Time & Society

Time in the Age of Complexity

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ABSTRACT. Technically-mediated forms of interconnectivity and communication are sustaining complex arrangements through which are emerging more dynamic and interdependent physical-digital relations. This article examines the intensification of time through the lens of complexity theory and argues that increasingly networked infrastructures are moving towards an integrated global complexity in real-time. I suggest that shifts in physical-digital temporality are having a significant effect upon how the 'social' is being reconfigured. KEY WORDS • complexity • ICTs • networks • real-time

Introduction

The 1990s saw the social sciences engaging with complexity in terms of books, articles, conferences, and workshops, leading some to label this more modern incursion into the social and cultural sciences as the 'complexity turn' (Urry, 2005b). This *turn* resulted from a gradual shift in discourse, over several decades, away from mechanistic Newtonian epistemologies towards systemic thinking (Capra, 1985). The systems thinking to emerge in the 1950s came out of cybernetics and was characterized by being open and sustained through flows of energy, rather than the earlier forms of closed systems. And systems thinking, the language of process over structure, began to be informed through new discoveries in the natural sciences. Discourses in the social sciences too began to be more transdisciplinary as solutions to social phenomena were sought from more and varied sources. It became necessary to find ways to understand and evaluate increasing patterns of conflict, unpredictability, flows, dynamic equilibrium,

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breakdowns, breakthroughs, and transnational relations. Approaches that proposed linear analysis and closed systems thinking became increasingly unsatisfying in providing means to interpret accelerating global flows, as well as more mobile social interrelations. Social science found itself increasingly lacking in its ability to analyse patterns of non-causality, where small anomalies or impacts can result in large-scale shifts; where multiple actors/parts can create emergent 'whole' effects greater than the sum of its parts; where phases of equilibrium are maintained not through stability but dynamic instability or 'order through chaos'; where contradictions work as part of a system; and when decentralized and bottom-up processes are increasingly becoming more effective against top-down hierarchical structures. Thus, the complexity sciences at this time emerged as a potentially significant tool for social science to better grasp and contend with these issues. According to a major report from the Gulbenkian Commission:

> Perhaps we are witnessing the end of a type of rationality that is no longer appropriate to our time. The accent we call for is one placed on the complex, the temporal, and the unstable, which corresponds today to a transdisciplinary movement gaining in vigour. (Gulbenkian Commission on Restructuring the Social Sciences [GCRSS], 1996: 79)

Complexity science not only resonates well with traditions of the social sciences, it also helps to bridge the gap between the natural and the social sciences, between disciplines and fields of knowledge. It encourages, and in some way demands, a shift to systemic thinking. Complexity also urges a break from mechanistic, linear, and causal methods of analysis towards viewing interdependence and interrelation rather than linearity and exclusion. Processes, flows, feedback cycles, fluctuations, networks, order from chaos, and dynamism are all features of the complexity sciences.

These phenomena are not new, yet it is timely that they are being recognized and deployed within analyses of social/global flows (Byrne, 1998; Thrift, 1999; Urry, 2003, 2005a; Chesters, 2004). Complexity allows for modelling a future world that is unpredictable, uncertain and often on the fringes of instability, while also maintaining adaptability, uration, and non-randomness. It is appropriate then that complexity and chaos theories have earlier origins in weather mapping and prediction, just as the flapping butterfly wing is tied in with avalanches (Mackenzie, 2005). Complexity views the physical world not as a set of consecutive, linear relations between things but rather as a pluralistic network of relationships that exhibit dynamic, creative, complex behaviour that cohere to a set of simple yet non-determining laws. As systems become progressively more complex they display behaviour that shows them to be more vulnerable to change and perturbations in the environment. In other words, they react more noticeably to small external fluctuations, which can lead to system instability.

Such instabilities, if not righted, can lead to the breakdown of the system and its eventual collapse. However, a system that is unable to maintain its stability within its present structure has an alternative other than breakdown – it can breakthrough. Complexity not only implies that global processes are sustained through multiple interconnectivities, but also that events, whether local or global, do not exist in isolation but produce effects through non-linear interrelations.

Debates on social complexity are now beginning to involve the interrelation of physical phenomena, and to account for the flows and patterns that determine non-linear behaviour. In this sense complexity becomes 'apparent'; that is, it materializes through dynamic flows and through behaviour, rather than as a fixed network. Within the social sciences especially complexity is seen as breaking down the dichotomies of order or chaos, of stasis or change, to produce a hybridization of processes that can exist in both order and chaos, with both pattern and uncertainty (Prigogine, 1997). Prior to notions of global complexity (Urry, 2003, 2005a) complex features were being played out on a global stage, in terms of flows rather than territorial solids and structures. In this way the complexity sciences arose at a time when overlaps between new sociocultural shifts were emerging in the previous two decades, especially in terms of an interconnected 'network society' (Castells, 1996), as well as cosmopolitanism and trans-nationalism (Beck, 2002). As Urry notes, this is a '''smooth world'', de-territorialized and decentred, without a centre of power and with no fixed boundaries of barriers', which leads Urry to conclude that 'all is movement' (Urry, 2005a: 2). Flows of information, people, goods, money, the material forms of circulation that embody complex social and political mechanisms (Appadurai, 2001) are areas that are open to analysis through complexity science. Similarly, the rise and fall of social revolutions has been viewed through a complexity lens (Artigiani, 1987, 1991).

This article addresses how emerging environments of embedded physical-digital networks, and increasingly wireless connectivity, are informing new complexities in relationships of time and space. I also discuss shifts towards ubiquitous 'everywhere' computing and digitally-embedded environments where complex interrelations and interdependencies between person-object-environment in-form a more pervasive complex system. Such complex arrangements are incorporating increased awareness, reflexivity, creativity, and inclusion. Further, that these developments in informational connectivity and pervasive computing are having a significant effect upon notions of temporality, such as the shift towards merging 'real-time' into physical-digital relations. While facilitating mobility these 'real-time' complex configurations may also manifest contestations of power.

This article focuses specifically on the technologies of communication that are reconfiguring relations of connectivity, communication, and time. I also examine how these increasingly pervasive computerized networks are in-forming sites of complex 'real-time', and what this real-time implies for both mobility and power. I turn now to examine temporal considerations within a framework of complex in-formations of information technologies and ubiquitous computing.

Complexity, Time and Technologies of Communication

Temporal and spatial considerations have become more intimately enfolded within the increasingly networked communication infrastructures of, predominantly, technically developed territories. In these networks there is a shift towards increased non-linear, dynamic, and complex networks of connection and communication. Due to the inheritance of a classical Newtonian, and largely western, conception of ingrained industrial time (Adam, 1990, 1998), a linear and sequential understanding and lived experience of time has been the dominant model. In a global environment that is becoming increasingly connected by economic, political, and technological flows the concepts of complexity, which view minor fluctuations as potentially resulting in major and widespread consequences, ask for a timely re-evaluation of a linear, sequential notion of time. Thrift argues that the 'metaphors of complexity theory make it easier to think about *time* in new ways . . . and especially the structure of the future as open, as full of possibility and potentiality, even as pliant' (Thrift, 1999: 56). This recognizes that complex processes are often connected with a '*future*': that is, dynamic states far from equilibrium that shift towards order can also be said to be moving in a directionality that supposes a future state. Since this future state is never wholly predictable, it levers open the door to possible futures, rather than suggesting a more static present time.

Concepts of complexity recognize the reconfiguring of time that embodies the notion of possible unpredictable future(s): not the past or the never-present, but the flows of change, dynamism, and diversity within webs of relationships and patterns of (re)forming order. For complexity, events are often non-linear and relationships form within shifting contexts that are irreversible. The latest investments are in innovative technologies that can self-organize their software and reprogram themselves according to adaptive need. Many of these developments are in the area of nanotechnology/molecular engineering (Drexler, 1990; Mulhall, 2002; Jones, 2004), and bio-mimicry (Benyus, 2002),[1] and envision possible artificially engineered future(s) based around biology. These scenarios, while not agreeable to all, forecast communication systems that will slowly become embedded within living molecular networks. Biological time, seen in terms of inner circadian rhythms (Adam, 1990; Loye, 2000),[2] might also form a part of the technological environment. It has already been hypothesized that time is accelerating towards a singularity (Vinge, 1993; Kurzweil, 2003), with accelerating returns becoming more widely accepted within both sociocultural and economic trends (Arthur, 1994; Arthur et al., 1997). Emerging insights into biological, physical, and chemical processes, as constructs of complex phenomena, have brought a new bearing onto how social theory must deal with time (Adam, 1990, 1995, 1998).

Urry sees time-space within global complexity as being compressed and folded into 'roaming hybrids' such as nanosecond instantaneity and commodified futures, as well as fragmented through automobility (Urry, 2003: 72). And Prigogine asks: 'Why does a common future exist at all? Why is the arrow of time always pointed in the same direction?' (Prigogine, 1997: 162). These irreversible trends of complex timescapes can be encapsulated within attempts to synchronize a global temporality, through such means as the Global Positioning System (GPS)[3] as well as the recent European Union Galileo positioning system,[4] which will rival GPS (controlled by the US military), and the Russian GLONASS.

With the advent of satellite positioning technology both location and distance can be calculated using radio signals that travel between the satellite transmitters and their ground-based receivers. In this way time, space, and location can become synchronized, compressed, and commodified into useable data. GPS thus,

> allows time synchronisation to better than a millionth of a second, which is useful for co-ordinating bank transfers and other financial transactions. The Global Positioning System consists of 24 satellites orbiting about 11,000 miles above the Earth, arrayed so that any spot on the planet is visible to at least six of the satellites at any time. Each satellite carries four atomic clocks on board, synchronised within a billionth of a second of one another by the master super-clock in Boulder. (Strogatz, 2003: 119)

Global positioning, as part of the accelerated convergence of systems of communication and connection, are not only forming complex webs of information flows but also compressing spatial and temporal distances ever closer towards an 'instantaneity event'. The new synchronized global heartbeat, Mitchell tells us, is speeding up:

> electronic vibrations subdivide seconds into billions of parts . . . calibrate GPS navigation systems, regulate power distribution and telephone systems, measure and commodify both human and machine work, and precisely construct the accelerating tempos and rhythms of the digital era – coordinated, where necessary, by a central atomic clock . . . seconds, milliseconds, microseconds, nanoseconds, picoseconds: the electronic global heartbeat keeps quickening and gathering power. (Mitchell, 2003: 12)

This technological atomic/satellite synchronization of time is the latest stage of social ordering that reached a previous height of calculability through clock time. The clock, as a physical representation of time, has been a metaphor of order, regularity, and authority within modern Europe for several centuries (Adam, 1990). Industrial urban life was so structured around the punctuality of clock-time that Simmel notes how 'if all the watches in Berlin suddenly went wrong in different ways even only as much as an hour, its entire economic and commercial life would be derailed for some time' (Simmel, 1997: 72). As sociologist Norbert Elias notes: 'By the use of a clock, a group of people, in a sense, transmits a message to each of its individual members. The physical device is so arranged that it can function as a transmitter of messages and thereby as a means of regulating behaviour within a group' (cited in Mackenzie, 2002: 93). As Elias stresses here, the clock is more than a time-device; it functions to regulate group behaviour. In this manner, the clock/watch can be seen to frame the social customs and etiquette of the wearer, similar to how the modern RFID (Radio Frequency Identity) tag constrains and modulates monitored offenders. In like manner, 'hearing or seeing a clock has become less important than the clock's often invisible and silent infrastructural role in directly regulating and synchronizing other technical elements, and indirectly coordinating disparate elements of a collective' (Mackenzie, 2002: 109). Time is now becoming evermore concerned with the *where* rather than the *what* – 'The watch does not tell you the *time*; it tells you *where* you are . . . globalization of location' (Virilio cited in Mackenzie, 2002: 91). The atomic clock of GPS 'affords an image of completion of globalisation' (Mackenzie, 2002: 91) that, according to Virilio, leads to a 'globalization of location'. Time use is being shifted away from locating an individual within the day towards locating a particular individual in terms of specific location and identity. This shift into identifiable timescapes has serious implications for personal privacy involving both state and commercial surveillance strategies, to which I shall return.

To illustrate developments in commercial satellite projects, in 1994 telecommunications entrepreneur Craig McCaw joined forces with Bill Gates of Microsoft to fund McCaw's vision of what he saw as the 'Internet-in-the-Sky' – known as 'Teledesic'. In 1994, Teledesic applied for an FCC license to build, launch, and operate a range of 844 satellites in Low Earth Orbit (LEO) to 'reinvent networking, global access, and even the global telecommunications infrastructure' (Pelton, 2000: 77). Through the infrastructure of these 844 satellites the company envisioned linking all possible homes to the Internet, to transmit the majority of business video conferencing, as well as doubling as a phone operator in such underdeveloped areas where there were no existing phone facilities. Its objective was to provide affordable access to global network connections, especially to those regions that would not otherwise have the capacity to. Teledesic promotes itself as a local service that is provided through a global network to create 'the vision of a Global Information Infrastructure to all the world's citizens' (Kohn, 1996). Such a 21st-century global broadband satellite system proposes a new perspective upon a networked future. As telecommunications guru Joseph Pelton writes: 'already, satellite systems such as Orbcomm, INMARSAT, American mobile, Telesat mobile, Globalstar, and Satellife provide a global internet interconnectivity to mobile or semi mobile terminals. Within the next five years the number of mobile satellite systems allowing Internet links will mushroom tremendously' (Pelton, 2000: 32). This mushrooming of connectivity will certainly lend itself to a complexity framework in that traditional land-based networks will be enlarged via a potential 'Internet-in-the-sky' with emergent features of instantaneity and co-presence within digitalized timescapes.

Despite these initial efforts by the Teledesic consortium it was unable to secure its initial goals. The commercial failure of rival systems Iridium and Globalstar demonstrated the ambitious scale of the 'Internet-in-the-sky' project, and commercial considerations finally forced Teledesic to officially suspend its satellite project on 1 October 2002.[5] However, the vision and the design of this venture remains active and still under discussion, as well as being a military-funded project.[6] The airwaves are still very much contested military and civil spaces of satellite strategies for positioning *bodies* within time, space, and movement. As a case in point the European consortium behind Galileo, which also involves China, India, and Israel, is based on a constellation of 30 satellites in constant communication with ground stations in order to be able to provide information on vehicle location, real-time navigation, speed control, and potentially pay-as-you-go cost tracking. There are currently designs and plans to establish a complex web of communications including short range car-to-car communications merging with cellular and RFID transponders interfacing with satellite and state transport data systems (Bell, 2006). Once Galileo becomes operative it will facilitate a tremendous shift not only in how transport mobilities and movements are organized and managed, but also in how information and privacy will become hotly contested within conveniences of 'real-time' information and navigation. This is one of the areas where complex networks may add to debates on how power relations may coerce how particular social classes experience time.

It is possible to view complex social systems as becoming increasingly rendered as sophisticated technological artefacts, linking horizontal and vertical mobilities into networks of real-time access or blockage. Such complex systems, the more they integrate social practices into lived experiences of mobility and real-time information, may play out to particular institutional and/or policy agendas. For example, Graham argues that premium networked spaces are opening up that divide the social fabric into privileged access – these spaces are 'the results of the *strategies* of coalitions of interests within the contested and highly complex geopolitical and governance contexts of their respective cities'

(Graham, 2004a: 228). Complex systems that seek to converge a myriad of flows, from personal information, daily in-car satellite navigation, to road tax, more and more become custodians over social practices of mobility and movement (Graham, 2002, 2004a; Graham and Marvin, 2001). Time then is likely to be experienced differently if there are agendas tied into privileged movements. A simple example could be that those people who have invested in satellite in-car navigation will experience the time of the journey differently from a person whose movement is less directed. At the other end of the scale social discourses may be construct around the pre-screening of mobile individuals, with privileged access being granted to the so-called 'kinetic elites'; or rather, the time-poor cash-rich and those deemed 'low-risk'. This notion of a kinetic elite 'is leading to an increasingly coded or software-sorted society and "splintered" urban landscape characterized by highly differentiated mobilities' (Wood and Graham, 2006: 178). The convergence of movement into real-time may necessitate the need to prioritize access to that very same 'real-time'. It appears that the more temporal relations are complexified, the more the relations have to be socially managed.

Space is becoming transformed into digitalized co-presence, shared moments across physical distances, as well as an increasingly contested region to move through. Time is being reconstituted into a coordinate within complex geographical webs that can be tracked, located, and guided. Time within a social context is increasingly becoming kinetic, dynamic, and part of the emerging 'always-on' complexities of modern life that incorporate a capacity to merge, and move between, both physical and digital geographies, through relations of connectivity, communication, and information. And increasing complexification in relations between technology and the environment – in the form of ubiquitous computing – is pushing 'real-time' further into our daily lives.

The Complexities of Real-time Computing

Technological change is fundamentally altering how a person is located within time, space, and environment. And these processes are increasingly dynamic as they shift relations within systems beyond the individual such that 'what matters is not technology itself, but its relationship to us' (Brown and Weiser, 1996). Developments in computerization have taken relationships away from fixed locations as in the stand-alone PC, to laptops that could be carried around, to wireless PDAs, to Internet connectivity on mobile phones. This trend in distributed computing is reaching a tipping-point, as complexity would say, towards a shift to ubiquitous computing where associations between people, place/space, and time will become embedded within a systemic relationship between a person and their moving environment. This shift referred to as the 'third wave of computing is that of ubiquitous computing, whose cross-over point with personal computing will be around 2005–2020' and will become 'imbedded in walls, chairs, clothing, light switches, cars – in everything' (Brown and Weiser, 1996).

In a seminal essay from 1996 computer engineers John Seely Brown and Mark Weiser coined the term 'ubiquitous computing' and envisioned the 'social impact of imbedded computers may be analogous to . . . electricity, which surges invisibly through the walls of every home, office, and car' (Brown and Weiser, 1996). Within a decade from this pronouncement computing has evolved from fixed locations of access to an increased wireless presence. And it is predicted to become ever more ubiquitous in a manner that will dissolve it into physical surroundings, making itself almost invisible, forming complex interdependencies of information flows as part of an embedded environment (Greenfield, 2006). Here, a technically augmented environment becomes interlinked with sensoring devices to form a complex feedback-responsive physical-digital system. Such an integrated system of person-information-environment, if it were to materialize, would accelerate temporal differences between multiple sites of information and have significant implications for the social. In this context, social theorists have yet to register the extent to which complex communicative webs may impact upon and transform variegated social experiences of time. While this increased complexification of interrelationships would foster ties of convenience it may also in-form greater entanglements of responsibility and control since an 'always-on' flow of information would keep users tied into obligations and schedules. Yet, as Greenfield (2006: 163) writes, the 'sheer complexity of ubiquitous systems' is yet to come. In order to balance any criticisms of technological determinism, it should be pointed out that complexity does not guarantee any predicted end-state, as complex relations undergo their own dynamic adaptations in an environmental context. A case in point here would be that of the mobile phone's short message service (SMS) that unexpectedly developed from a maintenance engineering convenience to a fully-fledged social phenomenon (Rheingold, 2003).

One area currently undergoing intense development is to transform the complexity of real-time events, such as traffic management, into instant on-demand streaming. One of these projects is Microsoft's 'Senseweb'. Senseweb aims to stream real-time traffic conditions direct from static and mobile webcams (to use the infrastructure of state transport camera systems) to give users a visual rendition of local conditions. This will be supplemented by up-to-the-minute information on the availability of local parking spaces, local petrol prices, as well as temperature forecasts. Other information to be included will be real-time data streamed from participating restaurants, via a device linked to Microsoft's central database, giving information on seating spaces and waiting times (Greene, 2006). Eventually it is hoped that Senseweb's North American service will be incorporated into Windows Live Local (Microsoft's 'Virtual Earth' online mapping platform): ‘By tracking real-life conditions, which are supplied directly by people or automated sensor equipment, and correlating that data with a searchable map, people could have a better idea of the activities going on in their local areas’ (Greene, 2006). At present the major software companies, such as Google and Yahoo, are racing to produce a prominent online mapping platform that will utilize real-time data streaming in order to assist mobile navigation. Of course, these developments are highly corporate and indicate the rush of major company players to benefit from the economic assets involved in these real-time markets.

In a similar project, Carlo Ratti of MIT’s ‘SENSEable City Laboratory’ has been working on what is termed *Real-Time Rome.*[7] The project aims to collect data from mobile phones (via Telecom Itali’s innovative Lochness platform), from buses and taxis in Rome, in order to better map and understand urban dynamics in real-time. By having real-time movements and connectivity being mapped, the project hopes to use this information to help individuals be more aware and informed about their environment. The city in this scenario is dynamic in real-time in terms of where people are, the places where you can go and get a drink, and the location of tourists and the concentration of different nationalities in the city. While this may certainly lead to informing a better understanding of space that is emerging, and has implications for urban design and planning, it also relays anxiety about civil rights and individual privacy. Complex entanglements of movement, time, and connectivity are as yet elements within young technologies that are open to multiple uses whether benevolent or clandestine. As dynamic complexity would say, everything remains in flux.

At the time of writing numerous examples abound of mobile technologies that use the phone with GPS device (in-built or separate) that visually map a user’s movements. In this seemingly complex arrangement of information, a user’s whereabouts are logged instantaneously onto digital mapping platforms that inform readers of current locations and accessibility of the user. This is an upgraded variation of online social networking platforms that relay information of when a current friend is in the neighbourhood. This is a move in real-time from blind-location to contactability ‘on-the-go’ that facilitates, and in many cases encourages, connections during a person’s daily fluid movements. Temporal differences once adhered to as structures are becoming more fluid as availability and transparency gradually replaces *interruptions*.

An example of where transparency has proved necessary within a person’s daily complex relations is in the case of researcher and artist Hasan Elahi. Elahi was detained and questioned by the FBI over his whereabouts on 12 September 2001 due to his ‘Arab appearance’ and his fluid lifestyle.[8] Despite showing his Blackberry phone with its appointments he was subjected to several intense interviews and nine polygraph tests over several months before being ‘cleared’ of any wrongdoing. After this experience Elahi decided to call 'his' FBI agent before every trip he made in order to supply the route and provide transparency. This arrangement then shifted towards real-time in that Elahi turned his mobile phone into a tracking device that he wears to report all his movements onto a map.[9] He also documents his life in a series of photos for all to witness, including the places he passes through, the meals he eats, and the bathrooms he uses. Other lifestyle records, such as banking records and purchases, are also flagged and made available. This form of self-surveillance not only serves as an art form but is also a means to create an ongoing, fluid alibi through making transparent all the complex entanglements that a physical-digital lifestyle entails. Here is an instance where pervasive communication technologies are integrating experiential time into the *now.* And ubiquitous computing that may one day be analogous to electricity, which surges invisibly through our lives, may thrust the entanglements of time, space, and location into ever greater complex systemic wholes.

Time 'Everyware'

Current metaphors, themes, and trends like to popularize notions of temporal-spatial intensity and acceleration mediated through technological innovation. Images of the world are steering towards a deliberate and more accurate representation of the real world, as computerized representations and collected data in-forms our environments. In keeping with this scenario the future could look like the following:

> In 15 years, we are likely to have processing power that is 1,000 times greater than today, and an even larger increase in the number of network-connected devices (such as tiny sensors and effectors). Among other things, these improvements will add a layer of networking beneath what we have today, to create a world come alive with trillions of tiny devices that know what they are, where they are and how to communicate with their near neighbours, and thus, with anything in the world. Much of the planetary sensing that is part of the scientific enterprise will be implicit in this new digital Gaia. The Internet will have leaked out, to become coincident with Earth. (Vinge, 1993)

What Vinge refers to as the new digital Gaia is a global planetary sensoring networked through an upgraded Internet that has 'leaked out' into a human convergence. In this highly techno-eulogized vision the human thus becomes a player within the feedback loops and informational processing of a truly global complex system.

In this scenario ubiquitous computing will be part of the social and natural environment as sensor microprocessors are lodged into everything from Nature, to buildings, to household objects, in such a way that it will become a pervasive presence. Greenfield considers this to be, in one form or another, an inevitability, and refers to this ubiquitous computing (ubicomp) paradigm as 'everyware': 'Everyware is information processing embedded in the objects and surfaces of everyday life . . . the extension of information-sensing, -processing, and -networking capabilities to entire classes of things we've never before thought of as "technology"' (Greenfield, 2006: 18). Greenfield writes that this state of ubicomp is one where information is made accessible at any point in space and time upon requirement such that social relations are enmeshed within an enveloping field of information that is more than the sum of its parts. By this Greenfield suggests that emergent effects are likely from the ubicomp environment as a person's relations with their environment becomes more whole, interdependent, and within a continual flow. The result being that 'Where everyware is concerned, we can no longer expect *anything* to exist in isolation from anything else' (Greenfield, 2006: 128). Users, Greenfield asserts, will see their transactions with everyware as being essentially social in nature yet remaining dynamic, unpredictable, and forming multiple networks:

> Before they are knit together, the systems that comprise everyware may appear to be relatively conventional, with well-understood interfaces and affordances. When interconnected, they will assuredly interact in emergent and unpredictable ways. (Greenfield, 2006: 141)

While this is seen as a technically feasible scenario it does not take into account how social practices will adapt and/or appropriate particular socio-technical devices. Nor does it distinguish between the privileged users and those splintered by such technologies (Graham and Marvin, 2001). Also, by taking a complexity approach to these developments we are reminded that systems often manifest unforeseen and unpredictable consequences in the face of changes, as well as creating 'normal accidents' (Perrow, 1984).

Recent literature on place/space/time technological convergences seem to show complex relations with one's environment taking on emergent properties and acting as an inclusive temporal-spatial networked social habitus. As a caveat Greenfield does warn that 'everyware' has the potential for clandestine state use for monitoring and tracking, and urges that the choice to be 'on the Net' should always be a voluntary one. Yet with such predictions of an increasingly sensored and enmeshed environment it is difficult to see how living 'off the Net' will be a choice. The dark future of a digitized and complex Orwellian panopticon still lingers furtively around the corner.

Whether or not these scenarios come to fruition present trends appear to indicate, in technically developed regions at least, an increased complexification of interrelations with daily objects and a person's immediate social environment. This will consist of multiple information flows, technically-mediated points of reference, and increased interactions with 'things', mediated via information-processing devices. Daily dealings with physical objects and routines are likely to be increasingly replaced by dealings with bits and flows of information. This seemingly can only lead to a further compression of time and space that was characterized as an early feature of globalization (Beck, 1998; Robertson, 1992; Urry, 2003). The emerging global complexity that is converging physical-digital scapes is thus also intensifying sites of place/space and time.

Conclusion

What I have argued as constituting complexity theory within the social sciences involves an increase in the density of relations between sites of connectivity and the multivalent paths of interdependencies. This density of physical/digital relations establishes complexity as a phenomenon capable of existing beyond metaphor and as a model in which to interpret the condition of contemporary social relations. The position of complexity emphasizes not so much structure but rather processes, and is more in line with earlier process-thinking (Whitehead, 1929), systems philosophy (Laszlo, 1972), and post-Cartesian epistemology (Capra, 1985, 1996; Goerner, 1999). It is also an amalgamation of modern theories on networked communications (Castells, 1996, 1997, 1998; De Kerckhove 1998; Dijk, 1999); social/global complexity (Eve et al., 1997; McLennan, 2003; Urry, 2003, 2005a), and pervasive ubiquitous computerization (Vinge, 1993; Butler, 2006; Greenfield, 2006). This mix of theoretical disciplines is exerting influence upon what constitutes the 'social' and involves the compression of time and space:

> Neither time nor space seem to exist as distance between places and moments. Time as distance has become replaced by relationships, fundamental action, and the 'trying out' of all possibilities before actualisation. (Adam, 1990: 59)

Distances are transformed into sites of co-presence as relationships weave connections over and beyond temporal barriers. In fact, such knowledge has 'changed our understanding and the meaning of physical reality . . . with the result that *all of nature is emerging as fundamentally dynamic*' (Adam, 1990: 89, emphasis in original). It can be stated that with an increasingly complex and interdependent geopolitical world stage shifting towards new understandings, connections, and relationships, it is crucial that perceptions and language are re-evaluated to facilitate an environment that is 'fundamentally dynamic'.

Those who support and advocate ubiquitous computing see it as shifting distributed connectivity towards a pervasive ever-present fabric, embedding itself invisibly around us much like electricity, and as such dramatically altering conceptions of time and space. Time in an age of this type of complexity is likely to be managed 24–7, whether personally or through digitized devices and assistants. Complex systemic relations of person-information-environment may enmesh the *social* into 'converged locatedness' that incorporates time, space, and positioning. In such an arrangement we would carry our *self* around with us as mobile units, always available, semi-transparent, and operating within a real-time that is open to all those who access our information/location.

I have argued in this article that social theory should not only register complexity as a relevant lens in which to view the 'social' but also that such a reconfiguration of the social involves interdependent dynamics that are increasingly a part of socio-technical systems that incorporate various structural relations of power. To illustrate, personal mobilities, communication/information flows, digitized and coded spaces (Thrift and French, 2002; Graham, 2004b, 2005) and urban scapes in particular regions can potentially become meshed into a multi-levelled yet pervasive field that will encapsulate, construct, and conceptualize the 'social' increasingly in real-time. If this occurs then it will transform how movement is enacted through socio-technical systems in relation to the real-time location of a person within digital time-space co-ordinates. This is not to imply that codified and complex mobilities will become a forced practice of coercion, or that such social passages will necessarily be uncomfortably noticed by the general legitimized user. The organization of complex mobilities, and in-built strategies of marginalization, may be rendered as *normalized* social practices, ever ubiquitous and seemingly rationalized as tools of convenience, efficiency, and effective management. As Wood and Graham argue, 'what is occurring is not a deliberate form of oppressive control but an institutional – bureaucratic obsession with function, with the smooth flow of goods and services, and with efficiencies of movement and transactional fluidity' (Wood and Graham, 2006: 182). It may simply be that in order to better manage the increasing complexification of social relations a more rigorous institutionalized framework may be applied. These are contexts and scenarios that require serious policy considerations and commitment.

To conclude, linear thinking may no longer be an effective mode of understanding multiple interrelations of time, place, and space within an increasingly interdependent geopolitical world. Complex social relations are unfolding that reconfigure sites of connection and imply increased intensities and densities in time-space correlations respectively. Perhaps social theory does not yet go far enough in accommodating these convergences towards a fundamentally dynamic reconfigured 'social'.

Notes

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1. Also known as 'bionics', bio-mimicry is the application of systems and methods that are found in nature to the study and design of modern technological systems.
2. Circadian: '*adj.* of or relating to biological processes that occur regularly at about 24-hour intervals, even in the absence of periodicity in the environment.' (Collins English Dictionary).
3. GPS was completed in its original form by the US Department of Defence, in 1994, for the purposes of providing the military with potentially the most sophisticated infrastructure for wireless location, for both surveillance and navigation.
4. For more information see http://ec.europa.eu/dgs/energy_transport/galileo/index_en.htm
5. For commentary on this decision see http://www.space.com/spacenews/archive03/teledesicarch_071403.html
6. See http://www.sciencedaily.com/releases/2002/04/020424073127.htm
7. See http://senseable.mit.edu/realtimerome/
8. Read account at http://www.worldchanging.com/archives/005105.html#more
9. See Elahi's site (http://elahi.rutgers.edu/)

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