Darwin And The Internet

by G. van Oortmerssen

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Introduction
(p 5-6)

Technological revolutions, like the invention of script, typography, the steam engine or electricity, have always had great impact on human development, but never as much as the current ICT revolution. Today every field of life at any given time or place is permeated with ICT. Internet (i.e. the whole of computer network connections and the world wide web), its evolution so far (i.e. the natural and self-regulating development of internet) and its possible future are the subject of this lecture.

The development of ICT
(p 7-13)

After the huge mainframes from the 1950s and 1960s and the 'mini'computer from the 1970s, it was the PC that really pushed the ICT forward from the early 1980s on. On the wave of this hardware evolution, the 1970 ARPAnet, with its cosily connected four (aka '100') initial computers, and CWI in Amsterdam being its first connection outside the US in 1986, quickly developed into the world wide internet and expanded to 1.5 billion users in 2008.

The architecture of internet is decentralised and flexible, and because of that also highly adaptive and stable. There is one protocol to get all data packages exactly where they should go: TCP/IP. And similarly there is one protocol to rule all surfing traffic on the world wide web (the 'real internet'): HTTP, specified in 1990 by Tim Berners Lee, an English engineer then working at CERN. The mid-1990s' boost in GSM connectivity, followed later by GPS, Wifi etc., further revolutionised internet connectivity.

Predicting the future is difficult because of the mere speed and capriciousness of new developments. The growth has been and will continue to be exponential. In general one can expect:

- more power in microprocessors, memory and storage (doubles every 1.5 years)
- more speed and bandwidth in networks
- more nodes in the internet framework (doubles every 5 years)
- more connected devices, like cameras, all kinds of sensors, GPS, satellites, RFID-tags etc.

Over all, there will be much more data and information and the challenge will be how to control, stream, digest, access, analyse, protect or personalise it.

Compression, connectivity and complexity
(p 15-22)

In the development of ICT so far three concepts play a central role: compression, connectivity and complexity.

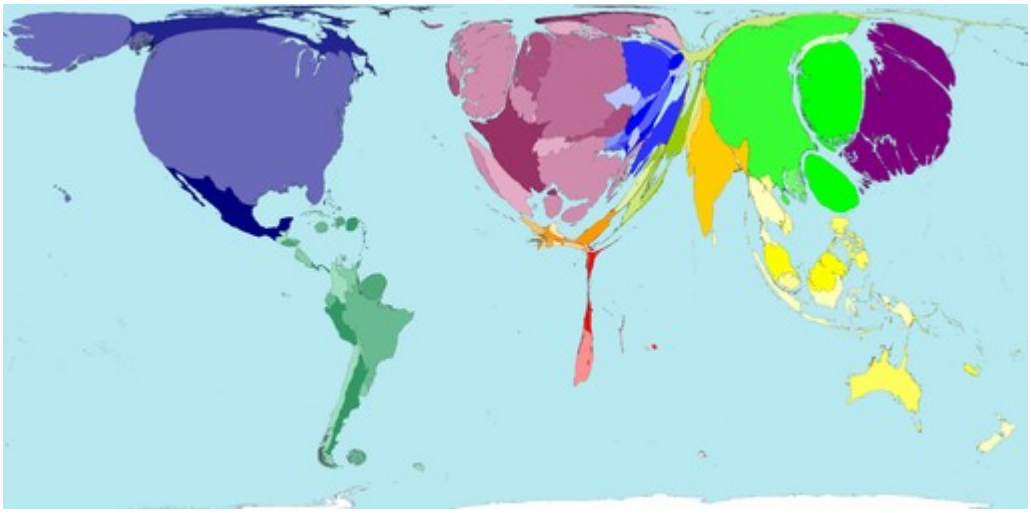
Compression in the first place concerns the microsizing of the hardware: microprocessors containing more microtransistors on increasingly smaller areas. Moore's Law says that microprocessor capacity will double every 1.5 years, while the price will remain the same. It's been like this for forty years and it will continue to for some more time. This hardware fact implies that ICT is subject to a huge compression of both time and space: speed increases exponentially and distance becomes virtually irrelevant.

Connectivity is all about networks. Life is based on networks: cells, ecosystems, economy, society. ICT adds the technology-based network. Computer networks exist to share and bundle computational power (as in cloud computing), to exchange information, and to communicate between people. The internet, as the global computer network to achieve this, has three layers:

- physical: cabling, wireless, routers, hubs, nodes
- world wide web: the hyperlinked content
- people: those connected through the internet

The WWW layer is about websites (e.g. Wikipedia), but also about social networks (e.g. Facebook) or web-based applications (e.g. Gmail). It becomes increasingly difficult to separate local applications from web-based ones (e.g. GoogleEarth). Some even say 'the network is the computer'.

Connectivity is unequally distributed. Most of Africa, and parts of South America and Asia greatly lack connectivity, simply because the physical infrastructure is not there. (See the Worldmapper graphical representation below.) However, there are good examples of the huge change for better that kicks in as soon as a place gets connected (e.g. Linknet Project in the village of Macha in Zambia).



© Copyright 2006 SASI Group (University of Sheffield) and Mark Newman (University of Michigan) – 'Internet Users in 2002'

Complexity of ICT has increased exponentially, both in computers (capacity of microprocessors, mini size, amount of data transport, interfaces) and in networks (architecture, amount of connections, protocols).

Mark C. Taylor (*The Moment Of Complexity: Emerging Network Culture*, 2001) describes a complex system as follows.

- many components are connected in many ways
- components interact both parallel and serial (i.e. simultaneously and successively)
- it is self-organising
- self-organisation creates structures as a result of component interaction, but these structures are not necessarily reducible to that interaction ('the whole is more than the sum of the components')
- emergent behaviour is locally initiated, but will have global effects
- it is not static, but evolutionary (i.e. open and adaptive)
- emergent behaviour occurs in a small probability space between order and chaos

Now this, ladies and gentlemen, *is* the Internet.

Evolution and the Internet
(p 23-28)

As Darwin described in *The Origin Of Species* (1859), biological life is driven by reproduction and natural selection. Would technology, i.e. ICT, be the next step in human evolution? The basic requirements are there. Natural selection is exactly how things enter and leave the internet. The market decides what hardware, applications or services will survive. Since Johann von Neumann (*Theory Of Self-reproducing Automata*, 1966) has proven that a self-reproducing machine makes a valid theory, and since computer viruses and genetic algorithms in software do multiply, reproduction is strictly speaking within the possibilities of ICT.

The evolution of ICT is characterised by complexity and connectivity, as described above. Emergent behaviour marks fundamental transitions into a more complex phase. The human ability to learn accelerates the development of connectivity, especially the transmission of information. By now the speed of networks by far outclasses the speed of the human nervous system (km/sec against m/sec). In human evolution the use of tools has made man more intelligent, but ICT tools, thanks to the speed of light, are too fast for man to follow.

The internet, with its close-knit web of connected intelligent devices, more and more acts like a living organism. It is able to gather information independently and to make decisions autonomously. New emergent behaviour is to be expected. The issue whether artificial intelligence or transhuman machines are within reach, is for now still speculation. The main difference is that human thinking is intentional, while computers are not. Computers do not have a will to live. But would it be possible that they evolve into that?

A central question is what effect internet has on humans (or: how layer 2 – WWW – interacts with layer 3 – people). Internet is all about information and its evolution includes simultaneously a spectacular increase of information and a similar increase in social relations. Coming from the PC era (filesharing), along Web 1.0 (websites) and Web 2.0 (interactive forums), we are about to enter Web 3.0 in which semantics (defined meaning added to content, which will significantly change the way we search the web) will be the new focus. Each technological change brings in new social relations.

For the future ‘Web x.0’ to come the major question will be:

- will it bring a virtual, superintelligent self-consciousness of the world wide web itself (‘layer 2 going independent’);
- or will it bring a social, collective and humane consciousness of the people (‘layer 3 still in charge’)?

The second option reminds us of the noosphere, a global skin of intelligent collective consciousness, as envisaged by Pierre Teilhard de Chardin (*The Human Phenomenon*, 1956).

Knowledge, power and ethics
(p 29-30)

When intelligent machines are involved in controlling human life, we urgently need to consider the human purposes behind that. Communication and control are both aspects of internet, the first to gather and share knowledge, the second to use power. But the human intentions behind both are a matter of ethics.

If Web x.0 is going to overtake human intelligence on the part of control and power, it is crucial to ensure that it will do so according to humane intentions. Also, since internet has become so complex that ICT is needed to regulate ICT’s complexity, it is essential that at the earliest stage of development of ICT – webapps, services, devices, networks etc. – we need to include humane values and principles before any system can be launched.

ICT research and education
(p 31-37)

Today ICT is part of our human consciousness, which has a far deeper impact than just being a tool we can take or leave. ICT also is constant change. Therefore research and education are vital to anticipate a future that will come at the speed of light. Research needs to analyse the growing complexity and nature of internet evolution, enabling us to decide what ethics need to be embedded into new ICT.

Fields of ICT research include:

- the core issues of information, communication and complexity
- the ethical issue of intentionality
- and additionally issues of connectivity (e.g. how the three layers of internet interact) and transformation (e.g. how information is processed)

ICT research, and consequently: education, need to be multidisciplinary. Only that way will it support the development of e-science, the new scientific analysis model that is enabled by ICT. There would not be models for climate change, or the project of unravelling the structure of the human genome without the connectivity and computational power of internet. Also required are ICT innovation ecosystems in which ICT is firmly embedded into social reality. Without these the ethics would easily be skipped.

[Omitted: specific comments on Dutch funding & non-funding, which, after all, might sound very familiar to British ears, or even more to Scottish…]

Conclusion
(p 39)

Over the past fifty years ICT brought in the global major paradigm shift, but the big revolution has yet to come.

ICT has woven a ‘noosphere’ around the earth, which speed is much higher than the human nervous system can keep up with.

Internet’s ever growing complexity will lead to:

- either a new social and collective consciousness, extending knowledge and power for people;
- or an autonomous technology that will control human life and become a new ‘species’ in evolution.

ICT requires much more research in order to support e-science, to analyse the ICT revolution and to ensure that humane values are embedded.

ICT research must be multidisciplinary, including computer and software science, mathematics, humanities, economics, law and media.

[Words of thanks]
[p 41-43]