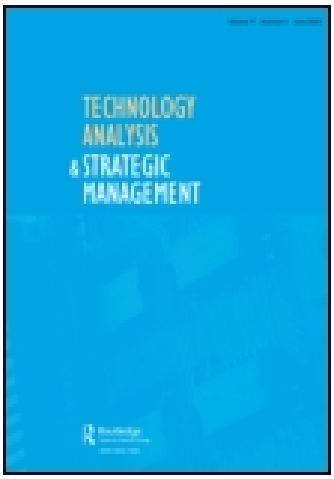


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# Navigating foresight in a sea of expectations: lessons from the sociology of expectations

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# Navigating foresight in a sea of expectations: lessons from the sociology of expectations

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Foresight can be described as the articulation of possible futures. It has a range of applications and is used with different methods, for different objectives and in different settings. Yet, anticipation in science and technology is not limited to foresight, but occurs in many more informal ways. This paper investigates the phenomenon that socio-technical developments are saturated with formal and informal anticipations and discusses the implications of this condition for foresight. The range of foresight studies is reviewed as well as the main results of the sociology of expectations, which studies the informal production and circulation of expectations in science and technology. Finally, three generic lessons from the sociology of expectations are derived, and it is discussed how these support or limit the ambitions of foresight.

**Keywords:** technology and innovation studies; technology road mapping; expectations of technological change; foresight; technological change and dynamics

## 1. Introduction

While foresight has been developed into an important instrument for both firms and policy-making, the active exploration of the future is by no means a privilege of foresight methods. Anticipation occurs in many more domains, in particular, in areas of science and technology, which are predicated on ideas of progress. Innovation studies have shown and discussed how expectations are part and parcel of all professional practices and circulate amongst engineers, board rooms, research institutes and policy circles (Borup et al. 2006; Van Lente and Bakker 2010). Expectations are produced, circulated, adapted and are forceful in various ways (Berkhout 2006). Foresight exercises, or 'formal' assessments of the future, thus, are surrounded by 'informal' assessments of the future (Salo 2001). This particular condition will have consequences for the established foresight approaches. This paper conceptually and empirically investigates the phenomenon that socio-technical developments are shot through with informal anticipations and discusses the implications for formal foresight exercises of science and technology.

The central question of this paper is whether and how foresight exercises, as formal articulations of possible futures, relate to a broader, informal, repertoire of visions and future assessments and how this both enhances and limits the efficacy of foresight. In particular, two questions stand

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out. How to characterise and understand the condition of foresight being surrounded by ongoing informal future assessments? What are the implications of this condition for the efficacy and practice of foresight? The next section will review the range of foresight exercises and their methods, objectives and settings. Section 3 will discuss the main findings of the sociology of expectations, which studies the informal production and circulation of expectations in science and technology. These two reviews allow us to reflect in Section 4 on the implications for the practice and relevance of foresight.

## 2. Foresight exercises

Various forms of foresight have been developed to support strategic decision-making amongst firms and policy circles (Cagnin, Loveridge, and Saritas 2011). During the last decades, dedicated foresight practices have emerged and various approaches and tools have been developed and evaluated (Coates et al. 2001; Harper et al. 2008; Eerola and Miles 2011). Schoen et al. (2011, 235) give the following definition:

> Foresight can be characterized as a systemic instrument aiming at enhanced capabilities in innovation systems and their parts. Foresight activities are seen as functions not only to identify promising technological pathways but also to engage relevant stakeholders and create common visions into action.

Generally, foresight is distinguished according to method, objectives and setting. Various typologies of methods are available, and the review article of Porter (2004) lists the nine families of foresight *methods* including quantitative and qualitative explorations and forms of stakeholder involvement.

The *objectives* of foresight may also differ. The basic idea is that decision-making in firms and policy-settings will benefit from explorations of the future (Gordon, Glenn, and Jakil 2005). Foresight exercises provide policy with better problem definitions, ensuring more involvement of stakeholders and help to implement the policy (Harper et al. 2008). The special issue of *Technology Analysis & Strategic Management* in 2008 provides a good overview of these intended benefits. In their review of theories and practices of foresight in Europe, Da Costa et al. (2008) list six, what they call, 'functions' of foresight for policy-making, see Table 1.

Others cluster the intended benefits of foresight into three different objectives (Könnölä, Brummer, and Salo 2007; Schoen et al. 2011). The first objective, priority-setting, concerns the ambition to identify a shared agenda, including future actions and allocation of resources. Foresight helps to highlight and evaluate alternative paths. Second, foresight might help to build networks and reinforce the connectivity of the innovation system. This can be through the creation of new combinations or the enhancement of existing networks. A third objective of foresight is to build a consensual vision of the future in order to harmonise strategies of the different stakeholders. This objective might lead to a search for the most probable future, or to the exploration of several alternative futures (Könnölä, Brummer, and Salo 2007).

Apart from methods and objectives, foresight exercises also differ in the *settings* in which they are used. Foresight has different users, varying from governmental agencies, funding agencies to individual research institutes or firms (Luiten, van Lente, and Blok 2006). Schoen et al. (2011) label these settings as 'arenas' and distinguish between (i) the arena of strategic orientation of research, which concerns the task of governmental authorities to develop policy instruments and regulations; (ii) the arena of research performance: the daily production of research and innovation

Table 1. Functions of foresight for policy-making.

| Functions for policy | Description |
|---|---|
| Informing policy | Generating insights regarding the dynamics of change, future challenges and options, along with new ideas, and transmitting them to policy-makers |
| Facilitating policy implementation | Enhancing the capacity for change within a given policy field by building a common awareness of current and future challenges, as well as new networks among stakeholders |
| Embedding participation in policy-making | Facilitating the participation of civil society in the policy-making process, thereby improving its transparency and legitimacy |
| Supporting policy definition | Jointly translating outcomes from the collective process into specific options for policy definition and implementation |
| Reconfiguring the policy system | Making the policy system more apt to address long-term challenges |
| Symbolic function | Indicating to the public that policy is based on rational information |

Source: Da Costa et al. (2008).

Table 2. Foresight objectives in relation to the arenas of governance.

| Arenas of governance | Foresight objective | | |
|---|---|---|---|
| | Priority-setting | Networking | Building visions |
| Strategic orientation | Macro policy priority-setting | National/EU level stakeholders networks | Overall political level vision building |
| Programming | Programmes scientific priority-setting | Programmes stakeholders networks | Sectoral vision building, context of roadmaps |
| Performing | Research institutions strategic processes | Research institutions partners and stakeholders networks | Research institutions first step in strategic process |

Source: Schoen et al. (2011).



by universities and firms, the production, diffusion and transfer of knowledge; (iii) the arena of programming, which translates the strategic orientation of governmental actors into research and innovation priorities. The arena includes research funding and related agencies and mediates between the governmental actors and the research actors. Schoen et al. (2011) also link these arenas to the various objectives and present the following comprehensive overview (Table 2).

Foresight is also exercised in firms, where it tends to be framed in costs and benefits (Reger 2001; Rollwagen, Hofmann, and Schneider 2008). This is the domain of strategic decision-making. Business studies have developed a set of techniques to assess the future for strategic decision-making (Kappel 2001; Van der Duin 2006). A popular technique is technology roadmapping, which has been used since the 1980s by Motorola and later by many other firms (Willyard and McClees 1997), like Philips (Groenveld 1997) and Lockheed Martin (Houston and Turner 2001).

Technological roadmaps basically are creative connections between expected developments in technological skills, sequences of products and potential future markets.

## 3. Sociology of expectations

In the last decade, the so-called sociology of expectations has studied how in scientific and technological developments actors continuously and explicitly refer to what is possible in the future: they draw from and add to a repertoire of images, statements and prophecies – and by doing so they contribute to a particular dynamic (Van Lente 1993; Brown 2003; Borup et al. 2006; Van Lente and Bakker 2010). This approach studies how expectations in science and technology are structured, how they grow, gain dramatic attention or quietly disappear, and how this affects the decisions of engineers, businesses and governments. It investigates how researchers, businesses and governments derive their agendas from their collectively created images of a promising technology and how they are fueled, for instance by the fear of lagging behind. It is helpful, thus, to study the insights from this literature, and consider what they mean for the process of foresight. After all, the conscious and deliberate production of expectations in foresight occurs in an environment where promises, expectations, visions already abound.

In general, the social sciences emphasise that human activities are intrinsically oriented towards the future. The classical sociologists Weber, Mead and Schutz stressed that future orientation is an inherent characteristic of human behaviour, since decisions and activities are framed by intentions and ideas about a future situation. People act not only in reaction to the past (socialisation) or present (roles in a social structure), but also relate to futures, as designers of their own lives. The orientation towards the future applies to the behaviour of individuals, groups, organisations and society as a whole (Konrad 2006). In all cases, actions, reactions and decisions are framed in images of the future that circulate in professional networks or in the general media.

According to the sociology of expectations, this general future orientation is in particular present in technological development. A central theme is that expectations are statements that *do* something, rather than being descriptive statements that may be true or false. An expectation is not just a description of a (future) reality, but rather a change or creation of a new reality (Guice 1999). In other words, expectations are *performative*: they do something. The utterance 'yes, I'll bring it to you tomorrow' is not a description but creates a situation of obligation; likewise, the statement 'this material promises a reduction in electrical resistance of 30% in two years' does something, depending on the situation and the audience. When uttered at a shareholders meeting of a company, it is a request to continue support for the firm to develop such material. If spoken by the head of a laboratory of the same company in front of its R&D department, it creates an obligation for the researchers: they should be able to meet this specification within two years. Van Lente (1993, 2000) has argued that such transformation of a promise into a requirement is a central mechanism in the dynamics of expectations: the 'promise-requirement cycle'.

Expectations, thus, can be defined as statements about the future – uttered or inscribed in texts or materials – that circulate. Many scholars have pointed to the variety of expectations: they may be positive (promises) and negative, and will vary in level, content and modality (Konrad 2006). The *level* of expectations may range from encompassing, abstract sketches of the future (macro) to detailed elements (micro). In terms of *content*, expectations may concern technical, commercial or societal aspects, and probably in a mix of these. And the modalities may range from taken

for granted statements that do not meet any resistance, to meticulously organised arguments to counteract foreseen rebuttals.

### 3.1. *Dynamics of expectations*

How, then, is the dynamics of expectations depicted in the sociology of expectations? The well-known story of Moore's Law is often used as a prime example (MacKenzie 1990). Gordon Moore, the director of Fairchild Semiconductor in the USA predicted in 1965 that the complexity of integrated memory chip would double every 18 months. This prediction was based on an extrapolation of the trend since 1959, when the integrated circuit was introduced. Three years after his prediction, in 1968, Gordon Moore founded with Robert Noyce the company Intel, which would play a leading role in the development of memory chips. The prediction of Moore remained valid with such precision that it has been labelled as Moore's Law, as if it were a natural law. The sociology of expectations, however, points to the central role that the prediction has been playing in the strategic game between the manufacturers of memory chips (MacKenzie 1990). They take the prediction of Moore's Law as a yardstick for their own progress and for further investments. When the promised specifications run the risk of not being met, additional measures are needed, such as entering into strategic alliances. Companies use the prediction of Moore to decide on the R&D goals and the size of the investments. They regard this as the right strategy because they assume that others will do the same: self-preservation implies to obey Moore's Law as the authoritative view of the future.

Clearly, Moore's Law is a self-fulfiling prophecy. When Robert K. Merton coined the term in 1948, he used the example of false rumours about solvency problems that brought a bank in real trouble. Merton emphasises the perverse nature of this situation: 'The self-fulfilling prophecy is, in the beginning, a false definition of the situation evoking a new behavior which makes the original false conception come true. [. . .] Such are the perversities of social logic' (Merton 1968, 477). The perversity, according to Merton, is in the discrepancy between the actual state and the collective perception, between, the sound bank and the false rumour. In the case of technological expectations, however, it is not easy to distinguish between the validity of a claim and the collective perception of it (Van Lente 2000; Berkhout 2006). While the financial health of a bank can be verified in ways other than rumours, a promising future of a technological option lacks such independent tests. In fact, the only reliable way to validate the claim is to try to achieve it. So, the 'perverse' discrepancy between a claim and the collective perception of it is much less. Yet, there is still a perversity of another kind: a compelling constellation of promising claims that enforces action in a way that perhaps none of the companies or researchers themselves would have chosen. Participants will reason in terms of 'not missing the boat, but the 'boat' only exists due to the collective decision not to miss it. Such response may be amplified by foresight reports, such as the roadmaps on the hydrogen economy (Bakker, van Lente, and Meeus 2011).

### 3.2. *Force of expectations*

The case of Moore's Law is extreme, but highlights the forceful presence of expectations in industrial and professional networks. The sociology of expectations has detailed three forces of expectations in the dynamics of technical change: legitimation, heuristic guidance and coordination. First, what expectations do is to raise attention and *legitimise* investments: a project or programme can be defended by referring to a promising future (Borup et al. 2006). While the

current performance of a technology or present evidence of research may provide insufficient reason for support, the claimed possibilities in the future justify the costs. Indeed, many studies show that expectations are protective: a project that fails now may promise to deliver something in the future and thus be granted support (Konrad 2006). Maybe it failed this time, but the next time it might succeed (Hellsten 2002). In some cases, such as nuclear fusion, this mechanism has secured costly research during decades (e.g. on the Joint European Torus and International Thermonuclear Experimental Reactor), while proper results are lacking. Other studies stress that while expectations are needed to start a project or a programme, they also introduce vulnerability when projects or programmes bring other outcomes than expected – as they usually do (Geels and Smit 2000). A familiar pattern here is the hype cycle, as introduced and used by the Gartner Advisory Group (Borup et al. 2006). They propose that a new development is accompanied by 'inflated expectations' that receive much attention and mobilise many investments, which, after a peak, turn into disappointments. Then many of those who were initially hooked leave, while the work is continued more modestly by a dedicated core group, and eventually some further progress is being made.

Second, expectations provide *direction* to the search processes of science and technology (Rip and Kemp 1998). Typically, there are many possible paths while choices have to be made. The optimal direction cannot simply be calculated – there are too many possibilities and there is too much uncertainty – but the promising direction is available through the informal expectations circulating amongst technology developers. Expectations thus reduce uncertainty in much the same way as heuristics do in research and development (Nelson and Winter 1982).

Finally, there is a *coordination* effect of expectations (Van Lente 1993; Konrad 2006). Technical development is not solitary work, but the work of networks of companies and research institutions. When a central control is lacking, as is usually the case, expectations indicate pieces of work and stipulate roles. Rosenberg (1982) argues that expectations about rapid technological development may inhibit the development: when potential customers believe that, within the next few months, an improved version is going to be available, they will postpone the purchase. Studies of financial markets have noted that investors are not only motivated by their own estimates of revenues and risks, but also by what they know or suspect about other investors. Froot, Scharftstein, and Stein (1992) shows that investors tend to use the speculative information that others use as well; this strategic game can lead to 'herd behaviour'. Other researchers argue that not only the pace, but also the content of research can be influenced by expectations. In the case of genomics, for example, where knowledge about gene sequences and protein structures promises to lead to new, more sophisticated and effective health technologies, many types of work are articulated (Van Lente 2006). The promised future situation contains sequencing of genes, characterisation of proteins, databases, dynamic models and so on. Actors will choose some of these tasks, assuming that other tasks will be enacted by others. This mutual positioning again may be reinforced by foresight reports that stipulate actions and agendas.

The term 'self-fulfilling prophecy' has now become so familiar that the term itself seems to explain the phenomenon, but the three forces of expectations together produce such effects. Indeed, there are many examples of unfulfilled promises (Douthwaite, Keatinge, and Park 2001; Hedgecoe and Martin 2003). Moore's law is an extreme case of a strategic game, reinforced by technology roadmaps, between manufacturers who cannot afford to lose the race. In most other cases of technological development, expectations are less coercive, but still forceful (Brown, Rappert, and Webster 2000).

### 3.3. *Expectations and strategies*

A general assumption is that expectations can play such a big role due to the inherent uncertainty of technological development (Antonelli 1989). Researchers, firms and governments have to make decisions about future products in future markets, about things which, by definition, do not yet exist. They thus face problems that are not fully known yet, and are uncertain about their future rivals in the future battlefields (Williams and Sorensen 2002). In addition, sociologists of science and technology point to the dynamic nature of science and technology: both are ruled by the belief that there will be a 'next step' (Collins and Pinch 1993, 1998). According to this belief in progress, a next version of products, systems or knowledge will be available (Braun 1995).

What matters here is the degree to which expectations are shared. Berkhout (2006) emphasises the distinction between private and collective expectations. The first type relates to the cognitive schemes through which individuals organise their experiences and choices, to be examined by psychological methods. Collective expectations, on the other hand, are available in public statements. They are not shared in the sense that everyone accepts them as valid, but in the sense that they are recognised and available as a resource to convince others. Expectations will not automatically lead to change; it is first necessary that others move accordingly. Berkhout, therefore, suggests viewing expectations as 'bids'. A bid will find more support when it aligns better with current interests and current moral orders, and when it allows multiple interpretations. To gain and maintain support, an expectation should not be too precise; otherwise it may no longer be shared. In that case, a counter-bid will soon be attractive.

The effect of expectations also depends on the social distance to knowledge production. MacKenzie (1990) describes in his study on guided nuclear missiles how the degree of uncertainty about the promised capabilities of the missile depends on the distance from the development itself. He calls this a 'trough of uncertainty'. For the involved engineers, the uncertainty is relatively high: they know all the details, conditions and assumptions. The uncertainty is also high for those at a distance, who are not involved: it is not clear to them what the expectation entails, and they are indifferent to its veracity. For direct stakeholders between these two positions, such as clients or prospective users, the uncertainty is relatively small: they accept the promise but lack insight into the details that may hinder the realisation. For them, the possibilities appear as facts. Brown and Michael (2003) describe the phenomenon of the trough of uncertainty in the study of clinical applications of biotechnology: persons who already invested in it, such as the prospective users doubt the least. The developers of a hopeful technology, on the other hand, see more uncertainties and have other options in case the applications will disappoint. This also raises questions about the epistemological status of claims about the future. According to a realist perspective on expectations, a distinction can be made between an expectation and the 'real' state of affairs. The 'rational expectations' tradition in economics, for example, calculates the optimal forecast based on the 'reality' of expectations. However, according to a constructivist approach to expectations, it is not possible to decide *a priori* whether the promises of stem cells or nanotechnology are 'true'. Instead, the promise of stem cell research or nanotechnology could either be accepted as meaningful and are acted upon – which leads to some new developments that will differ more or less from what was promised – or could be ignored, and then no developments follow. So, it is only retrospectively possible to determine whether or not a promise is 'true' and at that time such knowledge is probably not needed anymore.

This does not imply that in a constructivist perspective all expectations are necessarily the same. Some expectations are more robust because they are connected to more actors, more data

and more developments (Konrad 2006). Instead of determining whether an expectation is 'true' or not, the constructivist perspective focuses on identifying or promoting the 'robustness' of an expectation (Sung and Hopkins 2006). This provides other opportunities for foresight and assessments. For example, constructive technology assessment (CTA) does not intend to give a final decision about the prospects of a technical development, but aims to enrich the innovation journey (which includes many choice moments) with more actors, more perspectives and, in general, more reflection (Schot and Rip 1996; Roelofsen et al. 2008).

For foresight exercises, it is relevant to consider that the constructivist perspective acknowledges that others are in the same situation as those who judge the expectations (Van't Klooster and Van Asselt 2011). In contrast, the realist perspective implies an asymmetry: others may be victims of the game of expectations, but the analyst, who studies them, understands the game and is smarter than others. One example is the tendency to unmask hype: others have been blinded by the hype, but the rational observer claims to be smarter and will intelligently respond to the hype. The consulting firm Gartner offers services based on such assumptions: it locates products and techniques on the hype cycle (from 'inflated expectations', via 'disillusionment' to 'productivity') in order to decide whether or not investments are useful (Figure 1).

This is an attempt to outwit herd behaviour, while forgetting that the herd consists of individuals with the same aim. The popularity of the Gartner graphs now suggests that a second order herd behaviour has emerged.

### 3.4. *Steering with expectations*

Expectations thus inspire new technological developments that subsequently have to be protected by other expectations, for instance provided by roadmaps or other foresight results. The term

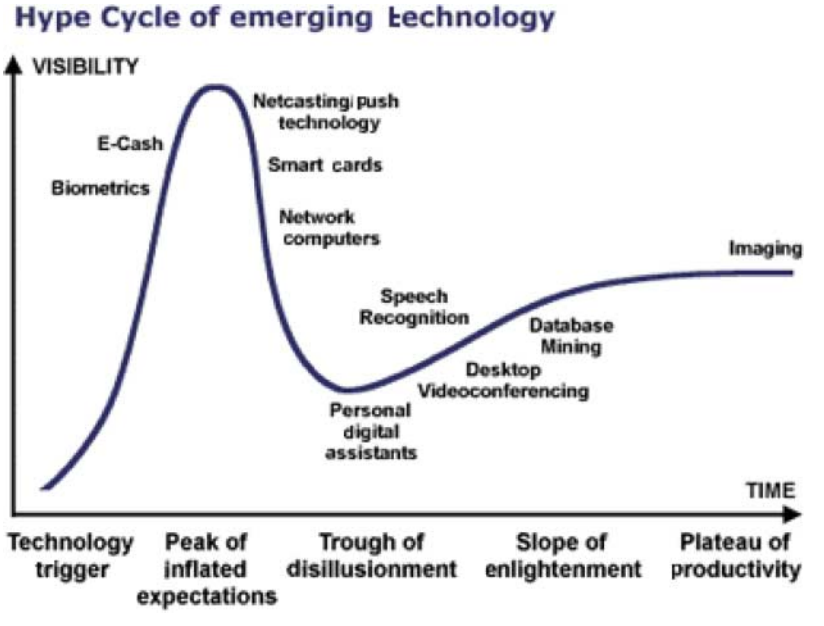


Figure 1. Outwitting the hype cycle.
Source: www.gartner.com.

'niche' has been introduced to denote this protection (Vergragt 1988) and traces back to the evolutionary metaphor of variation and selection (Nelson and Winter 1982). New technological options, as variations within a selection environment may or may not survive. The market is a distinct selection environment, next to institutional (regulations), cultural or political selection environments. New technologies need protection to survive (in a company or a governmental programme), as they evolve by trial and error; the first 'error' should not be punished immediately. Such protection is based on a promise: in the end, it will be successful. Niches can be used in policy, it is believed, to steer technological development.

A similar steering effect of expectations is also central in studies of *Leitbilder*, or guiding visions (Dierkes, Hoffmann, and Marz 1996; Sturken et al. 2004) like the 'electronic superhighway' in the 1990s or the 'hydrogen economy' of the last decade. The idea is that a choice of the right *Leitbilder* will lead to a successful coordination of efforts (Grin and Grunwald 2000; Kuusi and Meyer 2002). The criticism is that such dynamics can be traced only *ex post*, and that the approach is insufficiently robust for an *ex ante* policy (Berkhout 2006). Eames (2006) and his colleagues have studied how the guiding vision of the hydrogen economy has lead to resistance. They show that when the general vision is filled in with concrete projects contestations will arise. Their example is the Clean Urban Transportation Europe project in the UK where industrial partners like Daimler-Chrysler and BP, and semi-public organisations such as Transport for London were involved. The starting idea that hydrogen is a sustainable and green solution to the mobility problem in London remained uncontested until stations for hydrogen were to be implemented. The residents immediately protested violently. They stated that the project leaders '[are] living in a fool's paradise to think that this is safe. When we were in grammar school laboratories, we were taught to treat hydrogen with respect' (*Financial Times*, September 27, 2003, cited in Eames et al. 2006). The fact that it was supported by a European programme was an additional reason for suspicion. As one spokesman put it: 'What I resent is the pressure from Europe to force one country to adopt this very dangerous technology' (371). Overarching vague visions that initiate and coordinate projects may run into trouble as soon they become more specific.

## 4. Lessons for foresight

Foresight concerns a diverse set of policy exercises with different methods, objectives and settings ('arenas'). In general, foresight can be described as the articulation of possible futures, intended as a realistic outlook, as a mirror to the current situation, as a means to involve stakeholders, or as tools to corroborate policy agendas. In companies, public organisations and in ministries foresight exercises are conducted for many reasons and with different effects.

The review of the sociology of expectations provides various generic lessons about the viability and limits of foresight. The discussion is organised along the three objectives of foresight as discussed in Section 2: priority-setting, networking and building visions. As indicated below, the lessons often resonate with what foresight practitioners have discovered. The discussion is summarised in Table 3.

The first generic lesson is that the formal articulation of futures takes place in situations where expectations abound and informal assessments are continuously made. In other words, foresight necessarily occurs in a 'sea' of expectations. The ubiquitous informal expectations circulate within and between groups of developers and policy-makers, and, inevitably, they do their legitimating and guiding work. Foresight, thus, necessarily draws from existing repertoires. Some argue that foresight studies run the risk to reinforce existing paths and thus contribute to lock-in (Jacobsson and Johnson 2000; Unruh 2000). On the other hand, foresight can be an antidote as well, by

Table 3. Lessons of the sociology of expectations for foresight.

| Objectives of foresight | Lessons of sociology of expectations | | |
|---|---|---|---|
| | Expectations are drawn from repertoires | Expectations are performative | Expectations enhance the strategic character of S&T |
| Priority-setting | The efficacy of foresight as an antidote to lock-in is limited | Enhanced legitimation for selected priorities | Foresight exercises and outcomes become part of innovation races |
| Networking | Stakeholder participation tend to reproduce repertoires | The newly established networks will start to promote the vision | Participants may press their version of the future |
| Building visions | Foresight outcomes will not be very original | Built visions may have unintended consequences | Visions may become self-fulfiling |



generating ideas on alternatives. Könnölä, Brummer, and Salo (2007, 610), for instance, argue that '[. . .] excessive prioritizing may decrease the diversity of options that challenge conventional approaches and dominant designs'. The efficacy of this antidote, however, can only be limited, according to the sociology of expectations. Since foresight necessarily draws from existing repertoires of expectations, is will not generate many 'new' expectations, although 'new combinations' between elements of the repertoires are possible. The same risks loom for the objectives of networking and vision building: they may reproduce images and arguments that are already circulating. Indeed, an increasingly important task for foresight is to critically reflect on the available, circulating expectations (Könnölä, Brummer, and Salo 2007).

The concern about the general tendency to favour established parties and visions, at the expense of better alternatives, also holds for networking. Foresight, it has been argued, may help to challenge established networks or even circumvent lock-in conditions by engaging different stakeholders (Havas 2003). This may support the emergence of competing coalitions. Such countervailing strategy, again, is weakened by the dynamics of expectation, because stakeholders may be new, but their contribution will draw from a more general repertoire (Nahuis and Van Lente 2008). An example here is that public participation in new technologies often does not lead to new and heterodox insights; instead of new coalitions, old partisan oppositions tend to be reproduced (Rip and Talma 1998).

The second lesson is that statements about futures are not innocent descriptions but are performative. The claims resulting from foresight, thus, are not to be seen as descriptive statements that may or may not be true. Once they are voiced and circulated, they will legitimise, steer and coordinate efforts, also for unintended purposes. They may be used, for instance, to strengthen the legitimacy of selected priorities. Once specific futures are articulated in foresight exercises, others may refer to these to underpin their position. Likewise, when networks are built with foresight exercises (in which claims about the future are made) these networks will adopt the claims and promote them. According to the 'trough of uncertainty' (Section 3), the performative rebound will be stronger when it concerns stakeholders at distance from the knowledge production.

Third, the sociology of expectations claims that estimates of the future are deeply rooted in the developments of which they seek to give an assessment. This adds a reflexive and strategic dimension to the process of foresight, as we saw in the anticipation of the hype cycle, where companies

and consultants anticipate the wave of expectations by locating their technological option in the cycle. Foresight will thus enhance the reflexive and strategic character of technological change, including self-fulfiling and self-denying dynamics. In the case of priority-setting, foresight will reinforce innovation races: governments tend to follow the choices of other governments. In most OECD countries, for instance, nanotechnology is now listed as top priority; referring to the efforts other governments have planned (Berube 2006).

## 5. Conclusion

Foresight exercises can be seen as formal articulations of possible futures, to be contrasted with the numerous informal articulations of futures that circulate in science and technology. As the latter are studied in the sociology of expectations, the question is what this body of literature has to offer for foresight. This article investigated the lessons of the sociology of expectations for the various practices of foresight. A review of foresight highlights the diversity in methods, objectives and settings ('arenas'). The review of the sociology of expectations discussed how expectations legitimise, inform and coordinate efforts in research, firms and government. These overviews allowed us to draw lessons for foresight. The condition that foresight is surrounded and nourished by informal estimates, voiced expectations, and circulating images of the future, both limits and enables the formal anticipations. Foresight exercises will draw from the repertoire of circulating statements, as we saw in the case of technology roadmaps. They thus tend to reproduce the circulating assumptions. In principle, this will also enhance the formal exercise, because the results resonate with current ideas and assumptions. However, the embedment in a sea of expectations also adds a dual vulnerability. When a formal articulation is surprising, that is, only loosely coupled to the informal articulations, it is vulnerable and less forceful because it is disconnected from the repertoires of the future that legitimise, steer and coordination action. On the other hand, when the formal articulation is tightly coupled to the repertoires of the future, it is not seen as adding much news. The alignment of formal and informal expectations makes foresight socially more robust, but cognitively more vulnerable. The general dilemma, then, is: how can foresight raise salience while not hampering its efficacy? While specific answers should be tailor-made, the basic step is to acknowledge the condition that foresight is embedded in ongoing anticipation and to make this condition more explicit. In addition, a justification of the political aim of the exercise (see Table 1) should include the performative and strategic consequences of the exercise. To continue the nautical metaphor: in order to navigate foresight in the sea of expectations, one needs both clear sight as well as a compass.



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## Notes on contributor

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