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1. Abstract

The notion of 'scientific citizenship' describes the role of citizens in a society, in which the integration of science with society has implications, direct or indirect, for citizens and creates a push for public participation in debating science & technology (S&T). In order to ensure *participatory* scientific citizenship fertile arenas or institutions for public participation must exist. This paper suggests that 'Technology Foresight' could facilitate participatory scientific citizenship, while at the same time actively reinforcing the public appropriation of new technologies and strengthening the policy relevance of the foresight.

2. The new production of knowledge and scientific citizenship

It is widely recognized that the world of science has been reconfigured over the last decades. *Internally*, disciplinary boundaries are loosing influence on scientific conduct as knowledge is increasingly being produced within the context of application. The organizing principles of knowledge production tend to be determined not by the codes of practice relevant to a particular scientific discipline but by a specific application. *Externally*, the traditional boundaries between science and society deteriorate since scientific problem solving very often is oriented towards societal problems. Science is increasingly expected to contribute to society; or in other words: the market for scientific knowledge has demonstrated an increasing demand for specialized and applicable knowledge and due to limited resources it is vital for the practitioners on the supply-side to meet the demands. To be competitive, knowledge production must fulfill needs; not necessarily economic ones, but social needs in a broader sense as expressed by the demand-side of the market (Gibbons *et al*. 1994).

The science-society relationship is in a process of integration. The scientists engaged in knowledge production are not uniformly representing a common institutional centre - the university - but represent a variety of institutions and companies within the public as well as the private sector. The networks of cooperation increasingly transcend the sectorial barriers, since the initiating force of research is not exclusively intra-scientific dynamics but also the need for societal problem solving that will draw together the specific competencies needed, independent of the institutional affiliation of the scientists possessing these competencies.

Knowledge production within the *context of application* is - in turn - knowledge production within a *context of implication* (Nowotny *et al*. 2001). Research aiming at solving social problems will affect social life, either directly as scientists interact with society and citizens or indirectly when scientific knowledge is used as a platform for policymaking, marketing initiatives, new technologies or different forms of interest articulation. Technological developments or future prospects affect the way we work, the way we recreate, our

understanding of life and death, and the way we relate to other people. In summary, the dynamics of science-society integration implies that knowledge production will increasingly affect the lives of ordinary citizens.

The penetration of scientific knowledge in to civil society involves new standards and procedures of quality assessment. Knowledge produced in the context of application is not merely assessed within the system of peer reviewing according to criteria such as the stringency of logic or methodology, but also by the societal relevance or 'social robustness' of the results. Societal stakeholders, industry, politicians, NGO's, and lay citizens are relevant participants in the societal validation of S&T, since they are as capable of evaluating the *political* implications of science as are scientists (Gibbons *et al*. 1994).

The new mode of knowledge production generates a new intimacy between science and citizens. Notions such as 'citizen science' (Irwin 1995) and 'scientific citizenship' (Irwin 2001) have recently transpired from S&T Studies and Studies of Public Understanding of Science as a terminological frame for describing the role of the public in a society, in which citizens are increasingly affected by developments in S&T, and in which there is an increasing push for citizens to take stands towards - and engage in assessment of and policy-making procedures regarding - S&T.

3. The scientific citizen: Spectator or participant

To grasp the political / democratic connotations of the term 'scientific citizenship' it is relevant to briefly touch upon a spectator-participant dichotomy of 'political citizenship'. The concept of 'Spectator Democracy' is used for describing a society ".. in which citizens are superficially *interested* in politics - as citizens they want to know what happens - but not by any means *engaged* in politics. It has no saliency to them, politics is perceived to play a role *for* their lives but it does not play much of a role *in* their lives" (Andersen & Torpe 2000: 5). This notion of spectator democracy is opposed by the notion of 'Participatory Democracy', which emphasizes citizen's *engagement* in politics - party membership, the inclination to vote, political consumption, participation in grass root activities or demonstrations etc. The inherently normative notion of participatory democracy stresses the importance of full citizenship in terms of both political and social *rights* (Marshall 1996/1950) and a republican ideal of civicness as a sense of societal obligation or *duty,* in which participation is a *virtue* (Sandel 1996). Participatory citizenship is not simply about enjoying the right to enter the sphere of politics, but rather about actually entering it.

Then, how should we understand the term 'scientific citizenship' in this context? First, the notion is in itself exemplary of the integration of the political and the scientific realm. The mission-oriented, border-crossing, and social-responsive knowledge production is faced with the challenge of encompassing the - conflicting, from a weberian perspective - inherent rationalities of both scientific and political conduct; balancing between values and objectivity, attitudes and the ideal of truths. Secondly, the notion implies that knowledge production must meet not only the rationality of both science and politics, but further that the knowledge producing system must be organized according to the premises given by these rationalities. In order to be legitimate, the new knowledge production must expand its organizing principles beyond meritocracy and peer validation towards democracy and societal validation.

Thirdly, bearing the spectator-participant dichotomy in mind, scientific citizenship does not necessarily mean that citizens actually engage actively in the societal validation of knowledge production. Citizens might as well assume a spectator position towards science and technology, recognizing the impact of developments in S&T *for* their lives but failing in making it an element of importance *in* their lives. The change in knowledge production towards a new 'mode' has created a push for public participation in S&T topics, but historically this process is still young - beginning after WW2 and accelerating during the 70s - and the creation of *arenas or institutions* for ensuring public participation is still an ongoing process.

4. Potentials for participatory scientific citizenship: Public understanding of biotechnology in Denmark

Modern biotechnology is a field of research that very well exemplifies the new production of knowledge. Research within this field is conducted within a variety of institutional settings, including the universities, government research agencies and private companies. There is a profound political awareness of biotechnology and a will to manage and regulate in terms of launching science policies and publicly financed research programs. Private companies are strongly engaged in biotechnological research, and there are comprehensive venture capital interests, as the potential profits from future production are high. The networks of cooperation integrate scientists from the various institutions, and biotechnology does transcend the traditional scientific disciplines. International statistics show that research related to the field of biotechnology is being performed within all of the traditional main fields of R&D including the social sciences and the humanities (Mortensen 2002).

Thus, the scope of biotechnology is wide, since it not only involves knowledge production regarding biology and technology, but also a range of considerations regarding ethics, law and social practices. The actual and potential impact of biotechnology on society is substantial. In a long-term perspective biotechnologies will clearly affect areas such as health care, agriculture, environment, energy production, crime fighting and a vast number of additional areas. In the process society will have to take stands regarding the legitimacy of the new technologies and the regulation of these technologies and find appropriate ways of expressing the citizens' attitudes towards this field of research.

The Danish Institute for Studies in Research and Research Policy has conducted large-scale surveys on the public understanding of science in general and biotechnology in particular in Denmark. The survey results give some indication of the present state of scientific citizenship. First, the public interest in research in general, and awareness of biotechnology in particular, has increased. Table 1 shows the distribution of self-reported interest in science and research on four categories ranging from 'not at all interested' to 'very interested'. Respondents declaring themselves 'very' or 'somewhat' interested in research increased from 51% in 1989 to 75% in 2000.

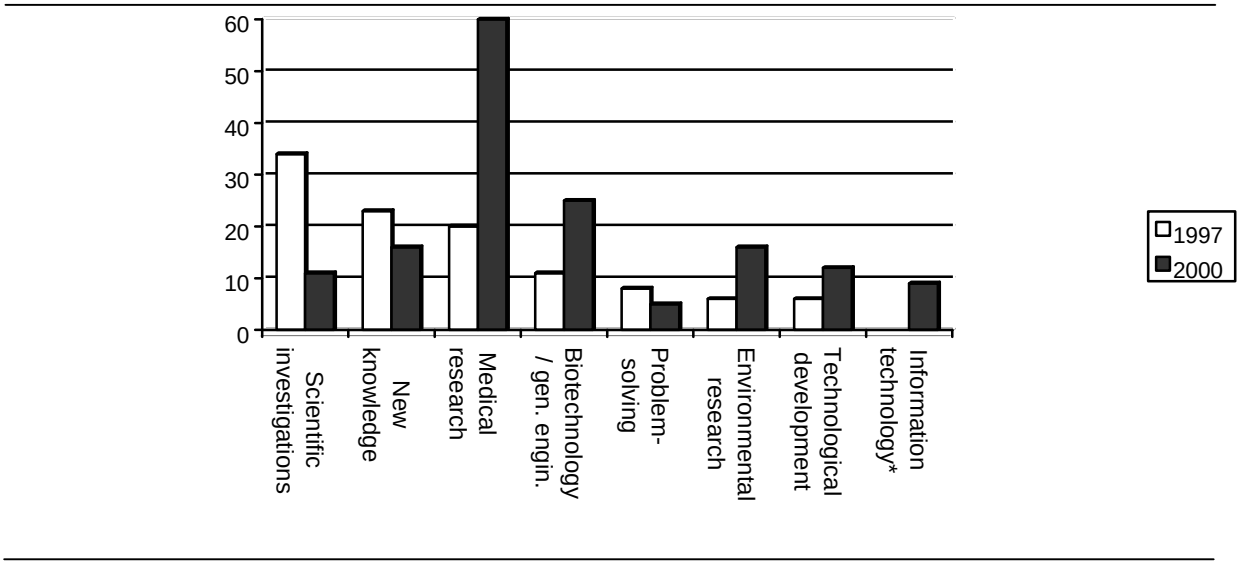
Table 1. Interest in science and research; percent

	1989	1997	2000
Very interested	16	19	24
Somewhat interested	35	38	51
Slightly interested	35	32	21
Not at all interested	13	10	4
Don’t know	1	1	0
Total	100	100	100
N	1512	1397	1397

When confronted with words such as 'science' and 'research' a range of specific research fields and broader terms come to the mind of Danish citizens. It is noticeable that perceptions regarding 'biotechnology' or 'genetic engineering' have increased from 11 to 25 pct. over the three-year period from 1997 to 2000. Unprovoked, 1 out of 4 respondents mentions biotechnology - or a related term - when asked what comes to mind when thinking about science and research in 2000. This is a rather high proportion of respondents, and it brings biotechnology into the second highest position regarding the distribution of perceptions of science and technology. Biotechnology is only outranked by 'medical research' that has a

unique position in the minds of the Danish citizens. Medical research is also the research area that the Danes are most interested in and the area that the majority is in favor of prioritizing in terms of increasing public funding.

Figure 1. Perceptions of science and research; percent

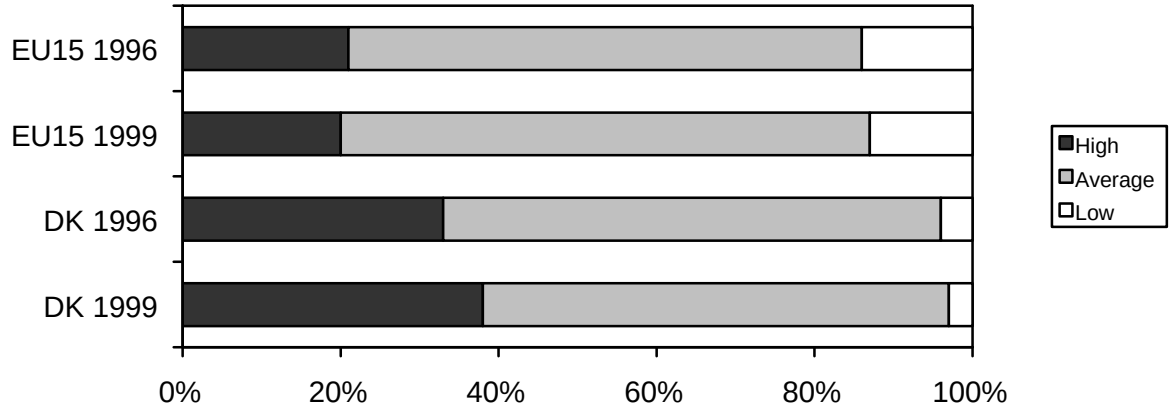


***** The category 'Information technology' was not included in the 1997-survey

Secondly, in Denmark, the level of factual knowledge about biotechnology has increased, and there is an ability to differentiate between various techniques or applications with regard to the value of their impact on society.

The Eurobarometres on public understanding of biotechnology from 1996 and 1999 encompass nine questions aiming at measuring the respondents' level of factual knowledge about modern biotechnology. Building an additive index based on those questions enables us to divide the respondents into categories according to their level of factual knowledge. Figure 2 suggests that the Danish segment of respondents is generally well informed compared to the average European citizen. During the three-year period from 1996 to 1999 the average score on the knowledge-index has even increased moderately from 5,7 to 5,9 amongst the Danish respondents, whereas the European average is 4,8 both years.

Figure 2. Level of factual knowledge of biotechnology; percent



A number of recent studies suggests that public assessment of biotechnology R&D varies according to the application of the specific research area - within the biotechnology field - in question (Durant *et al*. 1998; Thulstrup 2000). There is generally a skeptical attitude towards biotechnology in food production, whereas the level of support for the application of biotechnology in areas of genetic testing and the production of new medicines and vaccines is relatively high. The results of the Danish survey are in accordance with these earlier findings. Respondents were asked, to which extent they expect modern biotechnology to help create a better life, distinguishing between medical biotechnology aiming at developing new medicine and treatment on the one hand, and animal and vegetable biotechnology aiming at creating new and better food on the other.

Figure 3. Expectations - Does modern biotechnology help create a better life?; percent

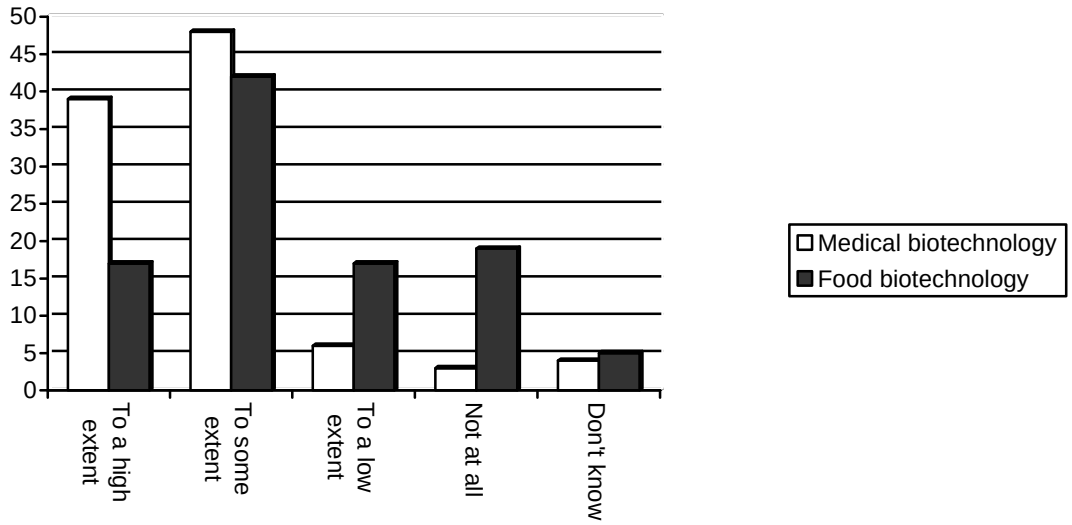


Figure 3 shows the expectations of the Danish citizens regarding biotechnology in the sphere of medicine- and food production respectively. The general level of expectations is decisively in favor of medical biotechnology. 87 pct. of the respondents expect of medical biotechnology that it will 'to a high extent' or 'to some extent' help create a better life, whereas expectations towards biotechnology in food production are lower.

Regarding scientific citizenship, it is thus reasonable to say that important preconditions for public involvement in debating biotechnology are present. Over the last years the interest in research and awareness of biotechnology has increased, and citizens have a high level of factual knowledge as well as an ability to differentiate between the societal benefits of various applications of biotechnology. In general, the level of public competence has increased, meaning that the attitude formation regarding biotechnology is reflexive, and systematically correlated with moral values and perceptions of utility and risk (Mejlgaard & Siune 2001).

The fact that Danish citizens have a relatively subtle insight in biotechnology does not necessarily imply that scientific citizenship is participatory. Citizens may very well recognize and appreciate the importance of biotechnology *for* their lives without actually making it an element of importance *in* their lives. In order to ensure that public participation in the assessment and validation of biotechnology is possible, there has to be different modes and institutions of public participation present. The following section suggests that Technology Foresight could potentially be such an institution.

5. Technology foresights as a facilitator for participatory scientific citizenship

Technology Foresights (TF) have been concerned with identifying strategic technologies or predicting major events in the future scientific-technological development, in order to prioritize the efforts within R&D and allocate resources correspondingly. Regarding the process of TF, it has also been the aim to promote co-operation between various actors, not least between industrialists, scientists, and policy-makers in the Triple-Helix (Cameron *et al* 1996). During the 90s a new 'generation' of foresights have occurred, which tend to include considerations not only concerning technology and its markets, but also about social dimensions of developments in S&T, thereby introducing social stakeholders as key actors and socio-economic problem-solving as a focal point (Georghiou 2002). In the following it is suggested that including the public in TF would be beneficial not only in strengthening scientific citizenship, but also in strengthening the policy relevance of TF.

First, TF is not only about predicting possible future scenarios, but also about depicting strategic technologies - and thereby shaping or reinforcing the paths of future development - on the basis of certain criteria. These criteria may be broadly concerned with economic competitiveness of firms engaged in R&D, general national improvements in wealth creation or the quality of life of the citizens, or have a more specific character (Loveridge *et al*. 2001), but it is a common ambition for foresight activity to pinpoint the technologies that will be useful in the future. Whether this practice will turn into successful policies depends upon some agreement as to the concept of usefulness. Taking biotechnology as an example, in reality, citizens tend to talk about applied biotechnology in a social, economical, and political context, stressing ethical aspects, and using a narrow, moral concept of usefulness but a broad concept of risk. Scientists, on the other hand, tend to talk about biotechnology in the laboratory, stressing technical and strictly scientific aspects of science, and using a broad, commercial concept of usefulness but a narrow concept of risk (Meyer & Sandøe 2002). This indicates that including the public in TF could potentially add valuable information regarding the perceived usefulness of various technologies, thereby qualifying subsequent political prioritization processes. Expert statements about future demands and possibilities are directed by the concept of usefulness applied, and if this concept of usefulness offends the democratic or moral orientation of the citizens, the policy-relevance of the statements will be limited.

Secondly, the non-economic - or quality-of-life - benefits are likely to be substantially larger than the economic benefits of biotechnology, which accentuates the importance of identifying, developing, and feeding back into policy processes valid indicators of non-economic benefits and detecting plausible future non-economic social gains (Arundel 2002). This calls for inclusion of 'the public' understood as 'consumers' as well as 'citizens', and not only for the representatives of industry and academia.

Thirdly, the general public appropriation of biotechnology as a socially robust project depends upon trust in scientists (see table 2). Biotechnology is an example of a field of research that has an enormous potential impact on society and will affect our social lives in terms of developments within areas such as health, foods, environment and so forth, and the results from the Danish surveys suggest that a personal, emotional identification with the people involved in scientific knowledge production is important in order to generate positive attitudes towards this field of research. TF could be considered a vehicle of trust in this respect, in line with related institutions, such as 'the Consensus Conference', workshops or public hearings.

Table 2. Trust in biotech scientists and attitudes towards biotechnology; percent

	No trust at all	Not much trust	Some trust	High level of trust	Total
Negative	42	32	10	6	12
Neutral	54	64	72	65	70
Positive	4	4	18	29	18
Total	100	100	100	100	100
N	26	161	880	275	1342

Finally, inclusion of the public in TF will probably force participants to 'flip the coin' and discuss the relevance of looking upon science and technology not only as instruments for solving social problems, but also as a source of social problems (Hermann 2001). Following Beck (1992), the systematic production and circulation of scientific knowledge, which eventually results in application, has - however value-neutral it may be considered - important *negative* consequences in society; BSE, Chernobyl, the nuclear bomb, global climate change, and human cloning to mention a few. The survey results of the Danish citizens' understanding of biotechnology suggest that the increase in public competence regarding the understanding of biotechnology is accompanied by an increase in *risk-aversion*, implying that questions concerning risk will be highly relevant in assessing future technologies. It is important to respect the fact that risk-perception may involve logics, which cannot be reduced to statistical calculation or related scientific measures.

Knowledge produced within the 'context of application' is, in turn, knowledge produced within a 'context of implication'. Science and technology affect the public - positively as well as negatively, improving our standard of living while at the same time creating new uncertainties - and the integration of science and society is likely to progress, since two forces - the success of science in producing novelty and the insatiable demand from society for innovation - will grow more insistent (Nowotny *et al*. 2001: 249). The success of future technologies will depend on public appropriation, which, in turn, depends upon creating bonds of trust between actors within the *agora* - and not only between scientists, industrialists and policy-makers in the Triple-Helix - and a subtle debate about the perceived risks involved. TF is capable of hosting such a debate as well as generating trust in cross-sectoral networks.

Inclusion of the public in TF will be beneficial in enhancing participatory scientific citizenship, and in addition it will qualify the foresight exercise itself by informing the process of prioritization as well as actively reinforcing the public appropriation of new technologies.

6. Developing methods for public inclusion in foresights: Using the insights of public inclusion in technology assessment

In Denmark, the political culture, with strong civic traditions and a comparatively lively intellectual climate, has proven fertile in creating subtle and wide-ranging popular discussions of new technologies as well as a number of institutions aiming at involving the public in technology assessment (Jamison 1999). The most prominent institution is the independently organized government-initiated institution The Danish Board of Technology, which has as its purpose to stimulate public debate about new technologies and advise Parliament on public assessment of different technologies.

The Danish Board of Technology employs a number of methods for public participation in technology assessment, amongst these the 'Consensus conferences' that engage citizens directly in the assessment of different technologies, including modern biotechnology. A group of 12-15 citizens are chosen to examine a specific controversial technological issue that has broader societal consequences. The citizen panel points out important perspectives to discuss, they cross-examine relevant experts in the field, and they then arrive at a consensus position. The outcome of the process is presented to policymakers and the public.

The citizen-based consensus conference has been adopted by a number of countries as an efficient model of direct public participation in questions concerning the consequences of new technologies in society. Several consensus conferences have been held in Denmark on issues relating to biotechnology. The Danish Board of Technology also engages in other activities aimed at informing and involving citizens on technology issues, ranging from perspective workshops and role plays to hearings in parliament and the publication of reports and books on issues of interest to the general public.

The methods applied by The Danish Board of Technology support a development from spectator scientific citizenship towards participatory scientific citizenship. Some of the methods would be highly applicable in TF, such as integrating elements of the consensus conferences in the foresight exercise. Lay-panel cross-examination of the executive expert-panels of the TF would be a supplement to the exercise, and the written consensus position of the lay-panel would function as a part of the over-all output of the foresight. Citizen participation in Scenario workshops is equally applicable, using the selection criteria of previous workshops performed with public participation. Furthermore, with the spread of web-based tools for TF, public participation will be less costly and highly accessible. In Denmark, the BioTik project has considered building a web-based citizen panel of up to 1000 participants, which could be an important actor in a foresight exercise.

Methods for public participation in TF have to be developed, and it seems that important insights could be gained from previous examples of public participation in technology assessment. It is relevant to remark that recent studies of public participation in technology assessment emphasize the need to clarify the circumstances for public inclusion in very practical terms (Irwin 2001); how should citizens be selected for participation? Which are the mechanisms of inclusion and exclusion? How does the institutional location of the exercise affect the outcome? To what extent should the agenda of the exercise be pre-framed? What is the appropriate balance between information and consultation, and on which technical and social assumptions is the exercise founded? Such questions are vital in ensuring that public participation does not become an artifact; that the position(s) and statements of the citizens are based on 'deliberation' rather than 'construction'.

7. Remarks on the extension of public participation in TF

This paper has stated a case for widening the scope of foresights beyond the core actors of the triple-helix; scientists, industrialists, and policy-makers. It has been argued that including the broader public in foresight exercises will strengthen 'scientific citizenship' and enhance a more social-responsive, democratic S&T world.

In so doing, the paper adds to what has recently been called 'the second wave of science studies' (Collins & Evans 2002), which has been concerned with solving 'the problem of legitimacy' in S&T, by advocating for public participation in decision-making on issues related to developments in S&T of visible relevance to the public. According to Collins & Evans, the second wave of S&T studies has given prominence to maximizing the legitimacy of technical decisions in the public domain by referring them to the widest democratic processes, whereas it has been less concerned with addressing 'the problem of extension', which refers to developing more subtle suggestions of whom to include on which issues; according to which criteria should lay-persons as well as certified experts prove themselves relevant with regard to making decisions concerning S&T.

Collins & Evans anticipate a third wave of science studies, Studies of Expertise and Experience, which will be concerned with identifying the members of a society, who should enjoy special access or rights to participate in decision-making concerning S&T due to special expertise, whether certified - as in the case of scientists - or experience-based.

Then, who is an expert on the future? TF is in essence a *creative* exercise concerned with ambitions and visions of the future, which seems to support the general argument that no segments of society could be excluded from participation on behalf of their lack of expertise.

Yet, in praxis, at least two questions are likely to influence on the extent to which public participation in TF will be effectuated. First, is the purpose of the foresight exercise to identify probable future technologies, or is it to identify desirable social ends and suggest technical solutions to meet these ends? Whereas the latter is a highly political purpose, with obvious relevance to the public, the first is more restricted to traditional forecasting, and is likely to have less general public appeal. Secondly, to which extent does the general public consider the technologies or research fields in question relevant? Collins & Evans distinguish between esoteric and public-domain science in arguing that some fields of research are of less relevance to citizens than others. Survey results confirm that the public perception of the impact on society of various fields of research and the public awareness of different fields of research vary. These discrepancies may imply that the inclination of citizens to engage in assessment activities and decision-making processes will depend upon the field of research in question.

The purpose of the exercise and the perceived societal relevance of the technologies in question will affect the public inclination to engage in TF. Yet, the main obstacle for public participation is the willingness of scientists, industrialist, and policy-makers to widen the scope of the foresight exercises. This paper has suggested that important benefits are obtainable in preparing TF for public participation.

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