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PROBLEMS OF A SOCIALLY AND ECOLOGICALLY ORIENTED TECHNOLOGY POLICY

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Abstract

There is no modern industrial country not pursuing research and technology policy in one or the other way. But there is a need for complete re-orientation in this policy field; especially an integration of social and ecological concern is needed. In the paper some of the tendencies of such a reorientation of state technology policy is pointed out.

Keywords: technology policy, innovation, social shaping of technological development, environmentally benign technology, market failure, dilemma of control, emission standards, risk assessment, expert knowledge, constructive technology assessment.

There is no modern industrialised country not pursuing research and technology policy in one or the other way. And although state interventionism in general is viewed more and more sceptically and there is an increasing shift towards favouring the regulating power of the market, hardly any calls for the state's withdrawal from the fields of research, innovation and technology have been voiced so far. On the contrary, not only is public R and T policy considered to continue to be indispensable for stimulating economic growth, it is attached even growing importance within the scale of state activities.

Rather than asking for an expansion of technology policy along existing lines, critics refer to the lack of attention devoted to the social shaping of technological development and to the social compatibility of technological change. Moreover, it is pointed out that there is a lack of ecological precautions and environmentally benign technology, a deficit whose solution is also expected from the state. There is a call for an integrative, or systemic, technology policy. According to OECD, there is a need for complete re-orientation in this policy field; its substance must be newly defined, new spheres of intervention must be identified and new structural arrangements be developed (OECD 1988). In the following, some of the tendencies of such a re-orientation in state R and T policy shall be pointed out.

The objective of government technology policy to increase social welfare has for a long time quite indiscriminately been equalled with growth and productivity progress. The technological innovations encouraged by state innovation policy, though, do not lead to productivity increases only; their development and application involve considerable risks of both social and ecological nature. This has given rise to an increasing scepticism towards the traditional objectives of public R and T policy (BRAUN, 1992). Social damage may by far outweigh productivity growth, leading, as a result, to a decline in social welfare.

It is important to note that social and ecological risks are the result not only of the very nature of substantive technology as such but also of its use under specific circumstances. As has been shown quite impressively by Perrow, the ecological risks of modern large-scale technology are primarily the result of the lacking mutual adjustment of social organisation and technological structures (1986). Also the hazards to human health as a central social risk in many cases are not due to specific mechanical properties but to work organisation structures and excessive performance standards.

Due to a specific selectivity, the capacity of the market to eliminate social and ecological risks is considered to be extremely low. Consequently, there are a number of market failures which possibly contribute to considerable shortcomings of production steering (LITTMANN, 1975): external effects of production and consumption; neglect of social and human standards; as well as differences between private and overall economic time horizons.

External effects of production and consumption increase dramatically with economic and technological development. Environmental damage as water and air pollution, the destruction of the ozone layer, as well as the gigantic growth in waste quantities make clear that many people's quality of life is considerably diminished by technological progress. Impairing the quality of the free goods of water and air as a consequence of industrial production at least raises serious doubts about the positive effects of productivity increase and economic growth on welfare.

The fact that scarce resources may be misdirected if environmental protection and improvement are left to the market becomes explicable if considering as the entrepreneurial goal a ratio between private profits and costs as favourable as possible. In line with this goal, the substitution of private costs for societal ones, from the entrepreneurial point of view, appears to be quite rational. This is true for the emission of toxic gases in the same way as for discharging contaminated waste water into the rivers. And as long as the wasteful use of scarce resources does not reduce profits, there is nothing, from the entrepreneurial perspective, that speaks against the exploitation of nature. Such an externalisation of costs may mean technological progress from the single entrepreneur's point of view, while at the level of society at large such behaviour results in reduced social welfare.

The specific market selectivity becomes also obvious when it comes to considering human-oriented aspects in the conception of technological practices. A decrease in operational costs as a consequence of work intensification due to the use of new technologies is considered as technological progress in the traditional sense, even if this goes hand in hand with physical and psychological strain. This assessment, though, cannot be shared on the societal level in view of the considerable social costs of, for instance, medical care and human capital lying idle. Again, costs accrued on the enterprise level during the production process are externalised and have to be borne by society as a whole.

Insufficient knowledge of the future scarcity of natural resources is said to be the reason for yet another form of failure of the market. Market prices, it is argued, are steering mechanisms related to the present and indicating only current scarcities of goods rather than signalling future developments. Such a short-term perspective of the market thus inevitably leads to inappropriate resource allocation and a misdirection of the innovation process from the point of view of social welfare. One argument along this line refers to the insufficient consideration of the needs of future generations (EWERS, 1990).

Such failure of the market is demonstrated by the way of dealing with non-renewable natural resources. The fact that their availability is limited is hardly reflected in the market prices as long as the supplied quantities correspond to demand. In this way, the necessary adjustment processes are deferred, which may lead to considerable friction and slow-down in growth at a later stage. Only if processes of adaptation to future conditions are initiated at a very early stage can the expected social conflicts be alleviated to some extent (LITTMANN, 1975).

The fact that the market mechanism contributes to environmental damage, the violation of human standards and the neglect of future situations of scarcity suggests further perspectives for public innovation control. This does not necessarily suggest renouncing the objective of growth but at least a re-orientation in the policy of growth.

There is a widespread view that the development and application of the new EDP-based technologies may solve not only economic but also ecological and social problems. These technologies are not only labelled as clean, they are also supposed to lead to the simultaneous optimisation of economic and social objectives. Stimulating technological progress by supporting research in and possibly the pioneering application of new technologies is thus considered as a comprehensive form of state intervention no longer requiring, in addition, a special orientation towards ecological and social objectives. Much rather, the basic pattern of technology support can be maintained.

DANEKE criticises that such a conception of new technologies makes them a kind of panacea. But these are, he argues, not unproblematic from the ecological point of view and, in addition, place high demands on enterprise organisation and public infrastructure (1992) while by no means leading automatically to the creation of socially compatible working structures (BADHAM, 1992). If the welfare-enhancing function of technological progress is not to be impaired by any negative effects, ecological and social objectives must explicitly be made the hallmarks of public R and T policy.

At first sight, a simple idea seems to provide a sensible orientation for a type of R and T policy aiming at economic, ecological and social objectives. This basic idea can be described as follows: Economic- technological innovations which would not be carried out under the conditions of an empirical price system, being considered unprofitable from the private enterprise point of view, shall be stimulated provided that they contribute to working towards the socio-economic optimum. On the other hand, those types of innovation must be discriminated against, which seem promising of success merely from the financial point of view of private industry but, taking into consideration social costs and profits, would result in no gain or even in a loss of people's economic welfare (LITTMANN, 1975).

This basic idea seems to suggest a dual R and T policy incorporating both support and regulation. The two main thrusts of technology policy are the support of technology and the regulation of technology. The former stems mainly from the desire to strengthen the national economy, while the latter is mainly necessary in order to reduce health and environmental hazards caused by the use of technology (BRAUN, 1992). It might certainly be much easier to correct any undesired aspects of technological progress on the user level rather than trying to establish an optimally structured development path of the economy as a whole via the distribution of research funds.

Putting the above-mentioned idea into practice poses considerable difficulties. Above all, the point in time at which the state should intervene by either supporting or hampering the process of innovation seems to be an open question. In this connection, COLLINGRIDGE has drawn attention to the central dilemma of control (1980). This is due to the fact that during the early stages of development technological innovation may not be controlled because of insufficient predictability, while later, as social and ecological consequences may appear, it is possible to do so. Control at this stage, however, becomes increasingly difficult as any changes are extremely costly due to the amount of technological, financial, institutional and cultural investments already made. MAYNTZ and SCHARPF give a very good illustration of the problematic nature of the above simple recipe as far as fundamental research is concerned. In politics, according to the authors, it is not possible 'to nurse the vegetables and pull out the weeds', as the potential for increasing social welfare and for jeopardising it is fed from the same roots (1990). The knowledge about nuclear fission, genetic engineering, or information storage as such may not *a priori* be categorised as supportive or detrimental to social welfare. The aim of welfare optimisation by public R and T policy may thus not be achieved by supporting fundamental research only in those selected fields in which new findings are expected to be conducive to welfare while refraining from support in all those areas where new findings conjure up ecological and social risks.

While it obviously causes insurmountable problems to exclude any negative effects of technological progress, be they of an ecological or a social nature, by state control over fundamental research, it does seem realistic to orient this research towards finding solutions to existing problems. It is possible to find out which type of knowledge is necessary for solving a given social or ecological problem. Of course, this does by no means guarantee that an adequate remedy to the problem will actually be found. On the one hand, knowing which kind of scientific knowledge is required does not automatically guarantee success, even if massive financial means are put at the disposal for the necessary fundamental research; and, on the other hand, new scientific findings are not immediately transformed into the necessary forms of technology utilisation. In spite of these imponderabilities, it seems appropriate to assign to state policy three main tasks (MAYNTZ and SCHARPF, 1990):

— generating knowledge to find technological solutions to social problems which have not been caused by technology itself;
— generating knowledge about possible negative side effects of currently practiced or prospective technological solutions (see also EDQUIST, 1992) and
— generating knowledge for minimising such side effects and solving problems having occurred due to former technological practices.

Although the authors have in mind here, in the first place, fundamental research in the field of ecological systemic relationships, their policy conception may easily be transferred to social problems. So, for instance, fundamental research may be aimed at finding out where technological practices do not comply with the criterion of social compatibility. Also research into adverse long-term effects of work practices can be made the object of fundamental research, in the same way as investigating possibilities of confining or totally eliminating such adverse effects. The authors are well aware, however, that the incentive structure currently existing in fundamental research is hardly adequate for directing scientific interest towards the investigation of ecological cause and effect relationships, as it is systematically designed to neglect interdisciplinary research. In view of this, it can be seen as the essential task of the state to initiate the kind of institutional change in fundamental research that is necessary for embarking on interdisciplinary problems (EWERS, 1990).

State regulation on the user level may take the form of either laying down concrete legal provisions or influencing price setting, for instance via the levy of taxes or other charges. This is also described by the concepts of normative or economic regulation. Public regulation is discussed above all as a means of achieving ecological objectives.

The issue of which form of regulation is more efficient for implementing non-economic goals in economic life is highly controversial. By means of economic instruments, like taxes and other charges, producers and consumers are supposed to bear those external costs which they have caused themselves and so far have been paid for by the community (SIMONIS, 1992). 'Shadow prices' for causing damage to the environment, it is assumed, will make the rationally acting subjects of economic life use clean technologies and environmentally benign products so as to avoid the costs arising from legal requirements and price rises. State intervention in the price setting mechanism, logically, shall lead to the elimination of unclean technologies from the market, to be replaced by environmentally benign product and process technologies.

This argumentation, it can be criticised, has some weaknesses. One major difficulty in fixing 'shadow prices' lies with determining the origins of a specific environmental damage and, accordingly, discriminating against the technologies causing the damage, as in most cases damage is of complex origins and appears only after some time. Moreover, levies and charges by no means invariably lead to the substitution of production technologies and products impairing the state of the environment for their clean counterparts. This is primarily a question of how high such 'shadow prices' are. The problem is that fixing the exact price levels is not possible for insufficient information on the damage caused by a specific technology. They tend to be the result of biased negotiations in which typically rather moderate prices are fixed, mostly providing little incentive for a change in technological practices or buying habits. In addition, the case of future generations is not taken into consideration in this procedure. Of special importance, though, seems to be the argument that trying to fix a price for environmental damage in principle suggests that nature-destructive processes are reversible. As this, however, in most instances is not the case, ecologically-oriented government regulation by way of the price in principle is not suitable for solving the problem of preventing environmental damage (SÖDERBAUM, 1990).

Also legal regulation has a number of disadvantages. It has proved to inhibit innovation in so far as there is no special incentive for producers to improve the state of the art beyond maximum permissible emission levels as fixed by the state towards the development of cleaner technologies. Those emissions remaining below the standard fixed by the state thus do not incur any costs (EWERS, 1990). Moreover, the problem with setting emission standards is that this has to be done when the extent of the individual technologies' harmful effects is largely unknown (SIMONIS, in this book). It comes as no surprise that emission standards tend to be too low since, as a rule, the expected damage is underrated (NOWOTNY and EISIKOVIC, 1991). In addition, proof has to be supplied that the foreseen legal regulations actually lead to the desired ecological effects.

Various authors therefore generally doubt the possibility of efficient state control of knowledge application at the enterprise level, be it via price or legal regulations (MAYNTZ and SCHARPF, 1990). This scepticism may be substantiated by a number of arguments. So, for instance, it cannot be excluded that even by far-reaching state control of knowledge application it is not possible to prevent the unintended negative side-effects of a basically desirable innovation, as technological contexts become increasingly complex and unpredictable. This is true, for example, also for the catalyser, whose use is certainly less harmful to the environment but which poses substantial, formerly neglected problems of ultimate disposal.

The thesis of controllability of knowledge application is little plausible also because of the fact that new scientific findings by their very nature constitute a public good which may be applied on a world-wide basis. State regulations, though, do not extend beyond national borders, thus being incapable of preventing certain technological developments as such.

Quite similar problems would pose themselves to a state technology policy attempting to achieve social objectives by means of controlling knowledge application at the enterprise level. Shadow prices for the use of labour in ways that are detrimental to health, for instance, independently of the difficulty of setting them, would be problematic above all because of the assumption of health as a renewable good. Legal regulation, on the other hand, is confronted with the problem of proving the causality between damage and specific technologies, an obstacle hardly to be overcome, as especially chronic diseases are the consequence of complex cause and effect relationships in which the coping potential of the person concerned plays a substantial role and, additionally, in many cases appear only towards the end of a person's working life.

Apart from the various forms of regulation, public contract placing is considered a specially suitable tool for implementing social and ecological aspects by means of public R and T policy (EDQUIST, 1992). By the mere choice from among several technologies available on the market, the state may in a certain way influence technological development, provided that the level of state demand is of any significance. So for instance, vehicles for state institutions might be purchased from the point of view of specifically ecological considerations. Also, private enterprises whose production organisation is considered as exemplary with regard to social criteria may be preferred when placing public contracts. Admittedly, this is only an indirect way of steering technological progress.

Of much greater significance is the placing of public contracts whose object is the provision of specific research and development results. As special advantages of this way of exerting public influence, the expected research and development results may be specified in detail, the instrument of contract placing may be used in a highly flexible way, and the state, through compiling the contracts, has the possibility of securing itself rather far-reaching rights to controlling the innovation process (LITTMANN, 1975). Although the chances for putting greater emphasis on social and ecological aspects within public R and T policy by means of placing research and development contracts are relatively good, there are some problems with using this instrument which must not be overlooked. Let us mention here only the difficulty of a technically adequate specification of research and development contracts by public institutions. As a rule, it cannot be taken for granted that there is sufficient qualified staff with the specific knowledge required for carrying out this task satisfactorily.

In view of the problems pointed out so far it seems necessary for public R and T policy to adopt new approaches. A technocratic policy trying to achieve ecological and social aims by means of interfering in the market mechanism or the improvement of regulatory practices will no doubt prove successful only to a limited extent. Such a re-orientation can be initiated above all by a change in political decision-making culture and by the development of new political decision-making structures and institutions.

Regarding the change in political decision-making culture, primarily with a view to taking into account ecological objectives, a number of demands have been expressed, as for instance (EWERS, 1990; SIMONIS, 1992):

— obligation of the emitter to prove non-harmful effect of emissions;
— acceptance of heuristic methods of decision-making, as cause and effect relationships are insufficiently known;
— individual obligation to automatically reduce permissible standards;
— priority to less optimistic prognoses.

Quite similar demands can be made on state policy for taking into consideration social objectives of technology development. To give only one example, enterprises should be obliged to prove that specific technological practices are not detrimental to health. Also abandoning the proof of causality of work-related ill-health may be conceived as a basis for political decisions. There is some doubt, however, as to the feasibility of actually implementing such changes in political decision-making culture. This explains an approach which, unlike the call for a change in public decision-making culture, does not aim at an automatic expansion of state control or regulation over the dynamics of technological development but rather at a redefinition of the conditions for legitimating regulatory policies (NOWOTNY and EISIKOVIC, 1991).

Assigning to the state the role of central societal control, including the definition of basic technological development lines, the establishment and administration of comprehensive research and development programmes, and also the control of knowledge application at the level of society, is certainly asking too much. A re-orientation of public R and T policy thus, in the first place, must be accompanied by a redefinition of the state's role in the technological innovation process, which should primarily be based on coordination, integration and information. There is more or less unanimous agreement in the literature, that public R and T policy can by no means remain restricted to supporting technological knowledge and controlling its application. Not least because of the far-reaching social consequences, which are primarily due to the systemic character of new technologies, does it seem to be the state's central task to create a consensus on socially desired and undesired lines of technological development (BRÄUNLING, 1986). This means at the same time that new decision-making structures are not only to aim at integrating external expertise but also at increasingly incorporating democratic elements.

What is generally considered an essential institutional innovation aiming at simultaneously pursuing economic, ecological and social ends within the scope of public R and T policy is the establishment of technology assessment centres. However, the heyday of a type of technology assessment oriented towards risk assessment in mere terms of quantity seems to be over, for which there are several reasons. Firstly, risk assessment by various experts, especially in the early stages of the process of technological innovation, has proved to be widely diverging. This makes clear that risk assessment is highly dependent on the subjective interpretations and interests of experts. In addition, risks of a social or of an ecological type in many cases are connected with specific technological practices rather than a specific substantive technology; here, however, a purely technocratic risk assessment is not possible. Finally, the traditional form of technology assessment, as a rule characterised by centralisation, bureaucratisation and expert-orientation, lacks the democratic element which, because of the serious social impacts of new technology systems, is decisive for an R and T policy based on consensus.

The impossibility of objectivising technological risks involves the danger of specific interests being imposed, even if unintentionally, by way of technology policy. There are various decision-making approaches designed to avoid this problem. Especially in the US, public R and T policy is based on the instrument of concurrent expertises. One has to admit, though, that particularly critical views are often excluded from the opinion-forming process, as these lack either the convincing lobby or the necessary resources for scientifically sustaining their ideas. To compensate for this, public R and T policy would have to be committed to the increased support of 'alternative research institutes'.

The problem of orienting the technological innovation process towards social and environmental concerns may not be solved by means of expert advice, as this type of technology assessment continues to be based on the idea of direct regulatory-interventionist control by the state. This, however, means that there is no direct link between technology assessment and the development of new or the improvement of existing technologies. There is no direct input of knowledge about social and ecological risks into the technological innovation process but only an indirect one via government measures. Moreover, technological practices including, apart from technical, also organisational and cultural aspects, largely defy the logics of state interventionism. Public R and T policy thus must watch out for alternatives to the classical centralist technology assessment model based on expert knowledge.

Such new forms of technology assessment have already started to appear on the horizon. At the enterprise level, those directly concerned are increasingly assigned an expert role in the techno-organisational restructuring of production and work processes; their experience with regard to social and ecological impacts of technology is thus immediately integrated into the technological innovation process (NASCHOLD, 1986; BADHAM and NASCHOLD, 1992). At the level of society, the institutionalisation of a democratic dialogue between various social groups and institutions constitutes a form of technology assessment (NOWOTNY and EISIKOVIC, 1991). The idea of 'Constructive Technology Assessment' as spread by NOTA in the Netherlands is another indication of change in the forms of technology assessment (BOXSEL, 1992).

Characteristic of this change is the transition from public regulation to the self-regulation of technological innovations (LATNIAK and SIMONIS, 1992). The state, or rather the institutions established by the state, confine themselves primarily to the role of providing the conditions necessary for experiments of a socially and environmentally oriented technology development and application. Thus, for instance, it may be regarded as the central element of constructive technology assessment to provide for the networking of researchers, innovators and other social groups according to the idea of a socio-technical map and to strengthen the mechanisms of communication and cooperation. Organising such a dialogue pursues the aim of integrating into the innovation process at a stage as early as possible a maximum of social perspectives and interests. Accompanying investigations on socially and ecologically-oriented technological innovations shall provide additional input into the social dialogue. In this way, at least this is the intention, a continuous learning process is set into motion. Moreover, by means of the widest possible diffusion of the knowledge gained in this way, social awareness of the social and ecological problems of technological progress shall be heightened.

Quite similar aims to the concept of constructive technological assessment are pursued by the SoTech programme of North Rhine-Westphalia (LATNIAK and SIMONIS, 1992) as well as by the Integrated Environment programme (DANEKE, 1992) developed by EPA in the USA. As far as the scope of expansion of such R and T policy is concerned, there is due cause for scepticism. Many state-supported social and ecological experiments are far from having model character, and there is hardly ever a diffusion throughout society at large. Nevertheless such experiments seem to contribute to a cultural change, increasing people's awareness of the social and ecological aspects of technology development and utilisation.

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