Technological Determinism:
A Technological or a Social Theory?

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> *{…} We had long ago predicted that the Pope would play the part of a simple archbishop in a united Italy, and were firmly convinced that this thousand-year-old question had, in our age of humanitarianism, industry, and railways, become a trifling matter. {…}*
>
> (F. M. Dostoyevsky, *The Possessed*)

The title of this paper paraphrases thesis VI[1] of D. Edgerton's well-known ten eclectic theses on the historiography of technology. Technological determinism (TD) is primarily a theory of society, not a theory of technology. The same author makes it clear that the notion of TD can be understood in two ways: as the thesis that a society is determined by technologies in use or as the thesis that technical innovation determines social change. The second option makes a stronger appeal to common sense, although it is more easily attacked academically. The first option leads to more subtle studies of the use of technology, which in principle are more difficult to be handled through monocausal methodological schemes.

In everyday life we come across the idea that technology wins wars, which is not an absurd idea, but the simple story of the atom bomb shows that the Americans succeeded in World War II although the Germans were well advanced in the relevant physics. Subsequently the bomb established the Cold War balance of power for fifty years and it can be claimed that the very same arms race was a factor for the collapse of the Soviet Union. The invention of the compass is credited with having brought geographical exploration in its wake, again not an absurd idea either, but after the appearance of the navigational device in Christian Europe in the mid-12th century it took 250 years and much heterogeneous engineering to use J. Law's seminal notion in the exploration of America. To continue the line of argument, the pill brought about the sexual revolution,

but only in certain parts of the world which proved receptive to it. The PC brings us into the post-modern world, but in Greece we still frequently use our computers in pre-modern environments.

We can claim in reference to the above examples that the use of the notion of TD in any case can tell us little and not necessarily the most interesting things about the important relations between technology and society. This proposition leads us to the contemporary technology studies of SCOT, CTA, ANT and after, which, as is well known, explore these relations.

Technology and modernity

The term 'technology'[2] has a different past in different languages. English distinguishes *technique* and *technology* taking for granted that *technique* refers to something quite different, skills and methods, while in French and in German both terms can be used in a supplementary way.

The term appears as early as 1728 in Christian Wolf's *Philosophia rationalis sive Logica* and its main influence was the opening of university teaching to technical culture in general; that is 'the science of things made by man's labour'. Later on in the same century, Joseph Beckman used the word 'technology' but the term in his sense put an emphasis on a fiscal science encompassing political economy, finance and management. In the *Encyclopédie* we find a full description of the technical professions and, as Salomon writes,[3] the whole undertaking of the project was directed at the accommodation of technical matters with the culture and practice of the *honnête homme* and was a hymn to progress. Technology triumphed on the basis of the progress ideology, on the very eve of the technical changes, which ultimately threatened this ideology.

M. Roe Smith expresses similar views, arguing that the intellectual heritage of technological determinism can be traced to the liberating enthusiasm of the Enlightenment and that the American experience provided fertile ground for the idea of TD where the founding fathers' faith in progress was mostly implemented by the use of mechanical technologies for liberty and moral and material improvement.[4]

In 1832, Babbage in his *Treatise on the Economy of Machines and Manufacture*, while lamenting over the situation of English science, focused on the social economic aspects, paving the way for Karl Marx to identify technology as a social process. Bigelow, a botanist and a physician, in his lectures at Harvard University in 1828, coined the term 'technology' in English[5] where he meant 'the principles, process and nomenclature of the most conspicuous arts, particularly those which involve applications of science, which may be considered as useful […]'. Thomas Carlyle, in the seminal article 'The Age of Machinery', published in Edinburgh in 1829, considered the mechanical components of the technological system to be the main characteristic of the new era, but soon it became clear that these components represent only a small part of the system.

Referring to these definitions, we must bear in mind, as Landes neatly comments,[6] that no economic or social system, at least historically, has ever been pushed to its extreme logical consequences. Modern historical studies on the industrial revolution show this clearly.[7] Strict definitions and monocausal explanations, although they may seem to be helpful, usually only hinder knowledge of the past and this also holds true in the case of mechanization.

These changes were not enough. Technology, as Leo Marx comments, was not simply filling a semantic void, which was simply representing the means through which progress could be achieved, technology virtually came to constitute progress, was reified, and became independent. The classical problem of the relation between society and technology emerges, since it was thought that there is a need to draw boundaries between the two. But the 'impact' of technology on society today is thought to be by no means a simple problem and hard demarcations are difficult, if not impossible. This case, leads us to a web notion of amorphous technology, very helpful to modern historical studies, but difficult to handle. We will not pursue this issue here, but will simply comment that the image of autonomous technology, which appears in various approaches, leads to a notion of an institution uncontrollable by social life, raising great political and moral issues.

The notion of technology, the last love of modern man according to Berdiayev, is linked inexorably with the 19th and 20th centuries, and its re-ification can easily be seen to be different in the various national environments.

In the USA it led to mass production and the scientific organization of work, in France it provided an example of state management, in England it created an empire and huge social inequalities, in Germany it was linked with the dream of the national restoration *Sundered*, in Russia it made an important contribution to the world-significant events of 1917 in Petrograd.

During the first half of the 19th century the problem of the machine was of central importance, while in the second half following the control of the Luddite movement, the organization and the creation of the large technological systems was of paramount importance. While the notion of technology was linked to the practical exploitation of abstract categories for production purposes and the creation of relevant institutions, U. Wengenroth's phrase characterizing technology as 'a way to do things, rather than ways to produce things'[8] captures the meaning of 19th century technology.

Due to the emerging crises, classical liberalism gave way to organization, which was embodied in technological systems. In any case the consequences of these developments were a fuel to the great upheavals of the inter-war period. For M. Weber the price for the disenchantment of the world is the iron cage of bureaucracy, the domination of a social machinery in itself, where reasonable technique depends upon the ability of men to adapt to certain types of reasonable practical conduct.

In the aftermath of World War I the destruction of three traditional empires, the appearance of new centers challenging world domination, the crisis of liberalism and the economic crisis at the end of the 1920s signaled the first important crisis of modernity.[9] State intervention appeared as the antidote to the crisis and technology was a field of intervention par excellence. These policies soon took on international characteristics in the inter-war period. In the USA Roosevelt's New Deal policies, in Germany the technocratic mania of the Nazis, in France the embodiment of scientific management to the economy and state administration, in Italy the symbiosis of fascism and futurism,[10] in Sweden the Social Democratic synthesis,[11] in the USSR the employment of policies of an unprecedented scale combining the ideal of communism with technological development. Similar ideas and policies were clearly present in inter-war Greece, especially in the liberal modernization policies of the late 1920s and the dictatorial policies of autarchy in the late 1930s.[12]

The notion of technology thus hints to its social essence and therefore, its study and its overall influence require an estimation of the general trends and values of the social environment in question. For the case of Greece we can trace these elements in the conclusions, for example, of a leading Greek industrial historian who closes her book by saying that in Greece at the end of 19th century 'we probably have to do with a new society […] alien to the insistence, the patient long-term commitment and systematic manner required for industrial works'.[13] TD would thus appear to have been undermined.

Technological determinism

The locus classicus of the recent discussions on TD is where[14] the editors in their introduction distinguish essentially between three broad kinds of TD which to our understanding form a continuum with respect to the importance of technology and its power to effect changes to societies.

These are hard and soft determinism and a third kind, which denotes the tendency to create a kind of society which 'invests technologies with enough power to drive history',[15] the latter kind having been thought of after the events of the early 1990s, has a definition involving reflective thinking and will concern us more here.

The volume included a reprint of a classical article of 1967 by the economist R. Heilbroner, which opened the discussion held in the spirit of the 'science wars', which were prominent at that period, and a modern rejoinder. The author's main thesis was that nuclear energy was an impossibility in the 16th century since we first had to pass through the period of the hand mill and the steam mill; that there were no gaps in technology permitting the conclusion that TD is a product of a certain period 'of high capitalism and low socialism'[16] when the factors for the control of technology are still weak. The author hoped in 1967, as we understand it, for a social control of technology. In the rejoinder his main effort is a heuristic notion of TD, i.e. how machines make history in a specific context and not their autonomous function.

Hard determinism presupposes the existence of a dominating logic, a kind of cunning of reason, which can be implemented through the

market or through the guardians of society. The above implies strong ontological commitments with respect to the internal terms of construction and development of the technological phenomenon and that this logic is independent of social or cultural influences. But as T. Hughes concluded[17] paraphrasing Henry Adams 'there is no one best way to paint the Virgin; nor is there one best way to build a dynamo'. Soft determinism accepts that the history of technology is a history of human actions, is the locus of historical agency embedded in a complex social economic political and cultural matrix, thus avoiding monocausal explanations, in order to conclude finally that technology is the major driving force in history. The third notion of TD deals with the terms of its validity and in this sense talks more about society than technology. The excursus in history we presented in the paragraphs above could be read as supportive of an idea of TD strongly present for example in the crisis situation during the inter-war period. Its validity talks less about technology and more about the special circumstances which lead to the acceptance of the need of a strong technological effort in order to 'move forward'.

Edgerton[18] also hints at another aspect of the issue of TD, asking us to consider both sides of the dichotomies, producer and consumer of technology, technological innovation, which leads to social changes and the use of technology, which leads to social stability. The topics here lead to problems where necessarily the unique, the monocausal notion of technology must spread out in a broad social milieu, making the social component an internal element of the investigation.

In general there is some doubt not only about the hard forms of TD but also about its soft versions, which puts in danger the views about the existence of a unique motion in history related to eschatology. Deleting the constant landmarks of the historical narrative from the other side as a form of social conscience is an unbearable burden for the majority of people even today. Recent schemes in historiography, which give a clearer picture of the past without preconceived notions, might have to lean on the big narratives as temporary shelters.

The notion of TD is linked to the Marxist tradition, where a determinism of eschatological character can be traced with a fixed sequence of social modes of production, while more weak versions of TD can also

be traced. Since railways did not destroy the Indian caste system, we will consider only the weak notion which is summarized by the well-known phrase 'The hand mill gives you society with the feudal lord; the steam mill society with the industrial capitalist', from the polemic between Marx and Proudhon of 1847.

M. Weber commented that the hand mill functioned in a whole series of social environments, and if we remember to give examples from England at the period of the industrial revolution, Arkwright's machine was patented as not permitted for domestic use, while long debates were held over the prohibition of child labor. These acts hint that social intentions modify or invalidate a monocausal notion of TD.

In what follows Marx will be interpreted as the scholar who linked empirical social research with abstract theory, who linked A. Ure the works inspector, with G. Hegel. The gap to the latter will be shown clearly if we remember the description of the master-slave relation in the *Phaeno-menologie des Geistes*. Taking this into account we still claim that Marxian empiricism, irrespective of all its high points, is an empiricism which is subjugated to an eschatological political program. Some scholars find it easy to write that the weak point in Marx is his proletarian revolution theory,[19] attempting in our view, an analytic reading of him. Marx is definitely one of the sources of modern STS, for example in the marvelous examination of the worker-machine relation in the first volume of the Capital,[20] he can be read as a sociologist of knowledge in his Theories of Surplus Value, where the dependence of the dominating economic theories on their social environment is presented, as a supporter of the notion of determination of the superstructure by the economic basis and as a social determinist when he calls on his native Germany to see her English future and a technological determinist in the Communist Manifesto for example.[21]

We will not pursue this discussion further but simply note that the idea of TD always had a very strong influence during the periods of enthusiasm in the communist movement, in Russia and China or in inter-war Europe[22] or in Greece in the 1940s, the ideas of TD being linked with a framework for their social implementation. At this point the platonic kind of rulers who are supposed to know how history works are coming into action, providing technology with strong autonomous characteristics.

At this point we wish to cite a little known critique of TD by S. Bulgakov. The author, a Marxist scholar in Russia at the beginning of the 20th century studied the agrarian development of his country and came to the conclusion that the general patterns of TD did not apply. He concluded later, in his white period as a Christian scholar influenced by Dostoyevsky, that the metaphysical in a highly *a priori* form, rather than the empirical element are important in economic materialism, while belief in the power of authorities was an intrinsic element of the whole scheme.[23] This author had also the wit to comment on the importance to study 'the explanation of the possibility of its own existence (of historical materialism)'.

These ideas lead us to the modern emblematic book of 1962 on TD, *Medieval Technology and Social Change* by Lynn White Jr. The author attempted to prove the TD thesis for the medieval period on the basis of extensive empirical material. The stirrup brought about a medieval society whose focus was the knight mounted on horseback, while the heavy plough transferred the center of civilization from the Mediterranean to Northern Europe. The book, although strongly criticized on the basis of pragmatic material based on the use of the stirrup in 9th century Siberia,[24] was always mentioned as a parabola. The author himself did not republish the work nor did he answer his critics.[25]

The aftermath

The issue of TD is part of very recent discussions in STS literature. The content of our discourse will be limited to the relation of the specific artifact to the social environment, which holds an important place in the field.

L. Winner, the author of *Autonomous Technology* first published in 1977, a book which can be read as a defence of TD,[26] wrote an article in 1980, now a modern classic,[27] in which he claims that artifacts have politics. This is an old idea, Plato's Republic may be recalled where he tells us that the ship demands a captain. Recent arguments in the same mode tell us that nuclear weapons demand a strong central government, ignoring the contemporary problem of the possibility of terrorist groups possessing them.

Winner's exemplary argument referred to the low bridges in Long Island, New York, designed by R. Moses. The story told is that the bridges designed in the 1930s were so low that only automobiles could pass under them, preventing buses and thus the poorer strata of society from visiting the better beaches. Winner claimed that Moses built the bridges low intentionally in order to achieve this political goal, thus artifacts do have politics and TD in the modern sense holds true. Recent debates[28] showed that the main argument was counterfactual, buses do in fact, pass under the bridges, while it is not clear whether Moses, the strong man in New York planning from 1920 till 1960, the man who dreamed about and planned for the car in the city, indeed had this intention. Winner is clear in his intentions, 'My point is not explanatory, it is about political choices'.[29]

B. Joerges, who produced the historical evidence about the buses running under the bridges, thinks that bridges could be thought of as boundary objects and thus are not able to be bearers of preconceived notions either of control or of contingency. The power represented by the technical device is not to be found, according to him, in the formal attributes of the devices but in their authorization, their legitimate representation, which gives shape to the definitive effects they may have. He concludes that the building form, for example, can impose certain constraints only in the most trivial sense.

Woolgar and Cooper who present timetables of buses running under the bridges consider the story as a dynamic, yet essentially inconclusive narrative. They argue that it is important to see the rhetoric of the Moses bridges legend, the durability of the story for them may have emerged from the 20th century obsession with individuation. We must ask what gives an 'urban legend' like Moses' bridges their seductive power and how is this story related to the community of its readers.

Winner argues in various points[30] that the departure from a certain form of realism leads one to impotence in politics, while Woolgar and Cooper answer that a departure from naïve realism enables one to challenge politics and the sources of power more fundamentally.

When Winner fixes the function and the surrounding metaphysics of his artifacts, provides them with an *a priori* status, he is able to pursue well-defined political aims and show us a modern version of TD.

It is worth exploiting this idea further to see its genealogical links with traditional forms of social and political thinking. Our hypothesis presented in this paper, that TD is an idea linked more to the social and the political than the technological sphere, would appear to be in agreement with the literature.

Notes

1   David Edgerton (1999), 'From Innovation to Use: Ten Eclectic Theses on the Historiography of Technology, *History and Technology* 16, 1999: 111–136.

2   Here I draw some elements from Y. Antoniou and M. Assimakopoulos (2003), 'Notes on the Genesis of the Greek Engineer in the 19th Century', in K. Chatzis and E. Nicolaidis (Eds.), *Science Technology and the 19th Century State: The Role of the Army*, Athens.

3   Jean-Jacques Salomon (1984), 'What is Technology? The Issue of its Origins and Definitions', *History and Technology* 1: 113, 125.

4   Merritt Roe Smith and Leo Marx (Eds.) (1994), *Does Technology Drive History? The Dilemma of Technological Determinism*, Cambridge: MIT Press: 2.

5   Leo Marx (1997), 'Technology: the Emergence of a Hazardous Concept', *Social Research* 64: 974.

6   David Landes (1969), *The Unbound Prometheus*, 2nd Edition, Cambridge: Cambridge University Press: 547.

7   See for example M. Berg (1980), *The Machinery Question and the Making of Political Economy*, Cambridge; M. Berg (1994), *The Age of Manufacturers 1700-1820*, Routledge; and R Samuel (1977), 'Workshop of the World : Steam Power and Hand Technology in Mid-Victorian Britain', *History Workshop* (3): 6–72.

8   U. Wengenroth, 'Science, Technology and Industry in the 19th Century', web working paper.

9   P. Wagner (1998), 'Social Reflections: The Technology Question during the First Crisis of Modernity', in M. Hard and A. Jamison (Eds.), *The Intellectual Appropriation of Technology, Discourses on Modernity, 1900–1939*, Cambridge: MIT Press: 230–231.

10   Charles Mayer (1970), 'Between Taylorism and Technocracy: European Ideologies and the Vision of Industrial Productivity in the 1920s', *Journal of Contemporary History* 5: 40–43.

11   A. Elzinga, A. Jamison and C. Mithander (1998) 'Swedish Grandeur: Contending Reformulations of the Great-Power Project', in M. Hard and A. Jamison (Eds.), *The Intellectual Appropriation of Technology, Discourses on Modernity, 1900–1939*, Cambridge: MIT Press: 129–162; and P. Meiskins and C. Smith (Eds.) (1996), *Engineering Labour, Technical Workers in Comparative Perspective*, London: Verso.

12   Y. Antoniou (2004), *Greek Engineers, Institutions and Ideas 1900-1950*, PhD Thesis, NTU Athens (in Greek).

13   Christina Agriantoni (1986), *The Beginnings of Industrialization in 19th Century Greece*, Athens: Historical Archive Commercial Bank of Greece: 350 (in Greek).

14   Merritt Roe Smith and Leo Marx (Eds.) (1994), *Does Technology Drive History? The Dilemma of Technological Determinism*, Cambridge, MA: MIT Press.

15   Merritt Roe Smith and Leo Marx (Eds.) (1994), *Does Technology Drive History? The Dilemma of Technological Determinism*, Cambridge, MA: MIT Press: xiv.

16   Merritt Roe Smith and Leo Marx (Eds.) (1994), *Does Technology Drive History? The Dilemma of Technological Determinism*, Cambridge: MIT Press: 65.

17   T. Hughes (1987), 'Evolution of Large Technological Systems', in W. Bijker, T. Hughes and T. Pinch (Eds.), *The Social Construction of Technological Systems*, Cambridge, MA: MIT Press: 68.

18   David Edgerton (1999), 'From Innovation to Use: Ten Eclectic Theses on the Historiography of Technology, *History and Technology* 16: 120–121.

19   J.M. Sherwood (1985): 'Engels, Marx, Malthus and the Machine', *American Historical Review* 90: 859.

20   See for example the excellent analysis by D. Mac Kenzie (1984), 'Marx and the Machine', *Technology and Culture* 25: 473–502.

21   B. Bimber (1994) in Merritt Roe Smith and Leo Marx (Eds.) (1994), *Does Technology Drive History? The Dilemma of Technological Determinism*, Cambridge, MA: MIT Press, presented a study on the notion of TD in Marx introducing the categories of nomological and normative determinism and through them a notion of locality in history. He concluded that Marx, in the final analysis, considered technology as a force in the service of humanity, in world history and not an independent dominating force.

22   See for example, J.J. Salomon (1973), *Science and Politics*, Cambridge, MA/London: MIT Press and Macmillan: 42.

23   Sergey Bulgakov (2000), *Philosophy of Economy*, New Haven: Yale University Press: 261–287, (first Russian edition 1912).

24 R.H. Hilton and P.H. Sawyer (1963), 'Technical Determinism: The Stirrup and the Plough', *Past and Present* 24: 90–100.

25 B. Hall (1996), 'Lynn's White Medieval Technology and Social Change, After Thirty Years', in R. Fox (Ed.), *Technological Change: Methods and Themes in History of Technology*, Amsterdam: Harwood: 85–102.

26 In a recent article L. Winner argues that TD has disappeared from the academic work but has a strong presence in everyday culture. See L. Winner (2001), 'Where Technological Determinism Went', in Stephen H. Cutcliffe and C. Mitcham (Eds.), *Visions of STS: Counterpoints in Science, Technology, and Society Studies*, State University of New York: 11–18.

27 L. Winner (1980), 'Do Artifacts have Politics?', *Daedalus* 109: 121–136.

28 B. Joerges (1999), 'Do Politics have Artifacts?', *Social Studies of Science* 29: 411–431; S. Woolgar and G. Cooper (1999), 'Do Artefacts have Ambivalences?', *Social Studies of Science* 29: 433–449.

29 B. Joerges (1999), 'Do Politics have Artifacts?', *Social Studies of Science* 29: 421. Attempts to methodologically introduce a democratic component in technological design have been proposed in recent years. CTA (Constructive Technology Assessment) by A. Rip, Th. Misa and J. Schot (*Managing Technology in Society: The Approach of Constructive Technology Assessment*, London: Pinter (1995)) seems to be one of the most important of these, moving in a framework of reflective modernity, similar to the one proposed by A. Giddens. The design process there takes into account the opinion of a series of heterogeneous social factors in order the acceptance of the product to have minimal objections while at the same time exploiting the interpretive flexibility guaranteed by SCOT.

30 See for example, L. Winner (1993), 'Upon opening the black box and finding it empty: social constructivism and philosophy of technology', *Science Technology and Human Values* 18: 362–378.