Technology and society in the information age

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Introduction

1. Judging technology

Before discussing our main topic, the interaction between technology and society[1], some mention should be made about certain cultural and ideological tendencies in the history of Europe that have affected not only social attitudes towards technology but have conditioned scientific understanding as well. Since the industrial revolution the notion of technology has been burdened with moral values and often extreme views in European societies: it has been regarded as an omnipotent solution to social problems, and on the other hand as a diabolic invention destined to alienate humans from themselves and nature. The basic question of 'whether technology is good or bad' has not changed since the Luddite movements in the early 19th century through the romantic spirit of a 'return to nature', the futurists' love for technology at the beginning of the 20th century culminating in today's radical environmentalist movements. The prevailing values of every age have stamped themselves on technology like layers of meanings each of which can be found in the **technophile** or **technophobe** approaches to understanding information and communication technology (ICT).

The most obvious feature of information society – even to the man and woman in the street – is the ever-growing number, variety and complexity of technological instruments and their constant change at an unprecedented scale and at a barely manageable pace. The need – and sometimes the pressure – to adapt to this rapidly changing technology in more and more areas of our everyday lives often ends up in frustration and shock for individuals and in moral panic for society as a whole.

When the real negative effects of technological change surface, it is primarily 'machines' (PCs, mobile phones, the Internet, etc.) that come to be seen as scapegoats by the public and the mass media alike exaggerating their contribution to the problem and forgetting their positive effects.

However, it is a fact that new technologies – and transformed versions of the earlier ones – play an active role in disrupting our conventional, that is, modern, values and way of life, leading to a sense of helplessness and indisposition in addition to challenging the abilities of individuals and the society as a whole to learn and to adapt.

The following chapter tries, from the perspective of **technorealism** (keeping a distance from the value-burdened extremes of **technophilia** and **technophobia**), to point out that technology is not a self-propelled monster unleashed into society to which one has no other choice than to adjust to, but is rather a social construct which – beside transforming our lives – is also shaped by society. Our introductory train of thought ends with Kranzberg's first law of technology which states: „Technology is neither good nor bad; nor is it neutral." (Kranzberg, 1985: 50). It is like us.

[1] We mean society in its broadest – that is sociological – sense, of which culture, economy, politics, etc. are all subsystems.

2. The scientific approach of the chapter

Studies considering science and technology as an inseparable and organic part of society – like information society studies – do not have a unified conceptional and methodological apparatus, nor a comprehensive and prevailing scientific paradigm. We can talk about a variety of multidisciplinary and interdisciplinary studies, schools, theories and approaches interacting with each other and comprising works of scholars from various traditional sciences like history, economics, sociology or anthropology. The great number of diverse approaches makes it impossible to review them completely, so we have to forget about introducing schools like the technology theories of evolutionary economics in detail. On the whole, the goal of this chapter can be nothing more than to provide an 'intellectual crutch' for discussing and interpreting information communication technologies by reviewing the most relevant and important theories, concepts, models and notions of the topic.

To close our introduction and to open the discussion, we argue that theories focusing on the processes of information, knowledge and communication (like information and communication studies, information systems literature or social informatics) cannot claim full understanding of information society without taking into consideration the results of studies exploring the intermingling nature of technology and society.

Technological determinism

The idea of **technological determinism** appeared in the latter half of the 19th century and has been a prevailing popular sentiment ever since, moreover numerous works of scientific importance also bear its marks. Its existence has significantly contributed to the endurance of some technology related misunderstanding.

Technological determinism argues that technology is the principal driving force of society determining its mode of operation, development, course of history, structure and values in a decisive manner. Converse effects are taken into account to a limited extent, fully disregarded or disclaimed. Technological development is thought to be propelled by the logic of science alone.

Most scientific concepts explicitly reject technological determinism; yet they assist its survival by studying only technology's influence on society. This is more symptomatic of ICT related researches. In this chapter we have therefore focused on theories examining society's impact on technology or the interaction of the two domains. The only exception we make is Everett M. Rogers' theory on the diffusion of innovations, which complements these approaches and shows a significant conceptual affinity to them.

Diffusion of innovation theory

Innovation has become a key activity of information societies. It is the cornerstone of economic competitiveness. National and regional (such as European) administrations develop high level strategies to promote innovative activities in the economy.

Innovation can be defined as basically novel inventions or concepts – arising from either professional research or ideas by amateurs – translated into practice. An innovation can be a technological object, a new organisational solution or an idea.

Innovations become market goods through product development and/or technology transfer. The product cycle consists of the following stages: introduction (to the market), growth, maturity and stabilization, and decline. The life cycle of common goods (e.g. road infrastructure) and public goods (e.g. public safety) go through the same stages. Rogers' theory applies to the life cycle of innovations as far as the maturity phase and at the level of communities and societies.

Rogers (1995)[2] explains the diffusion of innovations[3] as basically communicative: diffusion is "the process by which an innovation is communicated through certain channels over time among the members of a social system" (ibid, p. 20). Diffusion is determined by the above mentioned four factors (innovation, communication channels, time and social systems). It is a process of decision making, in the stages of which different types of information and knowledge transferring mechanisms play crucial roles. The diffusion of innovations – thus, of technologies too – takes place within social networks, so called **diffusion networks**. The ability of individuals to adapt depends on the cohesion of these networks, in other words, to the extent of its homophily (similar socio-economic status, qualifications, attitudes); on structural equivalence (on the individual's position in the network); and on the threshold of other users which makes it worthwhile for a group member to adopt the given technology.

Innovators play a crucial role in diffusing an innovation between homophile diffusion networks. They tend to use the technology first, and usually possess heterophile social relations (they maintain regular relationships with several social groups and through them, several networks of diffusion). Chronologically, the second group to adopt an innovation are called the early adopters; these are followed by the early majority, then the late majority, and lastly, the laggards. Each of these ideal-typical groups is characterized by specific socio-economic factors, personality values and communication behaviour. For example laggards are the most disadvantaged group along the socio-economic scale.

When studying the diffusion of ICT, at least one more category must be added: the refusers, who consciously resist usage throughout their lives (also known as diehards).[4] The existence of this group indicates that no technology ever penetrates a society fully. To reach 100% diffusion both society and technology need to change as compared to their initial status when the innovation was introduced.[5]

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[2] Rogers published his book, *Diffusion of Innovations* in 1962, what he developed under the influence of his critiques. We use the 1995 version of his general diffusion theory.

[3] Rogers uses the term innovation in the broadest sense not only for technological objects, but ideas etc. However, we will relate the term to technological innovations.

[4] A good example for refusers are those who plan not to switch to digital television (http://en.wikipedia.org/wiki/Digital_switchover), even after analogue television broadcasting is completely switched off. According to forecasts in the UK, 6% of the population will refuse to watch digital television even if the change would cost them nothing after the 2012 analogue switchoff. They object the digital switchover in general, thus their resistance is based on moral considerations (The Generics Group, 2004: 3).

[5] This issue is discussed in detail in section four.

The process of diffusion is broken down into different stages from the individual user's point of view. First, one typically acquires information regarding innovation through mass media channels (or cosmopolitan communication channels). The following three phases are dominated by interpersonal channels (or local channels). In the second phase, persuasion and opinion forming take place, followed by deciding on the adaptation, finally evaluation and confirmation of the usage. Of course, refusing the implementation (even several times) is an option too, but it can be followed by acceptance, and vice versa, the evaluation of implementation can lead to discontinuing usage.

Rogers analyses the characteristics of an innovation affecting its own diffusion (such as relative advantage, compatibility, complexity, trialability and observability), but gives little attention to their socially constructed nature.

The main advantage of Rogers' theory is that a key role is ascribed to communicative processes. This momentum makes the theory a close relative to other approaches introduced in this chapter (such as *SCOT* and *ANT*). Rogers' theory can be drawn upon in the analyses of such information society related issues as the digital divide or e-inclusion.

Science, Technology and Society studies (STS)[6]

The beginning of Science, Technology and Society studies dates back to the early 1970s, when the first studies were published (Cutcliffe, 1990). The novelty in the pioneering works, which lends them their special character even today, was that they stressed – contrary to technological determinism – society's crucial role in the development of science and technology, framing the three intermingling domains in complex theoretical systems. The works of philosophers, historians and sociologists were collected in two books in the mid-eighties (Mackenzie et al, 1985; Bijker et al, 1987), which have become the most cited publications of this school. Some of these approaches have developed into theories, generating further discourses and *STS* has been crystallised into an interdisciplinary field of research with both common research areas and methodology.

The *STS* school is far from being the dominant scientific paradigm of this area of knowledge, but has several advantages that make it indispensable when examining information society and ICT. These are its strong empirical basis and complex approach to analysing interaction between technology and society, their manifold co-dependence, and complex co-development. Within the several concepts of *STS*, many schools exist criticising and complementing each other.[7] The "social construction of technology" school, the "Actor-Network-Theory" and the systems approach to the history of technology all see the relation of technology and society as a "seamless web" (Bijker et al, 1987: 10).

1. Social Construction of Technology – SCOT

The foundations of *STS* were laid down in the 1980s by the "Social Construction of Technology"[8] school, which focuses on the development phase of technologies at the micro level, and pinpoints that technology (and natural scientific developments) are basically shaped by social processes.

The conceptual framework of *SCOT* is built upon four basic notions by Bijker and Pinch (1987). The first is '**interpretative flexibility**' which states that scientific outcomes, engineering (based upon the former) and the resulting technologies are shaped by meanings assigned to the technology by relevant social interest groups. Different meanings and interpretations can conflict in the form of discussions and debates between these groups; and that is the true determinant of technology's functionality and design. **Relevant social groups** can consist of individuals, organisations and institutions. All groups are included for whom technology related problems are relevant: not only user groups, but non-users too, who also form their own opinions about a given technology and its implementation.[9] The social component can be summarised by stating that the functionality of a technology is mainly determined by what users want to use it for and how they want to use it. Scientific achievements and engineering provide a framework which limits the unfolding of user needs.

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[6] Though the term 'Science and Technology Studies' is more widespread, we would like to hold on to the longer version, since it contains the term 'society' which underlines its importance in these approaches.

[7] On the following pages we summarize some studies from the book, *The Social Construction of Technological Systems* (Bijker et al, 1987). The studies are focussing on the common issues of sociological and historiographical approaches to technology and society, and have become basic works of the field.

[8] We note that the concept of socially constructed technology is not only peculiar to SCOT. Other schools, like the Social Shaping of Technology also follow this conceptual path. Thus SCOT has become a differentiating trade mark of this school.

[9] A good example is the pejorative nickname of the mobile phone in Hungary in the 1990s, when it was not widespread: 'rudephone' (*bunkofon* in Hungarian). This term was mostly used by non-users, who found it annoying to see other people making phone calls in public places.

Any given technology stabilizes when debates are settled. This is the phase of 'closure and stabilization'. Closure, however, does not mean finalizing: newly joined user groups can reopen the debates which can lead to new modifications to or variations of the existing technology (Kline-Pinch, 1999: 113-115).

Using the terminology of evolutionary approaches, we can say variations, mutations and hybrids are brought to life during the diffusion of a certain technology, which is chiefly true for ICT. Take the different variations of computers (desktop PC, portable notebook, PDA, etc.) or the convergence of mobile phones with other electronic devices (such as PDAs, digital cameras, mp3-players, game consoles, or GPS devices) which are typical hybrids. Bijker and Pinch emphasize that the meanings assigned to technologies are determined by the norms and values of social groups which draw the 'wider context' of socio-cultural and political environment into the set of determining factors. Drawing on the wider context concept, R. Laudan argues that changing social values can bring new technological constructs or their complete generation to life. The heterogeneous and hierarchical community of technological development functions as a mediator of social values and forces value orientation in society to change (Hronszky, [1997] 2002: 101).

Introducing the wider context into the concept, *SCOT* drew attention to the importance of macrostructures, though not to elaborate on them in detail (Klein-Kleinman, 2002). The shortcoming of *SCOT* is that on the one hand it pays little attention to reverse processes, namely the social implications of technology, and on the other hand it does not discuss the whole life cycle because it misses out the growth, maturity and decline phases.

The commonalities between diffusion theory and SCOT are apparent: both theories consider communication processes between and within social groups as dominant factors. The two theories can be considered as two sides of the same coin, though their theoretical synthesis is yet to be completed. Instead, their joint application can be found in a variety of empirical researches. Jakku and Thoburn (2006) used them as a framework for analysing agricultural decision support systems, Fontana and Sørensen (2005) applied the two theories to develop an approach where mobile services development was studied as interactive innovation; or they were used for studying how innovation diffuses in the British construction industry (Larsen, 2005). The efforts that combine the advantages of the two approaches are incidental, isolated and use different components of the theories depending on to what field the researchers apply them. A systematic synthesis of the two approaches would definitely contribute to a deeper understanding of innovations in the information age.

2. Actor-Network-Theory

Actor-Network-Theory is another school of STS studies, which is more and more widely used. It is a new branch of the sociology of science and technology, the basis of which was elaborated by Michel Callon, Bruno Latour and John Law in the 1980s. They – along with other scholars – developed their concepts into a theory.

A basic statement of *ANT* is that technological objects along with their socio-political context co-develop and shape each other mutually into socio-technical entities through constant interactions. The objects and their context form heterogeneous networks made up of human and non-human components which are connected to each other dynamically. These heterogeneous components can be objects, techniques, institutions, organisational solutions, human abilities or cognitive structures.

Human components as network builders are constantly formed and constituted by the networks they are part of. Actors in this network are connected by intermediaries, which in many cases, have social meanings. Texts, technical artefacts, currencies or human skills can function as intermediaries.

One of *ANT*'s – much debated – theorems is that the natural state of society is disorder. Order is achieved through the constant and endless efforts made by the actors to build networks.

Callon (1987) argues that an actor-network cannot be derived either from the actor or the network. The actions and the will of actors are inseparable from the network, and their effect runs through the whole network.[10]

The above mentioned vanishing boundaries lead to several consequences. Methodologically, on the one hand *ANT* focuses on events and outcomes, instead of actors, and on the other hand, a common terminology is applied to analyse both human and non-human components (Király, 2005: 54). Furthermore, technology's impact on society can easily be explained by the way in which solid technological objects as manifestations of social relations can ensure social cohesion (Latour, 1992).

When building networks, actors allocate resources and seek allies to enforce their interests. Thus, the nature of network building is principally political, and its central notion is power. By understanding power relationships, the way actors are defined, associated and obliged to be loyal to alliances can be described. The real source of power is where the factors holding actors together are defined and redefined constantly, and where the obligatory point of passage can be found.

The constant shifting of power between technology and society is called **<u>translation</u>** (Latour, 1992): as a result of this process, networks are formed progressively, in which certain entities gain control over other entities.

ANT redefines the role which actor-networks play in the reproduction of power. It denies that technology – and that in particular technological objects – are only instruments for and manifestations of reproducing power inequalities. It states that power is the consequence of collective action, not its cause. And since human actors are also part of the networks as are technical objects, the less powerful also have the opportunity to affect actor-networks, and through them, technology. *ANT* theorists, though, do not deny the existence of power inequalities or their reproduction through technology to some extent. At the same time they emphasize that the networks – stabilised and held together by different translational strategies and tactics – embedded in technological objects, show a certain degree of flexibility which can be modified by all actors of the network. They ask questions about how power translation operates at the level of organisations (Law, 1992). At the level of society the same question goes like this: how does the burden of past social values carried by technological tradition affect societal changes (Király, 2005: 49-51).

It is no accident that Feenberg (2003) uses e-mail as an example for how actors with less power can decisively determine the course of technology. The development of ICT is full of stories such as this where non-professional, but adept users started using technology in ways which had not been anticipated by the engineers and designers of the original technology.

Actor-Network-Analyses in practice

ANT seems to be an ideal approach for studying information communication technology, and it is used as a framework for analysing ICT systems and projects.

A case study by Stanforth (2006) on the implementation of an e-government information system in Sri Lanka shows the theoretical power of *ANT*. A financial reform including the implementation of a public expenditure management (PEM) information system was carried out in the country from 1995 to 2006. The imple-

[10] The vanishing boundaries between actors are partly explained by Law's (1987: 111-134) 'heterogeneous engineering' concept. Engineer-sociologists, while designing a technological object, define a certain history and society in which these objects are implemented. Thus, they do not separate the conventional categories of technology and society.

mentation project was only a partial success. The PEM was built for the Ministry of Finance, the Prime Minister's Office and some civil organisations and was financed by the Sri Lankan government and international organisations. The writer analyses to what extent the global and the local stakeholders of the project were involved in different stages of the project, and how the amount of control they possessed changed in time (translation). The actors are grouped into interested, hostile and neutral stakeholders. These roles changed constantly during the project. The failure of the project was caused by the lack of an obligatory point of passage locally (e.g. within a governmental organisation), which could have coordinated the global and the local networks. The bottom line of the case study is that the failure of implementation was not due to the characteristics of the technology, but rather to the inadequate operationalisation of the complex actor-network.

3. Systems approach to history of technology

Science and technology historian, Thomas Parke Hughes (1987) studies technological systems at a metalevel, and – similar to the previous schools – thinks technology is both socially constructed and society shaping.

Hughes argues that technological systems are heterogeneous networks consisting of physical and non-physical artefacts such as organisations, scientific components, legislative artefacts or natural resources. The components are socially constructed since they are made by individuals (or using Law's terminology: heterogeneous engineers). The characteristics of the specific components are derived from the system they interact with. Changing any system component results in changing all other components. The heterogeneous components of a socio-technological system are coordinated by hierarchically organised system builders.

Technological systems are open. They function embedded in an environment they cannot control. Certain elements of the environment can depend on the system, yet they will not become part of it due to lack of interaction. The uncontrolled environmental elements lead to uncertainty in the system which drives it to incorporate them. In other words, uncontrolled environmental elements make technological systems grow.

Pattern of evolution

The evolution of Large Technological Systems (LTS) – such as electric power – follows certain patterns. Social construction takes place when inventions are transferred to innovations, and at the same time, they become components of a technological system. Inventions in a LTS can be conservative or radical. Radical inventions typically inaugurate new systems, while conservative inventions help to improve the existing system incrementally. The pace of development is usually faster upon the introduction of new technological systems, while the incremental improvement of technological systems by conservative inventions is much slower.

Conservative inventions are usually products of professional inventors who work in mission-oriented private or public research organisations. Radical inventions resulting in new technological systems are less likely to appear in these organisations. The source of radical inventions is typically the independent inventor, who played a crucial role in the renewal of industries in all ages.

Innovations become products through technology transfer. During this process technological systems respond and adapt to environmental changes developing a so called technological style. This term is useful in describing and explaining the differences between various forms of certain technologies occurring in time, space and different organisational and cultural contexts.

The next evolutionary phase of large technological systems is growth and consolidation. A typical problem during the growth period is the **reverse salient**. Reverse salient appears in a system when a component of the system becomes dysfunctional due to an incremental innovation of another component. This can be corrected with another – usually conservative – invention.[11] In many cases the reverse salient cannot be corrected in the old technological system. This inaugurates a new system, which completes or competes with the old one.

Nevertheless, without a reverse salient, there can also be a change in the course of research and development. A **presumptive anomaly** can have the same effect. In this case system builders anticipate such future changes – based on scientific calculations – that a technological system becomes inoperable or uncompetitive compared to a new and more effective system.[12]

Consolidated technological systems respond to the changing environment (e.g. social changes). This drives competition between systems, which can have several outcomes. One is the decline of the old system and the domination of the new one. Another is that further innovations can ensure the integration of the two systems into a universal one, as happened in the case of direct and alternating current electric power systems. Today something similar happens in the case of converging landline, wireless and mobile telecommunication networks (see NGN development program[13] or the BcN program in south-Korea[14]).

Another important characteristic of large technological systems is their stratigraphic nature. New technological systems are initially built where the network of preceding systems are denser (Hughes, 2000). For instance, telecommunication infrastructure is built principally where preceding systems such as road and electric infrastructures are present. Internet started unfolding on copper landline telephone infrastructures, then, expanded to coaxial, fibre optic, wireless, and finally mobile telecommunication networks. Today, electric power infrastructure has become the 'natural' frontier of the Internet. Nevertheless, the Internet is a good example of how new systems affect older ones: in some developing countries, electric power supply is being extended to new territories in order to provide telecommunication services (e.g.: implementation of wind powered mobile base stations).

LTSs gain **technological momentum** while growing. This means components of a system (especially capital intensive ones with a long amortisation period) move in the same direction following certain goals along a specific trajectory.[15] Technological momentum can account for preserving outdated social values and relations. When a technological system is emerging, social norms and values manifest in it, but after consolidation they are carried along unchanged in a changing social environment. Technological momentum can move a system forward that has already lost its functionality. That is why technological stasis (the end of evolution) can be delayed in contrast to social changes. Technological stasis is followed by the decline of the system which is replaced by a new one more able to adapt to the changing environment.

In the opposite case, when technological development is ahead of social development, **social resistance** – as the evolutionary school of history of technology calls it – can occur. This leads to either the delayed diffusion or the total disappearance of the innovation, or the modifications of dominant values and lifestyle in a given society (Hronszky, 2002: 73).

[11] The compass became a reverse salient on iron ships using electronic equipments, which made it unusable. To correct this, a new device had to be invented which could function in the altered conditions too. This was the gyroscopic compass.

[12] Constant (1980) showed that in aviation, the turbojet engine was invented because aerodynamics had predicted piston-engines and propellers would need to be replaced when flying near the speed of sound at great heights, and not because they had already proved to be dysfunctional in those conditions.

[13] Next Generation Network, a global standardisation initiative by International Telecommunications Union (ITU NGN-GSI, 2003).

[14] Broadband converging Network (2006 Korea Internet White Paper, 2006).

[15] An LTS with a high level of momentum can give the false impression of being out of control. The period between the two world wars was characterized by such systems. Today, the mobile telecommunication industry has gathered a high level of momentum, which invested hundreds of millions of euros into building third generation mobile networks. At the moment, in spite of the lukewarm interest of mobile users in services offered on these networks, the mobile industry keep pushing forward making this LTS grow.

The phenomena of technological momentum and social resistance can immediately explain the delayed diffusion of inventions with obvious advantages. The widespread use of electric cars, for example, could ease environmental damage through decreasing exhaust fuel emission. To fully replace internal-combustion engines and the technological system they are part of, a consolidated alternative technological system has to evolve which is as large and complex as its predecessor. In Hungary, a kind of social resistance which is rooted in cognitive and lifestyle related causes is responsible for the sluggish up-take of internet usage.

Information and communication technology

1. Limits of applying STS studies in empirical research

The application of these theories and schools on ICT is problematic in many respects. First, as we stated above, there is not a single, widely used paradigm which has synthesised the various schools and theories dealing with technology and society. Second, these fragmented approaches do not have a fully-fledged mode of application to the relationship of Information Control Technology (ICT) and (information) society.

Third, *SCOT*, *ANT*, the evolutionary- or the systems approach to the history of technology – when dealing with information society – does not take into account the results of approaches (such as information science or information systems literature[16] or social informatics, information management and knowledge management, communication and media studies) studying the very essence of the information age: information, communication and knowledge. The list of unnoticed or partially incorporated sciences, which focuses on the role of ICT in human information processing and other cognitive activities, is much longer. These, though, miss the approach of STS and evolutionary schools, particularly the concept of technology and society as a seamless web. Merging the two modes of understanding information society is in its infancy, though studying ICT systems cannot be complete without them both.

2. ICT as a technological system and its characteristics

Considering the role of information and communication technology in society, – agreeing with the theorem formulated in the information society chapter of this book: 'The processes of information production take place in the minds of individuals,…' – we put the emphasis on the ICT-enabled extension of individual and collective cognitive skills in time and space, on the increase of information processing performance, and on new patterns and schemes. Technology is of secondary importance from this point for view, but not from its implications for society.

From what has been said so far, ICT can be seen as a universal technological system, which is interwoven with and permeates older technological systems, creating new technological systems at the same time. The network of its human and non-human components may surmount any previous systems in complexity and heterogeneity. ICT's peculiar function is to support the acquiring, storage, processing, transmission, dissemination, management, control, transformation, retrieval and use of information typically in a digital format.[17]

ICT is characterized by a relatively traditional regularity: the accelerating pace of development. Two million years passed between the invention of the most primitive stone tools and the chopper cores. It took only a couple of hundred thousand years for the appearance of flake tools (Hronszky, 2002: 3). As far as communication technologies are concerned writing was invented – at least – tens of thousands of years after the appearance of spoken language. Printing (in Europe) came 5,000 years after writing, and after another 400 years, the telegraph was invented, which was the first global and real-time telecommunication instrument. The first

[16] Steve Sawyer (2001) criticises the second edition of '*The Social Shaping of Technology*' for completely missing out references to these two sciences.

[17] Some flagship technologies of ICT are microprocessors, telecommunication infrastructures, or – belonging to the world of non-physical artefacts – e-mail and SMS applications, and of course, the world wide web (www), which can be considered a technological system in itself.

commercial internet service was launched 150 years after Morse's first message. In the information age, successive new technological systems replace each other with a greater and greater acceleration.[18]

Variations, mutations and hybrids appear and disappear in uncountable quantities and in a surge. In the case of bicycles, it was not obvious at first sight that the stabilisation and closure phase can be reopened. It is much more striking for ICT artefacts. Think about mobile telephones.

Another crucial evolutionary pattern – and as general as acceleration – is the increase in performance of instruments. This is driven by the demand for storing, processing, displaying and transferring larger and larger quantities of information, and by the increasing number of human activities related to them. The growing amount of aggregate performance is indicated by the world indices of energy consumption by ICT, and the growing concerns for energy savings.

Convergence features physical (communication devices, networks) and non-physical (databases, communications channels, content distributing systems) artefacts of ICT systems from the beginnings. ICT as a term refers to the still unfinished convergence of information technology (IT) and telecommunication systems. The outcome of this convergence is an integrated and unified technological system at a higher level. At the moment, we can observe the convergence of ICT and other systems such as television broadcasting and consumer electronics at the level of devices and standards. These systems had belonged to ICT for a long time, though in a less integrated way.

ICT also pervades systems (without exception) which existed far earlier than the information age. This happens to all the fundamental technological systems of conventional industries and sectors: agriculture, industrial production, conventional services (financial, logistics), education, healthcare and public administration.

Everyday life is no exception to this. Conventional 'real life' activities complemented, supported or mediated by ICT are expanded into the dimension of virtuality. Thus, we can speak of e-commerce, e-administration, electronic communication, internet banking, etc. The terms pervasive or ubiquitous computing and ambient intelligence refer to this phenomenon.

[18] The first home video system using VHS format was introduced to the market in 1977. DVD video hit the market exactly 20 years later. In 2006, only 6 years have passed and two new and non-compatible formats were launched: Blu-ray and HD-DVD.

Information society and ICT

As we noted earlier, the bulk of information society related literature studies technology's impact on society. Thus, we concentrate on factors that signal the socially constructed nature of ICT, or their interplay. These are the issues of control and the changing structure of society.

1. 'The control revolution'

The first question to ask about ICT is why did these technologies emerge in the second half of the 20th century? Why not earlier or later? What social processes brought them to life and made them indispensable?

James R. Beniger (1989), in his classic book, finds the roots of information technology in industrial societies. Information society is the ultimate solution to the control crisis of the industrial age, revolutionising control mechanisms by – among other means – ICT. Beniger sees society as a processing system sustained by its control systems: bureaucracy and technology.

Beniger illustrates the crisis of control with pathological symptoms of the American industrial economy. Problems arose first in controlling distribution-related information. The telegraph provided one of the first solutions. Logistical problems caused by growing mass production also amplified the crises of control. What should be produced? How much? When? How should the supply chain be organised? These questions had to be answered on a daily basis and the control mechanisms and techniques at hand could not provide adequate solutions. The first step to resolve these problems was the emergence of a managerial class, who specialised in control related workplace activities. Alongside production and distribution, consumption started to show symptoms of a control crisis. A more intensive flow of information between vendors and consumers was necessary to utilize the capacities of production lines more effectively. This facilitated the introduction of marketing activities, and later on, in the United States, between the wars, lead to the development of new market research methods.

However, the revolutionary solution to this 20th century crisis came with the emerging information society from the 1960s on: this is the real control revolution. The improvement of production efficiency took place in industrial society, but the problems caused by it are only resolved by revolutionising the control systems of distribution and consumption, and this is what has been happening in information society.

Focusing on the development of computers and the Internet, we can observe the signs of control crisis. These two technologies were originally used by large private and public organisations in desperate need of managing, processing and distributing increased quantities of information, where earlier technologies had become obstacles to the further growth of the organisation.

2. Network: the new mode of organising society

Manuel Castells, one of the most cited scholars in the information society literature, explains the origins of ICT from the perspective of social developments. He argues that the network is the dominant structure of society in the information age: power, money, information and society itself is reproduced in networks. ICT enabled the management of these network structures. Networks can incorporate practically anything (Castells, 1997). Online communities are plausible examples of networking. Computers and telecommunication networks were originally designed to process and exchange data and databases, but they were used for interpersonal communication from the very beginning. The alternative use of new devices assists ongoing social changes. Electronic mail, which is the equivalent of postal mailing, enabled more flexible and real-time one-to-one communication. The real networking, though, starts with mailing lists, which are the first form of many-to-many telecommunication. One of the mailing lists was run by academic researchers discussing science-fiction. Online networks of users are organised around common interests. Online communities have become widespread and the repertoire of their communication channels includes online discussion groups, public chat rooms, networking web sites, peer-to-peer networks, weblogs, photo and video sharing websites and their various combinations.

Social networks supported by electronic communication channels play a crucial role in the development of ICT as a technological system. The circle of potential independent innovators widens – for example, user innovation. It is easier and faster to channel feedback regarding innovations from relevant social groups at the development stage, thus diffusion and development of a certain innovation can advance parallel with each other. The increasing intensity of information flow between vendors and customers results in customised and personalised products and services, in particular information industries, multiplying the variations of technological artefacts.

Summary

Having taken a closer look at the relationship between technology and society, we see that a complex and interactive network takes shape, in which neither of the factors dominates in shaping one or the other. Society affects technology as much as technology affects society; nevertheless, the complex patterns of their interaction are not yet understood completely.

The dominant relationships and values of a given society are imprinted in technological objects and in whole systems which may carry those values and relationships through later ages. Technology and society co-evolve in time, but asynchronicity can occur too. Because of the effect of technological momentum, it is possible that a technological system reacts more slowly to changes in the socio-cultural context, and vice versa. Technological development can outpace the development of prevailing norms, values and the whole way of life. In the latter case, technology can either lose its impetus, or change society by quelling social resistance.

ICT and information society are the results of radical changes. The revolution in information and communication technologies is a kind of technological paradigm shift. Information society is the age of a new social structure and a new mode of development.

ICT means completely new technological systems (internet, mobile telecommunication, etc.) which technicised new areas of everyday life. ICT assimilates earlier information and communication systems (landline telephone, radio, television, consumer electronics) and increasingly pervades conventional technological systems (construction, logistics).

The emergence of ICT is explained by the crisis of control systems in the industrial age. ICT became the new technological control system and in the meantime, society (as the processing system) has transformed drastically into an information society.

Networks became the dominant form of social reproduction and the mode of development. ICT-enabled social networks react to the development of technological systems, process of which is most apparent in ICT as a technological system.

Revision questions

1. Compare diffusion theory to SCOT.
2. What commonalities and differences are there between the systems approach and the Actor-Network-Theory?
3. Give examples of the socially constructed nature of ICT.
4. How can ICT reproduce power inequalities? Alternatively, how can it change them?

Key terms

Actor-Network: A heterogeneous network comprising human and non-human components where technological objects and their socio-political context shape each other and co-develop into socio-technical entities through constant interactions. [Actor-Network-Theory]

Diffusion network: Social networks through which innovations diffuse within a given social group. [Rogers' diffusion theory]

Interpretative flexibility: refers to the flexible nature of discussed and debated meanings ascribed to scientific results, engineering processes and the resulting technologies by relevant social groups within a certain social context. [Social Construction of Technology, SCOT]

Presumptive anomaly: based on scientific calculations, system builders anticipate such future changes – that a technological system becomes inoperable or uncompetitive compared to a new and more effective system. As a result, the course of research and development can take a completely different path. [Systems approach to history of technology]

Relevant social groups: The members of such groups shape the development of a technology. They may be individuals, organisations or institutions. All other groups organise around these groups if they consider technology related problems relevant [Social Construction of Technology, SCOT].

Reverse salient: An anomaly in the growth phase of technological systems. It occurs when a conservative innovation of a component makes another formerly functional component (physical or non-physical) inoperable. If it cannot be corrected by conservative innovations - a radical innovation is needed to foster a new technological system. [Systems approach to history of technology]

Social resistance: can occur when radical innovations are introduced. It can delay or halt the diffusion of a given technology. On the other hand radical innovation can change the dominant values and lifestyles in society. [Evolutionary history of technology]

Technological determinism: argues that technology is the principal driving force in society determining its mode of operation, development, course of history, structure and values in a decisive manner. The effects of any opposing direction are taken into account to a limited extent, fully disregarded or disclaimed. Technological development is thought to be propelled by the logic of science alone.

Technological momentum: Components of a system (especially capital intensive ones with a long amortisation period) move in the same direction following certain goals along a specific trajectory. Technological momentum can move a system forward that has already lost its functionality. That is why technological stasis (the end of evolution) can be delayed. [Systems approach to history of technology]

Technophilia: is enthusiasm for technology, which expects and perceives only positive social changes from technological development. Ideologically it originates from liberal-progressive traditions.

Technophobia: The opposite of technophilia. Aversion to and fear of technology and its negative implications for society. Technophobes expect and perceive only negative changes and anticipate a dystopian society.

Technorealism: makes efforts to assess the social impacts of technology objectively taking into consideration positive and negative effects.

Translation: is the constant shifting of power between technology and society, and between entities of the network. [Actor-Network-Theory]

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