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Why and How Technology Matters

Wiebe E. Bijker

Technology matters. Bicycles were instrumental in the political and social emancipation of women (Bijker 1995); photo and film technology induced a subtle form of apartheid (Wajcman 2005); nuclear arms and energy shaped, for example through the non-proliferation treaty, international relations since the 1950s (Smit 2005); the low-hanging overpasses on Long Island discourage since the 1920s the presence of buses on the parkways, thus preventing public transport to the prestigious Long Beach public park (Winner 1980).

Politics matters too, to understand technology's development. The refrigerator got its hum (that is: is now driven by electricity rather than gas) because of the political power play between American electricity and gas utilities in the 1920s (Cowan 1983); gender politics resulted in the contraceptive Pill rather than the male pill (Wajcman 2005; Oudshoorn 2003); the technical development of anti-ballistic missile systems can only be understood by analyzing the dynamics of the international political relations between the US and the USSR (Smit 2005); the Long Island overpasses are *deliberately* low, because of the racial and social segregation policy that its designer, Robert Moses, maintained: "Poor people and blacks, who normally use public transit, were kept off the roads because the twelve-foot tall buses could not handle the overpasses” (quoted in Winner 1980, 23).

Technology matters: it matters to people, planet and profit; it also matters to policymaking and politics; and it should thus matter to political studies. In this chapter I will argue why this is the case, and what consequences this may have for political studies.

Before arguing why and how technology matters to politics, it seems prudent to define what I mean by "technology" and "politics." Although the next section will offer a preliminary answer to that question, my central argument in this chapter will be that technology and politics cannot be defined in simple and neat ways: both can be very different things in different contexts. Worse, their "definitions" are interdependent: technology and politics constitute each other to an important degree—as two sides of the same coin. The implication of this argument is that the answers to the "why" and "how" questions about technology’s influence on politics are closely tied together; and that these answers are also closely tied to answering, *vice versa*, about politics’ influence on technology. It only makes sense, I will argue, to discuss the relation between technology and politics in a contextual way, related to specific circumstances. General statements, such as "all technology is political" or "all politics is technological" may be true, but not very helpful.

I. What is Technology?

Although an important argument in this chapter will be that the boundaries between technology and science, society, politics, *et cetera*, are contingent and variable, we have to start somewhere. It is helpful to distinguish three different layers of meaning in the word "technology." At the most basic level, "technology" refers to sets of physical objects or *artefacts*, such as computers, cars, or voting machines (and note the gender bias (Wajcman 2005)). At the next level, it also includes human *activities*, such as in "the technology of e-voting," where it also refers to the designing, making and handling of such machines. Finally, and closest to its Greek origin, "technology" refers to *knowledge*: it is about what people know as well as about what they do with machines and related production processes. Using "technology" in these three meanings, allows to be more specific than when employing "technology" as a container concept at macro level, as for example in: "Political modernization ... embraces today changes in politics and government in individual countries and states derived from major shifts in technology" (Graham 2001, 9963).

These three layers comprise the most common meanings of technology. For my discussion of the role of technology in politics, and especially in political theories, this is not enough however. It is important to recognize that—within these common meanings of technology—different *conceptions* of technology can be used. These concepts differ in the (often implicit) underlying assumptions about technology's development and about technology's relation to other societal domains. I will distinguish two conceptions: the standard and the constructivist concepts of technology.

A. Concepts of Technology

The standard image of science and technology was the dominant view of technology among students of technology and society until the 1980s, and is still widely held by citizens, politicians and practitioners. In the standard image of science, scientific knowledge is objective, value-free and discovered by specialists. Technology, similarly, is an autonomous force in society and technology's working is an intrinsic property of technical machines and processes.

Some of the implications of these standard images are positive and comforting. Thus, for example, scientific knowledge does appear as a prominent candidate for solving all kinds of problems. In the domain of political thought, this naturally leads to technocratic proposals, where technology is viewed as a sufficient end in itself and where the values of efficiency, power and rationality are independent of context. The standard view accepts that technology can be employed negatively, but in this view the users are to be blamed, not the technology. Not surprisingly, the standard image also leaves us with some problems. For some questions, for example, we do not yet have the right scientific knowledge. An adequate application of knowledge is, in this view, a problem too. The role of experts is problematic in a democracy: how can experts be recognized by non-experts; how can non-experts trust the mechanisms that are supposed to safeguard the quality of the experts; and, finally, how can experts communicate their esoteric knowledge to non-experts? In the realm of technology, an additional problem is that new technologies may create new problems (which, it is hoped, in due time will be solved by still newer technologies). The most pressing problem, however, relates directly to the central issue of this chapter. It is best explained by introducing "technological determinism."

The standard conception of technology implies a technological deterministic view of the relation between technology and society. Technological determinism, then, comprises two elements: it maintains that (1) technology develops autonomously, following an internal logic which is independent of external influences; and that (2) technology shapes society by having economic and social impacts. Technological determinism thus implies that technology does *not* matter much to politics, nor to political theory. The little relevance that technology, in a technological deterministic view, has for politics only relates to its societal impact. After all, if technology's development is really autonomous, it cannot be subject to "outside" control in the form of policy making or political debate. Technology’s blessings and curses then just happen "out of the blu," and politics can only hope to anticipate these developments and effects, and prepare society for it (Winner 1977). Applied to, for example, the nuclear arms race: “In our bleakest moments, the nuclear world has seemed to be a technological juggernaut out of control, following its own course independent of human needs and wishes.” (MacKenzie 1990, 383) A classic reaction to this diagnosis was—at least in retrospect—the establishment of the Office of Technology Assessment attached to the US Congress in 1972 (Bimber 1996). I shall return to this below.

However, technological determinism is not only politically debilitating—it is also empirically wrong. Especially since the 1980s, many historical and sociological case studies have shown that technology *is* socially shaped (MacKenzie and Wajcman 1999). In the case of the nuclear arms race, and more specifically the technical development towards increasing missile accuracy, the empirical argument against technological determinism is clear-cut: “An alternative form of technological change exists, which is no less progressive (on some conventional criteria, such as its use of novel inertial sensors, it is more so), but where progress has a quite different meaning. Its institutional base is civil and military air navigation, where extreme accuracy is little prized, but reliability, producibility and economy are” (MacKenzie 1990, 385). This empirical work in the history and sociology of technology has led to an alternative conception of technology: the constructivist view. In the 1970s and 1980s detailed empirical research on the practices of scientists and engineers led to the formulation of a constructivist perspective on science and technology. This work by sociologists, historians and philosophers became known under the banners of "sociology of scientific knowledge" (SSK) and "social construction of technology" (SCOT).[1]

Social shaping models stress that technology does not follow its own momentum, nor a rational goal-directed problem-solving path, but is instead shaped by social factors. In the SCOT approach "relevant social groups" are the starting point for the analysis. Technical artefacts are described through the eyes of the members of relevant social groups. The interactions within and among relevant social groups can give different meanings to the same artefact. Thus, for example, to union leaders a nuclear reactor may exemplify an almost perfectly safe working environment with very small chances of on-the-job-accidents compared to urban building sites or harbors. To a group of international relations analysts, the reactor probably represents a threat because of its potentially enhancing nuclear proliferation, while for the neighboring village the risks of radioactive emissions and the benefits of employment may strive for prominence. This demonstration of interpretative flexibility is a crucial step in arguing for the feasibility of any sociology of technology—it shows that neither an artefact’s identity, nor its technical "success" or "failure," are intrinsic properties of the artefact but subject to social variables.

In the second SCOT step, the researcher follows how interpretive flexibility diminishes, because meanings attributed to artefacts converge and some artefacts gain dominance over others—and in the end, one artefact results from this process of social construction. Here, key concepts are "closure" and "stabilization." Both concepts are meant to describe the result of the process of social construction. "Stabilization" stresses process: a process of social construction can take several years in which the degree of stabilization slowly increases up to the moment of closure. "Closure," a concept stemming from SSK, highlights the irreversible end point of a discordant process in which several artefacts existed next to each other.

In the third step, the processes of stabilization described in the second step are analyzed and explained by interpreting them in a broader theoretical framework: why does a social construction process follow this course, rather than that? The central concept here is "technological frame." A technological frame structures the interactions among the members of a relevant social group, and shapes their thinking and acting. It is similar to Kuhn's concept of "paradigm" with one important difference: "technological frame" is a concept to be applied to all kinds of relevant social groups, while "paradigm" was exclusively intended for scientific communities. A technological frame is built up when interaction "around" an artefact begins. In this way, existing practice does guide future practice, though without logical determination. The cyclical movement thus becomes: artefact –> technological frame –> relevant social group –> new artefact –> new technological frame –> new relevant social group –> etc. Typically, a person will be included in more than one social group, and thus also in more than one technological frame. For example, the members of the Women's Advisory Committees on Housing in the Netherlands are included in the technological frame of male builders, architects and municipality civil servants—this allows them to interact with these men in shaping public housing designs. But at the same time many of these women are included in the feminist technological frame, which enables them to formulate radical alternatives to the standard Dutch family house that dominates the male builders' technological frame (Bijker and Bijsterveld 2000). Extending this concept, Lynn Eden has used "organizational frames" to explain why the US government, in its nuclear armament planning, concentrated on blast damage and systematically underestimated, and even ignored, damage from mass fire (Eden 2004). (Pre-empting what I shall argue below, her study also shows that to understand state politics, it is often necessary to delve into the politics of agencies, services and private companies — distinctions between "kinds" or levels of politics do not match the practice of politics, and one should therefore be careful to use such distinctions in methodologies and theories.)

Before I start using the constructivist conception of technology to address the questions why and how technology matters, there is one other issue to discuss: which technologies are we considering anyway?

B. Specific Technologies?

The thrust of my argument below will be that *all* technologies matter to politics and to political theory—from the pyramids in old Egypt to the space shuttle in modern US, from Internet to public housing, and from guns to voting machines. Some technologies however are, at first sight, different because they are explicitly *meant* to play a political role, and thus have been studied by political scientists. The use of new communication and Internet technologies to improve upon democratic processes is the most recent example (Hague and Loader 1999). Hacker and Van Dijk (2000, 1) define digital democracy as "a collection of attempts to practice democracy without the limits of time, space and other physical conditions, using information and communication technologies or computer mediated communication instead, as an addition, not a replacement for traditional 'analogue' political practices." The term "digital democracy" highlights that it is not an altogether different form of democracy, breaking with all established practices in particular times and locations (as suggested by the term "virtual democracy"), or a naïve reliance on direct democracy (such as in "teledemocracy"), or something identical to previous experiences with radio and television (such as the term "electronic democracy" would suggest), or only occurring in and through the Internet (as suggested by the term "cyberdemocracy").

The impact of digital technologies on democracy (and hence on politics and political science) is often overstated when presented as a solution to current problems of political legitimacy (e.g. by Barber 1984). But it is also underestimated when the implied fundamental change in political practices is not recognized. "From way back politics is a matter of verbal skills, management capacities and the art of negotiation. It is a collective routine of talkers and organizers. In digital democracy this routine would transform into a practice of people working primarily as individuals at screens and terminals, clicking pages, reading and analyzing information and posing or answering questions. It is likely to become a routine of technical and symbolic-intellectual skill instead of a practical-organizational and verbal-intellectual one" (Dijk 2000, 31). This would have quite different consequences for different models of democracy. In answering the question how technology matters to politics, I will continuously stress the importance of the specificity of different technologies, contexts and political systems: what works in the US does not automatically work in Europe, and *vice versa*. Van Dijk (2000) does exactly that, when he discusses the different ways in which digital democracy may take shape when seen in the context of

Held's (1996) models of democracy; Hagen (2000) does the same by following the discussions on digital democracy in different *national* political cultures.

In some cases, technology matters in politics because it explicitly and deliberately is "politics by other means." Most obviously this is the case for military technology (Smit 2005). Since the Truman doctrine of "containment," the Cold War nuclear strategies, and Reagan's impenetrable "peace shield" of the Strategic Defense Initiative, "the key theme of closed-world discourse was the global surveillance and control through high-technology military power. Computers made the closed world work look simultaneously as technology, as political system and as ideological mirage." (Edwards 1996: 1) Also many sophisticated forms of contemporary political and social control in civil society are rooted in the development of technologies. Much contemporary control is better symbolized by manipulation than by coercion, by computer chips than by prison bars and by remote and invisible filters than by handcuffs or guns. An increase in technical sophistication of these control technologies often implies being more covert, embedded and remote; often involuntary and occurring without the awareness or consent of its subject (Fijnaut and Marx 1995; Lyon 2003).

In other cases, technology matters to politics because it has become so highly politicized that hardly anyone would think of ignoring or disputing this political dimension. Nuclear power is a clear example. The fact that nuclear power reactors may be operated in such a way that they produce weapon-grade fission material makes them political in an almost trivial sense. But there is much more involved. For example, this possibility of producing weapon-grade material need not be an explicit political decision, but can be designed into the reactor. In the case of France, this resulted in producing weapon-grade plutonium before the government had decided to build an atomic bomb:

> Flexibility in the basic principle of the gas-graphite reactors meant that they could produce both plutonium and electricity. How well they did one or the other depended on the specific design. But the fact that they could do both made possible the production of weapons-grade plutonium in Marcoule's reactors before the government officially decided to build the atomic bomb. This flexibility also made it possible for the [the French Atomic Energy agency] CEA to demand plutonium from [the French national electricity producer] EDF's reactors: thus technologies could not only enact political agendas but also make possible new political goals (Hecht 1998, 334).

A link between nuclear technology and politics exists, in addition to the military connection, also in the role of nuclear energy in the general economic policy and in the national self-image. Hecht (1998, 335) concludes about the first French "civil" nuclear project:

> The EDF1 (reactor) was important not because it itself would produce economically viable electricity but rather because it constituted the first step in a nationalized nuclear program that would enact and strengthen the utility's ideology and industrial contracting practices. In this instance as in many others, EDF1's technical characteristics were inseparable from its political dimensions. Had EDF1 failed too function properly, or had engineers and workers been unable to garner

> adequate operational experience from the reactor, the plant would have failed both technically and politically.

Nuclear power can also be argued to be an “inherently political technology” in that it presupposes an authoritarian, if not totalitarian, state (Winner 1986). No government can, anymore, dream to delegate a decision about installing nuclear power to a group of engineers, arguing that nuclear technology is merely a neutral technology. Such a decision now is generally recognized to be political, involving discussions about societal risk, public health and international relations.

However, the example of nuclear energy also shows the difficulty of arguing that one technology is more political than another. Surely, not everyone accepts the argument that a nuclear state would inevitably become a closed and totalitarian police-state; certainly, some engineers still believe that a decision about installing nuclear power is best made on the basis of technical-economic arguments, uncorrupted by politics. And, for that matter, also guns and weapons have been called neutral and apolitical: it is the shooter who is political, not the technology. On the other hand, arguments about the importance for the national economy and for the national identity have been made for other technologies than nuclear power too—for example about railway infrastructures and biotechnology (Dunlavy 1994; Gottweis 1998). Other technologies have been labeled political that would—at first glance—not be so. Classifications such as the International Classification of Diseases are powerful technologies: “embedded in working infrastructures they become relatively invisible without losing any of that power” (Bowker and Star 1999: 319). The bicycle was political, in the hands of suffragettes.

At the end of this section in which I reviewed technologies that seemed specifically relevant to politics, I thus can only conclude that all technologies matter to politics and political theory—all "artifacts have politics" (Winner 1980). This does not merit, however, general and abstract statements about the relation between politics and technology. The other lesson from the previous discussion of "political technologies" is that all technologies matter differently. Before I review the various answers to this question about the nature of the relation between technology and politics, however, the notion of politics need to be unpacked as well.

II. What is Politics?

Technological determinism induces, I argued, passivity; political determinism may do so as well. The latter then refers to the view that “what happens is a result of decision making by a state. Sometimes a particular person (the President, perhaps) or a collectivity (the "political-military elite," perhaps) is seen as representing the state. But in all cases, the form of explanation is the same. The state is conceived of as akin to an individual, rational human decision maker. It has a goal, and chooses means … to fulfill that goal” (MacKenzie 1990, 395). In this section I shall not attempt to give a comprehensive review of the various meanings of "politics": that would, in a handbook like this, be like carrying water to the sea (or coals to Newcastle). Rather, I want to remind that "politics" and "democracy" have just as rich a spectrum of different meanings in different contexts as "technology" does: only by recognizing this richness, we can reap the potential fruits of studying the relation between technology and politics. Instead of reviewing political scientists on this matter—for those analyses I refer the reader to the other parts and volumes of this handbook—I shall discuss how students of science, technology and society have conceptualized politics in their work.

The basic point is well summarized in MacKenzie's reaction to the political determinism mentioned above. Whether to explain the choice between counter force or counter city strategies, between building missiles or bombers, or between extreme accuracy or more destructive power: "In explaining each, I have always had to disaggregate "the state," identifying the often conflicting preferences of its different parts such as different armed services and even subgroups within these services. So the state should not be thought of as unitary. I have also typically had to disaggregate "decision," identifying instead various different levels of policy process, each leading perhaps to a result, but not necessarily to any overall coherence." (MacKenzie 1990: 396) Such then is the agenda for this section: to disaggregate the notions of politics and democracy as used in technology studies. (I limit myself to technology studies; similar cases, arguments and concepts can, however, also be found in studies of *science* and politics.[2]

Politics may refer then, first, to the political system of modern democracy. The functioning of knowledge, transparency and accountability in a "civil epistemology of the modern democratic polity" as founded in the political philosophies of Jefferson, Paine, Priestley and De Tocqueville receives, for example, a new emphasis when the role of technology is highlighted:

> The belief that the citizens gaze at the government and that the government makes its actions visible to the citizens is, then, fundamental to the democratic process of government. The shift from

> the projection of power through pomp and splendor to the projection of power through actions which are either literally technical or at least metaphorically instrumental is, in this context, responsive to the taste Tocqueville ascribes to democratic citizens for "the tangible and the real." The political significance of acting technically in the democratic field of action lies precisely in the supposed anti-theatricality of technology (Ezrahi 1995, 162).

Technology is thus seen as producing and upholding a modern democratic concept of visible power whose exercise appears publicly accountable to the large public. I will return to discussing politics at this general level of political culture, but will first investigate the implications of this "civil epistemology of the modern democratic polity" for the role of knowledge and expertise in politics.

Politics is then, second, also knowledge and expertise, especially in a modern society that is so thoroughly technical and scientific. And because technical expertise has been a traditionally a male domain, politics thus is also sexual politics—mirroring the gendered character of technology itself (Wajcman 2004). Another important issue is how to relate expert knowledge to political deliberation. One answer to this question is technocracy. The label "technocrat" was fairly neutral until World War II, but then acquired a derogatory ring. In the wake of the French revolution, engineers and scientists had built technocracy on a radical distinction between politics and technology: “universalistic science and conflicted politics were to go their separate ways, and the fact-value distinction given institutional form. By this apparent separation of means (technology) and ends (politics), the technocrats hoped to configure the relationship of the state to its citizens in amoral terms, and return authority over the technological life to the bureaus where they served as administrators” (Alder 1997, 302). But after 1945 this backfired on the technical elite: the term "technocrat" came to mean “someone who had breached a boundary, who had moved from his area of expertise into the domain of political decision making. The dangers inherent in breaching this boundary were considerable; first and foremost among them was the capitulation of democracy to technocracy” (Hecht 1998, 28). Technocracy, in this view, meant the replacement of politicians by experts—financial and administrative experts as much as technical and scientific. Discussions about technocracy seem to have faded out since the 1960s. In other settings and in other vocabularies, however, the politics of expertise and the role of expertise in politics still are—or are again—central issues. The first relates to the role of scientific advise in politics and regulation; the second is linked to recent experiments on democratization of technology.

Politics thus is, third, scientific advise. Scientific and technical advisers play such a dominant role in the politics of our modern society that they have been dubbed "the fifth branch," in addition to the classic three branches of the state and the fourth branch of civil service (Jasanoff 1990). The politics of regulatory science, or more precisely the boundary work between science, technology, regulation and politics has become a focal point of research (Bal and Halffman 1998; Halffman 2002). This work employs a methodological focus on boundary work (Gieryn 1983; 1999): the work that is done by scientists, policy makers, civil servants and politicians to distinguish politics from technology and then to relate the two again in specific terms. The ontological foundations of these studies of boundary work are completely opposite to the basic assumptions underlying technocracy. Where technocracy was based on the positivistic assumption that technology and politics are fundamentally different things and can be distinguished clearly, these boundary studies work on the constructivist assumption that technology and politics are *made to be* different, resulting in different distinctions depending on the specific contexts. This constructivist perspective also allows an explanation of the "paradox of scientific authority" in our modern knowledge society, which is directly relevant to politics and political theory: on the one had we live in a "technological culture" in which science and technology are the all-pervasive constituents of the societal fabric, including political institutions and politics; on the other hand we see that the authority of engineers, scientists, doctors and experts-in-general is not taken for granted anymore. What are the implications for political decision making, how do advisory institutions such as the US National Academy of Sciences or the Dutch Health Council succeed in giving scientific advice to politics without being able to claim an intrinsic, time and context independent authority? These bodies of scientific advice maintain their scientific authority by continuous boundary work, and not because of some intrinsic institutional characteristic of their institution or of their position between politics and science/technology (Hilgartner 2000; Bal, Bijker and Hendriks 2002).

The fourth meaning of politics I want to discuss is again related to expertise, but now to the expertise of non-scientists and non-technologists. This is an important issue when democratization of politics is translated into the need to increase public participation. This focus on participation was dominant in technology studies in the 1990s, and is still an important issue. Its origins date back to the controversy studies in the 1970s (Nelkin and Brown 1984; Nelkin 1979; Nelkin and Pollak 1979), industrial democracy studies in the 1980s (see below), and of course to a more general questioning of established democratic institutions in the 1980s and 1990s (Bijker 2002). Much of this work refers to Barber's (1984) plea for a "strong democracy."

The most explicit argument, formulated in what almost could be called a blueprint for a new society, can be found in Sclove's *Democracy and Technology* (1995). When public participation in politics of technology is argued for, the question is pertinent whether this public does have the necessary technological expertise to assess the various alternatives. The question of expertise of the lay participants in democratic processes is an almost irresolvable one when viewed from a positivistic perspective—hence the technocratic solution of delegating such decisions to technical experts.

From a constructivist perspective this is different. Constructivist analyses of scientific knowledge and technical expertise, as I argued above, have shown that such expertise is not intrinsically different from other forms of expertise. The conclusion, then, is that groups of non-scientists and non-engineers have other forms of expertise, rather than no expertise, and that the label "layperson" as opposed to "expert" is not appropriate (Bijker 1997). This does not preclude the possibility that such groups of participants do acquire scientific and technical expertise, as has been documented for patient groups in AIDS research, and for women users in architectural and urban design (Epstein 1996; Bijker and Bijsterveld 2000). Recently, philosophers of technology have drawn upon the pragmatist John Dewey, "whose early articulation of the problems of combining participation and representation remain pertinent today" (Feenberg 2001, 140). Already in the 1920s, Dewey argued for radical changes in democratic institutions to accommodate them to what he called "the machine age." Dewey (1991, 15-16) specified the general public as consisting of "all those who are affected by the direct consequences of transactions to such an extent that it is deemed necessary to have those consequences systematically cared for." Does Dewey's definition of public lend support to pleas for more direct democracy and citizens' participation? Or does it, rather, stress the need to focus on the process of political deliberation: “What characterizes the range of Western democratic politics for Dewey is not a specific fixed institutionalized form, like free elections or a parliament of representatives. Democracy, we read in Dewey, is precisely the constant flux and experimentation with different political forms that are spurred by the contestation existing ones elicit and which construct different collectives and articulations among them” (Gomart and Hajer 2003, 56-7). To the political participation by groups of "other experts" I will return below, in the context of sub-politics.

A fifth meaning of politics—but it will be clear by now that my various disaggregates of politics are overlapping and intertwined—focuses on large technical projects. Many of the current political controversies are related to decisions about such large projects—from infrastructural works such as airports, railway lines, or water works to large plants such as powers stations or waste facilities. Because large parts of the general public are affected by these plans, the cry for public participation is loud. At the same time, the worry that NIMBY (Not In My Back Yard) effects will hamper political decision making up to the point of damaging the public cause, is equally pertinent (Gerrard 1994; Piller 1991). Also studies that do not explicitly focus on the participation question, typically highlight the political dimensions of large technical systems.[3] As Thomas Hughes, arch father of the historical studies of large technological systems, observes: these technologies “give rise to binding nuclei for a host of dependent political and economic interests. Interwoven with political and economic interests of particular kinds, technology is far from neutral” (1983: 318-19). And he concludes about his three historical case-studies of electricity distribution: “In Chicago, technology dominated politics; in London, the reverse was true; and in pre-World War I Berlin there was coordination of political and technological power” (Hughes 1983, 461-2)

Yet another important way of relating politics to technology is through industrial democracy. Work in the 1980s linked action research for labor unions with broader perspectives on social democracy and democratization of society: “democratization must now be seen as the primary strategic goal of the labour and social, movements. It is the precondition for further social advance. Moreover, it seems … to be the only viable response to the industrial challenge of effecting a rupture with Fordism, and the immediate political challenge posed by the New Right” (Mathews 1989, 220). Initially, much of this work was directly tied to democracy at the shop floor, but Mathews does relate this to broader democratization strategies, associating workers and citizens as agents of social change. In the 1990s the focus continued to shift to this wider societal perspective (Sclove 1995).

The seventh meaning of politics I want to discuss transcends the previous perspectives on industrial and direct democracy, and returns us to the macro level of society and political culture. Politics in Ulrich Beck’s (1986; 1992) "risk society" acquires a very different meaning as compared to classic political theory. Marx’ and Weber’s concepts of "industrial" or "class society" now have to be substituted, Beck argues, by the concept of "risk society." The central political question is not anymore about the production and distribution of wealth, but about risk: “How can the risks and hazards systematically produced as part of modernization be prevented, minimized, dramatized, or channeled? Where they do finally see the light of day in the shape of "latent side effects," how can they be limited and distributed away so that they neither hamper the modernization process nor exceed the limits of that which is "tolerable"— ecologically, medically, psychologically and socially?” (Beck 1992, 20). The role of technology is here specifically analyzed in the light of the risks it causes. Especially the risks associated with ionizing radiation, pollution and genetic engineering are central: their often irreversible harm, their being invisible to the unarmed human eye, and their causes being only identifiable through scientific knowledge (and thus being open to social definition and construction) require a reassessment of politics in the risk society. The distribution of risks now determines social and power relations, instead of the distribution of wealth, as was the case in class society.

This must have implications for our conception of politics: “A central consequence … is that risks become the motor of the *self-politicization* of modernity in industrial society; furthermore, in the risk society, the *concept, place and media of politics* change” (Beck 1992, 183, italics in original). In the industrial society, the citizen was partly *citoyen*, using the democratic rights in arenas of political deliberation and decision making, and partly *bourgeois*, defending private interests in the fields of work and business. Correspondingly, a differentiation had occurred between the political and the technical systems in industrial society. Negative effects in one system were compensated in the other: “Progress replaces voting. Furthermore: progress becomes a substitute for questions, a type of consent in advance for goals and consequences that go unnamed and unknown” (Beck 1992, 184). The social inequalities of the class society, the high development of production forces and scientification of society, and the dramatic and negative global effects of technology yield a radical transformation of the relation between the political and the non-political: "the concepts of the political and the non-political become blurred and require a systematic revision.… On the one hand established and utilized rights limit freedom of action *within* the political system and bring about new demands for political participation *outside* the political system in the form of a *new political culture* (citizens" initiative groups and social movements)” (Beck 1992, 185, italics in original). Societal change is not debated in parliament or decided by the executive government, but created in the laboratories and industries of microelectronics, nuclear power and genetic modification. These technological developments thus loose their political neutrality, though at the same time continue to be shielded against parliamentary control: “Techno-economic development thus falls between politics and non-politics. It becomes a third entity, acquiring the precarious hybrid status of a *sub-politics*” (Beck 1992, 186). Politics is thus spreading into society, and is being "displaced" from the centers of traditional political power into a polycentric system. For a stable development of a future democratic structure of the new risk society these sub-politics need to be supplemented with new political institutions (Beck 1997; 1993; Dijk 2000).

Now that I have deconstructed both technology and politics into a variety of context-dependent meanings, let us turn to the core question: how and why does technology matter to politics, how do the "two" relate?

III. Why and How Does Technology Matter?

I shall review various answers to the questions why and how technology matters to politics and to political theory, even though several of these answers have already been given implicitly in the previous sections. I will start with the general question of the relation between technology and political culture, then turn to the specific field of technology assessment.

A. Technology and the Political Culture of Democracy

One way in which technology has been considered to matter to politics and political theory, is in quite general terms about the relation between technology and modernization. A central claim of modernization theories is that technological development and economic, social and cultural change go together in coherent ways (Inglehart 2001). Arch fathers of modernization theory such as Karl Marx, Emile Durkheim and Karl Weber took their starting point in the industrial revolution and the way in which it had transformed Western European societies and politics. Subsequent work linked modernization to development by asking questions about the differential impact of technological development on politics outside Europe and North America (Graham 2001). In the 1990s, this style of political studies could observe that "yet another revolution in technology linked to information technology, the growth of knowledge based industries, and the globalization of economic processes produced major realignment in politics and economics" (Graham 2001, 9964). These studies have led to new theories about modernization that combine the observation of the shift from mass production to knowledge based industries, with an analysis of structural economic policies, the creation of market economies world wide, and fundamental changes in political institutions of state and society. At this general level of modernization theory, also the relation between technology and democratization is questioned, as for example in: "The emergence of postindustrial, or "knowledge" society, favors democratic institutions, partly because these societies require highly educated and innovative workers, who become accustomed to thinking for themselves in daily job life. They tend to transfer this outlook to politics, undertaking more active and more demanding types of mass participation" (Inglehart 2001, 9970). One answer, thus, is that technology matters to politics, because it has shaped the modern state and its political and democratic institutions. But can this be made more specific?

Another way in which technology matters to politics and shapes politics is by providing the means for political discussion and development. I intend this in a most comprehensive way. Technology basically shapes the political world, from the language and the metaphors, to the economic boundary conditions, and the communication technologies. The technology of computers not only controlled the vast networks that were central to the globalist aims of the Cold War, but also provided the apocalyptic vocabulary and metaphors in which the foreign policy was formulated. This technology "constituted a dome of global technological oversight, a *closed world*, within which each event was interpreted as part of a titanic struggle between the superpowers" (Edwards 1996, 1-2). In this case, technology mattered to politics because it helped to shape its very aims and means; at the same time it was also object of politics and technology policy.

In the case of computers and cold war, technology and politics thus co-evolved as two sides of the same coin. This "co-evolution" or "co-production" of technology and politics (or society) is a common phrase in current technology studies (Jasanoff 2004). It needs to be made more specific to do real explanatory work however. One way to do that is to use Hecht's concept of "technopolitical regime": these are grounded in state institutions (such as CEA and EDF; see above) and consist "of linked sets of individuals, engineering and institutional practices, technological artifacts, political programs, and institutional ideologies acting together to govern technological development and pursue technopolitics (a term that describes the strategic practice of designing or using technology to constitute, embody, or enact political goals)" (Hecht 1998, 56-7). This concept allows to describe the interaction between politics and technology in a quite specific way. CEA's technopolitical regime involved the production of weapons-grade plutonium and thus helped to create France's de facto military nuclear policy. EDF's regime positioned its reactors deliberately in counterpoint to CEA's technopolitics, and thus created France's nuclear energy policy. In similar vein, the concept "technological frame" has been used to describe in detail the interaction between Barcelona politics and the technology of town planning and architecture (Aibar and Bijker 1997). The difference between the two concepts is that the technopolitical regime is connected to state institutions in which a variety of social groups are acting, while a technological frame is linked to one relevant social group that may be dispersed over a variety of societal institutions. It is important t to recognize that both are analyst's concepts describing the relation between technology and politics; the actors involved may think quite differently about this relationship. In the case of the struggle between France's CEA and EDF, Hecht describes how EDF even deliberately and strategically tried to separate politics from technology, to take a "technocratic pose" (Alder 1997), and to create a technological determinist interpretation in which there was such a thing as a single best technology that should be adopted without political deliberation.

Another way in which technology matters to politics, is by shaping the means of political debate: the arena, the communication links, the agenda. Such a perspective can, of course, be applied to analyzing 18th century politics and the technologies of architecture (think of an analysis of the plan of parliamentary buildings and the lay-out of meeting rooms), mail correspondence and messenger communication; but most current research focuses on the relation between digital technologies and politics (Bimber 2003). Most experiments with digital democracy are conceived and experienced "as a means of reviving and reinvigorating democratic politics which for a variety of reasons is perceived to have lost its appeal and dynamism" (Tsagarousianou 1998, 168) Such experiments started in the 1980s to challenge the monopoly of existing political hierarchies over powerful communication media, to amplify the power of grassroots groups to gather and distribute critical information, and to organize political action. Then other initiatives followed by local authorities to improve contact with citizens, to upgrade the delivery of services and information, and to encourage citizen participation in public affairs (Tsagarousianou, Tambini and Bryan 1998). Both American and European local authorities created experimental "digital cities," hoping that new information and communication technologies would help to resuscitate declining citizen participation in political life and give new vigor to local politics.

These digital city experiments use very different definitions of (digital) democracy: they ranged from mainly deliberative to more plebiscitary models, and from grassroots self-organization and empowerment to public information provision-centered projects. Interesting questions regarding the access to political debate are raised by these experiments: "Who will carry the cost of rendering the network services accessible to the public? Will the right to access be complemented by ensuring that citizens develop the competence to use the services available to them and overcome, often socially conditioned, and class, gender, age and ethnicity-related, aversion to and distance from the technology and skills necessary? How are the rights to free speech/expression and concerns over the abuse of the city network balanced?" (Tsagarousianou 1998, 171). It will be clear that answers to these questions will be very different, depending on the national and, indeed, local political culture. In the American libertarian civic tradition a key goal may be to encourage the formation of citizens' groups and initiatives. In a traditionally left-wing Italian region the focus may be on securing the network access as a public good and the implementation of citizens' rights. An English digital city experiment may be designed as a means for economic regeneration. Taking stock of how these digital technologies matter to politics is a sobering experience. Behind the rhetoric of digital democracy often the main activity is the dissemination of information of which the agenda and content are controlled by the governmental authority. "In spite of the discourses of interactivity which underlie most "electronic democracy" initiatives, most of them have in practice been executive-initiated, top-down and mostly based on giving more access to information. Politics in this form remains more of a model of convincing through the dissemination of information than of communication and discussion" (Tsagarousianou 1998, 174).

B. From Technology Assessment to Precaution

Technology assessment, often abbreviated as TA, is one concrete way in which politics has been dealing with technology since the 1970s. Technology matters to politics in our modern societies because, as I argued above, these technologies do shape so pervasively our societies and cultures. The term "TA" is also used when non-political actors such as firms, consultancies or health care agencies want to evaluate and assess the promises or profits and the potential costs and risks of new technological options. I will restrict myself to the public, political use of TA.

The beginning of TA, under that name, is marked by the US Technology Assessment Act of 1972, which assigned to the Office of Technology Assessment a mission of providing neutral, competent assessments about the probable beneficial and harmful effects of new technologies. Breathing a rather technological determinist view, the law explained as its rationale that: “it is essential that, to the fullest extent possible, the consequences of technological applications be anticipated, understood, and considered in determination of public policy on existing and emerging national problems” (quoted by Bimber 1996). The agency’s role was seen as an "early warning device," providing foresight about the possible positive and negative consequences of technological developments. It could build on early sociological studies of the societal effect of technology, such as by Ogburn (1946), and on early management approaches to handling technological uncertainties, such as by the RAND Corporation (Yearley 2001). By the mid 1980s the original exclusive emphasis on being expert witness to parliaments by providing scientific reports, the concept of TA “was complemented with an interest in linking up more closely with decision making, or at least contributing to setting an agenda. Public debates about energy and environmental issues helped to make this aspect of TA more prominent” (Yearley 2001, 15512). TA has become an important ingredient of government technology policy. In the 1990s and into the 21st century, TA also started to add participatory approaches to the expert-based methodologies. In some European countries (Denmark, the Netherlands) forms of public participation now have been institutionalized, especially for TA’s agenda setting role. Largely independent of this development of public TA, in the 1980s also TA for specific technology sectors became institutionalized—the clearest examples are the in many countries legally required Environmental Impact Statements, and the field of medical technology assessment.

All varieties of TA combine forms of anticipation and feedback, joining, so to speak, “writing a history of the future, supported by judgments of experts and by social-science insights and data, and informing action or preparation for action" (Yearley 2001, 15513). This combination creates the fundamental "anticipation and control dilemma": at an early stage of a technology's development, it still is so malleable that it can be controlled and changed but its impact cannot be anticipated; and when the impact becomes clear, the technology has become so obdurate that it is difficult to control (Collingridge 1980). This increasing obduracy of technology has been conceptualized is different ways: technological systems, acquire "momentum" (the exemplar is the large-scale electricity distribution system (Hughes 1983)), and technologies acquire "path dependency," when they incorporate investments, users, other technologies, etc. (a well-known example is the QWERTY keyboard [David 1985]). This obduracy of technology is socially constructed, and helps to include the societal impact of technology into constructivist technology studies (Hommels 2005). Constructive Technology Assessment is meant to offer a political and managerial solution to this dilemma. It builds on societal experiments with the introduction of new technologies; it mixes private and public actors, provides occasion for societal learning about new technologies, and results in feedback into further design and development (Rip, Misa and Schot 1995). The critical question can be raised whether such efforts can escape the boundaries set by the rationality of the dominant power structure: "Rationalization in our society responds to a particular definition of technology as a means to the goal of profit and power. A broader understanding of technology suggests a very different notion of rationalization, based on responsibility for the human and natural contexts of technical action." Feenberg (1995, 20) then proposes to call this "subversive rationalization," "because it requires technological advances that can be made only in opposition to the dominant hegemony."

Closely linked to technology assessment—and an obvious way in which technology matters to politics, i.e. as object of that politics—is technology policy. But what can this be? To foster technological innovation—with its emphasis on change—is not a natural role for governments: “In all well-ordered societies, political authority is dedicated to stability, security and the status quo. It is thus singularly ill-qualified to direct or channel activity intended to produce instability, insecurity and change” (Rosenberg and Birdzell 1986: 265). It has also been argued that in a free market economy, the only justifiable role for technology policy would be to perform technology assessments (Freeman and Soete 1997). Nevertheless, technology policy in a broader sense is increasingly seen as an important responsibility of government (Branscomb 1993). It is now also realized that a technology policy that merely focuses on the supply side is not enough, and that research and innovation policies to address the demand side need to be added (Branscomb 2001). Since the 1990s the concept of "national system of innovation" is increasingly used, both in innovation studies and in policy discourse. This results in stressing the coherence of political, cultural, managerial and institutional characteristics in determining the innovative capacity of a country.[4] Thus technology policy is being broadened to incorporate insights from technology studies as well as other social sciences.

Conceptualizing modern society as a risk society, as I described in the previous section, has implication for the ways in which technological developments are assessed in politics. Let me briefly retrace the way in which politics handled risks before the 1990s. Probabilistic risk assessment had been developed in the early 1970s as a reductionistic engineering technique to estimate the risk of a system’s failure as resulting from the mishap of single parts or sub-systems. The so-called "reactor safety study" of the US Atomic Energy Commission of 1975 used this technique and concluded that citizens were more likely to be killed by a falling meteorite than by an accident with a nuclear power plant. With this risk conception, it made sense that politics would, in a technocratic fashion, delegate the management of risks to experts. The Three Mile Island nuclear plant accident of 1979 then violently questioned this solution. This accident could, by technical analysis, never have happened. It thus "brought to public and sociological attention an incipient schism between the state, its technological experts and citizens" (Rosa and Freudenburg 2001, 13357), This was further aggravated by a series of psychometric studies that showed the discrepancies between public and expert interpretations of risk, for example: a systematic underestimation of risks to which one is routinely exposed, an overvaluation of novel or possibly catastrophic risks, and an undervaluation of risks to which one is exposed by own choice. This caused a problem to policy makers: "If they base regulations on expert judgments—that is, keyed only to the statistical probability of harm—policies may be unpopular or even subverted, whereas basing policies on the public's apparent preferences threatens to make regulations arbitrary, unscientific, or too costly" (Yearley 2001, 13361). Moreover, social constructivist analyses have shown that expert risk estimates cannot be equated with "real" risks anyway (Wynne 1992).

A key element in how technology matters to politics in our high-tech risk society is the uncertainty of scientific knowledge, technological risks, social-economic parameters, and cultural values and priorities. There is a variety of ways to characterize these uncertainties.[5] But they all lead to describing a world where "in the sorts of issue-driven problems characteristic of policy-related research, typically facts are uncertain, values in dispute, stakes high and decisions urgent." Such a world needs what Funtowicz and Ravetz (2001, 19) have called "post-normal science." This label refers to the non-normality of current politics, technology and science: “In "normality," either science or policy, the process is managed largely implicitly, and is accepted unwittingly by all who wish to join in. The great lesson of recent years is that that assumption no longer holds. We may call it a ‘post-modern rejection of grand narratives’, or a green, NIMBY politics. Whatever its causes, we can no longer assume the presence of this sort of ‘normality’ of the policy process.”

A striking new development, which may well turn out to be a focal point of how politics and technology matter to each other in the next decade, is the precautionary principle. The probably most cited version of the precautionary principle is the one in the Rio declaration: “Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation” (UN 1992). This provides a way for politics to handle technologies under highly uncertain conditions: the principle allows interfering, even when it is not clear what the risk exactly is. It implies a shift from prevention of clear and manifest dangers towards precautionary action to avoid hypothetical risks. A wealth of literature has developed since, that translates this principle into various precautionary approaches (Klinke and Renn 2002; EEA 2001). The interpretation and implementation of the precautionary principle inevitably will vary, according to the legal and scientific doctrines, and to the openness of the political culture. This is, possibly, also its weakness. The precautionary principle has an intuitive appeal but lacks broadly shared conceptual clarity. It may be depicted as a “repository for a jumble of adventurous beliefs that challenge the status quo of political power, ideology and civil rights” (Golding 2001, 11962; see also O'Riordan and Jordan 1995). Nevertheless, I think that developing the precautionary approach may offer a prudent next step in the evolution of politics’ dealing with technology: it may help to sail between the Scylla of the illusion of a technocratic, rational politics and the Charybdis of political bankruptcy in the light of paralyzing uncertainty about new technological developments. Implementing the precautionary approach will help politics (in all its various meanings) to avoid the pitfalls of technocracy and technological determinism because it integrates constructivist views of science and technology into technology assessment and political deliberation and decision making.

IV. Implications for Political Studies

The previous review may be summed up by the slogan that "all technology is political and all politics is technological." I have shown how this slogan is based on a variety of empirical studies of technology and politics, and how it translates into specific theoretical interpretations of the relationship between technology and politics. I will not try to summarize this rich variety, further exemplified by the subsequent chapters in this volume, in general statements. Rather, I will formulate some "lessons" for political *studies*.

The first reason to pay attention to technology in political studies is that such a focus on the technological in society will reveal aspects of politics that remain unnoticed otherwise. Only through an analysis of the "nuts and bolts" of missile technologies and the intricacies of accuracy tests can we fully understand US foreign policy since the 1950’s. Only through an analysis of the details of nuclear reactor design and its implications for the proportion of fissile material in nuclear waste can we understand French atomic weapon politics. And I have argued that this applies to *all* technologies—from bicycles to public housing, from electricity distribution to railways—because we live in a "technological culture": a society that is constituted by science and technology. “It is too weak a position even to see technology and politics as interacting: there is no categorical distinction to be made between the two” (MacKenzie 1990, 412-13).

A second, more specific reason to study technologies is that they shape political concepts and discussions. (The same applies, of course, *vice versa*: politics shapes technology; but that is not the point here.) New forms of communication and information technologies are changing people’s ideas about democracy and practices in public arena’s. But, again, only a detailed analysis of the technical intricacies of, for example, Internet search machines will reveal that this medium, originally hailed for its open and non-hierarchical character, is now increasingly structured by commercial interests that consequently also will shape digital democracy projects in specific ways. It is important to actively render such influences of technology visible, because the more successful technologies are, the more they get black-boxed and entrenched in society. The most pervasive and influential technologies are often the least visible and thus immune to political deliberation.

Thirdly, more strategic lessons can be drawn from studying technology—lessons that relate to the practice of political studies. A focus on technology helps to recognize the boundary work that fuels practical politics. Distinctions, problem definitions, identities: they are all actively constructed by the actors involved, rather than found in nature or society as intrinsic properties. Classification is a balancing act and technology assessment is boundary work.

The bottom-line, then, is that technology should matter to political studies because it matters to politics. And technology matters to politics because our world is pervasively technological. Such are the—quite simple—answers to the "why" question of this chapter. There is no such simple answer to the "how" question however, or it would be the constructivist *adagium*: context matters. Technology matters to politics in as many different ways as there are contexts of politics and contexts of technology.

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Notes

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[1] See, e.g.: Collins 1985; Collins and Pinch 1998; Bijker, Hughes and Pinch 1987; Bijker and Law 1992.

[2] See, e.g.: Bal and Halffman 1998; Collins and Evans 2002; Guston and Keniston 1994; Guston 2000; Guston 2001; Halffman 2002; Jasanoff 1990; Nowotny, Scott and Gibbons 2001.

[3] See, e.g.: Abbate 1999; Hughes et al. 2001; Summerton 1994; Mayntz and Hughes 1988; Hughes and Hughes 2000.

[4] See, e.g.: Dosi et al. 1988; Nelson 1993; Miettinen 2002; Elzinga 2004.

[5] See, e.g.: Funtowicz and Ravetz 1989; Wynne 1992; Asslet 2000.