From memory societies to knowledge societies: The cognitive dimensions of digitization

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On networks: The power blackout

On August 14th, 2003 around 4 o'clock in the afternoon, the power suddenly went off in one power station in the United States. A domino effect was felt throughout the electricity network, and in 9 seconds 61 billion watts were lost (Lovins 2003) and 50 million people were left without electricity in what constituted the largest blackout in North American history.[1]

Instantly, machines stopped humming with one last sigh; streetcars and subways stopped dead on their tracks; lights shut down; financial networks and their interface points—banks, ATMs, stock markets—became inoperative; and, information and communication networks, web and email servers, broke down.

Toronto, one of the cities affected by the blackout and home to the authors, came to a halt. Medium and large businesses were forced to close down because individual products are no longer physically priced but coded, hence requiring a barcode reader/decoder. Companies sent employees home for there was nothing they could do without their electronic extensions. Individuals turned to old mass media, such as battery operated radios, in order to gain some understanding of the situation at hand.

As the hours progressed two things became clear: our reliance on this invisible and infinitely malleable medium, and the mediated and networked character of modern life(s). It is not our intention here to find the culprits of such massive failure nor

[1] On September 28,2003 a similar event occurred in Europe this time leaving 58 million Italians in the dark after a tree fell down in the Swiss alps!

discuss its cause. Instead, we want to reflect on the architecture and design of the electricity network, using this as an example to understand the networked, knowledge society.

Networks are constituted by three main elements: technology, people and places. The technology represents the infrastructure of the network, the persons are those who control it, and the places are defined by nodes and hubs (Castells 1996; see also Stalder 1998). When put in place, however, networks create a space that although connected to the physical place, but is not dependent on it. Networks transcend place, transforming it into space.

In the case of the electricity grid, each power plant constitutes a node, a physical location, which is linked to others through the means of hubs. Hubs are located in strategic points. The various electricity plants are organized within an 'intelligent' network of hubs and nodes that is imbued with self-protection capabilities.

The advantages of this networked character are clear. If node X needs more power and node Y is not using its full capacity then power can be 'automatically' routed to node X. It is this design feature, the ability for self-regulation, that affords it with 'intelligence'.

But each node is also designed with a self-protection instinct. When a node is overwhelmed—by demand or any other cause—it shuts itself down, so as to prevent serious inner damage. However, due to the networks' self-regulating features, its traffic is immediately re-routed to another node. An endangered node has the ability to remove itself from the network, but it does not control its links and hubs. The hubs remain intact, hauling the node's responsibilities along and, in some cases, bringing other nodes down.

In a sense, the nodes are competing with the larger network, but are controlled by it. Their self-preservation feature competes with that of the global network, and their autonomy is subjugated to that of the larger body.

The domino effect that was felt on August 14th was a direct result of this tension between nodes and networks, autonomy and interconnectivity. It is indicative of a globalized world constituted by multifold social and technological networks. As László Barabási (2003) puts it, "unless we are willing to cut the connections, the only way to change the world is to improve all nodes and links."

When the electricity network fell it brought with it the failure of all the services and institutions that depend on it. Except in the infrequent cases where local power generators were available, access to financial networks and to information and communication networks was no longer possible. Even telephones and wireless communications, usually the last medium to go, worked only sporadically.

1. Electricity, the third language technology

Indeed, the world is one single electronic grid, whether we consider the power grid, the telephone, the audiovisual media or the internet. If the outage brings to mind

the practical importance of electricity, it should also cause us to reflect on its psychological, cognitive and social roles. Electricity, the only medium without a message (McLuhan 1964), is the third major language technology after speech and writing. It is also the basis of knowledge societies. Thinking itself is partially dependent upon an electrical activity. We have electricity in our bodies to drive our central nervous system. So there is a certain kind of continuity between our gestures and our tools, something that can be observed in children playing videogames, or in a person typing at a computer, for example.

Thus the encounter of electricity with language on the telegraph lines was perhaps the most powerful technological combination imaginable: maximum complexity, that of language, multiplied by maximum speed, the speed of light. The fruits of this union have produced new technologies at an ever accelerating rate to this day, and there is no sign of it abating.

The conquest of the world by electricity has gone through two major phases, analogue and digital. The analogue phase was entirely committed to the amplification and/or transportation of signal, whether for power generation, lighting, heating or communication. This sudden surge of power whipped the social body into new associations and configurations, changing production and distribution behaviors in markets and retribalizing nations and societies. This sudden acceleration of human activities was difficult to master giving way to global social upheavals which led to the first and second world wars.

The networked environment is a secondary elaboration of electricity, a more refined stage characterized by a greater degree of absorption of its effects in the social body. The increase of networks today reveals a new stage of maturation of the establishment of the electrical realm. We have evolved from a "broadcast society" to a "networked society". The growth of connectivity has been exponential since the invention of the telegraph. It is hard to resist the temptation to see a teleological pattern in the accelerating progress of electronic networking technologies. There is a kind of physics of connectivity, it grows along certain patterns at differing rates of speed. Two basic kinds of acceleration can, and do, happen particularly with respect to technological development: **linear** and **radial** acceleration.

1.1 Linear acceleration (connection and processing speeds)

Linear acceleration is that which regulates the speed of performance of any system be it a processor or a carrier of signals, a motor or a highway. If a computer runs a million times faster today than the early Apple II C, that has to do with linear speed. Just as the speed of processing of computer chips has picked up an exponential rate since 1946, the speed of delivery of networks has never ceased to increase dramatically since the invention of the telegraph:

1. 1844: telegraph: 5 bauds (1 baud = 1 bit per second)
2. 1876: telephone: 2000 bauds
3. 1915: twisted pair of copper wires: 30000 bauds
4. 1940: co-axial cable circuits: 7.6 million bauds

5. 1983: early fiber technology: 45 million bauds
6. 1996: early photonic technology: 100 billion bauds

In 1962, Telstar, the first commercial communications satellite, delivered 700000 bauds over a uniformly received footprint. To the wired environment, one must add the wireless communications which, since the invention of radio in 1901 have expanded the area accessed and covered by the signal distribution. Over-the-air signals create another condition of connectivity both one-way and two-way. Personal technologies such as the pager, mobile phone, PDA and RIM make potentially everybody accessible. At this level of connectivity linear acceleration changes to radial effects because of increasing interconnection.

1.2 Radial acceleration (interconnection)
Radial acceleration is that which measures the rate of increase in the volume of connections, or the traffic. In terms of configurations and number of connections, each new technology seems to have introduced a quantum leap:

i. The telegraph: city-to-city connections; people had to walk to the post office and wait in line for their turn. Cities were connected one-to-one and one-on-one. That could be considered as a rather low level of connectivity.

ii. The media - radio, television, and the press: One-to-many connection; have their own funneling pattern which reduces and condenses the flow of information down to the compressed sound-bite or the headline. This pattern encourages some interconnectivity at the information-gathering end but edits out much of the potential originality at the production time. The end result is to be broadcast (whatever the publishing medium) so that precludes interconnectivity.

iii. The telephone: individual location-to-individual location connections; The level of connectivity is considerably increased. While, the telephone does not "interconnect", it simply connects people one-on-one, it does offer at least a one-on-one return avenue for knowledge production.

iv. The internet: one-to-one, one-to-all, all-to-one, all-to-all, many-to-many, etc. The internet makes publishing instant and allows it to be selective; it allows any number of configurations of connections between people. It is the prime interconnector which is why it is called the INTERnet.

v. The World Wide Web: the web introduces yet another quantum leap because it not only interconnects the people as the internet does, but also the things people say, write, edit and display, word for word, image for image and sound for sound. The web is a single environment of collective and connective memory. It is collective by content, but connective by access, meaning that each individual must access it on his or her own terms, while the product of that access enters into the collective lore. The World Wide Web is already an emergent property of networks.

vi. The mobile/cell phone: all the interconnectivity modes afforded by the web and internet, plus a body-to-body connection, one no longer calls a place, but a person.

Penetration rates vary enormously among countries—although the greatest variation is between continents. For instance, the most connected European countries, Italy and Portugal, had penetration rates of 88.9% and 85.6% in 2002 (Jüptner 2002); overall Western Europe adoption rate stood at 75.2% in 2002 (eMarketer 2002). Africa, however, has an estimated 35 million mobile phone users in 2003, with only three countries—Morocco, South Africa, Egypt—having a penetration rate of over 10 per cent (Cellular Online staff 2003). The development and implementation of new services and technologies such as General Packet Radio Service (GPRS) which enables continuous wireless connection to data networks, mobile phones can be used to send and receive data over an internet protocol (IP) based network, facilitate the interconnection to a mobile internet.

1.3 Focused self-organization

All information and communication networks are brought together as the internet, the network of networks. The internet is based on an open architecture that allows it to grow exponentially. Much of what has happened on the internet has emerged in a self-organized fashion with the networks adjusting for challenges such as low bandwidth, crowding, censorship, viruses, spam and other calamities that have piled up upon it since its inception in 1967.[2] However the focus has always been provided by the rigor of the code. Networks function through the means of software. It is the software that standardizes them, allowing for communication across networks. It is this software that gives them shape, regulating the actions of those using them. Thus, networks are decentralized, but they are not uncontrollable. In the world of networks "code is law" (Lessig 1999). Code—constituted by hardware and software—effectively defines what can and cannot be done.

The example of the mobile phone network is illustrative here. The usage behavior of users can be regulated in many different ways. In Europe, for instance, mobile phone carriers charge less for calls within the same network, thus encouraging the expansion of their service. Until recently in Brazil text messages (Short Messaging System-SMS) could not be sent to networks other than the user's, effectively limiting the communication reach.

In the case of the internet the network itself is 'dumb' and the terminals that are located at the endpoints 'smart'. The network is programmed to carry anything to its endpoint by the fastest route possible. It does this automatically, re-routing if one of its components fails. "The intelligence of the network is concentrated at the endpoints, the personal computers and servers at the terminus" (Basel 2001).

As the 1s and 0s, bits and bytes, circulate on the network they create new spaces. To this new space Castells (1996) gives the name of "space of flows". The space of flows is the space created by information exchanges, it is not material, but has an existence. Think, for instance, of the global financial networks. Their links and exchanges, their fluctuations, have a definite impact on the places (and peoples) they connect. They are simultaneously immaterial and very real. Networks are not

[2] As the ARPANET.

ethereal. They are physical. They have a physical infrastructure that sustains and supports them. The disposition of hardware is not random, but rather tactical. Hubs are placed in geographically strategic places, emphasizing their importance within the network. Networks have the power to create spaces of visibility while relegating others to invisibility. Those excluded from the network are, to a great extent, made invisible (c.f. Sassen 1991; Castells 1998; Castells 1999).

2. Knowledge technologies

There is a close association between language, mind and technology. Nietzsche observed that the use of typewriter changed both his style and the nature of his writing. Each time language changes its main support system, so does cognition, and so does knowledge. This is because language entertains a close and intimate relationship with our inmost sensibility and also with both the content and the structure of our minds. The technologies that support or manage language also affect the mind, of necessity, simply because language is a system for the articulation of the mind, a kind of operating system writ large. Technologies that transport language behave as environments that condition both thought and speech. As Luria, a Soviet psychologist once said "language is the tool of tools" (Luria 1976; Luria 1979).

The following table attempts to identify some key differences in the kinds of knowledge environments supported by our main language technologies:

MEDIUM	SPEECH	WRITING	ELECTRICITY
DOMINANT MODE	Oral	Literate	Digital
SPATIO-TEMPORAL PSYCHOLOGY	World as organism Looking to the past models	Infinite space Looking to the future	Instantaneity - time and space as one
INFORMATION-PROCESSING BASE	Context (people are bound to and by their context)	Text (writing detaches text and user from context)	Hypertext (random access to any text)
COGNITIVE MODE	Multisensorial Mythic/magic Collective	Abstract Rational Private	Multimedia Integral Connective
KNOWLEDGE STRUCTURE	Myths (origins) Proverbs Legends Recipes Palabra	Bureaucracy Code of law Treatises Libraries Schools	Networks Databases Search engines Links Blogs

Figure 1: Comparative chart for knowledge practices under oral, literate and electronic conditions

2.1 Oral societies: Societies of context

There are indeed three main stages of language as we know it, oral, literate and electronic. The principal interface between self and world in the oral society is the physical body. The whole body talks, the whole body remembers, the whole body of everybody takes part in the body politic. *Oral society is the society of context*, not of text, for obvious reasons. People are always in context, they live in a kind of extended present, even when referring to events that occurred in the past. They revere their ancestors who showed them the operating rules of their principal reference, God(s), the first and the fundamental context. These societies are "religious" almost by necessity, not by choice. Their survival depends on shared experience. That is the context. To keep that context alive, they ritualize it and re-enact it, which is a way for a collective to remember. Oral societies, having to rely on verbal memory have been more or less obliged to live in a world in which the body has to do the job of remembering, and they have to keep re-enacting the past. They don't study the past, they simply make it present. This makes oral societies also conservative by necessity, rather than by choice. It is a society that is perceptually dominant in that its members rely on their senses (sensory) rather than on pure sense (meaning) to understand and cope with reality. Even its memory is anchored in sensory modalities, statues, monuments, songs, story-telling, play-acting.

2.2 Literate societies: Societies of text

By contrast, the written word allows people to keep records and accumulate knowledge, and to decontextualize it. Literate societies use a tool to store language. This tool helps people to turn context into text, to detach text from context, hence to detach themselves from it. It fosters fiction and innovation. *Literate societies are societies of text*.

In societies of text, knowledge is documented, compartmentalized, categorized, classified in records that are then archived for future retrieval. The archival of knowledge has brought about an entire infrastructure and science of information uniformization, classification and retrieval (c.f. Bowker & Leigh Star 1999). Information must be classified and stored in ways that afford its effortless retrieval. This emphasis on rational and systematic organization of knowledge is a defining trait of literate societies' mode of social organization, where control is exercised on the basis of knowledge (Weber 1947). Educational and institutional systems, with their emphasis on specialization and standardization of knowledge and on individualism are tokens of this organizational mode.

But it must be added that not all societies that use writing are societies of text. It all depends on the degree to which their writing system or their social system allows them to detach the text from the context. Many societies that use writing retain a dominantly oral cultural base.

2.2.1 The special case of alphabetic literacies

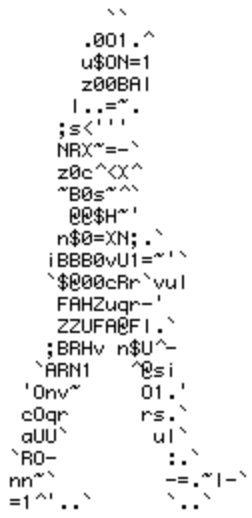
Alphabetic literacy differs from all the other writing systems because it allows one to represent faithfully the line of speech as it is read, and does not require the reader to first go back to context merely to decipher the text, as in Hebrew, Arabic

or Chinese, to give some examples. The more faithful and simple the tool, the easier it is to detach the text from the context and to re-place it in other contexts (this is the origin of fiction, of course, but also that of most innovations, i.e., technologies). Alphabetic literacy, by detaching text completely from context, also detached the reader, and liberated individual minds from the collective one of the tribe. The literary mind, organized by principles of logic and grammar, is not very religious, although its faith in technology has been likened to that of a religion (Noble 1997). Individuality is a far more important concept than community in textual societies. In fact, readers do not always need others to thrive. Instead, in this type of social organization people are all more or less "self-made people". Individualism is a natural consequence of a system that allows you to appropriate and manage language for our own purposes whether as a reader or a writer.

The printed material is the dominant interface and clearing house of the literate society. Not all language is worth writing/printing/reading, only carefully crafted selections of language, so what is printed takes its position in a certain hierarchy and order of priority, at some level, in whatever genre, and whatever category. Books and papers propose to people at large the contents of “reality” filtered through the modality of text. To a reader in alphabetic cultures, language first appears as an abstract string of easily recognizable signs, then as a mental construction, a kind of “assisted memory”. In order to read, we have to translate these abstract signs into something meaningful. We do that in our head and we call that “thinking” or “imagination” or “mind”.

Thinking with one's pen, as Wittgenstein suggests, is a kind of technological assistance very much in line with "computer-assisted" activities. Writing allows one to externalize thinking and give it a kind of objectivity that is comparable to hearing the response of someone else to a question. The difference with speaking is that writing is both an archived process and a solitary activity that allows complete control. Thinking by oneself allows complete control over the production of meaning. What is lost in that condition is the dialogue. When speaking to someone, we benefit from knowledge that is not contained within us, but we cannot, short of writing that knowledge down as Plato did for Socrates, retain it for other, later uses. When we write, we can keep the knowledge longer, but it is less flexible than when speaking.

The printing press made knowledge personally accessible, it democratized learning and education in ways never seen before. Information could be read and compared. Standardization became a necessity and a *modus operandi*.



2.3 Networked societies: Societies of hypertext

Networks are at the basis of the hypertext society. By hypertext we don't just imply "a text that is linked to other texts", but a meaning that encompasses all the world of electronic communication in permanent information and storage processing. It implies a network of resources, people and content that is fluid and dynamic. Any one who is online is a *de facto* node of the world wide network of hypertext, constituting and being constituted by the larger network. Hypertext is similar to context, albeit not absolutely collective, since it operates both in real time and asynchronously through the means of specific nodes within the network, the Uniform Resource Locators (URLs). Knowledge production and processing in hypertext societies is a networked process that enrolls human and nonhuman—technical and scientific—actors. Human cognition and machine processing are brought together in novel ways that augment and transform both parties. Rather than building self-contained machines, machines and humans are coupled together into new hybrid actors. Real world information and computer generated information are brought together, allowing individuals to simultaneously affect and be affected by both realities (Viseu 2003a).

Today, language circulates, combines and recombines from anywhere in the world at the speed of light. Knowledge is available instantaneously, professionally organized, intelligently accessible in digital form. The digital is to the electronic word what paper is to the printed one. Digitization is electricity's wordsmith but it is infinitely more malleable than the printed word, reducing and translating all experiences, including sensory ones into the same very simplified code—a code of 1s and 0s. It is thus that digitization allows the senses back into the technologies of linguistic exchange.[3] That is what is meant by multi or hyper-media (vision, hearing), virtual reality (kinesthesia), interactive systems (touch). What Walter Ong

[3] In one of his lectures at the McLuhan Program for Culture and Technology Paul Levinson remarked that the real digital divide is not between those who have access and those who do not, but between that which can be digitized and that which cannot.

(1982) in *Orality and Literacy* named "secondary orality" is the result of the electrification of language. Whether we are watching television or surfing the web, we are seeing multisensorial transpositions of language, with a high emphasis on iconicity, on movement and interaction.

Networks relate. Connect. Link. They are constituted by that which they connect, but they are more than the sum of their parts. Knowledge and meaning emerge out of the relationships between nodes. It is in their flows and constant renegotiation that knowledge is established (c.f. Massumi 2002).

3 Cognitive dimensions

The key issue is what is the shape of knowledge and mind in the society of hypertext ?

Hypertext is an electronic condition of language affecting thinking, writing and reading. Literate people speak silently in their heads and call that thinking, while electric societies paradoxically "write orally". This is a kind of treatment of language where it appears simultaneously in context and is archived at the same time. It has some of the fluidity of thought (and, in the future, with the improvement of morphing techniques, perhaps even some of the fluidity, if not the speed, of imagination) and the immediate pertinence of talk with the lasting quality of writing.

3. 1 The mind of hypertext

In a literate mind access to memory is private and discreet, but it is an access to the subject's memory only, not to anybody else's. Access to the text may be commonly available but the transformation of text into thought and images is entirely privatized (which is the reason why, contrary to popular and academic opinion, newspapers are not "mass" media). Thinking or deliberating in hypertextual conditions is to access everybody else's memories and to share directly in real time into the knowledge capital of the human condition.

Furthermore, hypertextual cognition is not limited to the single individual accessing the collective memory in a connective way. It is also shared cognition. It is a process in an environment of awareness that does not have a single centre, a single self, but travels from person to person. The contents of our screens are available simultaneously to many people at once, synchronously, or over time, diachronously. The contents of screens and databases may not be as flexible or nuanced and complex as those of our private minds, but they are often more reliable, not only by repeating faithfully what they originally represented, but also by enriching themselves with new links and new additions and adducing new partners in thought.

Hypertextual cognition is deeply linked to the technology that mediates it and vice-versa. The assumptions designed into the technological mediator will determine the activities it constrains or enhances, and these will change over time. The USENET case is useful to exemplify what we are discussing here. USENET was initially a connection between several American universities and later became the home

system for of the internet's newsgroups (discussion groups). When they were conceived newsgroups were asynchronous, textual conversations. In order to read and participate individuals had to either be online, looking at the screen, or know exactly where to search. However, with the development of powerful search engines, and the indexing of this information onto their search algorithms, newsgroups lost their ephemeral character. As they shifted into permanent and searchable archives, the experience and expectations of those participating were drastically transformed.

3.2 Digital versus mental objects

The mind of hypertext is dominated by icons, logos, links. Its main interface is the screen. Electricity favors iconic relationships. Everything we see on a screen is a kind of "mental object" an icon, an image of memory, but externalized. When screens support the display of digitally constructed objects, one cannot help but notice the great similarities between mental objects (MO) and digital objects (DO). Among the points DOs have in common with MOs:

They depend on connections
They are meant to be networked
They are recreated on demand, “just-in-time”, so to speak
They are reasonably reliable (DOs perhaps more so than MOs)
They are vulnerable to systemic attacks and destruction (mental breakdowns, viruses)
They are part of a greater - reasonably homogenous whole
They rely on very low intensity electrical (organic and electronic) energy
They are made of varying doses of perceptual, iconic and conceptual content (wireframes and polygons are typical equivalents to imaging concepts, while rendering does the job of sensory memory)
They are scalable and susceptible to shortcuts and generalizations

Thus many complexities of mind are emulated by information and communication technologies (ICT). Of course DOs also add the hugely expanded potential of both being provided by someone other than the mind of the user, and by being amenable to co-production in real-time by several participants. In effect, technological trends show the relentless drive towards faster and larger connections as well as more pertinent (hypertinent as we call them) connections. The rapid improvement of search engines from the early days of Yahoo! < www.yahoo.com> to the present time of Gurunet < www.gurunet.com> and Google < www.google.com> shows cognitive progress in leaps and bounds.

3.3 Main features of knowledge in hypertextual format

Again, it is probably easier to distinguish some features of hypertextual cognition by contrasting them with those of the preceding format:

TEXT	**HYPERTEXT**
Frontality/horizontality (page/stage)	total surround/immersion (screen, VR)

Linearity	random access
Causality	Self-organization / serendipity
Sequentiality	Simultaneity
Fragmentation	Integration
Centralization	Decentralization
Rationality	Emergence
Abstraction	Simulation
Analysis	Pattern recognition
Representation	participation/interactivity
Historicity	All-at-onceness

Networks change our conception and perception of time and space. For instance, as readers, our main relationship to spatial display is frontal, whether we consider the page, the stage, the perspective or the theory. With the electronic environments we are surrounded by information, or we penetrate it as in Virtual Reality installations, or, more simply, as when we displace a cursor in a search space on our screen. Our relationship to texts is sequential and linear (even if we can, of course, skip pages) while we have random access to hypertexts and hypermedia, something that we can appreciate when we search for a specific place on a DVD as opposed to patiently run a videotape to get to the same point. Causality dominates our sense of historical progress. We perceive time as flowing in one irreversible direction (usually to the right of centre), but with electronic media we make all times simultaneous, just an issue of pertinent retrieval. Analysis and synthesis organize and produce the rational mind, whereas principles of self-organization implying the interaction of many independent causes that operate in the emergence of phenomena such as, precisely, the development of the internet and the web and blogs.

No longer measured in kilometers, space is measured in units such as 'clicks' or signal indicators. How many clicks away is our destination? How much signal does my mobile phone have? No longer measured in hours, time is immediacy, it is the now, the "timeless time" (Castells 1996). The effects on cognition are unquestionable, as it brings out the minds of the users to the screens, interconnects them and accelerates them on networks.

In the next few sections of this paper we outline some of the key concepts of knowledge societies as we see them developing or emerge. These concepts are not meant to exhaust the topic of the cognitive transformations in knowledge societies. Instead, they provide some insight into the different stages of the life cycle of information and knowledge, that is, its production, processing, distribution, storage, and access or retrieval.

3.4 Augmentation

Real time, anywhere, "anywhen" communication, be it via the web or the mobile phone, text, images or audio, is not only transforming but also facilitating the creation of new social and cognitive dynamics.

Knowledge production and processing in knowledge societies is an increasingly networked process that *interconnects* human and nonhuman—technical and scientific—actors. Human cognition and cognitive technologies are brought together in novel ways that augment and transform both parties. The result is the creation of new kinds of hybrids, entities that defy categorization, and that can simultaneously affect and be affected by real world information and computer generated information (Viseu 2003a).

A good example of augmentation is the wearable computer. A wearable computer is an intimate, cognitive technology, one that shares an individual's personal space and becomes part of his/her embodied, sensorimotor structures, thus having a potential for changing that individual's interpretation of the world and of him/herself (c.f. Varela 1999; Varela & Mulder 2000). Wearable computers are cognitive technologies that are proactive in the process of decision making. They are designed to become "technological companions" or a "second skin" that besides providing sensory and cognitive augmentation are also involved in the process of decision-making. With wearable computers the body becomes an information conduit and its role changes drastically, becoming, in Lev Manovich's (2002) words, a "data space" from which data is extracted or inserted (Viseu 2003b; Viseu forthcoming).

3.5 Acceleration

The acceleration of the lifecycle of knowledge is another distinguishing characteristic of knowledge societies. Information and communication technologies have facilitated the acceleration of knowledge on all fronts. Knowledge is produced, manipulated, distributed and stored almost instantaneously, at speeds (and spaces) far beyond anything we had experienced before. Some of these stages become automated, for instance, information is immediately archived as it is entered in a website's dynamic database.

In many ways this acceleration is related to the break down of spatial boundaries. The colonization of space has been achieved by landing on the moon, shrinking the planet via networks and duplicating real space by virtual space. The new challenge is the conquest of time. As we embrace speed, and accelerate time, we enter the age of "timeless time" as Castells (1996) puts it.

Several examples are illustrative of this new knowledge speed. Word of mouth, for instance, has become mediated by electronic technologies giving it an instantaneous and expanded character. Internet gossip is both instant and worldwide and in many instances can make or break reputations. For a professional example, film distributors report that their revenues are being greatly affected by technologies that allow the viewers to communicate—text messaging, voice or email—their opinions to others as soon as a film is over (or even before). Word of mouth has always been a crucial element in a film's success or failure. But, while before it took about a week for the word to spread, it now takes one or two days. Studios report that "[i]n the U.S. these days, the pace of chat is fast enough, in some cases, to affect a movie's box office results from its Friday opening to Saturday night." (Muñoz 2003). Moreover, the combination of mobile

phones with the web, allows the establishment of a parallel, independent communication channel.

The speed of information diffusion has also enabled the creation of new social dynamics, such as 'cyberactivism'. Cyberactivism refers to the use of ICTs in the organization of social activism movements, protests and events. If in Western countries it is usually associated with the web, in other countries cyberactivitism relies mainly on the use of mobile phones and on their capability for text-messaging. Text messaging offers a series of advantages, it relies on cell phones that are often more ubiquitous than internet access, 'texting' is cheaper than making a phone call, messages can easily be forwarded to groups of people, and senders can receive a notice that indicates if the text message has been delivered or not. For instance, in the Philippines demonstrators used text messaging to coordinate their protest actions against President Joseph Estrada in real time. One newspaper quotes an unemployed construction worker saying, "The phone is our weapon now" (Rafael 2003). Moreover, text messaging was widely used to distribute information, jokes and rumors during the impeachment hearings of Joseph Estrada, hence playing an enormous role in eroding whatever legitimacy he had left (ibid). Newspapers report that at the height of this movement 70 million text messages (SMS) were being sent daily, in a country where only about 7 to 8 million people own mobile phones (Ayson 2001; Rafael 2003).[4]

As speed accelerates all spheres of life, it is important to start examining what the effects of constant accessibility associated with an obligation for immediacy are.

3.6 Ubiquity

The perception of time is also changing profoundly due to the ubiquity of personal technologies. Waiting for someone or something, for example, has gone through a radical transformation. While waiting in a line-up, one can be on the phone. If someone is late, one can call or be called to better manage time. Likewise, meeting someone no longer has a fixed character. A meeting can be set up on the fly, by simply calling someone and finding out where they are.

Mobility, the ability to navigate seamlessly through place and space, without losing the ability to access and distribute information—that is, without losing connectivity—is certainly one of the marks of knowledge societies. In North America this seamless navigation has been primarily achieved through the use of personal technologies, such as the PDA or RIM, that facilitate ubiquitous, or always-on, internet connection and above all, email connectivity. In most other parts of the world, however, the technology that has had the greatest impact on mobility is that of wireless mobile/cell phones.

Mobile personal technologies have a definite impact on the ability to access information anytime, anywhere. As they permeate through all spheres of life, the

[4] Ayson (2001) also reports that the internet penetration in the Philipinnes in 2001 was close to 2 million less than a third of that of mobile phones. For more on this specific event see Rafael 2003.

world that surrounds us becomes more complex and interweaved, creating hybrid, fluid spaces that are defined in interaction by those that compose them (c.f. Castells 1996; Sheller & Urry 2003). The interplay of digital and physical spaces is illustrative. A practical example is that of mobile game developers—such as Alive!—who take advantage of the implementation of location technologies (such as GPS) in mobile phones to develop multiuser games that take advantage of the users' physical location. If two players are in close physical location they will receive a text message (SMS) indicating their geographical distance, and when they are close enough, they are able to play in virtual space against one another.

3.7 Connective knowledge production
The interactive feature of ICTs is of crucial importance to understand the knowledge society. Not only can virtually anyone - granted that access to the networks' infrastructure and digital literacy are available - produce knowledge to be shared by others, networks also facilitate and enhance the opportunities for collaboration between individuals, be it in real-time or asynchronous. Collaborative software is being used in a variety of contexts. It supports teamwork over time and space, that is, when those participating are physically distant; and it complements 'real' space interaction, for instance, by being used in the classroom to foment discussion and conceptual development.

It is this capacity for collaborative action and knowledge production that marks one of the knowledge societies main characteristics: emergence. In a networked knowledge society the whole is greater than the sum of the parts. The whole is relational and under constant renegotiation, its shape and identity continually being redefined.

3.8 Innovation
Innovation is a condition of knowledge. It is but the continuation and exacerbation of a tendency that was bred into us by the alphabet. By allowing people to extract information from human situations (history, local lore, rules and proverbs, rituals, etc) and to store them for uses in other contexts, the alphabet allowed permanent recombination of meaning in technology, science and fiction. The difference now is that the delay between conception and production has been reduced to quasi instantaneous effects. This leads to a situation where we will merely think something up and get it done, much like the old – very old – days of magic.

Not being biased towards any type of content the internet (in its current shape) fosters, through its wires or waves, endless creativity and sharing. Peer to peer networks are exemplar of the internet's architecture. Networks such as the now defunct Napster < www.napster.com> or Kazaa < www.kazaa.com> connect individual computers to other individual computers allowing for direct exchanges amongst them. With every new item, or recombination of an old one, that is uploaded by any of the members of the community, the commons are enriched.

3.9 Obsolescence: In literate societies knowledge was traditionally stored in paper. Paper is biased towards space (Innis 1951) hence not being too resistant to time. However, paper presents an advantage over digital media: If it survives the passage

of time it can be accessed without the need for further support. Digital data is not visible to the naked eye without the help of a machine to translate it. This machine must not only speak the same language as the data, it must also be compatible with its material format. The format of portable media, for example, has changed considerably. Old 3.5" floppy disks and newer 5.25" have become irrelevant as data files become too large to be stored in them. In this process large amounts of knowledge can be rendered inaccessible, and thus virtually lost. The issue of knowledge storage will play a great role in the maintenance of knowledge societies. In the words of Roger Fiedler, a high level executive from Knight-Ridder, "we are always threatened with a case of digital Alzheimer".

4 Key issues in the knowledge society

While the trends that shape the knowledge in hypertext continue to unfold, they also raise political and social issues that need to be addressed to prepare society to reap theirs benefits and avoid their potential downside.

4.1 Democratization of knowledge

Information and communication networks facilitate not only individual input (production) but also access to information. Two examples are of particular interest, the democratization of medical information and MIT's OpenCourseWare.

Medical information is perhaps one of the most elitist kinds of information in the sense that first hand access to it is restricted to a limited few: the health professionals. By the same token, health related information is not only of a sensitive but also vital importance for the average citizen. The importance of searching for health related information online has been widely documented. For instance, Baker et al. (2003) report, in an article published in the Journal of the American Medical Association, that "Approximately 40% of respondents with internet access reported using the internet to look for advice or information about health or health care in 2001" (Baker et al. 2003). Hence, initiatives that place medical information in the public realm are of major importance. One of such initiatives was undertaken in 1997, under the presidency of Bill Clinton, and consisted of providing free access for all to MEDLINE® MEDLINE is the National Library of Medicine reference database. It contains "more than 11 million articles published in 46000 biomedical journals" (MEDLINEplus n.d.) constituting the "world's most extensive collection of published medical information" (MEDLINE 1997). While access to health information online is not, and should not, be taken as a substitute for seeing a doctor, it is helpful in providing individuals with knowledge about their condition. (The issue of the authenticity of the information retrieved will be discussed in the next point).

Another example, of another initiative that facilitates access to valuable knowledge that was previously limited to a restricted group is the Massachusetts Institute of Technology's (MIT) OpenCourseWare. MIT's OpenCourseWare is a web-based publishing initiative that allows everyone to access the teaching materials— lecture notes, video lectures, simulations, lab courses, reading list— that are used in the each of MIT's courses. As its website declares, "[t]he idea behind MIT OpenCourseWare (OCW) is to make MIT course materials that are

used in the teaching of almost all undergraduate and graduate subjects available on the Web, free of charge, to any user anywhere in the world" (MIT OCW n.d.).

The potentials behind initiatives such as the two described here is immense. However, these are increasingly being countered by initiatives that retrieve information from the public commons, placing it within the realm of private property (see point on 'legislation' for more). It is important in this regard to reach equilibrium between the notion that "information wants to be free" (John Perry Barlow, 1996) and adequate rewards for information creators, distributors and providers.

4.2 Legislative framework of property

The importance of the legal framework of property, intellectual property and copyright stems not only from the fact that nowadays knowledge is increasingly being converted into digital formats, but from the fact that as it does it becomes 'information', that is, a (usually private) product that can be copyrighted and that is bound by intellectual property or trademark rights. Since digitization affects all spheres of life, the result is that copyright law is entering the realm of disciplines such as zoology, botany, and genetics. Hence, the contents of a cell, or a gene, the constitution of a plant, can all be subject to these rules.

The changes made to the current legal framework are having, and will continue to have, a significant impact on creativity and innovation. As growing numbers of entities and information are taken from the public realm to be placed under the control of a private owners, the commons is depleted. (See Lessig 2001 for more on this topic).

4.3 Customization

If literate societies relied on the standardization of language and thought, and on mass news delivery, hypertextual societies open the possibility for customization and variance; customization of one's access to the world, variation in the ways of expressing oneself. The internet has imploded the dynamic process of creating meaning with language. New terms and practices spread like viruses among internet users. Take 'googling', for instance: it refers to the practice of using Google, the search engine < www.google.com> , to look for information about someone else, usually prior to meeting this person (Swidey 2003). With its ability to make the past present and permanent Google is transforming the social dynamics of getting to know others.

Furthermore, the internet offers more opportunities to customize one's access to reality, because it is a "my-way" medium. It **not** only offers a "one-way" channel (like the radio or television), and a "two-way" communication (such as the telephone) it also offers the possibility of a "my-way" interface, that is, the possibility of personalizing the medium itself and what it delivers. For instance, newspapers sites can be customized to deliver only news about sports, or the contrary, to exclude all news about sports (Negroponte 1995). Email filters can, for example, be created to automatically delete incoming information containing the terms 'x' or 'y'. In its extreme, customization gives users the world at the

measure of their specific needs; Individual comfort is elevated to its maximum exponent.

Several authors (e.g., Shapiro 1999; Sunstein 2001) have warned of the risks of tailoring reality to fit individual preferences. Aristotle, in *Politics*, states that "a city is composed of different kinds of men; similar people cannot bring a city into existence" (quoted in Sennett 1994). But, what would Aristotle say about a world which is customized to fit each individual's needs, which is experienced differently by every individual. Is it still one common space? Is reality merely the sum of its citizens or is it a greater entity? Combined with the tendency of broadcast media to "atomize" in narrowcasting to reach ever smaller and more specialized audiences, the bias of customization is threatening common information intake and the very nature of public information itself.

4.4 Authentification and trust

Determining the authenticity of the information being retrieved is a problem that, we believe, will become pivotal in years to come. The issue of judging the accurateness, authenticity and legitimacy of the information being retrieved is not an easy one, especially given the exponential growth in the number of information bits that are available on the World Wide Web. Misinformation—be it in the form of spam, pyramid schemes or untruthful information—poses serious obstacles to the creation of 'trust' in online environments, and has been classified by some as the more threatening kind of computer viruses (Cannon 2001). Reflecting upon the example offered above, the democratization of access to medical knowledge is helpful to understanding the extent of the implications of information authenticity. In literate societies the physicality of the source—a health professional or a book on the subject—gave it some legitimacy. Errors were still made, but because access to information was restricted it was easier to determine the credentials of the source. Nowadays, however, medical advice is offered in a variety of websites, email lists, email spam and support groups, among others. The multiplicity of information available—often contradictory—makes it imperative to design mechanisms that will help individual users judge the authenticity of the information they are accessing.

The Ebay < www.ebay.com> peer-evaluation system, where individuals are rated by their peers on the basis of their interaction history, is one possible way of dealing with this issue. Similarly the creation of communities of interest and practice, such as Slashdot < www.slashdot.com> , provide good examples of the creation of online reputations that are based on the recorded history of one's digital persona.

4.5 Accountability

The sharing of the decision making process with others and with socio-technological entities aggravates the always problematic issue of assigning accountability. An example is the practice of relaying illicit content from a multiplicity of servers in various countries, or issuing forbidden material in one country from one where the same content is authorized. Where can responsibility be assigned in such practices? The example of wearable computers illustrates this

point well. If these cognitive technologies become pro-active, being able to act and react to certain stimuli, where can we place the origin of action? In the individuals who designed the technology? in the technology itself? Or in the person who is wearing it? This issue is all the more important as new legislation is enacted in some Western countries preventing users from reverse engineering the technologies they acquire. For instance, in the United States the Digital Millennium Copyright Act (DMCA) prevents users from tinkering with the design features of digital technologies.

The increased use of software agents—mediating actors—is also of importance. Agents are currently being developed mainly in the context of electronic commerce. The idea behind it is that an sets up the parameters of his/her agent, who then trails the world wide web in search of the best deal. For instance, Patti Maes, a professor at the Massachusetts Institute of Technology (MIT), is conducting research on the development of software agents to assist users deal with the growing numbers of incoming information. "Her team [has] built the first successful (sic) prototypes of agents for personalized information filtering, eager assistant agents, agents that buy and sell on behalf of a user, matchmaking agents and remembrance agents" (Maes n.d.)

4.6 Identity

Our conception of self is increasingly being extended through the electronic networks. Be it the internet, mobile phones or other networked media, identity is increasingly fluid and relational. As time and space are measured in networked-terms, so is identity. Who a person is is intimately connected to the networks that he/she belongs to, and to the nodes and hubs that link him/her to others. Moreover, identity is dependent not only on physical elements, but also on digital characteristics, and it is, to some extent involuntary and/or unconscious. Activities, in the electronic realm, leave footprints, that are beyond the individual's control and can then be stored in databases where they can be retrieved. The image that they create has been given different names. For instance, Agre (1994) calls it a "digital individual", Kilger (1994) a "virtual self", Poster (1990) an "additional self", Clarke (1994) a "digital persona" and Mark Federman, a "digiself" (2003).

As Sheller and Urry (2003) suggest "one's identity is no longer neural networks but also by electronic ones. Persons are nodes in these networks. The body functions as a hyperlink to gain access to all these fragmented selves, and to connect to other nodes in the personal networks that no longer exist only in physical spaces". Legislation on digital identities and their relationships to organic and social ones is still under construction.

4.7 Private/public

Likewise, notions of public and private space blend, giving shape to new kinds of 'privates'—the self is extended through electronic networks that define it and constitute it (see googling example above)—and new types of 'publics'. Howard Rheingold's (2002) description of mobile phone use amongst teenagers in Finland is exemplar. He observed that the mobile phone is often used as a social, public medium, when images and messages displayed on the screen are shared with

others who are present or when the conversation itself is made public. Rheingold concludes that "a new mode of social communication, enabled by a new technology, has already become diffused into the norms of Finnish society" (Rheingold 2002, xvi).

Reactions against the pervasiveness of communication and the personal availability that it requires are also becoming apparent. France, for instance, has become the "first country to legalize jamming devices for public use" (hAnluain 2002). In England, a proposal to enable subway stations with signal spectrum was met with protest by part of the passengers (ibid). Artistic experimentation also provides an example here. The Grand Prize winner of the 2002 Media Arts Festival of Japan's Agency for Cultural Affairs explored the theme of the "frustration and anger caused by other people's mobile phones" (Jones & IDEO 2002). This project, titled *Social Mobiles*,[5] and developed by Crispin Jones and IDEO, proposed new functions for the mobile phone. For instance, the electric shock phone, that ensures that people talk with a low voice by giving them electric shocks when they don't. Or the catapult phone that launches sounds into other people's phone conversations thus effectively jamming them (IDEO & Jones 2002).

Personal stories are also emerging. In their investigation of the internet use in everyday life, Clement et al. (2003) report on the need, felt by some, to establish clear separations between times of availability and off-times. They ask if it is possible that we will witness "an increased reaction against the often proclaimed ideal of the 'always-on, always-accessible' internet?" (Clement et al. 2003).

4. 8 New divides: One of the biggest challenges today is the growing inequalities between poor and rich. Although there was some initial prophesizing about ICTs as the great equalizer (e.g., Toffler 1980; Negroponte 1995), reality has proved them wrong. At the dawn of the 21st century the gap between affluent and developing countries has not been reduced. In fact, some authors argue that networked ICTs have been developed and implemented along the lines of this dualism—that is itself a product of a neo-liberal capitalist policy—hence exacerbating it (see for instance, Castells 1999; Sassen 1998; Stiglitz 2002; Klein 2000). In sum, the geography of inequality existent in the world, was transposed to the infrastructure and space of networks.[6]

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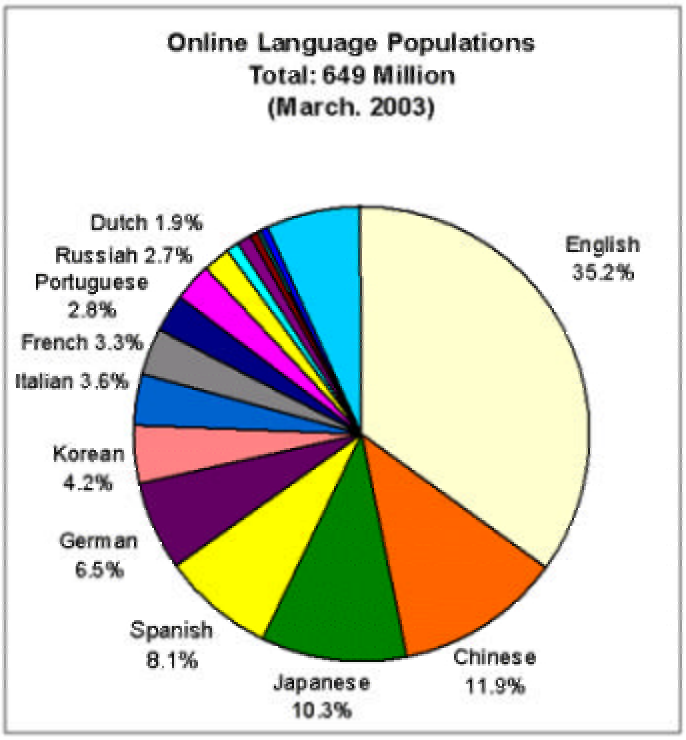
[5] < http://www.ideo.com/case_studies/Social_Mobiles/index.html>

[6] In a somewhat paradoxical fashion, many of the places that are made more invisible by the power of networks are the ones suffering the most from their remains and disposals. A series of recent articles in Mercury News documents the networks of the e-waste business. That is, the sale of information technology waste, often constituted by toxic parts, to China. It exposes the sweatshop work rules that bind those who work in their 'recycling', and the disregard for environmental regulations (Schoenberger 2002). Likewise, Klein narrates her conversation with a 17 year old girl who assembles cd-rom drives for IBM in the outskirts of Manila: "[we make computers [the girl says] but we don't know how to operate computers" (Klein 2000, xvii).



[DO YOU HAVE A SOURCE FOR THIS? URL, ETC..]

These divides are not only relative to access. Digital literacy, the ability to make effective use (Gurstein 2003) of the capabilities of ICTs, is also an issue. So is language, the ability to read English (the language of the web). However, the earlier claims that English would be and remain the overwhelmingly dominant language of the Internet need to be measured against the rapid rise of other languages on line, an indicator that the geography of inequality is not destiny.

On the other hand, this divide is, in many ways a process that feed onto itself: because there are few Africans online, there is little African content. The lack of African content draws less Africans towards the web, and so on.

The hopeful news is that on all fronts the digital divide is being eroded by the adoption of cheap, pervasive and easy-to-use (cellular phones, SMS) technologies. The mobile phone penetration is ten times faster and larger then that of the internet, its adoption being felt across the globe. Mobile phones require a less burdensome physical infrastructure and this has led some to defend it as a solution for the digital divide. Continents such as Africa, traditionally afflicted by a depleted public service infrastructure, are profiting from the appearance of wireless communication technologies. Mobile phones offer the possibility of accessing the web, but more important than that, they are fomenting the creation of an alternative network which, in some ways, is less rich than the web, but by the same token much more personal. In the mobile phone networks, the creation of hubs and nodes is more democratic, albeit far from equalitarian.

4.9 Political dividers

Another aspect of digital divide is that political conditions can increase it by excessive control. Countries that track internet activity include not only repressive or one party systems, such as Saudi Arabia, China and Burma, but also established democracies, as Britain, Russia and Australia (NYT staff 2001). While it is true that there is software that allows users to circumvent these barriers (e.g., the now defunct *safeweb.com*) it is also true that great efforts are being made to make the internet a more regulated environment (see Mann 2001; Lessig 2001).

Moreover, a number of innovative initiatives are using the mobile phone to emulate internet-communication, hence providing a different kind of access. In Portugal, for example, the multimedia branch of the state owned television company (RTP) offers a service called 'TVChat', a television channel where individuals can emulate real-time 'chat room' communication using the text messaging feature (SMS) of their mobile phones. In 2002 RTP reported having 15 thousand users per day that translated into 40 thousand daily messages, adding up to about one million messages per month (Telemoveis staff 2002).

Not all political initiatives go in the direction of controlling internet access and use. In fact, successful e-government projects, and more importantly, e-governance initiatives, are being developed at global, national and local levels. Moreover, politicians have started using the web to divulge their ideas and positions on matters of interest for their constituents. Weblogs or 'blogs' are the latest instruments used for this. Blogging is not only a kind of personal diary made public, it is also a networking device and an instant personality scan all at once. It helps to build trust not only by presenting transparently verifiable facts about oneself and one's opinions, but also the automated index of one's interest and preoccupations along with the network of people querying them. Blogging has been available since the late 90's but only reached public and political attention in the last few months. It is said that Howard Dean, a Democratic Party Candidate for the US presidency, owes his rapid rise from relatively unknown to favorite to having posted his opinions in "Blogging for America", his political platform on line.

A blog is in Winer's terms, a "kind of a continual tour, with a human guide who you get to know. There are many guides to choose from, each develops an audience, and there's also comraderie and politics between the people who run weblogs, they point to each other, in all kinds of structures, graphs, loops, etc" (Winer n.d.). An example of such an initiative is that of Portugal, where the possibility to 'own' a blog has been legislated so that all members of parliament are able to host their online memory in the Parliament's server (Oliveira 2003).

5 Conclusion

Knowledge is dynamic, flowing, shared, and applied. A knowledge society is one that shares information at least to the extent that is can help to secure the survival and the harmony of the social body. Today, globalization makes it clear that the larger social body is all the people on the planet. There is much in knowledge that concerns and affects them all. Our prime objective then should be to share knowledge in larger and larger realms.

The hardest question is how to reconcile mindsets. The shift from religious to secular that occurred during the transition from oral to literate societies was accompanied by a brutal clash between irreconcilable mindsets. Greek tragedy was invented to ease the passage from orality to literacy among the Athenians. The same kind of traumatizing transition occurred from the Middle Ages to the Renaissance. It was impossible to reconcile the epistemology of the Christian Church with that of the secular individual. After two hundred years of religious wars, the secular mind took over and established tolerance, supported by the dominant information-processing device of the times, the printed word. The strategy of tolerance worked for Europe until the 20th century during which the world suffered the worst convulsions of its history. Today, we are confronting another great change of mind, a similar situation, except that it is taking the form of a contraction of time (instantaneity) as well as of space (globalization). We are dealing not with a simple transition, but quite literally a juxtaposing, a forced cohabitation between religious and secular orders. The violence can take extreme forms.

We need to create epistemological conditions where people can experience other cultures ways of seeing and being in the world to get a relativized perception of their own reality. Indigenous knowledge must be experienced from within to help support the democratic ideal. However, this must be done without becoming condescending or indifferent. Other knowledges and knowledge of the other must not only be made available but also understood and discussed. The future we should be aiming to create must ensure that the networks provide different cultures and peoples with equal representation and access to the knowledge flows. It is important to counter the tendency of having the networked space become a replica of the geographical inequalities.

We need to assess where we are now and what we must be careful about as we plan for the future. In our current networked societies, knowledge (and information) has become easier to access and to produce. Knowledge is more dynamic than ever before, with thoughts immediately becoming part of the Commons (e.g., blogs), and languages are being renewed and revived through the constant evolution of new vocabularies and associated practices (such as googling).

Cognition is, by necessity, also undergoing major changes. The ubiquitous availability of computer chips and devices has accelerated the thought and decision making process, but it has equally increased the demands placed on individuals. Real-time implies constant ability to access but also constant need to reply. The cognitive impacts of this increased demand are still not known.

Furthermore, the potential for collective and connective knowledge production is now more enhanced than ever. Groups of individuals can collaborate remotely, with the support of a variety of networked software and hardware. The hybrid character of this collective knowledge production is also becoming increasingly explicit. We are currently experiencing a growing implementation and use of computing devices that actively participate in cognitive processes, such as decision making. Cognition,

then, is manifestly a shared process. Mind and cognition, in the twenty-first century, are not bound by the body, instead they are as distributed, decentralized and interconnected as the networks that surround us. This argument is far from new—e.g., Bateson 1972; Vygotsky 1962; Vygotsky 1978—however, now it is more visible than ever before.

The technological artefacts that participate in the cognitive process, as we have shown, are not mere neutral tools that individuals use as they will. Instead, these artefacts greatly affect (and are affected by) the thought processes that they help develop and sustain.

It is clear that we are standing at the edge of an era with great promise. Knowledge, the staple of knowledge societies, is a unique resource in that it expands by use and grows by sharing (unless it is subject to copyrights).

Returning to the argument we made at the start of this article, we must realize that in a world that is so interconnected as ours, there is a risk of a domino fall of fantastic proportions. To guarantee that this does not happen, we must ensure that all nodes are represented and all links working. As László Barabási (2003) puts it, "unless we are willing to cut the connections, the only way to change the world is to improve all nodes and links."

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