THE INTERACTION BETWEEN INFORMATION AND COMMUNICATION TECHNOLOGIES AND THE NETWORK SOCIETY: A PROCESS OF HISTORICAL CHANGE

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Societies evolve and are transformed through a complex interaction of cultural, economic, political, and technological factors. In any given society, the available range of technological processes becomes organised into technological paradigms around a nucleus that enhances the performance of each individual one. Informationalism is the technological paradigm that currently provides the basis for a new type of social structure known as the network society. This social structure consists of information networks that are driven by information technologies and has become the dominant form of social organisation at the present time. Informational development is the result of both cultural and technological innovation and the process of innovation itself essentially depends on the existence of free, high quality university and research institutions within the context of a free society. Under informationalism, freedom, science, and power all come together and are inter-related in a "virtuous circle".

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1. Introduction: technological paradigms

As Rosalind Williams, director of the MIT Program on Science, Technology and Society, writes: For historians of technology, technological determinism is the unthinkable thought. It is a non-issue because there are no technological forces separate from social ones. Of course, technology is socially constructed! The real question to ask, then, is "What are the historical forces shaping the construction of the technological world?"[1] Societies evolve and transform themselves through a complex interaction of cultural, economic, political, and technological factors. Technology, however, has its own dynamics and technologies that develop and diffuse to decisively shape the material structure of society that they impinge upon. Technological systems evolve gradually to the point where a major qualitative change or technological revolution occurs, ushering in a new technological paradigm that integrates discoveries into a coherent system of relationships characterised by synergy. A technological paradigm organises the available range of technologies around a nucleus that enhances the performance of each individual one.

The Industrial Revolution was thus organised around industrialism, a paradigm characterised by the capacity to generate and distribute energy by human-made artefacts, irrespective of the natural environment. As energy is a primary resource for all kinds of activities, societies were able to exponentially increase their control over nature and the conditions of their own existence by transforming the production and distribution of energy. Moreover, the technological revolution created a nucleus around which technologies in other fields were able to cluster and converge. The revolution in energy technology (first with steam power, then later with electricity) established the basis for other associated revolutions in mechanical engineering, metallurgy, chemistry, biology, medicine, means of transport, and a wide variety of other technological fields that came together to form the new technological paradigm.

This technological infrastructure made possible the emergence of new forms of production, consumption, and spatial and social organisation that, as a whole, came to form the urban industrial society. Key features of the industrial society were industrial factories, large corporations, rationalised bureaucracy, the gradual phasing out of agricultural labour, the process of large scale urbanisation, centralised systems for the delivery of public services, the rise of mass media communication, the construction of national and international transportation systems, and the development of weapons of mass destruction.

Industrialism existed in a variety of cultural and institutional forms. Industrial capitalism and industrial statism were antagonistic forms of social organisation yet shared fundamental similarities in their material foundations. History, culture, institutions, and evolving patterns of political domination created a diverse array of

[1] Williams, 2002, p. 116-118.

industrial societies as different as Japan and the United States, Germany and the Soviet Union. These were all however historical variations of the same socio-technological species, namely industrialism.

2. Informationalism as a new technological paradigm

This analogy may help explain the meaning, and the importance, of the new technological paradigm currently replacing industrialism as the dominant matrix of 21st century societies. I conceptualise it as informationalism, which is constituted around the strategic importance of information and communication technologies. Nevertheless, industrialism does not disappear just like that and the process of historical transition proceeds through the absorption of preceding social forms by new, emerging ones so that real societies are considerably more disorganised than the ideal types constructed for analytical purposes. How do we know that a given paradigm, e.g. informationalism, is dominant vis-à-vis others, e.g. industrialism? Quite simply because of its superior performance in the accumulation of wealth and power. Historical transitions are shaped by the winners in the world. We do not really know if producing more or more efficiently embodies a higher value in terms of humanity because the idea of progress is an ideology[2]. How good, bad, or indifferent a new paradigm is depends on whose perspective, whose values, and whose standards are considered. We know that it is dominant, however, because when it is implemented it eliminates any competition. In this sense, informationalism is the dominant paradigm replacing and subsuming industrialism in present-day societies. However, what exactly is informationalism?

Informationalism is a technological paradigm; it refers to technology and not social organisation or institutions. Informationalism provides the basis for a certain type of social structure that I call the network society. Without informationalism, the network society could not exist yet this new social structure is not produced by informationalism but by a broader pattern of social evolution[3]. Prior to elaborating on the structure, origin and historical diversity of the network society, a consideration is given of its material infrastructure, namely informationalism as a technological paradigm.

The characteristic aspect of informationalism is not the central role of knowledge and information in generating wealth, power, and meaning because these have played a central role in many, if not all, known societies throughout history[4]. Many different forms of knowledge have certainly existed but knowledge, including scientific knowledge, is always historically relative; something that is considered to be true today may well be catalogued as an error in the future. Over the last two centuries, there has clearly been closer interaction between science, technology, wealth, power, and communication than previously but one cannot get a true understanding of the Roman Empire without considering the engineering technology of its vast public works and communication patterns, the logical codification of government and economic activities according to

[2] Kumar, 1995.
[3] Castells, 2000.
[4] Chandler & Cortada, 2000.

Roman Law, and the processing of information and communication made possible by its developed language (Latin). Throughout history, knowledge and information, together with their technological underpinning, have been closely associated with political/military domination, economic prosperity, and cultural hegemony. In a sense, therefore, all economies are knowledge-based economies and all societies are essentially information societies[5]. What is distinctive of our historical period is a new technological paradigm ushered in by the Information Technology Revolution and centred around a cluster of information technologies. The thing that is new is the information processing technology and the impact of this technology on the generation and application of knowledge.

This is the reason why the concept of informationalism is used here and not the notions of knowledge-economy or information society to explain the technological paradigm based on the increase of human ability in information processing around the twofold revolutions in microelectronics and genetic engineering. What is actually revolutionary in these technologies vis-à-vis previous information technology revolutions in history, for example the invention of the printing press?[6]. Printing was indeed a major technological discovery that had wide-reaching consequences in all areas of society although the changes that it brought about were much greater in the context of Europe in the early Modern Age than in China when it was first invented. The new present-day information technologies have an even greater historical relevance in that they are ushering in a new technological paradigm on the basis of three major, distinctive features: a) their self-expanding processing capacity in terms of volume, complexity, and speed; b) their recombining ability; and, c) their flexibility in terms of distribution.

The process of historical transition proceeds through the absorption of preceding social forms by new, emerging ones.

These features, which constitute the essence of the informational paradigm, are described in detail below. The two fundamental fields of technology (microelectronics and genetic engineering) are first considered separately, which is followed by the interactions between the two.

The microelectronics-based revolution includes the microchip, computers, telecommunications, and networking. Software development is the critical technology that operates the whole system although the true power of processing is to be found in the design of the integrated circuit. These technologies allow for an extraordinary increase in man's capacity to process information in terms of the volume of information, operation complexity and processing speed although how much is “much more” compared with previous information processing technologies? How do we know that there is a revolution going on that involving an unprecedented leap forward in processing capacity? An outer layer of the answer lies in what is purely empirical. The last 30 years have seen a sustained exponential increase in

[5] Lyon, 1988.
[6] Mokyr, 1990.

information processing power and capacity in terms of bits, feedback loops and speed, coupled with an equally dramatic decrease in cost per operation. However, I venture the hypothesis that there is something that is not merely quantitative but also qualitative, namely the ability of these technologies to self-expand their processing power as a result of feedback from the technological development of knowledge generated on the basis of the technology itself[7]. This is a bold hypothesis as there may be physical limits to the further integration of circuits in microchips and the expansion of processing capacity. So far, however, every doomsday prediction in this field has been belied by new manufacturing breakthroughs. On-going research into new materials (including biological materials and chemically-based information processing on biological DNA) may well extend the level of integration to an extraordinary degree while parallel processing and the growing integration of software into hardware through nanotechnology may provide additional sources of self-expanding power of information processing.

Therefore, a more formal version of this hypothesis is as follows: in the first 25 years of the Information Technology Revolution, we have observed a self-generated, expansive capacity of technologies to process information; current limits are likely to be superseded by new waves of innovation in the making; and (this is critical) when and if limits to processing power on the basis of these technologies are reached, a new technological paradigm will emerge in forms and technologies that are unimaginable today except in science fiction scenarios .

Microelectronics-based technologies are also characterised by their ability to recombine information in any possible way. This is what I call hypertext (following the tradition from Nelson to Berners-Lee) and what most people call the World Wide Web. The real value of the Internet is its ability to link up everything from everywhere, and to recombine it. This will be even more explicit when the original design of Berners-Lee's World Wide Web is restored in its two functions, as a browser and editor, instead of its current limited uses as a browser/information provider connected to an e.mail system[8]. While Nelson's Xanadu was clearly a visionary utopia, the real potential of the Internet, as Nelson wanted, is in the recombining of all existing information and communication on the basis of specific purposes decided in real time by each user/producer of hypertext[9]. Recombination is the source of innovation, particularly if the products of recombination themselves become supports for further interaction, in a spiral of increasingly meaningful information. While the generation of new knowledge will always require the application of theory to recombined information, the ability to experiment with this recombining from a multiplicity of sources considerably extends the realm of knowledge, as well as the connections that can be made between different fields[10].

The third feature of new information technologies is their flexibility in allowing the distribution of processing power in various contexts and applications. The explosion of networking technologies (along the lines of Java and Jini languages in the 1990s), the staggering growth of cell phones, and the development of the mobile Internet from

[7] Walsham, 2002.
[8] Berners-Lee, 1999.
[9] Packer and Jordan (eds), 2001.
[10] De Kerckhove, 1997.

a wide array of portable appliances are key developments that point to the growing capacity to have processing power, including the power of networked communication, everywhere there is the technological infrastructure and the knowledge to use it.

The second component of the Information Technology Revolution is genetic engineering, which is often considered as an entirely independent process vis-à-vis microelectronics although this is not the case. Firstly, in analytical terms, these technologies are obviously both information technologies since they focus on the decoding, and eventual reprogramming, of DNA, which is the information code of living matter. Secondly, there is a much closer relationship between microelectronics and genetic engineering than people seem to realise. Without massive computing power and the simulation capacity provided by advanced software, the Human Genome project would not have been completed, nor would scientists be able to identify specific functions and the location of specific genes. Biochips and DNA chemically-based microchips are no longer a thing of science fiction. Third, there is theoretical convergence between the two technological fields around the analytical paradigm based on networking, self-organisation and emergent properties, as shown by the revolutionary theoretical work of Fritjof Capra[11].

Genetic engineering technologies, the transformative power of which is just being unleashed in the early 21st century, are also characterised by their self-expanding processing capacity, their ability to recombine and their distributing power. Firstly, the existence of a Map of the Human Genome and, increasingly, of genetic maps of species and subspecies, creates the possibility of connecting knowledge about biological process in a cumulative way, leading to a qualitative transformation of the understanding of processes that were previously beyond the realm of observation. Secondly, the recombining ability concerning DNA codes is exactly what genetic engineering is about and what sets it apart from any previous form of biological experimentation.

In the first 25 years of the Information Technology Revolution, we have observed a self-generated, expansive capacity of technologies to process information; current limits are likely to be superseded by new waves of innovation in the making.

There is another more subtle innovation, however. The first generation of genetic engineering largely failed because cells were reprogrammed as isolated entities without the understanding that context is everything in both biology and information processing in general. Cells only exist in their relationship to others. Interacting networks of cells, communicating through codes rather than isolated instructions, are the object of scientific recombination strategies. This kind of recombination is far too complex to

[11] Capra, 2002.

be identified in linear terms. It requires simulation techniques with massive computer parallel processing facilities for emergent properties to be associated with gene networks, as in some of the models proposed by researchers at the Santa Fe Institute. Thirdly, the promise of genetic engineering is precisely its ability to reprogramme different codes and their communication protocols in different areas of different bodies (or systems) of different species. Transgenic research and self-regenerative processes in living organisms are the frontier of genetic engineering, with genetic drugs intended to induce capabilities of self-programming by living organisms, the ultimate expression of distributed information processing power.

Incidentally, genetic engineering shows quite vividly how mistaken it would be to assign positive meaning to exceptional technological revolutions regardless of their social context, social use, and social outcome. I cannot imagine a more fundamental technological revolution that the capacity to manipulate the codes of living organisms. Neither can I think of a more dangerous and potentially destructive technology if it becomes uncoupled from our collective capacity to control technological development in cultural, ethical, and institutional terms.

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3. The network society

The network society has built up from the foundations of informationalism and expanded throughout the planet to become the dominant form of social organisation in our time. It is a social structure that consists of information networks powered by the information technologies that characterise the informational paradigm.

A social structure can be defined as the organisational arrangement of humans in relationships of production, consumption, experience, and power, as expressed in meaningful interaction framed by culture. A network is a series of interconnected nodes and a node is the point where the curve crosses itself. Social networks are as old as humankind. Under informationalism, however, they have taken on new life because new technologies enhance the flexibility that is inherent to networks while solving the co-ordination and steering problems that, throughout history, have hindered networks in their competition with hierarchical organisations. Networks distribute performance and share decision-making along the nodes of the network in an interactive pattern.

By definition, a network has no centre, just nodes. While nodes may be of different size, and thus of varying relevance, they are all necessary to the network. When nodes become redundant, networks tend to reconfigure themselves, deleting nodes and adding new, productive ones. Nodes increase their importance for the network by absorbing more information and processing it more efficiently. The relative importance of a node does not stem from its specific features but from its ability to contribute to the network with valuable information. In this sense, the main nodes are not centres but switches and protocols of

communication, following a networking logic rather than a command logic in their performance[12].

Networks work on a binary logic: inclusion/exclusion. As social forms, they are value-free. The results depend on the goals of a given network and on the elegance, economy and self-reproductivity of the forms designed to perform these goals. In this sense, the network is an automaton. In a social structure, social actors and institutions programme the networks. Once programmed, however, information networks powered by information technology impose their structural logic onto their human components, until their programme is changed, usually at a high social and economic cost.

In order to apply this formal analysis to the actual workings of society, a brief characterisation of the fundamental structures of this network society is described.

Firstly, the new economy, the present-day economy, is built on networks. Global financial markets, the heart of investment and securities, are constructed on electronic networks that process signals, some of which are based on economic calculations although they are often generated by information turbulence from different sources. The outcome of these signals, and of their processing in the electronic networks of the financial markets, is the actual value assigned to all assets in every economy. The global economy is built around collaborative networks of production and management, with multinational corporations and their ancillary networks accounting for over 40% of GGP (Gross Global Product) and about 70% of international trade. Companies themselves work in and by networks. Large firms are decentralised in internal networks while SMEs form networks of co-operation, thus maintaining their flexibility while pulling resources together. Large firms work on the basis of strategic alliances that vary according to products, processes, markets or periods of time in a variable geometry of corporate networks, which link up with small and medium-sized business networks in a world of networks inside of networks. Furthermore, what I call the network enterprise often links up customers and suppliers through a proprietary network, as in the business models spearheaded by Cisco Systems in the electronics industry or Zara in the garment industry. The actual operational unit in the economy is the business project operated by ad hoc business networks. And all of this complexity can only be managed through the use of the tools of informationalism.

Productivity and competitiveness become vastly enhanced through this networked form of production, distribution and management and as the networks of the new economy expand through competition and the global phasing out of less efficient forms of organisation, the new, networked economy becomes the dominant economy everywhere[13]. Economic units, territories and people that do not perform well in this economy or offer any potential interest to these dominant networks are discarded. On the other hand, whatever source of potential value that arises, and from wherever, is connected and programmed into the productive networks of the new economy.

[12] Watts, 1999.
[13] Lucas, 1999.

Under such conditions, work becomes individualised. Management-labour relationships are defined in individual arrangements and work is valued according to the ability of workers and managers to reprogramme themselves to perform new tasks and new goals, with the system being driven by technological innovation and entrepreneurial versatility. Not everything is bad in this new working arrangement. It is a world of winners and losers, although more often than not of uncertain winners and losers of no return[14]. It is also a world of creativity and destruction, a world characterised, simultaneously, by creative destruction and destructive creation.

Cultural expression becomes patterned around the kaleidoscope of a global, electronic hypertext. Around the Internet and multimedia, manifestations of human communication and creation are hyperlinked. The flexibility of this media system facilitates the absorption of the most diverse forms and the customisation of the delivery of messages. While individual experiences may exist outside the hypertext, collective experiences, shared messages, that is, culture as a social medium, by and large get captured in this hypertext. It constitutes the source of real virtuality as the semantic framework of our lives. Virtual, in that it is based on electronic circuits and ephemeral audio-visual messages. Real, because this is our reality, since the global hypertext provides most of the sounds, images, words, shapes, and connotations that we use to construct our meaning in all domains of experience[15].

Politics is itself becoming increasingly taken over by the media world, either by adapting to its codes and rules or by attempting to change the rules of the game by creating and imposing new cultural codes. In both cases, politics becomes an application of the hypertext, since the text simply reconfigures itself to the new codes[16].

Networking logic, which is rooted in informationalism, has also transformed our experience of space and time. The space of flows, which is characteristic of the network society, links up distant locales around shared functions and meanings on the basis of electronic circuits and fast transportation corridors while isolating and subduing the logic of experience embodied in the space of places[17]. A new form of time, which I call timeless time, emerges out of systemic trends to compress chronological time to its smallest possible expression (as in split second financial transactions), as well as blurring time sequences. This can be observed in the turning of professional career patterns away from the predictable progression of the organisational man, who has now been replaced by the flexible woman[18].

Sucked in by this whirlwind and bypassed by global networks of capital, technology and information, nation states are not sinking as predicted by the prophets of globalisation. They are adapting in structure and performance and are themselves becoming networks[19]. On the one hand, they build supranational and international institutions of shared governance, some of which are

[14] Carnoy, 2000.
[15] Jankokwisky et al., 1999.
[16] Thompson, 2000.
[17] Graham and Marvin, 2000.
[18] Williams, 2002.
[19] Nye and Donahue, eds, 2000.

highly integrated, such as the European Union, while others are much looser, such as NATO or NAFTA; some are asymmetrical in their obligations, such as the International Monetary Fund, imposing the logic of global markets over developing economies. In all cases, however, political sovereignty becomes shared among various governments and organisations. On the other hand, a process of political decentralisation is taking place in most of the world, with resources shifting from national governments to regional and local governments, and even to non-governmental organisations, in a concerted effort to rebuild legitimacy and increase flexibility in the conduct of public affairs. These simultaneous trends towards supranationality and towards locality induce a new form of state, namely the network state, that appears to be the most resilient institutional form for managing global governance[20].

4. The genesis of network society and informationalism

Where did this network society originate? What was its historical genesis? It emerged as a result of the accidental coincidence of three independent phenomena in the last quarter of the 20th century.

The first of these was the Information Technology Revolution, the key components of which came together as a new technological paradigm in the 1970s (ARPANET, 1969; USENET News, 1979; the invention of the integrated circuit, 1971; the personal computer, 1974-76; the software revolution: UNIX codes designed in the late 1960s and released in 1974; TCP/IP protocols designed in 1973-78; recombinant DNA, 1973)[21].

Networking logic, which is rooted in informationalism, has also transformed our experience of space and time.

The second trend was the process of the socio-economic restructuring of the two competing systems of capitalism and statism that experienced major crises resulting from internal contradictions in 1973-75 (capitalism) and 1975-80 (statism). These crises were dealt with by new government policies and new corporate strategies. The perestroika of the capitalist system worked whereas the restructuring of statism resulted in failure because of the inherent limitations of statism to internalise and use the information technology revolution, as is argued in our study with Kiselyova on the collapse of the Soviet Union[22]. Capitalism was able to overcome a structural trend towards rampant destructive inflation through informational productivity, deregulation, liberalisation, denationalisation, globalisation and networking, to ultimately provide the economic foundations of the network society.

The third trend that gave rise to this new society consisted of the cultural and political values pro-

[20] Pisani-Ferry and Tubiana, 2002.
[21] Mansell, ed., 2002.
[22] Castells and Kiselyova, 1995.

jected by the social movements of the late 1960s and early 1970s in Europe and America, along with certain sui generis signs in Japan and China. These movements were fundamentally libertarian although the feminist movement and the environmental movement extended the notion of freedom to a fundamental challenge to the institutions and ideologies of patriarchalism and productivism. These movements were cultural in that their focus was not on the seizing of state power (unlike most of their predecessors in the century) or on the redistribution of wealth but on categories of experience; established institutions were rejected, the call was made for new meanings of life and, consequently, for the redrafting of the social contract between the individual and the state, and between the individual and the corporate world[23].

World War II was the matrix of most of the discoveries that led to the Information Technology Revolution, while the Cold War was the melting pot for their development.

These three phenomena emerged independently from each other and their historical coincidence was serendipitous, as was their specific combination in different societies. This is why the speed and form of the process of transition to the network society has been different in the United States, Western Europe and the rest of the world. The more entrenched the institutions and rules of the industrial society, or of pre-industrial societies, the slower and more difficult the process of transformation. No value judgement is implied in this differential path towards the network society -- the network society is not the promised land of the Information Age. It is quite simply a new, specific social structure and its effects on the well-being of humankind are undetermined. It all depends on context and process.

One of the key components of this historical accident that has given rise to our 21st century world is the new technological paradigm of informationalism. Where did this originate? War, of both hot and Cold types, has been an essential ingredient in this process of technological innovation, as it has been throughout history[24]. World War II was the matrix of most of the discoveries that led to the Information Technology Revolution, while the Cold War was the melting pot for their development[25]. Arpanet, the ancestor of the Internet, was not military technology in the true sense, even if its key technologies (packet switching and distributed networking power) were developed by Paul Baran at Rand Corporation in a proposal to the Defence Department to build a communications system able to survive nuclear war. The proposal was never approved and the DOD-based scientists designing Arpanet only found out about Baran's work when they were already building the computer network. However, without the support of the resources and freedom of innovation provided by the Advanced Research Projects Agency

[23] Castells, 2003.
[24] Abbate, 1999.
[25] Hughes, 1998.

at the Pentagon, computer science in the United States would not have developed at the pace it did, Arpanet would not have been built, and computer networking would be very different today. Likewise, while the microelectronics revolution has been largely independent from military applications for the last 20 years, during the 1950s and early 1960s, in the critical, formative stage, Silicon Valley and the other major technological centres were highly dependent on military markets and their generous research funding.

Research universities were also essential seedbeds of the technological revolution. In fact, it can be argued that academic computer scientists captured the resources of the Defence Department to develop computer science in general and computing networking in particular for the sake of scientific discovery and technological innovation, without much direct military application. Actual military design was done under conditions of extreme security in the National Laboratories and there has been very little innovation from these laboratories, in spite of their extraordinary scientific potential. They were the mirror of the Soviet system, and so was their fate, as they became monumental tombs of ingenuity.

Universities and research centres of major hospitals and public health centres were the crucial sources of the biology revolution. Crick and Watson worked out of Cambridge University in 1953, and the key research leading to recombinant DNA took place in 1973-75 at Stanford University and the University of California at San Francisco.

Business did play a role in the origin of informationalism, but just corporations that reinvented themselves, not established ones.

Business did play a role but not established corporations. ATT traded its proprietary rights for microelectronics against its telecommunications monopoly in the 1950s and later passed up the opportunity to operate Arpanet in the 1970s[26]. IBM failed to anticipate the PC and only jumped on the bandwagon later, under such confused conditions that it licensed the operating system to Microsoft and left the door open for the PC clones that would end up pushing IBM to survive as a services company. As soon as Microsoft itself became a quasi-monopoly, it made similar blunders, such as missing out on the Internet until 1995, when it introduced its Internet Explorer, a browser that was not originally created by Microsoft but based on the reworking of a browser designed by Spyglass, a company that licensed Mosaic software from the National Center for Supercomputer Applications. Rank Xerox designed many of the key technologies of the PC age at its PARC research unit but it only half understood the wonders its researchers were doing, to the point that they were commercialised by other companies, particularly Apple Computers. The business component at the source of informationalism was therefore, by and large, a new breed of business -- start ups that quickly became giant corporations (Cisco, Dell,

[26] Abbate, 1999.

Oracle, Sun Microsystems, Apple, etc.) or corporations that reinvented themselves (such as Nokia shifting from consumer electronics to cell telephony, then to the mobile Internet)[27]. Capable of transiting from their entrepreneurial origins to innovation-driven, large-scale organisations, these new businesses built on another fundamental component of informationalism, namely the cultural source of technological innovation represented by the hackers culture[28].

There are no technological revolutions without cultural transformation. Revolutionary technologies have to be thought of. This is not an incremental process, it is a vision, an act of belief, a gesture of rebellion. Finance, manufacturing and marketing will surely and ultimately decide which technologies survive in the market place. However, they will not necessarily decide which technologies develop because the market place, as important as it is, is not the only place on the planet. Informationalism was partly invented and decisively shaped by a new culture that was essential in the development of computer networking, the distribution of processing capacity, and the augmentation of innovation potential by co-operation and sharing, following the logic of open source and horizontal networking[29].

The understanding of how certain institutional environments are conducive to innovation and to advanced technological change, while others are not, is essential for identifying the sources of wealth, power, and well-being in the world

5. In a virtuous circle

In short, technology and society come together in the same process of historical change. Technological change is discontinuous and ushers in new periods of structural transformation around new technological paradigms, the logic of which is similar to that discovered by Khun for the scientific revolutions[30].

Informationalism is the technological paradigm underlying the formation of the social structure that characterises our world, the network society, although the process of integration of societies and people around the world in this globally diffused network society is extremely uneven. The understanding of how certain institutional environments are conducive to innovation and to advanced technological change, while others are not, is essential for identifying the sources of wealth, power, and well-being in the world. Innovation, in both its cultural and technological manifestation, is the source of informational development and it essentially depends on the existence of free, high quality university and research institutions in the framework of a free society. It is under informationalism that freedom, science, and power all become inter-related in what has become known as a virtuous circle.

[27] Tuomi, 2002.
[28] Himanen, 2001; Levy, 1994.
[29] Weber, 2003.
[30] Kuhn, 1964.

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