Expectations In & About Science and Technology

a background paper for the 'expectations' workshop of 13-14 June 2003
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1. Introduction

The role of expectations in the context of science and technological innovation is now the focus of increasing attention from a wide range of constituencies. Science and Technology (S&T) scholarship is increasingly looking to expectations to provide insights into the way various fields develop or indeed fail and according to whose measures of success. Historians and economists too have similarly sought to develop a conceptual vocabulary with which to better understand the relationships between expectations and longer-term transitions. Firms and policy makers are confronted by promises (and often also concerns) and have to decide what to do about them.

While analysts can focus on the phenomenon of expectations in & about science and technology, and explore various approaches to understand them, for practitioners who have to do something in response to them, there are substantial issues that they want to be clarified. For example, judging or misjudging the veracity (or better, the pertinence) of expectations has immediate and acute implications. Policy makers, investors and consumers have all experienced the sometimes-costly effects of disparities between present expectations and eventual realities. Obviously, there is no way to improve veracity as such. This is for the simple reason that there is not necessarily a 'true' state of affairs to which the expectation should conform, largely because of the effects of self-fulfilling and self-negating dynamics. Nevertheless, one could speculate about the possibility of a 'quality control' applied to the generation and uptake of expectations.

Analysts and practitioners have much to learn from each other about the dynamics of expectations and whether it might be possible to engage with expectations in such a way that mistakes might be avoided. The phenomenon of promise-disappointment 'cycles' suggests that whilst expectations are essential to mobilising effective interest, an early surge in hype appears to be necessary in order to get a hearing. Thus disappointment seems to be built into the way expectations operate in science and technology. Early hopes, what Mokyr and Stoelhorst refer to as 'hopeful monstrosities', are rarely proportionate to actual future results. Futures are much more usually left wanting when compared to the expectations once held of them. Indeed, any number of successive disappointments in fields as diverse as biotechnology and e-commerce have resulted in lasting damage to the credibility of industry, the professional groups and investment markets – that is, until the next promise arrives! So, expectations and the frequent disappointments to which they lead are accompanied by serious costs in terms of reputations, misallocated resources and investment. These insights are of course widely shared already, though more usually tacitly. Nevertheless, it remains difficult to see whether - *this time* – our high expectations might be justifiably warranted.

Clearly, it is important for analysts to take stock of what is known about such dynamics, or at least recognized, and locate such an analysis in a more integrated and sophisticated understanding of expectations linked to anticipatory action and agency. This is particularly important for new, emerging science and technology, where the uncertainty about eventual performance and value is structurally endemic.

This paper endeavours to make a start at examining various routes to understanding the dynamics of expectation. It also points to various aspects that might be better developed in future work, and in particular whether or not it is possible to engage with expectations more constructively than before. We will offer a broad overview of recent approaches to understanding the dynamics of expectations in & about science and technology, principally drawing on contributions from S&T studies, but within the context of wider sociological and historical research. But we also want to move towards distilling some key general insights with

a view to consolidating the current state-of-the-art. Whilst of course realising explicitly that this paper, and the workshop into which it feeds, is part of an attempt to establish, articulate and identify what this 'art' might be.

Our first step is to elaborate upon the phenomenon of expectations: the nature and dynamics of anticipation in the evolving emergence of scientific and technological contexts. This is linked to foundational questions, about time and agency, about the configuration of relationships in knowledge communities and so on. It is also linked to the sociological and cultural phenomena of hopes and concerns, signals, rumours (promise of a technology as an 'urban legend') and how these add up to more or less forceful repertoires.

In the discussion on the phenomena of expectations we identify specific dynamics, and possible variation across scientific & technological domains including expectations about new materials, say polymers or nano-particles, as shaped differently than expectations about new systems (air-traffic control). In this part of the paper we draw on earlier and ongoing work on expectations and (scientific and) technological change. Whilst many such perspective are inspired by co-evolutionary and actor-network approaches, we should be mindful of other potential analytical approaches.

With this objective in view, we will secondly sketch out in schematic terms broader elements of a state-of-the-art within which expectations can be analytically framed. Various important analytical developments can be identified within historical, sociological and economic literatures that are likely to be significant in understanding questions of anticipation.

Finally, there are significant issues of importance to practitioners, be they scientists and technologists, managers making tactical and strategic decisions, or policy makers and societal actors, and how these are approached and sometimes instrumentalised (with 'roadmapping' as an extreme example). Strategy development (including scenarios and portfolio analysis) and science & technology foresight are activities where understanding of expectations is of key importance (and the exigencies of doing these exercises often take precedence over understanding what is being done). Additionally, a number of important developments have taken place in domains of governance that are significant to our discussion, including the precautionary principle and interactions between technological promise and ELSA (ethical, legal and social aspects).

There are three key questions to which we would like to respond in this paper and, more importantly, in the workshop to follow.

- How can we actually specify the phenomena of expectations, their material and rhetorical manifestation, and the various routes of action and agency through which they emerge? These might include scenarios or repertoires varyingly scripted and diffused materially, formally, informally, information networks, etc.
- How might we characterize the current state-of-the-art in S&T literatures? Which perspectives are currently being drawn on, and similarly, which remain underutilized? In what way might it be possible to consolidate these perspectives into a stronger and more coherent account, even theorization, of expectations? There are any number of sources for this including Constructive TA, critical foresight, Techno-Economic Networks, socio-economics (classical and evolutionary), law, sociologies of time, etc.
- How can understanding particular cases lead to more general insights, and perhaps a diagnosis of ongoing changes in handling expectations? What expectation related issues are practitioners confronted with, how do they handle them and what insights can we draw from this?

Whilst we want to elaborate upon each of these areas in turn, we are keen that our paper should be 'platform' for raising further questions, identifying particular concerns and highlighting difficulties to be interrogated further following the workshop.

2. The phenomenon: nature and dynamics of expectations

Without doubt expectations play a constitutive role in the development of science and technology in several ways and for several reasons. That is, whilst *expectations mobilize the future into the present,* they do so with varying success and according to different time frames and forms of organisational relationship. They are then fundamentally constitutive or 'performative' (Michael 2000). They are introduced and circulated with defining implications for the way in which sectors take shape and evolve. This is not necessarily a uniform process but one with marked contrasts from one case to another.

So while expectations can be formulated as (probabilistic) predictions, say, life expectancy or expected frequency of failure, *there is always a performative aspect* to them. That is they perform a real-time purpose in shaping present day arrangements across areas as diverse as life insurance, health care, reliability engineering, risk management and much more. Expectations are part of the world of action: they incite, block, justify. This can be further understood in narrative terms: expectations help shape the plot (and its further development) that guides actions and interactions. Moore's Law is a classic example here. In the early 1960s the prediction of G.E. Moore, the research director of Fairchild Laboratories, predicted that the complexity of integrated circuits would double every 1.5 years. In most respects, this prophecy has become self-fulfilling because it has become embedded deep within the future-oriented in the strategic games of chip manufacturers. It is an expectation that has essentially been adopted as the obligatory yardstick or measure of success and progress for chip manufacturing.

Expectations can be performative also in the sense that promises are performative. The phrase 'I promise X' is not just a description, it makes the person who enunciates the phrase accountable for doing X (or a version of X). Pronouncing an expectation does not create accountability, but does lead to reactions and the idea that the enunciator should justify the expectation. This is how early promises and early warnings lead to reactions and sometimes to escalating arguments for and against (specious inflation). In more concrete situations, formulating an expectation, say about the usefulness of a tool or a procedure, can be read as an implied warrant to others that they can use the tool or the procedure.

Clearly then, the dynamics of expectations are crucially constitutive, especially in the early stages of innovation. That is, promises will be inflated, and have to be inflated in order to get a hearing. So it is almost inevitable that early hype will eventually give way to disillusionment, except when the emergence of new promises helps people forget their former disappointments (Brown and Michael 2003).

Because of the constitutive character of hyperbolic expectations, we are repeatedly presented with the real difficulty of judging the veracity of future claims and expectations. That is, how, in real-time, we can separate the hype from a more likely or realistic future for innovation. If we accept that expectations are constitutive, by what means can we isolate the genuinely constitutive from erroneous expectation? Whilst it is possible to be critical of the assumptions we hold about the future, it is often far from possible to isolate or insulate our critique from the dynamics of expectations. We have to accept that it is not feasible to place ourselves objectively outside the dynamics of expectations as if we were disinterested observers. We may however, on occasions be deeply critical of hyperbolic expectations and cautiously reticent about them whilst acknowledging that today's anticipations are foundational to constructing the future. Futures are not inevitable but rather, they are 'fought for', resisted or embraced (Brown, Rappert and Webster, 2000). Indeed, as Franklin points out in respect to the contested expectations built up around stem cells, '... it is a mistake to think that we can somehow factor out the hype, the media or the work of the imagination to exaggerate either the promises or the risks of new technology. This is not going to be possible, now or in the future, because it is precisely the importance of imagining a future yet-to-be that fundamentally defines the whole issue of the new genetics and society' (349, 2001).

Similarly, Geels and Smit have sought to elaborate upon the cyclical character of promise-disappointment sequences and the way in which changes in expectations correspond to particular constitutive moments in a product's development:

> 'The reason that initial promises and expectations are too optimistic is *not* that forecasters or futurists are ignorant or shortsighted. Instead, the promises are strategic resources in promise-requirement cycles. Initial promises are set high in order to attract attention from (financial) sponsors, to stimulate agenda-setting processes (both technical and political) and to build 'protected spaces'. Promises thus play a role in the social processes that are part of technological development. This performative dimension of future images provides a complementary interpretation of the failure of some future speculations.' (Geels and Smit 2000, p. 881-882)

The general idea of expectation dynamics was originally set out by Van Lente (1993) and Van Lente and Rip (1998)), and a visualization of their point about an expectations-requirements cycle is visualized below (the figure is taken from Geels and Smit 2000, p. 881).

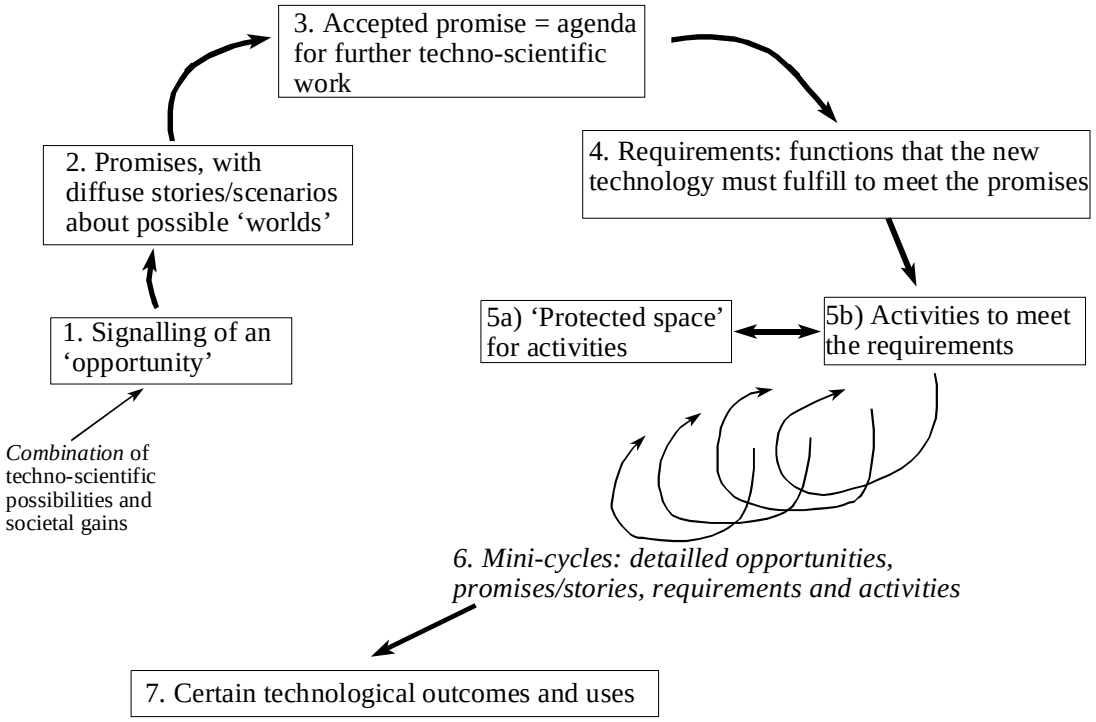

Figure 1: The dynamics of promises and requirements in technological developments

Figure 1 illustrates that the dynamics of expectations is a *nested phenomenon.* When a promise is accepted and is part of an agenda of further work, other more detailed expectations have to be articulated and taken up. A broader, encompassing promise, thus, may help to protect more specific promises. Van Lente (2000) points to the importance of the encompassing promise of technology as such: the culturally anchored notion – or ideograph - that technology will continue to offer possibilities for progress. This notion goes back to the Enlightenment and has been important in the exploration of new fields such as electricity, ICTs, biotechnology and nanotechnology. According to Van Lente the promise of technology as such results in 'mandate'

to technologists: a freedom to explore and develop, combined with a societal obligation to deliver in the end.

In the domain of genetics and genomics, many examples of the importance of expectation dynamics can be found, as in the construction of markets and products of gene therapy in the USA (Martin 2001), xenotransplantation and stem cells (Brown and Michael 2003), and the 'selling' of the Icelandic genomic data (Fortun 2001). 'Geno-hype' (Fleising 2001) is everywhere, and leads to 'geno-hope' as well as the emergence of paths and path dependencies.

Here and in general, the quality control of promises and expectations is an important challenge. The analysis of expectations have been important in understanding content, but has rightly steered away from normatively predictive questions of whether expectations are true or erroneous. As we have already indicated, 'truth' or 'error' are never unequivocal because of these self-fulfilling and self-negating 'prophecy' effects – a general sociological phenomenon (Merton 1948)! However, we might tentatively suggest that there are possibilities for focussing on the quality of the process of promises and requirements and their eventual outcomes; this is more important than a debate on the probability of certain predictions.

The same point can be made about early warnings and the quality of the expectations and counter-expectations involved. For example, adequate operation of the precautionary principle must depend on the need to fully and explicitly articulate 'threat scenarios' in warnings (Rip 2002a). Similarly, one can think of methods to articulate 'promise' scenarios and check the quality of how the scenario was made.

Already at the very earliest stages of a field's formation, actors use 'hypes' and 'hopes' as a means to initiate movement, position themselves and others, build alliances and marginalise competing fields - this is how networks and industry structures emerge. The dynamics of expectations thus articulate with the emergence of irriversibilisation, the production of a particular narrative order that polices the future behaviour of a whole range of actors. Of course, path dependency and irreversibility has been taken up by industrial economists, evolutionary economists and network economists (e.g. Håkansson and Snehota 1995), while actor-network theory, with its interest in 'warm', that is, fluid situations, and how they cool off, offers additional intellectual resources (Callon 1998).

However, there are striking differences and variations across sectors. The growth of biotechnology was sustained largely by small R&D firms, allied to venture capital and/or big firms in the agrofood and pharmaceutical sectors. Genomics has been strongly linked to diagnostics and counselling, but also, at one remove, to life and health insurance companies; and to pharmaceutical and agricultural companies. For nanotechnology one sees only a few small companies producing prototypes, but significant mobilisation within policy circles and some disciplinary professions (chemical engineering). So there are important differences here in the kind of relationships that we can find in different sectors and corresponding implications for the role played by expectations in mobilising activity. Where a sector's relationships are characterised by highly impermanent forms of alliance (loose networks) and where uncertainties are very acute, the mobilisation of expectations clearly operates as a means to stabilise relations and rehearse potential roles. This might be the case for instance in highly volatile sectors, particularly ICTs. On the other hand, where relationships are already established (close knit), expectations are often mobilised to protect existing spaces and insulate networks from potential threats and displacements (FORMAKIN 2001). This might, for instance be true in those contexts populated by different longstanding innovation relationships (pharmaceuticals) or professional bodies (genetic diagnostics).

It is not quite clear what affects these contrasting structural differences and their dynamics will have on further co-evolution. Differences and variations across these sectors have proved to be a significant intellectual challenge to industrial and regional economics, policy making and strategy. In Technology Analysis and Technology Foresight we have seen some recognition of these issues because relevant actors need their prospective questions to be answered. One such example, is the development of a whole series of genomics scenarios and background

studies drafted for the UK's ESRC's (Economic and Social Research Council), but the crucial question lies in the degree to which that and similar undertakings relate to industrial strategy (IAF and CRIC 2002).

This raises another key concern about the way expectations vary within fields as much as between fields. Brown and Michael have stressed the need for a situated mapping of expectations that recognises variation in expectations between different kinds of actor (basic researchers, entrepreneurs, potential end users, and so on) (Brown and Michael 2003). So, in addition to temporal variabilities already discussed (promise-disappointment cycles), fields also exhibit spatial variabilities where people will attach different levels of trust to expectations.

Expectations have the appearance of greater authority for those who see themselves as having little influence over the outcome of a promise (publics for example). This easily translates into a normative framing of expectations: *It's going to happen so you might as well get used to it!* Equally, a heightened sense of confidence often reflects a detachment or distance from the acute uncertainties more usually experienced by researchers at the 'coal face' of conducting the research on which a future field will depend. Also, people closely involved in scientific work more usually offer quite contradictory expectations about their field. When wearing a public entrepreneurial hat they might make strident claims about the promise of their research. But when amongst research peers, they will be much more cautious. Essentially, actions based on future projections must always be sensitive to one's position or placement within the knowledge economy of expectations – whether one is involved in bench science, entrepreneurial activity, policy making, or technology analysis.

There another foundational issue here whether to see expectations as essentially rhetorical or material in character. That is, to what extent are expectations the enunciated views and ideas of people (utterances), or are they 'inscribed' expectations, in texts, bodies, materials, objects and machines (embedded). We have to further articulate the way in which these two phenomena relate to each other. That is, what are the routes of transmission between rhetoric and materiality? Further dynamics can probably be understood from the second perspective, even if one might want to also look at specific actors and their behaviour that would probably require input from the first perspective.

Once given voice to (uttered or otherwise inscribed) expectations appear to have a life of their own, because their rhetorical content (and material obduracy) incites reaction, obliging certain forms of activity (ANT of Callon and Rip, combined with Harré's positioning theory, is useful here). Further, expectations imply future scenarios that prescribe the roles of other actors, who may go along, but most often modify or contest their positioning within a scenario. The ensuing interactions between expectations and between their carriers (in their contexts) lead to sequential patterns, including the recurrent patterns of promise-disappointment cycles.

In sum, we can usefully see these phenomena as the dynamics of a political economy of expectations. Expectations are central to the transactions, exchanges and politics between relevant actor-constellations. Such constellations exhibit various anticipatory political regimes, the governing rules of prevalent games. Additionally, we might suggest that we can see expectations dynamics in terms of quasi-markets, where anticipations have a substantive value which alters radically over time and often in relation to new information or changing circumstances. Expectations can even be understood as tradable assets whose value lies only in the future, and whose investment burdens are borne in the present. Having introduced some of the main phenomena with which the analysis of expectations has been concerned we now want to briefly mention some of the main analytical approaches relevant to making sense of expectations.

3. State of the art – other analytical approaches

Anticipatory expectation, as an analytical object, has emerged in a number of social science disciplinary fields over the past several decades. One of the distinctions we have to make here is that we are interested in studies that can be loosely defined as 'critically constructivist' rather

than necessarily predictive or normative. What they have in common is an intention to 'look at the future' rather than 'look into the future' (Brown, Rappert and Webster 2000).

The disciplinary composition of contributions that adopt this perspective is quite varied covering fields as distinct as Political Economy, Sociology, History and Philosophy of Science (HPS), and Sociology and Science and Technology Studies (STS). Whilst there are important lessons to be learnt from all of these approaches we want to advance and build upon the latter given its suitability to more specific assessments of expectations within the context of knowledge and technology. Nevertheless, it is important to that there is, and rightly should be, significant crossover between these approaches.

Economics & Political Economy: Expectations also has an established literature in classical economic theory (Koppl 2002; Burczak 2001; Carabelli and Vechhi 2001; Shiller 2000) and has more recently attracted interest within the sociology of money and markets (Pixley 2002; Luhman 1998). Economic theory tends to approach expectations somewhat positivistically or normatively in terms of producing 'rational' calculations to determine 'true' future value. Where 'non-rational' uncertainties prevail investors sometimes minimise the risk of being marginalised in a market by herding or mimesis. More sociological accounts by contrast recognise the obvious theoretical difficulties of distinguishing between 'true' and 'false' assessment of future value – especially since expectations are so constitutive of future values anyway.

Sociology and Social Theory: On the whole sociology has tended to steer clear of discussions about the future because of its associations with positivist forecasting (Barbalet 1996). Another reason why expectations are somewhat nascent within sociological literature is because of the level of abstraction involved. It is simply difficult to analytically engage with future-representations has having a definite researchable solidity that can be easily conceptualised. And yet some of the literatures already cited above, in addition to others, point to the significance of future-orientation within sociologies of time (Merton 1984; Adam 1998, 1990; Virilio 2000), memory and commemoration (Bartlett 1932 [1995]; Jedlowski 2001; Halbwachs 1950 [1997]), the emotions (Barbalet 1996) and symbolic interactionism (Mead 1932). Whilst there are major differences across many of these contributions, a common theme is the constant subjective interplay between present, past and future – ultimately disrupting simplistic notions of linear temporal sequence and determinism.

HPS: From within the history of technology there are important accounts of how expectations change over time in relation to various 'real time' factors (Marvin 1998; Levine 1989). Marvin's *When Old Technologies Were New* tells of the way early predictions of the role of electricity in primarily providing public entertainment failed to appreciate the eventually much more pervasive privatised domestic utility of electricity in the household (189-190). The more generic point here is that expectations tend to reflect current conceptions of technological utility – 'the tendency of every age to read the future as a fancier version of the present' (190). Roy Porter's paper the changing expectations of medicine from historical antiquity to the present day is also insightful here (2001).

***Science and Technology Studies*:** Expectations have become an increasingly central analytical register for numerous STS studies. The range and breadth of which now takes in genomics and biotechnology (Fortun 2001; Feising 2001; Plein 1991), nanotechnology (Selin 2002), gene therapy (Martin 2001), telemedicine (Rappert and Brown 2000), reproductive governance (Mulkay 1993; Franklin 1997), ICTs (Geels and Smit 2000; Wyatt 2000), pharmacogenomics (Hedgecoe and Martin *forthcoming*) and transport (Schaeffer 1998) to name just a few key areas. Expectations themselves, in more generic terms, have commanded serious analytical attention (van Lente 1993, 2000; van Lente and Rip 1998; Brown, Rappert and Webster 2000; Verganti 1999; Deuten and Rip 2000; Michael 2000; Guice 1999). Some of this has been translated into important comment and critique on future-oriented practices including scenarios and foresight (Rip 2002; De Laat 2000; FORMAKIN).

Out challenge then is to move beyond a case study based assessment of the field and better articulate central concepts with a view to arriving at a more coherent synthesis of key work.

That is not to suggest that an analytical framework can emerge independently of case-based considerations and the important differences that define separate sectors, their materials, organisational configurations and the periodicities of product development. Nevertheless, a number of conceptual considerations can be articulated which will operate differently within different contexts.

As we have already seen, there are difficult analytical tensions in many cases between 'linguistic-rhetorical' accounts of expectations on the one hand, and more material-artefactual conceptions on the other. In seeking to understand the role of expectations, the analytical tendency of STS scholarship has tended to focus on statements, discourses or speech acts which explicitly manifest future-oriented representations (visions, metaphors, promises, aspirations). So we tend to 'cite' people making a promise or deploying a futuristic image. The side-effect of this is that we become less analytically sensitive to the expression of expectations that are not accompanied by obvious speech-acts. Or rather, expectations are often silent or mute when instantiated within technologies.

This then is an important problem in terms of how we research future-orientation and even how we define 'expectation'. We also need to ask therefore whether we sometimes have an unduly cognitive or mentalistic approach to acknowledging representations of the future. It might for instance, be possible to argue that future-orientations are just as evident in materials and natures (immortal stem cell lines, computational processes, gene therapies, viral vectors, GMOs, etc). These might be technical process, or species continuities, or cyclical routines, or other temporalities in which a future is embedded whilst not necessarily being articulated in language, metaphor or discourse per se (Adam 1998; Mackenzie 2000).

Nevertheless, in linguistic terms expectations are evident in a wide range of discursive formations, each credited with affecting material and structural change – see Wyatt on metaphor (Wyatt 2000), Brown on breakthrough (Brown 2000), Van Lente's on 'the promising gene' (2002). But again, it is less clear whether and in what way socio-cultural metaphors become instantiated materially or institutionally.

Additionally, and also mentioned above, we are faced with the difficulty of attaching a value to expectations. That is, what role can we play in checking the quality of the expectations surrounding science and technology fields? Is there a critical role for Science and Technology Studies in producing some kind of quality assurance that also accepts that expectations will inevitably and unrealistically over-inflate the future? These questions bring us to the next and final set of considerations in our background paper, questions and difficulties for practitioners.

4. Issues for practitioners, instrumentalization

What can we say about *outcomes* of the dynamics of expectations? What can we say about feedbacks and learning? What are the possibilities to modulate these processes so as to do 'better' – the thrust of Constructive TA.

For practitioners these expectorations are, of course, more than an interesting phenomenon. They have to deal with them and make assessments of their veracity and robustness. In general, expectations in new science and technology are accompanied with the proviso that unexpected effects ('you never know …') must always be expected. Promises about the 'goodies' will be made, but the implied warrant is not strict: if the 'goodies' do not materialize, that is not held against the science & technology. (Although this might change if such reneging on promises occurs again and again; cf. Don K. Price.) For science and technology, there is another second-order expectation: new ideas and options will come with expectations about their potential and relevance. Such expectations will therefore be not *adhoc*, but be addressed to a generalized audience, will circulate and be shaped so as to be able to circulate. A practice of formulating acceptable expectations emerges, and strategies are developed how much inflation can be tolerated and is prudent. This is where eventual quality control of robustness and pertinence has to start.

In the last decades a number of techniques, instruments and practices have evolved that seek to articulate and assess expectation in technology, such as technology forecasting, backcasting, roadmapping, scenarios methods, and, of course, technology assessment. These methods assume, in some way or another, *anticipatory competencies* with actors without checking what these may be, and without thinking through what a productive 'aggregation' would be (cf. Rip/Laredo, unpublished).

A second challenge relates to the *ethical concerns* as interference with expectation dynamics, because ethical concerns start from principles, deontology, rather than eventual outcomes and their uses. But the ethical principles refer to a constitution that guarantees (or at least accommodates) a "good life" – a scenario of an outcome. In other words, reference to the future and how it can be filled in is unavoidable and implies ethical and political reflection and discussion.

It is here that analysts can and should learn from practitioners, but also improve their understanding based on the types of thinking and analysis discussed in the first two parts. This might then lead to improved (and more reflexive) instrumentalisations. For example, developing methods of assessment for judging the robustness and pertinence of expectations. Or how to learn from retrospective case-studies – which probably requires putting them in the context of the wider political economy of expectations to see how recurrent patterns in the dynamics of expectations come about. In our paper we shall touch on these possibilities, but we expect (if we may use the term) that discussions during the workshop will address these issues further.

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Appendix 1: Towards an annotated bibliography?

One of the activities of the network of expectation studies could be the development of an annotated bibliography. The following is a beginning; its usefullness will be discussed during the workshop.

Steven Glynn, 'Constructing a selection environment: competing expectations for CFC alternatives', *Research Policy* 31 (2002) 935-946

> Nice paper about the debate and the various positionings, but little data on expectations. Idea of 'competing expectations' is important (and is a bridge between variation and selection) but is not really conceptualized.

Lampel, Joseph, 'Show-and-Tell: Product Demonstrations and Path Creation of Technological Change', in Garud & Karnoe (2001), 303-327.

> Demonstration is an embodied expectation, and staged/performed (cf. technological drama). Part of an enactment process in which behavior of collectivities is changed through an envisioning process (306). In particular, envisioning intersting, promising technological paths (320).

Lissoni, Francesco, Technological Expectations and the Diffusion of 'Intermediate' Technologies, CRIC (Manchester), Working Paper No. 8, August 1999.

> Refers to Rosenberg (1976) for 'technological expectations' (+ further references). These feed into strategic considerations which technology to adopt and when, and will often lead to choosing intermediate technologies rather than the most advanced ones. [Cf. Schaeffer on 'generations' and future chronology more generally.] A model for diffusion of mid-range technologies is constructed and tested for electronic colour pre-press industry. [An interesting contrast can be made with public rhetorics about the need to be at the frontier, and adopt the most advanced technologies.]

Geels, Frank (PhD thesis) discusses hype/bandwagon/backlash for a few examples, and presents the graph (from Gartner.com) of technology trigger, peak of inflated expectations, trough of disillusionment, and slope of gradual improvement.

Papers from EASST conference, York, 2002:

- Nik Brown and Mike Michael (TA&SM article, pdf file)
- Adam Hedgecoe, Visions of pharmacogenetics. (PGx)
- Jonna Kangasoja on 'promiseware' (dialectics of selling promiseware and securing the public good) (pdf file)
- Kornelia Konrad (pdf file)
- Sarah Parry on discursive regularities in stem cell debate, documents – one is "constructing a demand for stem cell therapies", while scientists in interviews confess these are pipe dreams.
- Andrew Smart, Vision of pharmacogenetics
- Kaushik Sunderrajan, personalized medicine as a promise and a fetish

Appendix 2: Expectations in contemporary 'timescapes'

First and foremost it is important to make the point that expectations emerge and are performed within particular spatial-temporal conditions that vary fundamentally from one time to another. In other words, orientation to the future is rooted in the real time temporal characteristics of the present, a unique and unrepeatable series of 'nows' (Mead 1932; Flaherty and Fine 2001; Adam 1990, 4). These presents can range from the periodicities of historical formations and 'timescapes' (Adam 1998). Or they might be the micro-conditions of the moment-to-moment. Bhaktin's literary term 'chronotope' expresses the point that orientation to the future and the past is always embedded in a specific scene or temporal location (Bhaktin [in Morris 1997, 18). Abstracting about the future therefore occurs at a certain juncture in the unfolding of a narrative or plot.

It is therefore important to identify certain temporal phenomena that are characteristic of the present that together form the backcloth against which future-orientation is performed and mobilised. These have been elaborated elsewhere (Brown and Michael 2003) but merit brief mention here:

- **Valorisation of speed** and incremental acceleration permeates every aspect of production and consumption and is central to competitive behaviour or 'if time is money, then speed is power' (Virilio [in Armitage 1999], 1986). Speed is widely seen as an indicator of progression into the future therefore impacts on contemporary characteristics of anticipation (Pels).

- **Speed fetishises novelty** and focuses attention on the exploitation of emerging or future opportunities rather than established routines and habits (Campbell 1998). Again, this dynamic together with the valorisation of speed places increasing pressures on the need to engage with the future.

- **Designed obsolescence:** Consumption patterns are subject to shortening timeframes of built-in obsolescence and just in time production (JIT). Today, obsolescence is a deliberate product design feature rather than a result of cumulative stresses of repeated usage (Reisch 2001).

- **Shortening future time horizon:** These pressures on the now have produced a particular contradiction in our relationship to the future. The category of the future, argues Nowotny, has been replaced by an 'extended present': 'The category of the future is shrinking towards becoming a mere extension of the present because science and technology have successfully reduced the distance that is needed to accommodate their own products' (Nowotny 1985:14-15).

- **Extending future time horizon:** At the same time, competition is forcing actors to increasingly colonise future markets, stretching the temporal envelope of the future. Attention is shifting from present and medium term markets encouraging competitors to look increasingly to future opportunities. Near-term acceleration leads to greater pressures on future-engagement, prompting some to suggest that the contemporary is marked by an unprecedented orientation to the long-term future (Giddens 1999).

- **Future uncertain:** Increased rapidity, and a more distal competitive time horizon, creates greater scope for events to vary from our expectations of them. This results in greater difficulties for reflexively monitoring the effects of emerging applications. This can be seen in the time lag between future competition and slower processes of governance and policy-making. The future in the contemporary timescapes has become more rather than less opaque. All of these conditions tend to produce an intensification of future-oriented action and agency across lots of contexts (Industry planning, Foresight exercises, internal corporate scenario capabilities, etc). Much of this institutional way of engaging with the future has had to move away from linear

forecasting of previous decades (particularly the 1970s and 80s) to adopt more qualitative strategies.

In broad terms then, these are just some of the wider features of contemporary temporality that have produced a particularly distinctive relationship to the future. Our engagement with the future is riddled with a whole series of dilemmas and tensions. On the one hand we recognise that expectations are often hyperbolic and yet at the same time we seem unable to get by without their attention-grabbing capabilities. Whilst we want to be more certain of the future, we also recognise that our quest for certainty actually generates the costly future uncertainties that we fear. And whilst the future seems to be rushing towards us with the ever-quickening pace of things, we must look further into the future if we are to maintain our competitive edge. Catch-22!