson, J. (2004). Squaring the Circle: Some thoughts on the idea of sustainable development. *Ecological Economics* 48(4), 369-384.

Robinson, J. and Tansey, J. (2006). Co-Production, emergent properties and strong interactive social research: The Georgia Basin Futures Project. *Science and Public Policy*, 33(2), 151-160.

Robinson, J., J. Carmichael, R. VanWynsberghe, J. Tansey, M. Journeay, & Rogers, L. (2006). Sustainability as a Problem of Design: Interactive Science in the Georgia Basin. *The Integrated Assessment Journal*, 6(4), 165-192.

Robinson, J., M. Bradley, P. Busby, D. Connor, A. Murray, B. Sampson & Soper, W. (2006). Climate Change and Sustainable Development: Realizing the Opportunity. *Ambio* 35(1), 2-9.

Robinson, J., S. Burch, S. Talwar, M. O'Shea, & Walsh, M. (2011). Envisioning sustainability: Recent progress in the use of participatory backcasting approaches for sustainability research. *Technological Forecasting & Social Change* 78, 756-768

Salter, J., Robinson, J. & Wiek, A. (2010). Participatory methods of integrated assessment – a review. *WIRE's Climate Change*, 1, 697- 717.

Scarry, E. (1998). *On Beauty: Tanner Lectures on Human Values*. Available at http://tannerlectures.utah.edu/_documents/a-to-z/s/scarry00.pdf (last accessed Oct.8, 2013).

Schroth, O., A. Dulic, & Sheppard, S. (in press). Visual Climate Change Communication: From Iconography to Locally Framed 3D Visualization. *Environmental Communication*.

Schwartz, P. (1992). *The Art of the Long View*. London: Century Business.

- Sheppard S.R.J. & Salter J. (2004). The Role of Visualization in Forest Planning, in *Elsevier Encyclopedia of Forest Sciences* (pp. 486-498). Oxford, UK.
- Sheppard, S.R.J. (2012). *Visualizing Climate Change: A Guide to Visual Communication of Climate Change and Developing Local Solutions*. Abingdon, UK: Earthscan/Routledge.
- Sheppard, S.R.J., Shaw, A., Flanders, D., Burch, S., Wiek, A., Carmichael, J., Robinson, J. & Cohen, S. (2011). Future visioning of local climate change: A framework for community engagement and planning with scenarios and visualisation. *Futures* 43(4), 400-412.
- Siebenhuner, B. & Barth, V. (2002). The role of computer modeling in participatory integrated assessments. *Environmental Impact Assessment Review*, 25, 367–389.
- Smith, J., & Snyder, K. (2011). *Bridging the Divide Between Science and Planning: Lessons From Ecosystem-Based Management Approaches to Local and Regional Planning in the United States*. Denver, CO: PlaceMatters.
- Stavness, I., Lam, B. and Fels, S. (2010). pCubee: A Perspective-Corrected Handheld Cubic Display. *Proceedings of CHI'10*, pp. 1381-1390.
- Svedin, U. and Aniansson, B. (eds.) (1986). *Surprising Futures: Notes from an International Workshop on Long-Term World Development*. Friibergh Manor, Sweden.
- The WorldWatch Institute (2013). *State of the World 2013 - Is Sustainability Still Possible?* Washington, DC: Island Press.
- United National Environment Program (2012). *Global Environmental Outlook Report 5*. New York: UNEP.
- UNWCED (1987). *Our Common Future: Report of the World Commission on Environment and Development*. NYC: Oxford University Press.
- van Exel, J., & de Graaf, G. (2005). *Q methodology: A sneak preview*. Available from www.jobvanexel.nl (last accessed Oct.6, 2013)
- van Kerkhoff, L., & Lebel, L. (2006). Linking knowledge and action for sustainable development. *Annual Review of Environment and Resources*, 31, 445-477.
- Van Manen, M. (1990). *Researching Lived Experience: human science for an action sensitive pedagogy*. Albany, NY: SUNY.
- Wack, P. (1985a). Scenarios: Uncharted Waters Ahead. *Harvard Business Review*, 5, 72-89. Wack, P. (1985b). Scenarios: Shooting the Rapids. *Harvard Business Review*, 6, 139-150.

- Wang, J., d'Alessandro, N., Fels, S. & Pritchard, R. (2012). Investigation of Gesture Controlled Articulatory Vocal Synthesizer using a Bio-Mechanical Mapping Layer. In *Proceedings of New Interfaces for Musical Expression (NIME2012)* .
- Ware, C. & Franck, G. (1996). Evaluation of Stereo and Motion cues for visualising information in three dimensions. *ACM Transactions on Graphics*, 15(2), 121–140.
- Webler, T., Danielson, S., & Tuler, S. (2009). *Using Q method to reveal social perspectives in environmental research*. Greenfield, MA: Social and Environmental Research Institute.
- Wright, P., Wallace, J., & McCarthy, J. (2008). Aesthetics and Experience-Centered Design. *ACM Transactions on Human-Computer Interaction*, 15(4).
- Yohe, G., Jacobsen, M. & Gapotchenko, T. (1999). Spanning ‘not implausible’ futures to assess relative vulnerability to climate change and climate variability. *Global Environmental Change*, 9, 233 – 249.