Creating Narrative Space: New Modes of Navigation for Online Scholarly Publications

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Abstract

Navigating online scholarly publications is theorized here as an active journey that readers embark upon and undertake, creating personal meaning through narrative structures that, in turn, make sense of the online data that has been individually explored. The concept of the "eversion" is examined as a useful way of understanding how readers interact with data via networked smart objects, and through different interface designs and mechanisms. The passageways and "border exchanges" between analogue and digital worlds are sites that illuminate how people engage with information seeking and digital sensemaking; coupled with the centrality of the contemporary digital self, the article argues for a humanistic outcome in this focus on human engagement with inverted analogue and digital worlds.

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Introduction

A recurrent utopianism haunts the digital humanities, which is perhaps simply an effect of technological determinism. Hypertext is an early example of this utopianism: not just in terms of conceiving how readers would navigate immersive environments, but also how they would become active participants in meaning-making networks. The hyperbole concerning hypertext soon subsided when such a mode of textual/informational navigation became normative, i.e., through mundane (but powerful) Web-based interactions; additionally, as with all new theories of reading, the outmoded type of reading that hypertext was supposed to replace was in itself a fiction (no pun intended). Deep readers have always read hypertextually, just minus the digital technology. But while digital utopianists can all too rapidly create their own science fictions – joining a largely rhetorical world of diverse futurists (Siemens, 2013, p. 830) – this is not to say that future-oriented predictions are not entirely without value. Furthermore, the theories and practice of hypertext still have value when developing new modes of navigation for online scholarly publications, and here these new modes will be examined via the concept of the "eversion" as articulated by Steven E. Jones (2014). This examination will also draw upon discussions from the newly formed Critical Digital Humanities Group, jointly hosted by the University of Victoria and Vancouver Island University, where members explore literary and critical theory through the lens of theories/methodologies from the digital humanities.

Eversion

Susan Brown (2011), while discussing digital historiography, asks two essential questions for future electronic scholarly publication: "What … constitutes a 'narrative' in a hyperlinked textual environment?" and "Can a set of search results, produced by a user's interaction with a set of texts structured on common intellectual principles, be understood as a new kind of literary-historical narrative?" (p. 17). Brown answers these questions via her discussion of the Orlando Project, but here I want to think them through in relation to what Steven E. Jones (2014) calls "eversion," that is to say, where the "scholarly interface" (Brown, 2011, p. 18) porting us into the digital world has been *inverted*: in other words, the digital world is porting into our physical or analogue environment. Jones notes that the *inversion* (of eversion) can be dated between 2004-2008, giving as an example the peaking and decline of Second Life just "as network technology became increasingly intertwined with everyday activities" (p. 21). This is of course the everyday of Web 2.0, as well as the "mixed reality" (Hayles quoted in Jones, 2014, p. 22), where "today's media have tended to move out of the box and overlay virtual information and functionalities onto physical locations and actual objects. [Leading to] … environments in which physical and virtual realms merge in fluid and seamless ways …" (Hayles quoted in Jones, 2014, pp. 22-23). Jones (2014) charts the emergence of the Digital Humanities (DH) with the ongoing event of the eversion; he argues that DH

> … scholars have responded to the eversion as it has happened (and continues to happen). This is reflected on many fronts, including work with (relatively big) data, large corpora of texts, maps linked to data via GIS, and the study and archiving of born-digital and new-media objects. (pp. 29-30)

Much of the data utilized in these examples comes from smart objects, such as GPS devices, smart phones, tablet computers, and sensors embedded in all kinds of mundane mechanical devices; the manipulation of this smart object data leads to what Jones (2014) describes as "the new DH":

> The new digital humanities often aimed to question "screen essentialism," the immateriality of digital texts, and other reductive assumptions, including romantic constructions of the network as a world apart, instead emphasizing the complex materialities of digital platforms and digital objects. [Whereby this is] … a collective response by one segment of the digital humanities community to the wider cultural shift toward a more worldly, layered, hybrid experience of digital data and digital media brought into direct contact with physical objects, in physical space, from archived manuscripts to Arduino circuit boards (pp. 31-32).

Passageways: Making sense of information frontiers

Based upon the ubiquity of smart objects and Internet connectivity, there is anecdotal and other related evidence of transformed expectations concerning all data sources coinciding with the period of the eversion. From an academic perspective, this signifies that not only will databases need to be permanently at hand (i.e., as immediately accessible and as fast as Google), but they will also need to be capable of feeding data into everyday personal knowledge environments, e.g., in ways analogous to live data feeds, Twitter streams, news alerts, and so on. Given the dominance of Web interactivity as a primary mechanism for information seeking, this does not come as a surprise. As early as 2002, for example, children were offering sophisticated critiques of youth-focused search engines, and designing relatively complex superior alternatives (see Bilal, 2002). Broadly speaking, knowledge searching now needs to make sense in and of itself, for example, the journey needs to be illuminated by sense-making, "context aware" (Perera, Zaslavsky, & Georgakopoulos, 2013) attributes that also coincide with hyperaware personal notions of identity motivation (see Buffardi & Campbell, 2008; Mehdizadeh, 2010), and often unrealistic expectations of the outcome (e.g., expectations concerning a desire for almost *instant* personal transformation *through* the acquisition of knowledge).

Database interface designers have long worked with rapidly changing skill-sets and expectations among users, and important lessons can be drawn to think through how knowledge seekers can now be best served in the everted "mixed reality" of their everyday lives. For example, database users who "are locked into a cycle of query refinement" can be best served by "dynamically generated previews of query results" (Jones, 1998, pp. 1-2); Jones further argues that "a direct-manipulation user interface which exploits diagrammatic techniques for query specification can circumvent problems with textual query languages" (1998, p. 1). Perhaps one of the most fascinating aspects of Jones' account of the VQuery interface from the late nineties is that of the meaning-making processes users engage in. Jones draws upon a key IBM Research Report from 1976, as well as the work of Halpin (1989), to argue for the advantages of Venn diagrams that "are highly expressive, can represent a broad range of queries, 'give a clear picture of the meaning of the query' and 'provide a simple means of clarifying what set comparisons mean'" (Jones quoting Halpin, 1998, p. 2,).

Problem solving can also be facilitated by the use of Venn diagrams, illustrated by Katzeff's (1988) research: "Katzeff … considered Venn diagrams in the context of users' mental models of information structures … The results show that the Venn diagram based models were more effective when subjects had to form complex queries requiring problem solving" (Jones, 1998, p. 2). Another fascinating aspect of VQuery is the ease in which backtracking can take place, as well as more complex bookmarking whereby search journeys or patterns can be saved for future reference, and for future user development. It is here that the journey through, or via, a set of search strategies starts to gain narrative status: the passageway, so to speak, is the personal story of that journey.

However, interface design can go in the opposite direction, deliberately minimizing search journeys in the same name of ease of use. For example, work on adaptive menus for personal digital assistants (PDAs) often has the reduction of task complexity as a key goal; as Jungchul Park and Sung H. Han (2013) argue, adaptive menu design can "… shorten the search path and reduce both the task completion time and the number of errors" (p. 306). Error reduction, however, may also remove from the system personal touches that stray into information frontiers – however tentatively – and need to be recorded in some way so they can be re-investigated or expanded upon. A simple solution here is to replace the centripetal force of an adaptive menu system (i.e., one that continually shrinks the user's information world in the name of efficiency) with the centrifugal force of an adaptable system, where the user can modify or even create his or her own expansive menu system that makes more personal sense. Barriers to implementing an adaptable system are reported by Park and Han (2013), including (in summary form) the following "disadvantages": the adaptable system "requires effort to adapt"; users find it "difficult to determine what to adapt"; and the adaptable system "requires learning" (p. 314; this user-response is also reported in an earlier study by Mackay, 1991). Of course "learning" is required for the use of any piece of software, yet in the world of bloated software "featurism," learning is not a problem because most of the features can be safely ignored, with the consumer merely being happy or comforted to know that they "are there" (McGrenere, 2002, p.11). The disadvantages of adaptable software that Park and Han report are reflective of the "burden" placed "on the user to become a designer which will then require considerable guidance to avoid irrational design" (Norman quoted in McGrenere, 2002, p. 25). Park and Han, however, also examine the adaptable interface, with some system support mechanisms (that they give the unfortunate label of "Bs"), whereby this interface will be:

- "Motivating the user to adapt the interface (reminding the user that he/she can adapt the interface)";
- "Giving hints about how to adapt" (a genuinely hated feature as reported by many users of any piece of software that does this);
- and "Criticizing the adaptations made by the user" (2013, p. 307; parenthetical comment in second bullet point by Lane).

However, participants in this particular study noted that the Bs system "[j]ust did not help" (Park & Han, 2013, p. 314).

This brief foray into the world of PDA menu design options foregrounds the psychology of user adapted software, where "difficulty" and "irrational design" are negatives that also may be, paradoxically, partial solutions to meaningful interaction with online knowledge systems. Users are complex human beings whose "interests evolve during information exploration as they learn and discover more about the topic at hand," in a process that is also one of "contextual evolution," as Michelle Q. Wang Baldonado argues (2000, p. 297, p. 305); she also suggests that, "[t]his evolution of a user's interests requires a synergy among searching, browsing, reading, and analyzing" (p. 305). Such a synergy reveals how habits based on using a pervasive environment such as the Web, will affect how users navigate academic interfaces, online publications, and databases (see, for example, the basic cross-platform clashes reported by Laura Manzari and Jeremiah Trinidad-Christensen, 2006). The passageways between electronic domains also add to an understanding of user interaction, as much as analyzing behaviour once they are "at" a particular resource, site, or "scholarly interface" (Brown, 2011, p.18). In an everted world, these electronic domains are hybrid in nature – they have as much to do with analogue as digital processes – especially where the two intersect or are situated differently to our expectations (e.g., complex interfaces in household objects that used to be passively controlled).

The interface as a site of eversion: Boundary experiences

Pondering whether the eversion is the "collective sobering up" after the "consensual hallucination" (Jones, 2014, p. 66) of a largely imaginary cyberspace, Jones (2014) argues that the "metaphors of interdimensional transit are signs of something real— real attitudes, ambivalences, conceptual struggles in response to specific technological challenges" (p. 67). The phrase that Jones (2014) utilizes for the shuttling back and forth between digital and physical worlds is that of "border exchanges" (p. 68), and it is a useful term that describes what happens at the interface: whether a user is moving into a real or largely imaginary notion of a virtual world, or whether that virtual world is entering or transitioning into analogue, physical space. An example of eversion is the Internet of things, or, the connection of smart objects leading to "context aware" computing (see Perera et al., 2013, for an overview); computer processors that used to remain separate from the user (i.e., that the user literally had to go to), are now frequently being embedded in everyday, connected, objects, working with the complex sensor data that is now being acquired. Such a distributed model of sensing and processing power means that in effect "cyberspace" has entered the physical world. Of course in reality, the Internet of things relies heavily on the cloud to perform the highest level of data processing; Perera et al. (2013), for example, discuss the hierarchy of processing "layers" in the Internet of things, with the lowest layer being the low-end and high-end sensor nodes themselves, then the sink nodes (static and mobile), then low-end and high-end computational devices, and then the cloud (p. 5). While it is true that "Information can be processed in any layer" there is a hierarchy here based on device "capability" (p. 5), with a trade-off between the amount of processing performed at the lower levels or layers and the overall efficiency of the system in terms of networked communications. The layered structure of the Internet of things is known as the "technology stack" and as Michael E. Porter and James E. Heppelmann (2014) note, external data can enter the stack at the level of the smart object/device or the "product cloud" as they call it. The significance of multiple data input locations "into" the

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technology stack is that the human subject's boundary experience, at the interface of digital and analogue worlds, is significantly enhanced or amplified. A concrete example, the prototype computing device called "MouseLight" (Song, Grossman, Fitzmaurice, Guimretière, Khan, Attar, & Kurtenbach, 2010), gives a better sense of the interactions that are possible at this "everted" boundary, i.e., a sense of *what actually gets exchanged* in an eversion-based "border exchange."

Working with the miniaturization of projector technologies, the MouseLight team developed a "location aware mobile projector" (Song et al., 2010, p. 2452) that works in conjunction with a digital pen. Pen strokes are registered as "virtual content on top of the paper," which means that the pen, in this instance, functions "as a proxy to interface between the physical information space and virtual information space" (Song et al., 2010, p. 2452). While similar devices have been researched and prototyped, MouseLight takes a different approach, decoupling the projector and the pen, meaning that users can "write" terms outside of the projection area (Song et al., 2010, p. 2453). The team argues that "MouseLight enables seamless virtual and physical information modification and transfer" (Song et al., 2010, p. 2455), achieved through three integrated information layers: the "*Printout database layer … auxiliary data* that is displayed in the context of the printed content"; the "*User database layer …* any new virtual display element, which is added by the user"; and the "*Viewport layer …* [which] contains global UI elements that enable a user to change the settings of the other two layers and to operate on them" (Song et al., 2010, p. 2454). The user, in other words, can dynamically modify the data displayed in the augmented reality that he or she is situated within while reading data on a printed sheet of paper, "writing" on a virtual layer on top of or beside that data, or interacting with virtual data/commands that are "locked-on-surface" and "aligned with the underlying printout" (2010, p. 2454; see also Song et al., 2009).

The border exchange here involves creating virtual layered data by interacting with the underlying physical data, which in turn creates an augmented reality that is then further synthesized with the analogue or physical surface data (there is a deliberate "dialectical" circularity in this description). What drives this synthesis is the goal-oriented human user, the same user who utilizes the data and devices that make up the "constellation" that we currently call the Internet of things. In other words, this is not the "flat ontology" of "object-oriented ontology" (Jones, 2014, p. 128), and while I agree with Jones (2014) that "[t]he ontology of things, their existence in the world, can complement or challenge the usual modes of abstract thought in humanities disciplines," I disagree that the humanities are *limited* by having a "focus … on the construction of the human subject" (p.128). What MouseLight teaches is that as much as the device is a tool that is simply ready-to-hand, it is one that participates in, and thereby contributes to, the meaning-making activities of its human user.

Arriving at narrative space

Throughout this article I have been alluding to the desire for a narrative record, as such, of the human-centric journeys or passageways through data – be it virtual data or data gathered and processed in actual material objects that populate our world. The eversion, understood as a boundary experience and a passageway between virtual and

physical states or systems, only makes that record more important, and of course from a digital humanities perspective, this interface is the very stuff of everyday activity:

> DH scholars work at the interface, the place of translation and transit, between, on the one hand, material objects in the collective archive and, on the other hand, the increasingly ubiquitous, physically distributed, digital network. Humanities scholars today, we might say, have a calling to explore the materialities of the digital, even as they explore (and participate in) the data-enrichment of physical objects, in and out of the archives." (Jones, 2014, p. 132)

Working at the interface, however, does not necessarily reduce the subject to a component, such as an electronic filter or basic switching device; the subject is not constituted here purely as a node in an ideological network, since the subject is always already capable of stepping outside of the *doxa* through questioning, critique, a methodological change, or a change of heart (*de-doxifying* an ideology; *unorthodox* behaviour, etc). While some critics/artists engaged in the new aesthetic might argue for the above-noted flat ontology – where the subject is merely one more component *in* the Internet of things – I suggest that the future of online academic publishing needs to focus in part on the fact that the contemporary networked subject, situated in the realm of the eversion, regards his or her self as the ultimate arbiter *of* all things. This has implications for the future of digital scholarly publishing, as the mode of engagement in the eversion needs to include human-centric meaning-making processes; in other words, the eversion is not another manifestation of the post-human, but a potential return to a humanistic mode of understanding being. For example, in the *Arcades Project*, Walter Benjamin (1999) puts into practice his theory of montage to create a critical constellation: a series of quotations and comments that are literally juxtaposed in certain ways to create dialectical images.

Critics tend to assume that one section of this book, section N ("On the Theory of Knowledge, Theory of Progress") has more significance or importance than any other because it is self-reflective, exploring the methodology and philosophy of the entire text of which it is one component and, through its self-reflexivity, the entire thing (we could say that section N is a "remnant" in the theological sense). I suggest that section N does have this importance, not so much because it is a moment of methodological self-reflexivity, but because it is a biographical record of a subject's (Walter Benjamin's) own journey through the montage form. See, for example, statements such as "What for others are deviations are, for me, the data which determine my course" (Benjamin, 1999, p. 456).

A contemporary subject-centred example from the world of the quantified self, and an architectonic being developed in ways similar to the *Arcades Project* (at the simplest level the juxtaposition of data), is that of online patient communities. Apart from the usual tracking data that one would expect of such communities, the most useful component for a holistic healthcare approach is that of the personal narratives uploaded by community members. Healthcare professionals have argued that the richness of the *juxtaposed* quantified and narrative data is highly valuable, and therefore leads to design decisions for future software, such as the ability to "Link

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quantified data to forum posts," not just in the sense of a hypertextual link to past posts, but giving site members the ability to bring past narrative data into current online conversations. "Such intertwined sharing of tracking histories within conversations can trigger rich stories to be constructed through peer-patient interaction" (Huh, Patel, & Pratt, 2012, p. 4).

The third example here is that of Stuart Moulthrop (2001) describing the experience of "mentally completing a hypertext link" (p. 187) that would accurately answer a Web query seen on a live Web ticker at a conference. Moulthrop regards the concept of hypertextual "narrative space" as apt for describing personal involvement in an extensive network of real-time information, and his shared experience with that of his partner "of being ourselves, in our lives and histories, somehow caught up in its [the Web's] circuit" (p. 187). While each of these examples foregrounds the aesthetic, materialist, and hypertextual concept and practice of "montage" (see Bernstein, 1998, p. 24), the stress here is the importance of incorporating personal narrative information into journeys through data, and I argue that this data includes the online publication of scholarly data. Rather than examine DH models that already exist (such as the synthesis of social networking, Web 2.0 technologies, and scholarly publishing with the Devonshire Manuscript), I want to remain at a more speculative level with practical outcomes in mind, partly because two philosophical comments can be brought to bear on this entire topic.

First, when Martin Heidegger is discussing reference and signs in *Being and Time*, he briefly touches upon functional objects that signify, noting that these signs offer both an enhanced orientation and an awareness of how the subject is situated within the "totality of equipment" (Heidegger, 1990, p. 110; Heidegger, 2010, p. 78 [Stambaugh translates equipment as "useful things"]). Second, Ludwig Wittgenstein (1991), in pondering how a person learns how a particular game functions, argues that even if we do not speak a particular language, we still understand that a person is correcting his or herself, such as when an individual corrects a slip of the tongue (proposition 54, pp. 26-27). What I am bringing together here is the notion that when a system falters, breaks, or is interrupted (say by a "bug" in a line of code), there is something of great value generated from a pedagogic perspective: a new "orientation" occurs in a way analogous to Heidegger's "indicating" signs. Translated into DH terms, a project called "The Modernist Machine" being developed in the MeTA DH Lab at Vancouver Island University is a response to the broader debates explored in this article.

The "narrative space" as a record of intellectual, critical passageways through data concerning modernism (primary texts plus the critical essays published on those texts), is re-articulated as a coding challenge that is also a new literary-critical orientation: the reader is given a set of parameters within which he or she is invited to create functional *code snippets* that articulate sense-making moments in response to the usual interpretive practices of reading, analyzing, and synthesizing. The code snippets are not meant to be merely "creative" responses, as in the fashion of the new aesthetic, but to combine critical insight with narratives of personal learning processes and experiences. A "snippet" is of course a small scrap or fragment; the Oxford English Dictionary (OED) also notes that a snippet is "A short passage taken from a literary work; a short

scrap of literary matter of any kind." The verb snip, from 1587, means to take, snap, snatch or cut up or off. The code snippet then has the potential to be a mimetic modernist fragment, a Claude Glass or filter through which we see or experience the text, but it is also a piece of the fabric of modernism, i.e., part of the continuum that we call modernism. The code snippet can function as a dialectical expression (perhaps of the DH dialectic), a critical statement, and potentially a move in a hermeneutic game, but again to avoid becoming merely an aesthetic exercise, "game" is being used here in the sense of Wittgenstein's (1991) "language games" in his *Philosophical Investigations*.

In The Modernist Machine, the reader does not "read code" as with critical code studies, instead the reader writes code as a new way of articulating narrative space; the code snippets are the passageways between data sets, and as these snippets accumulate, they in turn become what Benjamin (1999) calls a critical constellation. The Modernist Machine is being developed as a prototype at a time when school curricula are shifting from teaching passive computer and IT skills to those of active coding and fabricating, such as the new curriculum underway in the U.K. and the associated low-cost Raspberry Pi computer project, which is meant to start a second successful national revolution in computing analogous to the one initiated in part by the earlier BBC Microcomputer project (See Royal Society, 2012).

I suggest, in conclusion, that coding skills are a key component of the eversion, and of users taking a more active role in carving out digital narrative space. Further, there are implications here for the teaching of digital literacy not just in an economic sense but in relation to how we articulate our personal engagements with digital data. New modes of navigation for online scholarly publications may need to involve not just the fundamental re-designing of interfaces, but a literal re-coding of the narrative pathways taken through such digital learning environments.

Website

The Orlando Project, http://www.artsrn.ualberta.ca/orlando

References

Baldonado, M.Q.W. (2000). A user-centred interface for information exploration in a heterogeneous digital library. *Journal of the American Society for Information Science*, *51*, 297-310.

Benjamin, W. (1999). *The arcades project* (H. Eiland & K. McLaughlin, Trans.). Cambridge, MA & London, UK: The Belknap Press of Harvard University Press.

Bernstein, M. (1998). Patterns of hypertext. *HyperText*, *98*, 21-29.

Bilal, D. (2002). Children design their interfaces for web search engines: A participatory approach. *Proceedings of the Annual Conference of CAIS*. URL: http://www.cais-acsi.ca/ojs/index.php/cais /article/view/459 [December 19, 2014].

Brown, S. (2011). Don't mind the gap: Evolving digital modes of scholarly production across the digital-humanities divide. Pre-publication version. In D. Coleman & S. Kamboureli (Ed.), *The culture of the humanities* (pp. 203-231). Edmonton, AB: University of Alberta Press.

Buffardi, L.E., & Campbell, W.K. (2008). Narcissism and social networking web sites. *Personality and Social Psychology Bulletin*, *34*, 1303-1314.

Halpin, T.A. (1989). Venn diagrams and SQL queries. *The Australian Computer Journal*, *21*, 27-32.

Heidegger, M. (1990). *Being and time* (J. Macquarrie & E. Robinson, Trans.). Oxford, UK: Blackwell.

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Heidegger, M. (2010). *Being and time*. (J. Stambaugh, Trans.). Albany, NY: SUNY.

Huh, J., Patel, R., & Pratt, W. (2012). Tackling dilemmas in supporting "the whole person" in online patient communities. *CHI '12 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, New York, NY, 923-926.

Jones, S. (1998). Graphical query specification and dynamic result previews for a digital library. *UIST '98*, 143-151.

Jones, S.E. (2014). *The emergence of the digital humanities*. New York, NY & Abingdon, UK: Routledge.

Katzeff, C. (1988). The effect of different conceptual models upon reasoning in a database query writing task. *International Journal of Man-Machine Studies*, *29*, 37-62.

Mackay, W.E. (1991). Triggers and barriers to customizing software. *CHI'91 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, New York, NY, 153-160.

Manzari, L., & Trinidad-Christensen, J. (2006). User-centred design of a web site for library and information science students: Heuristic evaluation and usability testing. *Information Technology and Libraries*, September, 163-169.

McGrenere, J. (2002). *The design and evaluation of multiple interfaces: A solution for complex software*. PhD dissertation. Toronto, ON: University of Toronto.

Mehdizadeh, S. (2010). Self-presentation 2.0: Narcissism and self-esteem on Facebook. *Cyberpsychology, Behaviour and Social Networking, 13*, 357-364.

Moulthrop, S. (2001). The analog experience of digital culture. In R. Koskiaa & M. Eskelinen (Eds.), *Cybertext yearbook 2000* (pp. 183-198). Jyväskylä, FI: Publications of the Research Centre for Contemporary Culture, University of Jyväskylä.

Park, J., & Han, S.H. (2013). Complementary menus: Combining adaptable and adaptive approaches for menu interface. *International Journal of Industrial Ergonomics*, *41*, 305-316.

Perera, C., Zaslavsky, A., Christen, P., & Georgakopoulos, D. (2013). Context aware computing for the internet of things: A survey. *IEEE Communications Surveys & Tutorials*, X.X, 1-41.

Porter, M.E., & Heppelmann, J.E. (2014). How smart, connected products are transforming competition. *Harvard Business Review*. November. n.p. URL: https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition [December 19, 2014].

Royal Society. (2012). *Shut down or restart? The way forward for computing in UK schools*. London, UK: The Royal Society. URL: royal.society.org/education/policy [December 19, 2014].

Siemens, R. (2013). Imagining the manuscript and printed book in a digital age. In R.J. Lane (Ed.), *Global literary theory: An anthology* (pp. 830-840). Abingdon, UK: Routledge.

Song, H., Grossman, T., Fitzmaurice, G., Guimbretière, F., Khan, A., Attar, R., & Kurtenbach, G. (2009). PenLight: Combining a mobile projector and a digital pen for dynamic visual overlay. *CHI 2009*, ACM Press, 143-152.

Song, H., Guinbretière, Grossman, T., & Fitzmaurice, G. (2010). MouseLight: Bimanual interactions on digital paper using a pen and a spatially-aware mobile projector. *CHI 2010*, April 10-15, Atlanta, GA, 2451-2460.

Wittgenstein, L. (1991). *Philosophical investigations* (G.E.M. Anscombe, Trans.). Oxford, UK: Blackwell.