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Binding Time in Digital Civilisations: Re-evaluating Innis after New Media

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Abstract

The spectacular history of the computer's power for calculation and command over distance has tended to divert attention from its very mixed record in mediating time. Gradual refinements in digital storage technologies have not overcome the tendency for digital artefacts to degrade, corrupt and disappear. The most distinctive feature of computer media though, is the diversification of spatiotemporal configurations that they have come to mediate.

This article returns to the seminal work of mid-20th century communications theorist Harold Innis, for an ethical framework that deals with this space/time imbalance. Just before computers were developed, he devised a method for analysing civilisations according to how well balanced the dominant media of an era were in relating to time and space. Space-binding media (such as papyrus or electronic communication), facilitate command and control over territory and support empire building. Time-binding media (such as stone and spoken communication within social hierarchies), operate to maintain cultural continuity and tend towards more stately and priestly structures. Innis's media ethics is based on societies finding a balance between these functions.

The computer has become the dominant media platform of the current era. From the first design, command and memory were on the same circuit. However, as Innis feared, their implementation was always out of balance, as command functions were cheaper and more effective than memory or storage. More recently, it can be argued that more sophisticated time-binding features are better supporting demotic uses of sound, image and text, managed in archives and cultural networks. This paper explores the value and limitations of Innis' theories for an understanding of the current epoch of internet media.

Introduction

Much has been made of the impacts of digital media on the experience of space: new modes of

perception and action at a distance; accelerating globalisation; shifting boundaries between work and home life; and so on. A parallel, but less conspicuous, transformation has occurred in how digital media affect human relationships with respect to time. The digitisation of cultural practices and artefacts has significant implications for structuring our connections with both the future and the past.

At the same historical moment as the first computers were being developed, Canadian economist and communications theorist Harold Innis was pioneering an approach to understanding media by examining how a computer's material, symbolic and organisational features supported different relationships to space and time. He showed that some media tend to favour space-binding: extending influence and meanings over distances, building empires and developing cohesion across space. By contrast, time-binding media influence cultural patterns in duration. For Innis, civilisations can be measured by the extent to which they find a balance between managing time and controlling space. If this ethical measure holds today, how have computers changed this balance in our own culture?

Since Innis's death in 1952, the mediascape has been constantly changing and has been influenced most dramatically since the 1970s by digitisation. These changes to media materiality are so significant that his approach must be entirely re-evaluated. Innis's methodology, which I examine in detail shortly, has been complicated by the way that digitisation abstracts media events and content from their material substrates, and makes their spatio-temporal location unclear. Innis's analysis of communication emphasises the material features of particular media: from ancient tablets to modern broadcasting. In comparison with physical and even analogue electronic media, the material status of semiotic events in computers is ambiguous. Digitised artefacts seem to have become virtual, temporarily slipping out of 'actual' existence. In fact, they still very much exist, but are split between several sites of inscription in computer transmission, storage and memory. Digitised artefacts are imperceptible until they are invoked through output devices. The concept of virtuality has been overplayed. Digitised data are not truly virtual, but simply imperceptible, and subject to random invocation through software (Chesher, 2002). Digital signals are transmitted and stored invisibly in multiple material media, each with its own properties (magnetic, optical, mechanical, etc). Even if these signals constantly shift substances, they never actually escape being physical. I argue therefore, that Innis's emphasis on materiality remains a key question for theorists of new media. It does not determine social outcomes in any simple manner, but as with any material culture, its affordances both express and influence the textures of social and cultural life.

In this paper therefore, I will revisit Innis's approach to the relationships between media and space and time. I will show the significance of his transdisciplinary intellectual transition from economic geographer to media theorist. In the process, I will note the resonance that his work has with some areas in contemporary media studies, philosophy, and science and technology studies. I will also evaluate Innis's arguments about the significance of media to cultural change in relation to the history of computers and networks.

Innis on media, space and time

Innis was among the first scholars to argue that social change is closely associated with media change. His later works in particular, *Empire and Communications* (1972b)and *Bias of*

Communication (1991), cast modes of communication as central agents of the transformation of civilisations. He analysed civilisations in the *longue durée* by tracing changes in the materials and techniques used to organise social activities, communicate over space, and pass knowledge down through time. He compared and assessed these civilisations according to how well the dominant media of each balanced command across space and dominion over time.

We must appraise civilization in relation to its territory and in relation to its duration. The character of the medium of communication tends to create a bias in civilization favourable to an over-emphasis on the time-concept or on the space concept and only at rare intervals are the biases offset by the influence of another medium and a balance achieved (Innis, 1991: 64).

Innis saw a dramatic and destabilising imbalance in the dominant media of the mid-twentieth century in their bias towards space and their neglect of time. He saw European imperialism, United States expansionism, and the centralisation of commerce and politics as strongly related to the dominance of centralised space-binding media such as newspapers, commercial printing, the telegraph, and radio. By comparison, he saw a neglect of objects and practices that had enduring value, such as archives, universities and books.

Innis is likely to have considered computers to be highly disturbing to the balance of media. Computer design in his day tended to prioritise control over territory and populations, supporting centralised monopolies of knowledge as evident in the first users of computers: the Census Bureau, Air Force, Atomic Energy Commission, Army and Remington Rand Sales Office (Ceruzzi, 1998). Computer databases are also time-binding media, but only within limits, something which will be explored later in this paper. Innis's assessment that "sudden extensions of communication are reflected in cultural disturbances" (Innis, 1991: 31) can certainly be applied to digital media, and he had great suspicions about modern technology, expressed in a polemical 1948 paper 'The mechanisation of knowledge'.

The conditions of freedom of thought are in danger of being destroyed by science, technology and the mechanisation of knowledge (Innis & Drache, 1995).

Innis's analysis of the relationship between communication technologies and cultural change only extended until the age of newsprint and radio. While the first commercial computers were becoming operational towards the end of Innis's life, there is nothing published to suggest he knew about these developments. Innis's legacy provides an alluring gap in the understanding of media in its lack of explicit attention to electronic computing. Even the more high profile media theorist Marshall McLuhan, who embraced Innis's work, wrote much more on television and other media than on computers. Innis' ideas continue to be taken up, for example in Catherine Frost's (2003) recent useful analysis of the Internet using Innis's work. She concludes hesitantly that networks can support 'multi-associative information flow' which might 'emulate certain features of oral communications'. Such hesitations, and the general ambivalence about defining the networked computer's profile as a medium, point to the need to re-configure, but not simplistically reject, Innis's soft media determinism.

Innis's attention to the agency of material objects and their material characteristics, remains contentious in media studies. He has often been critiqued, or dismissed too easily, as a technological determinist (Burnett & Marshall, 2003). However, recent work in philosophy and social studies of science has challenged the conventional assumptions about the incommensurability between human and non-human agency. Innis's lack of distinction between

objects and human ideas and actions can be read alongside Guattari's concept of the asignifying semiotic: signs such as credit cards that operate in everyday life as well as having meaning (Guattari, 1995). Innis's approach also anticipates posthumanism and actor-network theory and their analyses of the imbrication of non-humans in human affairs (Latour 2005). The work of Friedrich Kittler on discourse networks and contemporary media also clearly belongs within Innis's legacy (Kittler, 1990, 1999; Kittler & Johnston, 1997). Derrida's conception of cultural inscriptions emphasises the cultural/material dimensions of archives: "… the technical structure of the *archiving* archive also determines the structure of the *archivable* content even in its coming into existence and in its relationship to the future" (Derrida, 1996: 17 italics in original).

Innis's influence has always been strongest in Canada. Library and Archives Canada recently put up a website on the legacy of Innis and McLuhan that includes short essays from several contemporary scholars on the theme "Archives as media". The site raises the question:
To what extent is historical knowledge not merely preserved, but shaped by the archive and its means of selecting, storing, and presenting information? (Libraries and Archives Canada, 2007: index-e.html)
Archives necessarily accumulate through ongoing interplay between human and non-human components. What is archived is conditioned by the material constraints of space, informational architectures of indexing systems and the personal and collective choices of archivists.

For Innis, the various time-binding media available to any community are qualitatively different as each retains impressions over time in different ways. Government records, personal letters, and published poems are preserved in different ways. Each is inscribed in different materials, follows different conventions, and is supported by different institutional frameworks. With its own distinctive combinations of media, any civilisation has a different orientation towards time.

To understand Innis's distinctive reading of time-binding media it is relevant to briefly recall his transition from social scientist of space to self-styled Humanities scholar of space, time and media. Innis's intellectual training involved investigating the technologies that build empires: conducting detailed research into the development of the economy and infrastructure of Canada. He wrote histories of the Canadian Pacific Railway and of the fur, cod, and dairy industries (Innis, 1940, 1962, 1972a). Each of these industries was structured very differently. For example, the fisheries were established in scattered independent settlements along the eastern coast of Canada and, by contrast, workers in the fur trade were dependent on the Hudson's Bay Company which ran a command economy from London (Di Norcia, 1990). The differences between the fish and fur industries emerged from the material properties, behaviours, and environments of the commodified animals themselves. The beaver's sedentary nature and its inadequate defences against humans contributed to the rapid growth of the trade in its fur. The dispersed distribution of fish stocks allowed fishing boats to operate more independently, and therefore the communities to adopt a more democratic ethos (Watson, 2006). Innis read cultures from the ground up, seeing spatial and economic patterns emerging from the properties of agents, environments and lines of movement at various speeds.

In his later work, Innis's attention increasingly turned towards the problem of how civilisations relate to time through different media. Time is harder than space to study empirically and so he switched methods from the notoriously detailed fieldwork and statistical analyses to the

accumulation of facts from a huge array of secondary sources. Collegial relationships with classics scholars such as Charles Cochrane, Edward Thomas Owen and Eric Havelock at the University of Toronto (Heyer, 2003) helped him take an increasingly interdisciplinary approach. He came to consider himself as much as a philosopher, historian and sociologist as an economist (Innis, 1991). His position as an outsider within the Humanities contributed to his unique insights grounded in his materialism, but also destined his work for controversy.

Innis drew on his understanding of the role of economic and material forces in building empires, and brought it to a new interest in time. He proposed a theory of history based on how much the dominant materials and modes of communication of a civilisation are biased towards space or time. When Innis refers to 'media bias', he is not talking about the subjective political slant of journalists, but objective biases emerging from the very properties of materials used in communication. He theorised that media bias in a particular civilisation emerges from the interactions between three interdependent layers: properties of media substrates, encoding conventions, and social and political arrangements using media for particular purposes. The computer presents complications at each of these three levels.

1. Media materiality

At the first level of media materiality Innis argues different substances have distinctive properties that support different styles of communicating and, most importantly, each tends to have a bias towards either space or time. For example, papyrus is light and portable in scrolls, can be made cheaply from water plants and can be written on with rapid strokes of a brush. However, papyrus deteriorates quickly and is therefore, biased towards extending communication across space, building, extending and maintaining empires (Innis 1972b). By contrast, carvings in stone last for centuries but are expensive and time-consuming to produce and cannot be transported easily. So, just as papyrus is biased towards space, stone is biased towards time.

The dominant media of a civilisation reflects the materials available to that community either from local sources or through trade routes: stone in Egypt; papyrus in the Nile Delta; clay in Babylonia and Assyria; parchment in the Carolingian dynasty; and paper, from China to Europe via the Middle East. The materials established the limits of communication in weight, durability, malleability, reflectivity and other technical limitations and capacities. The expense, complexity of manufacture, and all other features affect how the dominant media can be taken up and by whom.

The most lightweight medium for communication is speech. This is the dominant medium in oral cultures where face-to-face conversations and the cultivated memories of citizens are the main means of transmitting culture over space and time. Innis favours the Greek oral civilisation as a model of a balanced regime of communication because he believed it did not constrain thought in the same way that writing did. As writing is introduced, thought becomes limited:

Writing with a simplified alphabet checked the power of custom of an oral tradition but implied a decline in the power of expression and the creation of grooves which determined the channels of thought for writers and readers (Innis, 1991: 11).

Innis was not the only scholar of his time writing about media change and particularly, the

significant historical transition from oral to literate cultures. Classicist Eric Havelock (1963) emphasised the transformations in thought with the emergence of writing in Ancient Greece. Walter Ong (1988) analysed the changes in consciousness and personality with the expansion of print. Most famously, Marshall McLuhan (1994) saw media as extensions of the human nervous system. McLuhan was a strong advocate of Innis' work, undoubtedly helping to sustain Innis's influence. However, McLuhan's reading of media was quite different from Innis's predominantly due to his disciplinary origin in literary theory in contrast to Innis's training in social science. Where McLuhan's reference points were surrealism and New Criticism, Innis's were economic staples, trade routes and modes of transportation (Watson, 2006). For McLuhan, mediated memory devices such as writing, printing, videotape or computer disks are prostheses of human faculties — extensions of individual human memory.

In contrast, Innis sees mnemotechnical media in a more materialist, historical and collective way, as 'time-binding media'. Whole societies carry knowledge into the future in distinctive ways, forming time-binding systems that are always bound up with centralised or decentralised social power and traded against immediate goals. Innis regards thought not so much as a property of active individual subjects but as a pattern grounded in changes in media materialities that emerge across an entire civilisation.

Computers complicate media materiality

The possibility of a machine that could abstract mediation from any particular material substrate was established during Innis's time. In 1936 Alan Turing's famous thought experiment demonstrated that any universal computing machine could, in theory, simulate any other symbol-manipulating machine. The material constraints of time and memory were the only limits. Such a computing device could be built from any suitable substance and in any valid form. Where print, radio and television were relatively bound to their embodiments in paper, spectrum and specialised electronics, computers could manifest in any number of interconnected components, comprised of many different materials — metals, paper cards, magnetic surfaces, semiconductors, radio and optical wavelengths.

Turing's mathematical approach to media was the opposite of Innis's because, for him, the material expression was mere technical detail. Turing's proposed machine, which would displace paper as the dominant media material, included an imaginary infinite 'paper tape' as an immaterial prop in his mathematical proof. While paper could never do this particular job in actual machines (even if cards and paper tapes did feature in some designs), some kind of time-binding component was central to Turing's abstract design for an automated computing machine. This design concept called for entirely new materials for automatic memory, which could be written, read, erased and rewritten automatically.

Extending Innis's materialist media analysis to computers becomes exponentially more complicated, with their integration of so many different interconnected material and hyper-material parts. The time-binding components of the earliest commercially available computers were notoriously difficult, unreliable and limited. For example, one early memory device used in the UNIVAC-1 in 1951 was the acoustic delay-line (Grey, 2001). It worked by sending carefully tuned vibrations through the substrate of long hot columns of mercury using techniques developed for radar. Information in the delay line was held in the precarious form of vibrations in the liquid cycling between opposing transducers at either end of the tube, which

would then amplify and retransmit the same information. The toxic mixture inside the delay-line had to be kept at a stable temperature to maintain a uniform speed of sound that would keep the memory traces in synch with the machine cycles. Even with such a complex apparatus of seven units, each with 18 delay columns, the system could store only 1000 computer words. Fast memory would remain a prohibitively expensive computing component for several decades.

The engineering of the computer, following the design attributed to Von Neumann, manifested a new form of 'present-mindedness' (Innis, 1991) in its pyramidal memory structure. Changes occurred from the top of the pyramid in the central processor and in the register flip-flops that store the information states for immediate use. The processor stepped from one instruction to the next at high speed in a digital 'stream of consciousness', making decisions that trickled up and down, and to and from, lower levels of memory and storage. The slower main memory was connected through a memory bus and supplies data and instructions as required. Larger amounts of data tended to be stored in other slower and less expensive components lower in the pyramid or even offline. This design, along with the extremely high cost of the fast memory components operating close to the processor, required a distinctive separation between main memory and storage, which persists in today's computers.

UNIVAC's long-term storage was as cumbersome as its random access memory was volatile. UNISERVO was a magnetic tape system that used extremely heavy reels of half-inch wide strips of nickel-plated phosphor bronze to input, output and store information. The metal tapes zipped past the heads at over 2.5 metres per second delivering 7,200 characters per second (Gray, 2001). However, tape drives gave only linear access to archival data, which meant that records were accessible at different speeds depending upon their position on the tape. Many tapes were stored offline making much of the data relatively difficult to access.

Since the 1950s, computer storage has been expressed in a proliferation of different materials and designs, with trends towards cheaper, faster, but incompatible systems. These have included: paper tapes; paper cards; magnetic tapes of several widths (three quarter inch, half inch, quarter inch, eighth inch, eight millimetre); compact audio cassettes; floppy disks (eight inch, five and a quarter inch, three and a half inch); IBM's hypertapes; stringy floppies; holographic systems; laser discs; and the 'millipede' probe storage. Few of these storage solutions have been engineered for the long term. Most of them are now superseded by 'solutions' with far superior capacities and performance. However, replacement systems are rarely compatible with previous standards and data is often lost in the move to new standards. The pattern in the computer market has been more and more rapid innovation, and planned obsolescence. Even the military, which demands high levels of durability, has had trouble sourcing components that will last (Condra et. al, 1997).

In the 1990s a number of commentators began to warn of the short-life span and vulnerability of the media holding much of today's cultural information. They cautioned of the risk of making ours a 'digital dark age' in which our cultural legacy would be lost to the fragility of digital records. Future historians may find all the data of our times, lives and experiences has disappeared (Brand, 1999; Hillis, 1998; Kuny, 1997). Physical storage media deteriorate quite quickly, making data unreadable within only a few years. Floppy disks are unreliable after five years, hard disks after twenty or thirty years and optical media such as CD-Rs and data DVDs

not much longer than that. Meanwhile, computer equipment becomes obsolete within eight years, often to be replaced with improvements that are incompatible with older standards: zip drives, SCSI devices and so on. Many documents prepared using older standards become unreadable without software versions or hardware platforms that have long been retired. Through a fatal combination of entropic forces, what had seemed to be immutable promise of perfect digital copies is betrayed by an instability inherent in the very flexibility of digital medium. As Rothenberg wrote in 1995, digital information lasts forever — or five years, whichever comes first.

The irony in the failure of computers as time-binding media is illustrated in a recent story about the computer records of Bronze Age excavations in North East London from the mid 1990s. A study found that the computer records of the dig had deteriorated more in one decade than the relics themselves had in thousands (BBC News, 2000).

Digital records have become increasingly remote and apparently immaterial with recent digital storage media. A sense of magically distanced information was accelerated particularly with hard disks, which gradually became the dominant solution for storing almost all data. Matthew Kirschenbaum (2004) argues that the hard disk is a 'black-boxed' inscriptive technology that supports quite different relationships to records. He argues that writing is displaced to a hidden, invisible magnetic substrate, remote from the user's hand and eye: hard disk platters move constantly, so they rapidly access data at random. Error-checking effaces any imperfections of copying. The capacity to store and make unlimited perfect copies of images, sounds and programs, as well as writing, unleash an insatiable drive to capture the cultural archive and keep it available (Kirschenbaum 2004). This trend towards abstraction and perceived distance has been extended in the silent circuits of solid-state memory devices, and even further with so-called 'cloud computing', where data is dispersed to somewhere unknown on the network.

Many changes in domesticated computer culture over the past 30 years were grounded in global markets in materials, production and distribution. The complex cultural changes associated with digital media owe much to the engineering of computers as physical devices, which has supported the more visible complexity of software. Far from escaping material concerns, the story of increasingly cheap and capacious computing hardware reaffirms Innis's attention to the role of global markets in configuring media.

2. Languages and genres

On top of the ways that substances structure communication, Innis examines a second level of media patterning — languages, scripts and genres of content. Each enables and limits what a community can express. For example, the hieroglyphics carved into stone monuments and pyramids of Old Kingdom Egypt tended to be square, upright, decorative and pictographic. This style emerged partly from working with chisel and stone, but also evinces the formal religious and political environments in which this medium was used (the third level of Innis's analysis). The rigid style, in combination with the use of durable media, was closely associated with a centralised society that venerated religious authority and in which knowledge was monopolised (Innis, 1972b).

After 2000BC, hieroglyphics came to be written by brush onto papyrus more often than by

chisel on stone. This writing was simplified, less like pictures and more like a flowing cursive script. These changes in materials and style were associated with new social arrangements and modes of thinking.

By escaping the heavy medium of stone thought gained lightness … [a] marked increase in writing by hand was accompanied by secularisation of writing, thought, and activity. The social evolution between the Old and New Kingdom was marked by a flow of eloquence and a displacement of religious by secular literature (Innis, 1972b: 16–17).

Alphabetical and phonetic scripts are more efficient than pictographic systems. With fewer characters, such scripts are quicker to learn and to use and so tend to favour traders rather than centralised groups protecting religious texts. Because simplified and democratised language allows the production of texts to become decentralised, vernacular texts become more common and the dominant forms of knowledge and belief in a culture tend to change.

2.1 Divergent languages and temporalities

Computer-mediated codes followed a similar path — from closed, rigid and institutionally-bound languages to much more accessible and widely used forms of symbolic interaction. Developments in computer operating environments and languages helped digital electronics shift from being the exclusive domain of specialists in the 1950s and 60s to becoming everyday artefacts of popular culture by the late 1980s. Early programming languages generated exclusive social groups based on mastery of FORTRAN, COBOL and other specialised languages. Programmers could make full use of the computer's power, where end users were bound to work within the capabilities of programs provided by programmers. Languages and applications of computers established what Innis (1991: 11) referred to as 'grooves' which channel thought and action, leading through what Deleuze calls "striation" (2004: 460), towards the 'control society' (1992). The complexity of computing standards and the high initial costs of hardware over three decades helped centralise power over these forms, similar to how monopolies of knowledge once gave power to the priesthoods that commanded arcane scripts and languages, such as hieroglyphics and the cuneiform. Like the ancient masters of writing, programmers' power was moderated by their relationships to powerful actors such as government, military, commerce and education.

While microcomputers have made computing more accessible since the 1970s, control over standards has become an even more influential force. Institutions such as Microsoft, Apple, Adobe, and so on, acquired market position and power by controlling the standards millions of people use to encode and interact with media content. Control over proprietary standards has major implications for the future accessibility of cultural records. It can mean not only monopolising knowledge but also, effectively holding part controlling interests in the environments in which people create new artefacts and knowledge. There are ongoing struggles for control over such standards and communities of users. Cheap equipment and networks have made other models of software development, such open source, more viable. The hope for a distributed, radical meritocracy on the networks is complicated by social dynamics and powerful interests (West, 2003).

Today, the computer's capacity to bind time is conditioned by the dominant encoding standards for capturing symbolic and sensory data: ASCII text; GIF and JPEG images; MP3 and WAV

sounds; MP4, WMP and MOV video; VRML spatial information and so on. Computers are often called convergent, but the proliferation of standards is also divergent, as these standards support many different sensory modalities, textual forms and regimes of access. Each establishes particular domains of possibility. For example, encryption and security schemes limit access to information, while networking standards, such as Ethernet and TCP-IP, open up channels of connection. The diversity of standards and the frequency of upgrades are major culprits in the 'digital dark ages' scenarios.

Software creates a diversity of dynamic environments: gaming engines, printing systems, e-commerce platforms, social software. Each establishes and frames spatial and transactional spaces that mediate particular cultural practices. Among other things, these tools and standards, and the rituals associated with them, condition what will be remembered and how. For instance, as Manovich (2001) argues, there has been a conflict between the cultural forms of the narrative and the database. He says the drive for narrative is to put sequences into order, while the database gathers entities but refuses to give them any final order. These genres, which are both software standards and cultural forms, define the stories and collections that become collective memory.

Beyond narratives and databases, software provides a range of different symbolic formations. Another key computer network form, the bitstream, reimposes the narrative's logic in streaming media and podcasts. Online applications such as YouTube offer a huge database of bitstreams, finding their own resolution of the narrative/database clash. The huge variety of data standards and computer languages make totalising media determinist accounts such as Innis's difficult to sustain. The implications of every command, file type and application is quite specific (on top of the questions of materiality discussed earlier). Each device, mode of connection and software application has its own signature temporalities and spatialities. The unprecedented diversity of platforms within so-called convergent media contributes to new kinds of cultural complexity.

3. Media and civilisations

At a third level, Innis argues that the dominant medium of a civilisation defines its distinctive character. Each medium is selected and developed because it suits particular interests within that society. Media both cause, and provide evidence of, the distinctive patterning of a society. Choices of media reinforce, and sometimes transform, a society. Some civilisations become tied to one medium, while others are subject to constant change. For example, Innis attributed the limited capacity of Egypt to build empire in part to "the inflexibility of religious institutions supported by a monopoly over a complex system of writing" (25). This contrasted with the Roman Empire where a "written tradition dependent on papyrus and the roll supported an emphasis on centralised bureaucratic administration" (107).

So for Innis, changes in materials and techniques of communication contribute to, if not bring on, crises that produce wider transformations in cultures. When new trade routes or inventions bring new techniques for communicating, social changes invariably follow. Innis reads conflicts between or within cultures as struggles over media. He sees the First World War as a conflict between British newspapers and German books and the Second World War as a confrontation between German radio and British newspapers (Innis, 2004: 89).

When looking at his own civilisation, Innis perceived a significant and still growing imbalance in favour of space over time. He showed how modern European empires emerging in the 1700s used a series of new media to gain power: first paper and printing and later, the telegraph and radio. These media afforded centralisation of national authority, with printed documents helping to establish uniform laws, education and administrative infrastructures. At the same time, portable and durable communication allowed other forms of administration to accelerate and decentralise.

Innis was disturbed by the trend towards present-mindedness, centralisation, and proliferation of media technologies that accelerated in the twentieth century. He had directly experienced the role of the speed of information as a signalman in the First World War. He witnessed the industrialisation of war in the Second World War, and the gathering clouds of the Cold War (Watson, 2006). He saw that the West privileged only immediate goals at the expense of past and future. This was not only apparent in leaders' statements, the increased cultural dominance of advertising and the decline of the university, but more fundamentally in media bias in the dominant material modes of communications. The book trade, newspaper journalism, and radio were conditioned by the material properties of pulp, paper, and the radio spectrum. Consequently, they supported cultural forms that increasingly prioritised the present.

Innis took a transdisciplinary approach to researching societies and the media that he believed defined them. This required something like a network analysis, tracing complex connections between media substrates, coding schemes and social organisation. The following entry from 1947-8 in the *Ideas file*, a collection of transcribed research notes kept by Innis, gives an indication of Innis's method of connecting and finding interrelationships between diverse phenomena: economics (declining value of book titles), technology (printing of images), cultural forms (advertising) and ideas (excess production allowing production of philosophical books).

Constant depreciation – new books drive out old books – publishers concerned with depreciation in publishing new books but also concerned with monopolies in building up their lines. How far printing essentially based on controversy perhaps centring around price system and philosophical books became by-product of excess capacity in quiet periods – Descartes in Holland centre of printing industry for Holland? Printing meant mechanical reproduction of images – consequent deterioration in value and closer adjustment to goods – advertising (Innis & Christian, 1980: 130).

Innis's work often did not follow the normal Humanities conventions of analysis, dialectic or narrative. Rather, he performed pattern-matching. An Innis biographer observes that his huge collections of index cards anticipate computer databases in their non-linear structure (Watson, 2006). For Innis, this method was appropriate as the features at all levels of communication are infinitely inter-woven, and not in any necessary hierarchy or a sequence. Perhaps ironically, Innis's fragmentary style of work, manifest many of the features of the very media epoch that he was critiquing.

Innis warned that modern media tend to create forms of knowledge that lose value almost immediately, to be displaced by something newer. He saw the inflated value of the most current information is evident in publishing, newspapers, and the centralised live broadcasts on

radio and television. These media extend control across space at the expense of considered reflection on the past and care for the future.

Modern media also establish and sustain monopolies of knowledge. They achieve this by regulating access to cultural artefacts, imposing selective and strategic delays on releasing information, and developing arcane technical systems to control it. Many of these trends continued after Innis's death: an increasingly globalised media with concentrated ownership, rigid intellectual property laws, rights management software and so on.

Importing Innis into the digital society

Beyond Innis's pessimism about the media of his time, how can his concepts help understand computer-based media? It is evident that digital technologies distribute signals, meanings and images through space and time in a manner quite different from other media. As I have argued, the abstraction to digital electronics of artefacts and operations in computers has allowed engineers to use many more substances and designs. This makes any direct link between digital media platforms and cultural forms a fair bit more complicated. Even if a media determinism that connects media substances with specific cultural practices was ever valid, the distributed existence of digital signs makes this much harder to prove. As I have shown, the multiplicity of mediation is apparent at all three levels of physical materials, code and social organisation.

In the post-war era, computers helped accelerate many of the trends that Innis identified in older media: extending command over peripheral spaces; centralising monopolies of knowledge; and bias towards space. More recently though, the cultural impacts of computers became more ambiguous and contradictory. Personal computers, networks and other digital devices became accessible to wider communities of users, and the contexts in which they operated became increasingly diverse. The multiplicity of communication configurations mediated by computers makes it difficult to equate any particular media features with specific cultural practices or mentalities.

Take, for example, this document, in word processor, web page or printout. It has an existence distributed across multiple sites and substances: copper wires, semiconductors, magnets, liquid crystals, optical fibres, toner, paper, and so on, which together constitute my laptop (and other manifestations of this article). Each of the components in this device has a story that is usually lost in the abstractions of global trade and commoditisation, but is significant to an Innisian reading of current media environments. Even more than with the fur trade a century ago, the stories behind the production of digital electronics are hugely expansive: space-binding, globalised, supply networks that find the cheapest labour forces, the largest government subsidies and other conditions. These networks keep the manufacturers in profit, make my laptop affordable and bring the words in my word processor documents to life.

The presence of this trade in electronic materials and components only comes to light occasionally, such as when the sources of 'coltan' came into question in the early 2000s. 'Coltan' is a colloquial term for a mined substance containing tantalum, an element with conductive properties that make it ideal for manufacturing small capacitors for miniature electronics. Most of the world's coltan is found in the Democratic Republic of Congo, which has been embroiled in decades of bloody civil war (Pflanz 2008). Activists argue that sourcing

coltan from Congo effectively means supporting the war and associated environmental destruction (Woods 2004). Just as the fur trade relied on a distance between the slaughtered beavers and the fashionable streets in European cities, so the ambiguities of global trade partly efface the sources of this element. On the other hand, in this case, it is the tantalum-accelerated communication networks that afforded the attention that activists were able to draw to this trade.

More often though, adjustments in digital media supply are experienced indirectly in lower prices that follow from changes in the production of electronic components. Hard disks are a good example: they have changed from being exclusively a product of the US, into wider regional locations, and then to a globally dispersed production. Since the 1990s production has extended mainly to South East Asia (Lynn 2002, Gourevitch et al 2000), even as the ownership has remained in the US. Just as data becomes randomly accessible on a hard disk, in the networked economy almost any site of production becomes substitutable for another. In the emerging epoch characterised by spaces of flows (Castells, 1996), the distinction between centres and peripheries becomes multiplied and distributed.

The electronic writing and hypertext criticism traditions have identified processes of change in writing in random-access spaces that parallel these changes in global trade. In a strong technological determinist case, Michael Heim argues that as writers using word processors change their everyday habits in composing and organising texts, their writing and very thoughts begin to change (Heim, 1987, 1993).

The word processor is the calculator of the humanist, giving its users the power to manipulate written language in new ways. Just as the printing press altered culture and scholarship soon after is invention, so too the computer automates the composition, storage, and transmission of written words …

Computer technology is so flexible and adaptable to our though processes that we soon consider it less an external tool and more a second skin or mental prosthesis … Writing on the language machine produces a new kind of writing and thinking. At our fingertips is the calculating machine dreamed of by Pascal and Leibniz, fathers of modern metaphysics, but now this calculator operates on our language as we spontaneously produce it (Heim 1994: 64–65).

However, Heim's idealist argument that the spirit of rationalist philosophers is channelled through the word processor, is less convincing than his observations about the materiality of writing electronically. The general fluidity of composition, and the organisational devices afforded by word processors, encourage different practices in individual and collective habits of textual production.

This media ontology of fluidity and perpetual material multiplicity drives a regular diversification of new media standards and spaces. However, the detachment of cultural texts from any particular medium is also responsible for a distinctive fragility in the time-binding features of computer media. When materials and codes are constantly in flux, a state which is designed to suit space-binding ambitions, the task of finding engineering solutions that will hold over any significant length of time is often deferred. Ned Rossiter draws on Innis to argue that material changes constitute a 'constituent outside' to discourse and to the creative industries (Rossiter 2004: 41). This analysis is convincing, but I would argue that these

material conditions are not actually outside, but constantly slipping inside and outside of perceptibility, control and scale.

Each Web 2.0 internet application configures space and time in its own way, arguably constituting a new medium in its own right. Facebook and Twitter ask users to write what they are doing *right now,* and make this short text available to others across space. They archive these entries, forming a kind of narrative record of past presents. Internet chat clients such as MSNChat, AOL Chat and ICQ ask users to enter their current status to signal their availability for chatting. Users conduct conversations in text (or as an audio or video bitstream) and automatically generate transcripts. The longer form of the weblog, or blog, orders all posts reverse chronologically so that the most recent post is at the top. In each case, while there is present-mindedness, there is also a time-binding record of the present being created.

From instant messaging to repositories, computers today operate according to a multiplicity of temporalities, usually slanted towards the present. The ethics of speed and ease-of-access are the principles that dominate. Traditional media values do continue to have influence. For example, when radio bulletins or newspaper stories go online, they often import conventions from the old media: writing in inverted pyramid style; featuring the most significant story at the top of the web page; and applying a homogenised set of 'news values'. However, the internet's hyper-materiality gives scope for more diverse orientations to time and space. The 'breaking news' sort carries present-centrism even further by placing the most recent story at the top of the page. On the other, many sites also feature a search-driven or customised news listing in which another system of value operates – finding stories that are most relevant for that search, or for that user.

Across the wider internet, the structures of communication have become more open, supporting many-to-many communication paths much more readily. However, many of these flows are controlled by an oligopoly of dominant service providers, such as Google, Facebook, eBay, Yahoo, YouTube and Amazon. Each is constantly seeking opportunities for control and monetisation, creating an increasingly uneven distinction between a new kind of "centre of calculation" (Latour 2005: 181) and peripheries. With social media, these centres of calculation benefit from free labour in these new randomly located peripheries: homes, offices and on the road — creating images, writing posts and submitting updates (Schulz 2007). The same people are also consumers, whose attention is on sale to advertisers.

Since the 'digital dark age' panic of the 1990s, the time-binding profile of the internet has changed significantly. Search engines and archival databases have brought distant events and historical texts into everyday life. Search engine databases still tend to privilege the present, though, by over-writing records of earlier versions of indexed websites (Hellsten, Leydesdorff, & Wouters, 2006). Internet web pages themselves have a limited lifetime. Site redesigns, closures, corruptions, broken links and crashes often degrade the contents of the web over time. Even services such as archive.org, Google Books and Wikipedia generate traces of the past that are constantly overwritten or compromised.

Conclusions

The dominant time-binding media of our 'civilisation' operate paradoxically to both diversify and homogenise cultural patterns over time. Since the mid-twentieth century, computer-based

communication has stretched Innis's reading of media materiality further and further. Computers and computer networks are comprised of complex interconnected material components. The constant substitution of cheaper components and more efficient manufacturing methods has allowed regular improvements in the material construction of computers. Alongside improving hardware and software designs, the trajectory towards mass customisation allowed digital technologies to access wider and different communities and increasingly diverse application domains. Computers began mediating more and more cultural practices such as calculation, writing, photography, play and working with moving images. These changes emerged alongside, and formed relations with, an already complex globalising analogue mediascape.

The digitisation of many cultural records has made many archives ubiquitously accessible. All these translations, however, are constrained by the limits and thresholds of digitisation: bit size; sampling rates; encoding schemas and so on. All these records become subject both to easy copying, and to threats of deterioration that are peculiar to digital media, as the artefacts are readable only through machines. While the assets being digitised are becoming more and more diverse, the computer has become so dominant as a medium of archiving and communication that there are few alternatives. Their dominance has made digital media a single point of failure.

While the approach to media history taken by Innis become much more complicated with computer media, many of his arguments remain useful. They do not provide the totalising theory of civilisation that Innis sometimes suggests, but rather offer the basis for a new theory of spatio-temporal media diversity that has emerged since his time. The monopolies of communication maintained by search engines, software standards and silos of copyrighted content are different from those created in other media, but have generated a reconfigured media space that Innis would no longer recognise.

In many ways, the invention of computers responded to concerns about the neglect of time, as expressed by Innis and others. The outcome has been a heterogenising of temporalities with a diverse range of digital media including many different bitstreams, databases and software environments. The proliferation of computers has been sustained by the globalisation of production and the mass consumption of microelectronic components and programming. The diversity of cultural forms associated with digitisation draws on this pattern of trade as much as the material and informational complexity of the devices themselves. Paradoxically, digitisation has ultimately increased the risk of data loss, whether through catastrophic failure or gradual deterioration. Innis's key contribution to communications theory — analysing the materiality of dominant media to understand something about the wider culture of the global community — remains surprisingly relevant.

References

BBC News. (2000). Old computers lose history record [Electronic Version]. *BBC News*. Retrieved 16 July 2007 from http://news.bbc.co.uk/2/hi/science/nature/654116.stm.
Brand, S. (1999). Escaping the Digital Dark Age. *Library Journal*, v124 n2 p46-48 Feb 1 1999.
Burnett, R., & Marshall, P. D. (2003). *Web theory: an introduction*. London; New York: Routledge.
Castells, M. (1996). *The rise of the network society*. Cambridge, MA: Blackwell Publishers.

Ceruzzi, P. E. (1998). *A history of modern computing*. Cambridge, Mass: MIT Press.
Chesher, C. (2002). Why the Digital Computer is Dead. *CTheory.net. Journal*. Retrieved June 6, 2009, from http://www.ctheory.net/articles.aspx?id=334.
Condra, L., Anissipour, A., Mayfield, D., & Pecht, M. (1997). Electronic Components Obsolescence. *Components, Packaging, and Manufacturing Technology, Part A, IEEE Transactions on*, 20(3), 368-371. doi: 10.1109/TCPMA.1997.623032.
Deleuze, G. (1992). Postscript on the societies of control. October, 59, 3-7.
Deleuze, G., Guattari, F. & Massumi, B. (trans) (2004). *A thousand plateaus*, Continuum International Publishing Group.
Derrida, J. (1996). *Archive fever: a Freudian impression*. Chicago: University of Chicago Press.
Di Norcia, V. (1990). Communications, time and power: an Innisian view. *Canadian Journal of Political Science, 23*(2), 335–357.
Frost, C. (2003). How Prometheus is bound: applying the Innis method of communications analysis to the internet. *Canadian Journal of Communication*, 28(1).
Grey, G. (2001). UNIVAC I: The First Mass-Produced Computer. *Unisys History Newsletter, 5*(1).
Guattari, F. (1995). *Chaosmosis: an ethico-aesthetic paradigm*. Sydney: Power Publications.
Havelock, E. A. (1963). *Preface to Plato*. Cambridge: Belknap Press, Harvard University Press.
Heim, M. (1987). *Electric language: a philosophical study of word processing*. New Haven: Yale University Press.
Heim, M. (1993). *The metaphysics of virtual reality*. New York: Oxford University Press.
Hellsten, I., Leydesdorff, L., & Wouters, P. (2006). Multiple presents: how search engines rewrite the past. *New Media Society, 8*(6), 901-924.
Heyer, P. (2003). *Harold Innis*. Lanham, Md: Rowman & Littlefield.
Hillis, D. (1998, February 1998). Public Session: Panel Discussion. Paper presented at *Time & Bits: Managing Digital Continuity*, Getty Center, Los Angeles.
Innis, H. A. (1940). *The cod fisheries: the history of an international economy*. New Haven, CT: Yale University Press.
Innis, H. A. (1962). *Fur trade in Canada: an introduction to Canadian economic history*. Toronto: Univ of Toronto Press.
Innis, H. A. (1972a). *A history of the Canadian Pacific Railway* ((1st ed.). Newton Abbot: David and Charles.
Innis, H. A. (1972b). *Empire and communications*. Toronto: University of Toronto Press.
Innis, H. A. (1991). *The bias of communication*. Toronto: University of Toronto Press.
Innis, H. A. (2004). *Changing concepts of time*. Lanham, Md: Rowman & Littlefield Publishers.
Innis, H. A., & Christian, W. (1980). *The idea file of Harold Adams Innis*. Toronto: University of Toronto Press.
Innis, H. A., & Drache, D. (1995). *Staples, markets, and cultural change: selected essays* (Centenary ed.). Montreal; Buffalo: McGill-Queen's University Press.
Kirschenbaum, M. G. (2004). Extreme inscription: towards a grammatology of the hard drive. *TEXT Technology*. Retrieved 2, 13, from http://texttechnology.mcmaster.ca/
Kittler, F. A. (1990). *Discourse networks 1800/1900*. Stanford, California: Stanford University Press.
Kittler, F. A. (1999). *Gramophone, film, typewriter*. Stanford, California: Stanford University Press.

Kittler, F. A., & Johnston, J. (1997). *Literature, media, information systems: essays*. Amsterdam: GB Arts International.
Kuny, T. (1997). *A Digital Dark Ages? Challenges in the preservation of electronic information. IFLA Council and General Conference Workshop: Audiovisual and multimedia joint with preservation and conservation, information technology*, *library buildings and equipment, and the PAC core program.* Copenhagen, Denmark. Retrieved August 11, 2007.
Latour, B. (2005). *Reassembling the social: an introduction to actor-network-theory*. Oxford: Clarendon.
Libraries and Archives Canada. (2007). Old messengers, new media. The legacy of Innis and McLuhan. from http://www.collectionscanada.ca/innis-mcluhan/index-e.html
Manovich, L. (2001). *The language of new media*. Cambridge, Mass.; London: MIT Press.
McLuhan, M. (1994). *Understanding media: the extensions of man* (1st MIT Press ed.). Cambridge, Mass.: MIT Press.
Ong, W. J. (1988). *Orality and literacy: the technologising of the word*. London; New York: Routledge.
Rossiter, N. (2004). Creative Industries, Comparative Media Theory and the Limits of Critique from Within. *Topia*, 11, 21.
Rothenberg, J. (1995, January 1995). Ensuring the longevity of digital documents. *Scientific American, 272,* 42-48.
Scholz, T. (2007, April 4). What the MySpace generation should know about working for free - Trebor Scholz 'journalisms' - Collectivate.net. *Collectivate.net.* Blog. Retrieved June 5, 2009, from http://www.collectivate.net/journalisms/2007/4/3/what-the-myspace-generation-should-know-about-working-for-free.html.
Turing, A. M. (1936-7). On computable numbers, with an application to the Entscheidungsproblem. Proceedings of the London Mathematical Society, Series 2, 42, 230-265.
Watson, A. J. (2006). Marginal man: the dark vision of Harold Innis. Toronto: University of Toronto Press.
West, J. (2003). How open is open enough? Melding proprietary and open source platform strategies. *Research Policy*, 32(7), 1259-1285.
Woods, K. (2004). Congo Coltan: Cellular Communication Connecting to Conflict. Initiative on Labor and Culture. *Work and Culture* Working Papers. Retrieved from http://www.yale.edu /laborculture/work_culture.html

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