TECHNOLOGY AND PUBLIC CHOICE: STRATEGIES FOR TECHNOLOGICAL CONTROL AND THE SELECTION OF TECHNOLOGIES

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Despite a dramatic growth in interest in technology over the last two decades, this has not resulted in a clear understanding of either the nature of technological change or the basis for its regulation. Part of the problem is the ambiguous heritage of science, technology and society studies which rose to prominence in the 1970s. This paper seeks to provide a theoretical scheme for categorising the commonly used models of technological change: to outline the limitations of 'technocratic' and 'technophobic' approaches to technology and social development and argue for the superiority of an explicitly 'technochoice' approach; and to discuss the dominant models for the public control of technology.

Keywords: technology, technological change, models, regulation, 'technochoice' approach

It is commonplace to observe that there has been a dramatic growth in interest in technology over the last two decades. Yet, despite this increasing interest, the discussion of the consequences and control of technology has not resulted in a clear understanding of either the nature of technological change or the basis for its regulation. It could be argued that this is only to be expected. There is no reason to assume that there should be one, universal, objective, and discoverable theory of technological change. Moreover, given the existence of conflicting interests, values and political programmes, it is not suprising that there are differing views on the most appropriate form of technological control. What one would be entitled to expect, however, is less ambiguity and confusion both within and between writers on the subject.

Quite often discussions of technology remain dominated by outdated and simplistic critiques of technological determinism, crude reassertions of the central importance of technology, simplistic pigeon-holing of theorists into technological 'pessimists' or 'optimists' (that then allows the theorist to present his/her own position as the only 'balanced' one), calls for action which substitute

exhortation for clear thought (by making theoretically indefensible or unjustified assertions about 'qualitative' changes in technology or its impact and the novel consequences of the uniquely fast 'speed' of contemporary change), and so the list goes on. Writings on technology issues then face the danger of degenerating into a loose compilation of theoretical polemics, aggregated data, and circumscribed policy analysis.

Part of the problem is the ambiguous heritage of science, technology and society studies. Its rise to prominence during the 1970s occurred as part of a reaction against both 'scientistic' theories of technological determinism and the 'neglect' of technology by other academic and policy oriented disciplines. This left the field in the position of simultaneously rejecting too great an emphasis on technology and condemning any underestimation of its influence. The tension that this builds into the discipline can be destructive as long as many of its practitioners remain theoretically complacent. Historical and contemporary data on the autonomous effectivity of technology in the context of its social shaping and use cannot be adequately conceptualised on the basis of *simple assertions* that technology is not 'neutral', that technological determinism is inadequate, and that attention needs to be paid to the direction, choice and promotion of technology.

In the face of this ambiguity and tension, the aim of this paper is deliberately analytical and schematic. This paper is intended to clarify the discussion of technology and social change in three main areas. First, it provides a theoretical scheme for categorising the commonly used models of technological change. Secondly, it outlines the limitations of 'technocratic' and 'technophobic' approaches to technology and social development, and argues for the superiority of an explicitly 'technochoice' approach. This provides the basis for the third section, which discusses the dominant models for the public control of technology ('managerial', 'corporate-elite' and 'radical-participatory'), all of which explicitly or implicitly recognise the importance of some form of technochoice. Unlike managerial and elite models in the past, these are deliberately defined as models recognising the existence of technological selection and choice. Their distinctiveness comes not from a denial of politics and choice in technological change, but in the specific approach they adopt towards the control issues that this raises.

The aim of the paper is *not* to provide a final solution to the 'problem' of explaining technological change and enhancing the public control of technical development. (The models are examined in greater depth elsewhere as part of an attempt to redirect thought on technology and social development.)[1] The purpose of this paper is, rather, to remove some of the confusions which inhibit useful debate

on technology and change, and to point out some of the dilemmas and problems facing the development of more appropriate theories. Far too often writers on technology and society pay lip service to vaguely defined, yet 'generally accepted', assumptions about the nature of technological change, while either contravening or confusing these assumptions in their specific studies. Similarly, traditional theories of technological control are often rejected by writers in principle, while they produce a modified version of these theories in their practical proposals. If this paper makes such a theoretical 'two step' more difficult by clarifying some of the issues involved, it will have succeeded in its purpose.

MODELS OF TECHNOLOGICAL CHANGE

Many commonly used models of technological change are misleading or confusing. Often writers are attributed to extreme 'technological determinist', 'technological optimist' or 'technological pessimist' positions which do not adequately capture the complexity of their thought or the qualifications that they make to their main arguments.[2] More importantly, the nature of the models used to classify such writers is often unclear. For example, when the label 'technological determinism' is employed, what level of determinism is involved? Does this apply to the *origins* of technological change or the *effects* of technological change? What is meant by the 'technology is neutral' thesis? Does this, again, apply to the source or effects of technology? When there is discussion of the 'use/abuse' model of technology — attributing the effects of technology to the way it is used rather than the technology itself — does this model not allow for any constraints imposed upon usage by the structure of the technology? A thesis of this kind appears absurd. Moreover, many of the critics of the use/abuse model are also critics of technological determinism, yet the rejection of the use/abuse model is based on the thesis that technologies, because of their very structure, *do* have a definite effect on social relations and the way in which they can be used. Does this not place the critic back again in the technological determinist camp?

Some clarity may be introduced into the subject by making a few central points. First, given the confused nature of past thought about technological change, the models should not be taken to encompass the total work of particular thinkers. It would not be surprising if one thinker employed, in a relatively loose fashion, a number of models. Thus we find, for example, both Schumacher[3] and Illich[4], challenging the idea that modern problems are due solely to the size and quantitative expansion of technology, yet at other times, they directly attribute these problems to size and scale.[5] The discussion of models

of technology should not be understood as a means for classifying and pigeon holing particular theorists, but, rather, as a logical ordering of alternative approaches to the major issues raised by technological change.

Secondly, the distinction should be clearly maintained between discussions of the *origins* of technological change and the *effects* of technological change. Technological determinism, for example, may refer either to the belief that technology develops in an autonomous fashion driven forward by its own technical dynamism, or to the assertion that the major changes in culture and social structure are due to the impact of technological developments. Similarly, the thesis of technological neutrality may involve the claim that technology is the product of a neutral dynamic, or the argument that technological advance merely has technical effects, the problems and benefits of technology being attributable solely to the way in which the technology is *used* ('use/abuse' model).

FIGURE 1

Models of Technological Determinism

	MINOR DETERMINANT	MAJOR DETERMINANT
AUTONOMOUS TECHNOLOGY	CRITICAL AUTONOMOUS MODEL	AUTONOMOUS DETERMINISM (strong technological determinism)
NON-AUTONOMOUS TECHNOLOGY	CRITICAL DIRECTED MODEL (strong anti-technological determinism)	DIRECTED DETERMINISM

It is possible, therefore, to distinguish different models of technological change based on the assumptions that: technology develops in a largely autonomous fashion, but that it does not determine the major changes in social structure; technology does not develop in an autonomous fashion, but the changes that occur in technology create major social transformations; technology develops

autonomously and is the major source of social transformation and change; or that technology does not develop autonomously and is not responsible for major social changes. Similarly, in the discussions of technological neutrality, it may be claimed that technological change has its origins in a technical process but has beneficial or retrograde social effects; has its origins in a non-technical, value-laden or politically influenced process, and has beneficial or retrograde effects; has its origins in a technical process and has nothing but technical effects; or has its origins in a process influenced or directed by non-technical factors and has beneficial or retrograde effects. For a diagramatic schema of these models see Figures 1 and 2.

FIGURE 2

Models of Technological Neutrality

	USE/ABUSE (Neutral effects)	DETERMINANT (Non-neutral effects)
SCIENTISM (Neutral origins)	CLASSIC NEUTRALITY	SCIENTISTIC DETERMINISM
NON-SCIENTISM (Non neutral origins)	NON-SCIENTISTIC NEUTRALITY	STRONG ANTI-NEUTRALITY

THEORIES OF TECHNOLOGY AND SOCIAL DEVELOPMENT

Amongst those social theories which stress the major importance of technological change, the two most prominent models have been what could be termed the 'technocratic' and 'technophobic' approaches. Both of these approaches accept that technological development occurs in a largely autonomous technical sphere and attribute fundamental social importance to the advance of technology. They both incorporate 'autonomous determinism' and 'scientistic determinism'. Where they differ, however, is on the issue of the desirability of advanced technology and the social conditions that it creates.

The Technocratic Approach

This approach to technological change represents the development of technology as the fundamental reality of modern societies and the

main source of novelty and progress. Taking much of its inspiration from eighteenth and nineteenth century French philosophy, this technocratic form of thought has become embodied in utopian writing from Bacon's *New Atlantis* to Bellamy's *Looking Backward* and beyond. Found most prominently in much of the writings of Turgot, Condorcet, Saint-Simon and Comte, it has been continued in the modern day in theories of 'modernisation', 'post-capitalism', and the 'convergence' of all 'post-industrial' societies.[6]

The primary reality of modern societies is perceived to be the quantitative development of technology and the necessary constraints that this imposes upon society. The nature, type and form of technologies are of far less significance than technology's quantitative 'progress' and the implications that this has for human knowledge, affluence and leisure. Progress is primarily achieved through stimulating technological development and economic growth, speeding up this development, and ensuring that society is adequately adapted to its requirements. In comparison with this process, different forms, types and uses of technology and growth are condemned to irrelevance. The political or socio-economic forces influencing the course of technological development, or the use of modern technologies, are relatively inconsequential when contrasted with the benefits that flow from increasing knowledge and control of nature, the creation of affluence and material wealth, and the increased leisure and free time that comes from the automation of production.

This model should not be taken as advocating complete passivity for there is the perennial problem of combatting disruptive elements, overcoming outdated traditional fears of new technology and challenging any 'Luddite' reactions against technology, 'romantic' appeals for a return to nature, or ideological attempts to transform capitalism or mass society in ignorance of the requirements of advanced technology and industrial production.

Meanwhile, there are always the tremendous technical problems of educating, organising and planning a society capable of the dynamism and flexibility required of an advanced technological, now 'post-industrial', state. This approach is clearly revealed in aspects of the writings of such authors as Daniel Bell, Zbigniew Brzezinski, Barry Jones and Alvin Toffler.[7]

The central feature of this model is its failure to examine the non-technical sources of technological change and the effect that these have in deciding different *forms* or 'paths' of technological development. Technology, and technological change, is largely presented in terms of the 'one best way', to which society must adapt. The process of 'adaptation' is presented in scientific and 'objective' terms, as an 'adjustment' of society to the technical requirements of scientific and technological progress.[8]

The technophobic approach

The technophobic approach accepts much of the technocratic model as a description of reality, but opposes these developments as the source of human degradation, environmental despoilation, and the destruction of social values and sense of community. Whereas the technocratic model praises the advance of science, secularisation, affluence, automation, and the establishment of a complex division of labour as the basis of social progress, the technophobic model regards such advances as the source of the mechanisation of man, rampant materialism, the fragmentation of individuals, the collapse of craft work and the decline of human creativity.

This reaction against the environmental and human costs of technological development is, of course, far from new. Since the Greeks first told of the fate of Prometheus and Pandora, popular myth has warned of the dangers of the technological *hubris* — in the form of the legends of Frankenstein, Dr. Faust and Dr. Jekyll or, in more recent years, the dangers of a future as portrayed in Orwell's *1984,* Huxley's *Brave New World,* or Vonnegut's *Player Piano.* From ancient Greece to the present, there have been a wide variety of romantic, humanist, Malthusian, and philosophical reactions against the Faustian Technic, the Dark Satanic Mills, the manic Promethean Quest, and the general price of progress. In the most recent era, many of these themes can be found in the work of such writers as Ellul, Illich, Roszak and Schumacher.[9]

In a similar manner to the technocratic model, the technophobic reaction gives an interpretation of technological development as an inevitable, uni-dimensional, autonomous and technical process. The source of this dynamism is variously attributed to the actions of a technocratic class, a technocratic culture, or technocratic competition.[10] The effect is to impose on all societies a similar kind of socio-economic and political structure inevitably linked to advanced technology. Any solution to the problems of an advanced technological society can, therefore, only be found through the rejection of advanced technology and a return to a less 'developed' form. Again, as with the technocratic model, forms and uses of technology are regarded as relatively insignificant in comparison with the quantitative advance of technology and its determination of society.

The technochoice approach

Many of the recent assessments of modern technology are directly critical of the cruder forms of both the technocratic and technophobic models.[11] These assessments may, however, take a number of different forms. On the one hand, they may focus on the exaggerated

importance attached to the impact of technology on society. Such assessments may regard technology as of minimal importance in influencing the course of social events, and employ some forms of the use/abuse model of technological effects (although this somewhat caricatures their work, this approach has influenced critiques of 'convergence' theory, 'post-industrial' society theory, and cruder theories of automation).[11]

On the other hand, critiques of the technocratic and technophobic approaches may be directed against the view of scientific and technological development as a neutral, technical or autonomous process. Within this latter approach it is emphasised that despite any apparent autonomy or uncontrolled incremental character that scientific and technological change may possess, at crucial points and in significant ways its development is shaped and controlled by social forces. This raises the important issues of who controls technological change and for what purposes, and how technology should be regulated and promoted in the public interest.[12]

The technochoice approach, as it is presented in this paper, is based on two main assumptions: (a) that technological 'hardware' and the organisational 'techniques' that surround its use make up a total technological 'package' which creates problems, possibilities and effects that are of crucial social significance; and (b) that the form taken by the 'hardware' and the 'software' of these technological packages is greatly influenced by political, economic and social forces responsible for the structure and type of technological development that is allowed to occur. This model is opposed to technological determinism through its emphasis upon the non-autonomous character of technological development and use. It is also in direct contrast to technocratic and technophobic theories of the effects of technology. The impact of technology on society is not seen as the inevitable consequence of a unilinear process of technological development. Different forms, paths, routes or types of technology are available, and, first, the type of path (and associated beneficial or harmful effects) will vary depending upon the constellation of social and technical forces, and, secondly, the effect of the selected technologies will be influenced and limited by the socio-economic and political relationships which have an impact upon how they will be used.

Before we continue further, it is important to be aware of what the technochoice approach does not imply. First, it does not imply that technological choices are solely responsible for all major social changes, for such changes are greatly influenced by the social relationships which make such choices, determine how the technologies will be used, and have an impact upon society separate from technology. Secondly, it is not another form of the use/abuse

model for it incorporates the assumption that the choice of technologies has an important effect upon social relations and the way in which technology can be used. Thirdly, the idea of choice incorporated in the concept of technochoice refers to two different phenomena: first, the structural shaping and selection of technologies which may occur through the action of established cultural practices, class structures or economic, social and political institutions — without any clearly active and conscious 'choice' being made, and, secondly, the conscious choice of paths of technological development which may be carried out through the exercise of power by dominant groups in society or the attempt by individuals or groups to develop and use technologies that are in the public interest — either of which may be incorporated in government attempts to control technology.

Despite this ambiguity, the concept of technochoice is retained because of the central emphasis that it places on technological change as a process of selection of specific forms or types of technology from amongst a number of actual or possible paths of development. The concept makes this point more clearly than the emphasis upon the control of technology. The image of controlling technology retains a much closer identification with the idea of technological change as an evolving, internally generated process with political control only exerted at times to influence the course of its direction. The image is more one of a political rider sitting astride and guiding an otherwise independent technological machine.

The idea of technochoice reflects an image of technological change as a process of continual selection from a whole range or series of technological alternatives. This may occur at various stages; for example, in the funding of research, the constructing and testing of scientific knowledge, the transformation of scientific knowledge into workable technologies, the designing of marketable products, and the determination of the type of technology that will become generally used and 'diffused' amongst the population. Actions and decisions made at each of these stages are important in determining the form of technology that we obtain. The image of technological change and social development is one of a series of alternatives at different levels of technological development, each of which forks out into a myriad of different possible directions, only a small number of which are actually selected or chosen, and which then influence the later range of choices available.

This approach is also different from that which regards existing large scale technological institutions as, in effect, autonomous and self-determining because of either the size, expertise, and institutional pull of these institutions, or their inevitable power once the technological system upon which they are based has become

established; e.g., automobile-based transport, centralised electricity-based energy systems, nuclear-based warfare systems, etc.

Such an approach recognises the limits of a narrow 'hardware' dominated technological determinism, yet stresses the extent to which the complex constellation of scientific technological organisations have now come to have such a dominant impact on technical activity that technological change can, for all practical purposes, be regarded as largely autonomous from meaningful political or democratic control.[13] In contrast, the technochoice approach, while accepting the power of such organisations and the complexity of technological change, continues to emphasise the existence of selection and choice. Some forms of selection are far more fundamental, established, difficult to reverse or obscure than others — yet they still remain as a potentially reversible social selection or human choice. Once this element of selection and choice is recognised, it is possible to examine the future of such technologies by investigating the balance of structural constraints and social forces acting to promote or to undermine such technological systems or paths of technological change. The course of development is always recognised as one of tension, conflict and struggle — even if one side is clearly dominant. Unless this tension is understood, any investigation of technological change will lapse into a crude functionalism that gives technology or technological institutions an evolutionary dynamism that allows no theoretical space for discussing alternative forms of human or political action, and actively encourages a passive acceptance of established interests.

MODELS OF TECHNOLOGICAL CONTROL

In a variety of ways the ghosts of technocratic and technophobic interpretations continue to haunt discussions of contemporary technology and social progress — often because of a failure of imagination in conceiving of progress in any other terms. Most writers would, however, now reject the extreme logic of technological determinism, and recognise the role of human choice and social selection in the direction of science and technology. As Wilbert Moore aptly pointed out:

> The doctrine that holds technology to be the primary fact of all social causation does not need yet another post mortem lethal blow. But some issues remain to be explored and clarified. The question is not whether technology causes social change: it does; or whether various social changes cause technology: they do. The only interesting question is: which changes under what circumstances.[14]

Similarly, in the sphere of controlling technology, it is often recognised that, technology is shaped and directed by social forces,

that control is exerted by groups and institutions, and that improved forms of control are desirable. The interesting question, however, is: *who* should influence *what type* of control over *what forms* and stages of technological development? The call for public control could, for example, refer to increasing state control over technologies developed in private business; increasing parliamentary control over state activities in this area; improving public accountability of parliamentary activities in this sphere; or, even, a more general interest in increasing society's control over its own activities.[15]

Amongst those who recognise the existence of technological choice and the need for improved control over technology, three general models are currently widely prevalent. These can be described as the 'managerial', 'corporate-elite' and 'radical-participatory' models. These are intended as analytical models, not complete descriptions of the theoretical perspectives of particular writers.

Managerial model

The managerial approach to the control of technology asserts that scientific and technological change is a key feature of modern societies. The increasing speed of technological development, accompanied by its widepsread impact, requires the establishment of new institutional mechanisms for both promoting and regulating technological change.[16] In order to deal adequately with the complexity of technological change, new forms of scientific knowledge and new forms of scientific expertise are required. These involve not just technicians capable of understanding the nature and implications of technology, but experts in the social sciences or policy analysis, capable of examining the social consequences of new technologies, and aiding in the non-disruptive implementation of technological changes. Science and technology policy, it is recognised, is an inherently value-laden activity. It involves making political choices which will have disproportionate effects on and advantages for different sectors of the population. Choices are inevitable and political interests are necessarily involved. It is argued that, as a result, the effective and non-disruptive management of technological change cannot occur if its social effects are not taken into account. The early recognition and resolution of any problems can only occur if more is made of scientific and social scientific expertise in the political decision making process.

This approach is found most prominently amongst writers concerned with the consequences of 'post-industrial' society.[17] It is argued that new demands are now being imposed upon the political system due to environmental pollution, resource depletion, automation and unemployment, the installation of new

communications technologies, etc. The traditional institutions of government are seen as being inadequate for dealing with these demands.[18] Particular critical attention is paid to the lack of knowledge of parliamentarians and the failure of parliament to exercise effective and responsible control over the executive, the bureaucracy and statutory corporations.[19]

The prescriptions for the use of new forms of expertise may, however, take a number of different forms. Although the traditional Saint-Simonian model of the scientific decision maker is not usually adopted, there are a number of weakened versions of the appeal to expertise. These involve: first, the argument that politicians will make the final decisions, but more expertise is required to advise politicians on the consequences of technological developments and the best means for achieving their policy goals[20]; secondly, the claim that more social scientists are required either to examine the social effects of promoting particular forms of technology or to contribute their knowledge to the regulation of potentially harmful technologies; and, thirdly, the view that more professional expertise is required to encourage an increasingly socially responsible ethic for guiding technological development (now that technical and economic progress is no longer regarded as an unqualified good).[21]

Despite its present widespread currency, the general managerial model possesses a number of serious limitations. First, it is not possible for experts to provide 'neutral' or necessarily 'socially benign' views of the means necessary to achieve the ends of political policy. As has been witnessed in innumerable cases, not only the 'technical' means, but also scientific 'knowledge' and 'evidence' itself, have an inherently political character.[22] Secondly, scientific advisers do not merely advise on means to achieve the goals set by parliament. Their knowledge and advice are important in shaping the policies themselves, defining 'realistic' alternatives, and supplying the 'evidence' on which they are based. Thirdly, there is a lack of consideration of the limitations imposed upon political action by the external control of private business (both national and international) over the development of technology and, indeed, over the state itself, and the autonomous effectivity of the scientific-technological establishment in determining the course of suitable technological change.[23] The limited capacity of the state to guide and direct technology, and the implications that this has for the 'control' of technology, are not seriously addressed. Fourthly, there is a recognition of the existence of technological alternatives without any questioning of the ability of the existing political structure to make legitimate choices that effectively represent the interests of the population. Criticisms of the limitations of the political structure are limited to critiques of the rigidity of bureaucracy and the time

pressures on parliament. They do not extend to a critical assessment of the foundations of the existing liberal-democratic structure. It is assumed, rather than argued, that this structure is capable of dealing with the issues involved.

Corporate-elite model

This model closely approximates to a technophobic 'no-choice' model, except that it accepts the existence of 'alternative' technologies and forms of development. This perspective emphasises the extent to which professional elites in statutory bodies, independent professions, and government bureaucracies select those technologies favourable to their own personal and institutional interests.[24] In addition, it stresses the selection, distortion, control and sometimes repression of technological development carried out by large scale and multi-national business corporations.[25] In combination, these 'elitist' and 'corporatist' assumptions result in a model which characterises the process of technological selection as determined by a rigid and authoritarian social structure.

The limitations of this model are similar to those which face any crude elite or economic determinist theory.[26] First, there is often an over-conspiratorial view of decision making with insufficient discussion of the structural basis of elite and corporate power, the divisions within or between elites and corporations, or the exact demarcation between the dominant 'elite' and the subordinate 'mass'. Secondly, there is a rather simplistic dichotomisation of authority which leaves the non-elite or non-corporate groups and institutions as an undifferentiated, powerless and, predominately, uncritical mass. There is little attempt to integrate into the basic analysis the effect of organisational gradations of power, elite or corporate adjustment to what the non-elite would regard as legitimate, the importance of sex, race, class, region, cultural differences and their effect on collective activity and power, etc. Thirdly, there is barely any recognition of the actual, or potential, influence of the political liberal-democratic regime on the activities of the autonomous elites and private corporations. The possibility of such influence is dismissed rather than argued.[27] In a manner similar to the managerial model's assumption of the viability of the existing liberal-democratic structure, the corporate-elite model simply dismisses attempts at political participation as ineffective.

Radical-participatory model

The radical-participatory model recognises, like the elite-corporate model, the restrictions imposed upon public control of technology by

the actions of established governmental bureaucracies, large corporations and, in some quite dramatic instances (e.g., forms of the military-industrial complex), the combination of the two. At the same time, however, it stresses the increased organisation of groups outside traditional political institutions; e.g., environmental movements, anti-nuclear movements, the peace movement, the women's movement, community and industrial democracy experiments, etc.[28] It is further argued that the intrusion of large scale technologies, and their associated organisational requirements, into the private lives of the ordinary citizen has been increasing,[29] and areas previously regarded as purely 'technical' (e.g., nuclear power) have proved sufficiently controversial to result in the mobilisation of mass movements. These new groups and movements, it is claimed, have succeeded in exerting pressure on both governments and corporations through direct action (protests, demonstrations, disruptions, strikes, etc.) and more formal avenues of participation (advisory committees, public inquiries, referenda, etc.).

The major issue facing modern capitalist states is, therefore, defined in terms of the ability of the state to incorporate an increasingly active citizenry into the processes of government and control of new technology.[30] Yet this process of incorporation poses a threat as well as a promise. The promise is the realisation of a truly participatory democracy.[31] The threat is the co-option, accommodation and ultimately the pacification of these radical movements, or their leaders, in a manner which renders their participation peripheral and ineffective.

The limitations of the radical-participatory model are attributable to its difficulty in resolving a number of central dilemmas. First, it fluctuates between accepting existing interest groups as representative of the 'public' and promoting the less advantaged groups or previously under-represented sections of the populace. In the former case, the presence of active groups makes it possible to incorporate interested members of the public in decision-making — but at the risk of favouring those most advantaged or with a particular narrow interest in the outcome. In the latter case, while clearly aware of inequalities of knowledge and power in the population, it is difficult to define which affected interests should be represented or given additional support in the absence of expressed grievances or agreed criteria of those 'most affected'. Mass movements may even emerge on issues of 'common concern', but different groups will be more or less affected by the outcome. There is no 'technical' solution to the resolution of such issues.

Secondly, there are limits on the ability of decision making bodies to undertake lengthy processes of participation if they are ever to fulfil their task of, finally, making a decision. Over-lengthy processes of

participation may hinder the ability of a corporation to make commercial, competitive decisions, and involve a public enterprise in inefficient and costly deliberations. In addition, participation and representation are not the only values involved in deciding upon the final outcome — in one sense, they are only the means for achieving a more desirable outcome. Participation must be balanced against other ideals, goals or criteria.

Thirdly, the appeal for increased participation faces the problem of, on the one hand, only participating ineffectively at too late a stage in the development of a technology to play an effective role, or, on the other hand, appealing for a substantial say in decisions that directly contradicts the principles of liberal democracy and private property (while, often, being incapable of justifying the superior representativeness of the forms of participation that are put forward). In short, the radical participatory approach faces a series of dilemmas concerning *when* to participate, *how* to participate, *at what level* to participate, *who* should participate, and *what outcome* there should be from participation.

CONCLUSION

In contrast to the controversies surrounding technological developments during the 1970s, the 1980s appears to many as a period of relegitimation of technical progress.[32] The institutions established by government to investigate or address the social and environmental concerns surrounding technological changes, are frequently lacking in the power, authority, or even genuine concern necessary to deal adequately with the issues involved. In Australia, for instance, Barry Jones' attempts to instigate a wide-ranging debate on the social issues surrounding the development of a post-industrial society have been largely restricted by government to the public promotion of key technologies for enhancing corporate profitability and economic growth.[33]

In the face of such developments, it appears likely that the recognition of technological choice, and the espousal of government rhetoric on the concern for the 'social' aspects of technology, are likely to result in the adoption of a 'managerial' approach to technological choice, with critics adopting a fatalistic 'corporate-elite' interpretation of the restriction of debate and proponents of 'radical-participation' appearing naively utopian.

There are two clear dangers associated with such a development. First, large sections of the population, negatively affected by the employment, health, control or environmental aspects of new technology, may become increasingly disaffected and regard existing

public bodies as illegitimate and incapable of addressing the major concerns of the public. Secondly, the widespread recognition that 'growthmania', the pursuit of growth for its own sake, is inadequate as a guide to public policy and social progress, will be ignored by the major decision making bodies. The challenge of consciously implementing a 'selective industrialism' in the public interest will not be taken up. The rhetoric of progress will then continue to be used to prevent public debate and justify the selective implementation of forms of technology and progress that may be only in the interests of established corporate and institutional organisations.

If such a development continues, the 'managerial' approach to the public selection and shaping of technology cannot be relied upon to represent adequately public concerns or to have the political power and authority necessary to implement any decisions that it makes. Despite the difficulties that it faces, only the 'radical-participatory' model appears to have the potential to overcome these problems. By improving both government awareness of public opinion and the access of interested members of the public to decision making bodies, it may provide the means, in the short term, to ensure that increased attention is paid to public concerns. In the longer term it helps create the kind of citizenry and institutional structure capable of taking on the difficult task of implementing a democratic strategy for shaping, selecting and controlling technological change.

The important issue that remains, of course, is how this is to be achieved. Clearly, prescriptions will vary, depending upon the type of technology involved and the social context in which it is developed and deployed. One of the most urgent areas of attention, however, is the extension of direct participation in 'local' issues of technological shaping, selection, and use, and co-ordinating this with 'central' institutional structures having the authority and capability to decide upon major technological directions. In this form radical participation in the exercise of technochoice is the challenge of technology and public policy in the 1980s.

NOTES AND REFERENCES

1. This article is an extended version of a paper presented to the ANZAAS Conference, May 1984 at the Australian National University, Canberra. It is part of a wider project on the major social and political theories of technology, and the political and philosophical implications of radical critiques of technology. For a further discussion and elaboration of the major issues and models, see R. Badham, 'The sociology of industrial and post-industrial societies', *Current Sociology*, 32, 1, 1984; *idem*, *Theories of Industrial Society*, Croom Helm, London, 1986; *idem*, 'The dangers of technospeak: 1984, Brave New World and

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