Foresight for STI: What and Why

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2.1 The Nature of Foresight and ForSTI

The term Foresight has long been applied to futures work, not least in H.G. Wells' call for "Professor of Foresight" in the 1930s, and in studies for the US government (involving Joseph Coates among others).[1] But as the previous chapter noted, "Foresight" has become prevalent as a description of futures-related activities only in the last couple of decades. Consultancies, University courses, research programmes, and all kinds of institutional activities are now badged as being Foresight activities. The rise of "Foresight" to prominence stems from the pioneering studies of John Irvine and Ben Martin in the 1980s.

Irvine and Martin were working in the Science Policy Research Unit (SPRU), University of Sussex (under the leadership at the time of Chris Freeman, who himself authored several important studies of STI and the long-term future.) SPRU was a pioneering institution that combined innovation studies with futures studies. (Indeed, in the 1980s it was still rather rare to find a university-based group of any size working on either of these areas.) Often the same researchers were engaged in both streams of work, and Irvine and Martin played an important bridging role. Their analyses of what they labelled Foresight[2] were initially presented in two substantial and influential books, the first (1984) entitled *Foresight in Science*, the second (1989) *Research Foresight*. Their approach was to examine how governments around the world were addressing long-term decision-making in STI (science, technology and innovation) areas, and as the books' titles indicate. "Foresight" was the label attached by these authors to the task. Martin (2010) provides a helpful retrospective on this work, explaining that they had been inspired

[1]The evolving application of the term, and the confusions consequent upon this, is traced out in some detail in Miles (2010).

[2]See Irvine and Martin (1984), and Martin and Irvine (1989).

I. Miles et al., *Foresight for Science, Technology and Innovation*, Science, Technology and Innovation Studies, DOI 10.1007/978-3-319-32574-3_2

by the use of "Hindsight" to describe efforts to determine the origins of new technologies in R&D and other activities.

These two path-breaking studies were systematic overviews of the area, of what practices various agencies were adopting, with what success. They were funded by UK and Dutch government agencies responsible for determining "promising areas of science", of establishing provision for strategic research. The studies are thus not ForSTI research themselves, but as studies *of* ForSTI.

Irvine and Martin saw Technology Foresight as primarily about informing research priorities, a major concern of their studies' sponsors. In explaining its importance, they saw it as being:

> ... the only plausible response ... to resolving conflicts over priority-setting caused by escalating experimental costs, limited resources, complexity in scientific decision-making and pressures to achieve 'value for money' and socio-economic relevance. ... Foresight provides, at least in principle, a systematic mechanism for coping with complexity and interdependence as it affects long-term decisions on research, in particular facilitating policy-making where integration of activities across several fields is vital.
>
> Martin and Irvine (1989, p. 3)

Their work informed the Technology Foresight Programmes (TFPs) in the UK, the Netherlands, and elsewhere, during the 1990s and onwards. This large scale of institutional activity gave the term considerably legitimacy and cachet. The result is that the term has now come to be applied to all sorts of futures activities, some of which lack the systematic approaches, the policy links, and the participative orientation of the best of these TFPs. The notion of "fully-fledged foresight" was introduced to differentiate these latter practices from more limited, less participative forms of futures study, carried out often as pure (and often desk) research with little link to decision-making. It should go without saying that desk research, scientific modelling, citizen debates, and many other activities can result in important breakthroughs, deeper insights, wider understanding. They may well contribute to ForSTI activities. But they feature different ambitions and scope, and ForSTI has contributions to make to decision-making and collective intelligence that reflect the elements of fully-fledged Foresight.

Many of the futures studies that have achieved most public visibility are not closely tied to particular decision-making processes. Sometimes they are the result of academic exercises; sometimes they are "wake up" calls from pressure groups. Such studies—when implemented with some degree of rigour, systematic appraisal, and open-mindedness—can be useful aids to planning, decision-making, and thinking about the future. They can be helpful inputs to exercises that are more appropriately termed Foresight. (Forecasting studies can also, of course, draw on reports and data produced in the course of Foresight activities!). Many of these traditional futures studies had been carried out by researchers and/or activists with very specific sets of concerns, anxious that these be properly attended to by decision makers. Often their efforts took place outside of the timetables and apparatus of policymaking. For this reason their impact was frequently limited or took much time to be realised. Efforts to promote the work as extensively as was the case for

The Limits to Growth, whose sponsors (the Club of Rome) organised media attention and governmental briefings around the world—and thus fed an emerging environmental movement—are rare indeed. ForSTI, in contrast, will typically be generated in response to policy concerns, and to be linked to policy cycles of one sort or another.

The (typically national) TFPs that took off from the mid-1990s differ from much other technology-oriented futures work in several ways. Typically they involve a configuration of three elements, though the precise emphases and methods vary considerably, and we see these elements as featuring to greater or lesser extents in ForSTI:

1. **Prospective**. As befits "futures studies" they put considerable effort into applying systematic methods to developing appraisals of longer-term developments. The larger TFPs examined a wide range of trends and possibilities, of challenges and opportunities, concerning STI.
2. **Policy-related**. Many of the early TFPs were intended to help establish priorities in funding research, and to orient related technology policies, such as training and regulatory development. They were often explicitly intended to inform major policy pronouncements, and timed so as to fit into the rhythms of policymaking. They were sponsored by influential policy actors, rather than being ivory tower or outsider analyses.
3. **Participative**. They usually set out to access knowledge and elicit opinions from a much wider pool of knowledgeable stakeholders than "the usual suspects".

Figure 2.1 captures the essence of the "Fully-Fledged Foresight" that combines these three elements of policy-relevant, participative, and prospective activity. Not all TFPs were so thoroughgoing, not least because there was a kind of bandwagon effect, and not a few countries launched pale imitations of one or other aspect of TFPs seen elsewhere. Serious policy learning is more than this sort of imitation: it requires understanding the underlying principles that lie behind specific policy instruments, and determining how to tune and implement a policy mix that is adapted to local circumstances and objectives.

Foresight, then, should not be confused with forecasting, though it should take into account the results of serious forecasting exercises, and such exercises may be part of a Foresight process. Forecasters often aspire for precision in an attempt to predict how the world might look at some point in the future, often using techniques like trend extrapolation, computer modelling, etc. By contrast, Foresight does not seek to predict: instead, it is a process that seeks to create shared "visions" of the future, appraisals that stakeholders are willing to endorse by the actions they choose to take today. It is focussed on *influencing the development of the future;* some commentators portray this as *creating the future*. We are inclined to see "creating" as too grand a claim, since many factors and actors play a role in this, and not all are mobilised in the Foresight process. Perhaps we can best see ForSTI as helping to *shape* the future.

One of the definitions in the literature captures key elements of this:

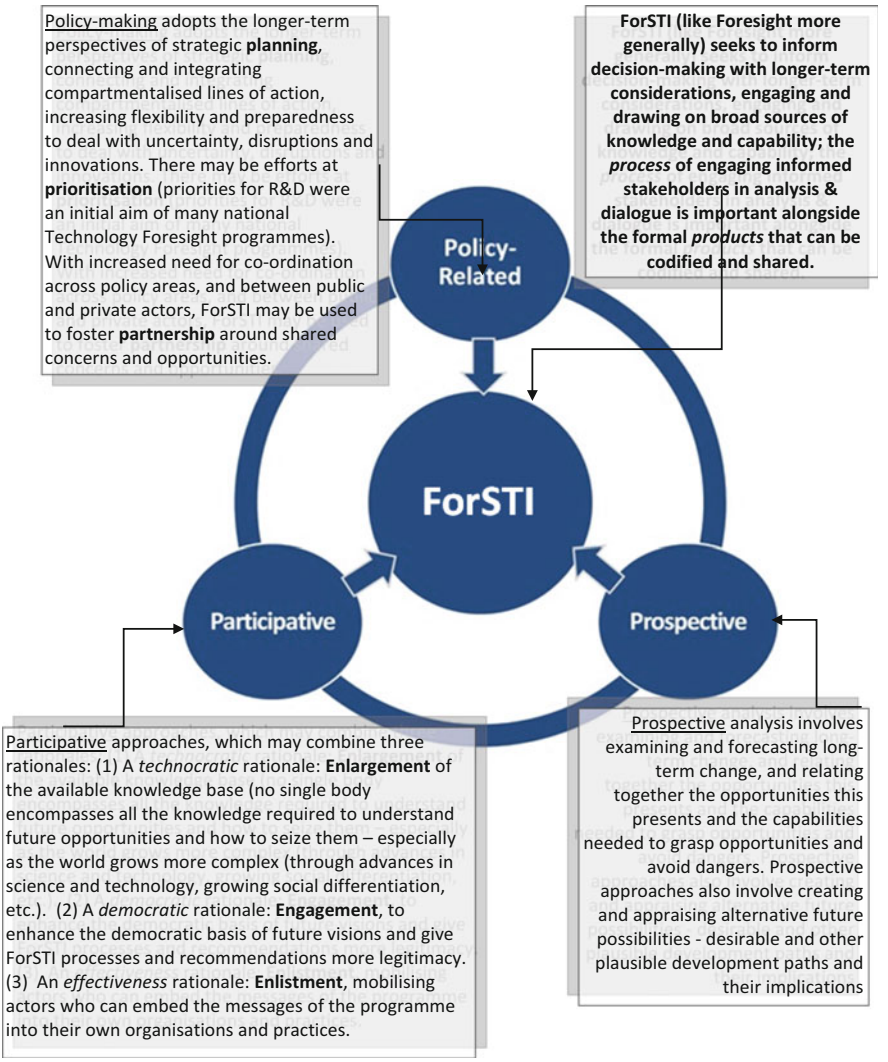

Fig. 2.1 Three components of Fully-Fledged Foresight (ForSTI). *Source*: loosely based on Keenan et al. (2003)

Foresight is "*the application of 'systematic,' 'participatory,' 'future-intelligence-gathering and medium-to-long-term vision building process' to 'informing present-day decisions and mobilising joint actions'*" (Miles and Keenan 2002).

So, typically, Foresight (and when it is applied to issues of STI, ForSTI)

1. considers multiple futures, which may include possible, plausible and desirable futures
2. is a participative process
3. is action-oriented

ForSTI does not replace technological forecasting, technology assessment, futures studies, or strategic planning of R&D. Each activity has its role, and in many instances these can be mutually supportive. However, these latter activities are sometimes conducted in a fashion that closes off debate and considerably limits the scope of the alternative futures and paths of action that are considered.

Many efforts to inform decision-making about longer-term implications of the issues and actions in question are relatively top-down affairs, oriented towards producing reports or other forms of intelligence to support policymakers or corporate strategists. Sometimes they are intended to sway the opinion of the public, or of a particularly important constituency. Two major varieties of such forward-looking activities are:

- **Expert Judgement**, where a gifted individual or a small expert panel weighs available evidence and generates an appraisal of the future (e.g. the scientific or technological achievements that can be gained, the dangers that need to be confronted, a list of priorities for research funding. . .). The panel may commission new studies or mainly draw on the expertise of its members. These members are often what in England are known as "the great and the good"—people that have established reputations in related fields, and who have credibility with the intended audiences and users of the work. While the renown of the experts will partly determine the impact of the work, there are cases where it may be dismissed as the product of special interests. It will be alleged that these are the "usual suspects" with limited inclination to propose radical alternatives; other experts, it will be alleged, could be found to give other views (Thus the dismissive acronym BOGSAT is sometimes applied to this approach—it is criticised as being just a "Bunch Of Guys Sat Around a Table"). Such an approach has often been employed to gather evidence and reach conclusions as to "critical technologies" or priorities for research in particular scientific fields. Variations on this, such as committees of enquiry and more participative "citizen juries" are sometimes engaged in other sorts of decision-making as to regards STI, especially where matters of regulation are concerned.
- **Technique**, where future prospects are appraised via more or less technically sophisticated procedures such as computer simulation and modelling, or some specific tool such as Cost-Benefit Analysis. Sometimes such approaches dominate the debate. Large and complex models—for example those used to forecast climate change, or some of the more ambitious attempts to explore world energy futures—may consume a great proportion of the funds required for a project. They can become the main element into which data and analysis are fed, and around which appraisals are constructed. Their legitimacy will partly rest on the techniques and approaches employed—often computer simulation has been treated with some degree of awe. But there is increasing awareness that simulations depend on assumptions about the object of study—and that these assumptions may be contested ("Garbage in, Garbage Out" is a mantra used to

indicate that the results of modelling are only as good as the underpinning assumptions and data). Models may well require expertise for informed interpretation of their results (and to mount credible challenges to these results). Since models are rarely able to deal with qualitative phenomena and structural changes, extending the study, beyond the narrow parameters that can be properly addressed by the model, may require other forms of expertise.

2.2 The Origins of ForSTI

The mid-1990s saw a substantial blossoming of ForSTI, in the form of TF programmes (TFPs), in Europe. These approaches in Europe were the result of policy learning, especially from the Japanese technology *forecasting* programme, as it was then known (the ongoing Japanese programme was soon rebranded as Foresight). Irvine and Martin (1984) were particularly impressed by the Japanese model of "research forecasting" that had developed in the decade prior to their review of approaches to STI; they recommended borrowing its guiding ideas. The Japanese framework, that had been underway since the 1970s, itself had drawn on earlier US initiatives. Techniques such as Delphi studies had been adapted to the Japanese context, for example.

In the 1980s and early 1990s, Japan was seen as, in many ways, offering a model of a national economy using STI to achieve rapid growth, catching up with and (in some areas) hauling ahead of European rivals. In one of the key studies developing the "national systems of innovation" approach, Freeman (1987) portrayed Japan as having a particularly effective innovation system (e.g. by allowing innovation efforts to be directed towards areas where capabilities in research and production meshed with opportunities to enter or create markets. This was not just a matter of Japan's growing economic and STI prominence. If Japan had been a struggling country, Irvine and Martin might have paid it less regard—but they were clearly impressed by the systematic nature of the Japanese programme. They noted that Japanese ForSTI has multiple aspects, going beyond sophisticated deployment of tools like Delphi. They stressed that the Japanese activities were not just a matter of forecasts and reports, priority lists and investment opportunities. Japanese ForSTI exercises featured significant "process" attributes—bringing people together to construct and share appraisals of current circumstances and future possibilities. They were impressed by the combination of bottom-up inputs, systematic analysis of trends, and efforts to apply a broad range of new approaches to decision-making and prioritisation in STI.

The reason for undertaking this review of ForSTI approaches round the world stems from STI policy challenges being confronted in the UK and Europe more widely. European countries had been becoming increasingly aware of several STI-related challenges in the last quarter of the twentieth century. Traditional science policy faced difficulties in choosing which of numerous competing lines of R&D to fund—some established areas were becoming extremely expensive, new areas were emerging. There were growing concerns about technology gaps with the

US and Japan, and about Europe's late reactions to developments in Information Technology (IT) and other fields. There was evidence of ongoing public concern about the implications of some large areas of STI such as nuclear power, and about hazards associated with food safety in a world of transformed agriculture and food industries. Media coverage of new IT often featured alarming forecasts of large-scale unemployment and job polarisation, and concerns were growing about reproductive technologies and bioscience more generally. Established tools for STI policy were seen to be struggling to deal with such challenges, and ForSTI might be at least a partial solution.[3]

Thus, several leading European counties launched TFPs in the early and mid-1990s—these included not only the Netherlands and the UK who had funded the Irvine/Martin studies, but also Germany and France and numerous other followed in short order. Approaches varied, with the first French and German exercises largely recycling a Japanese Delphi study, rather than adapting the Japanese principles to their own context. (This led to extremely poor consequences in the French case, where there was considerable resistance to what was seen as an alien tool, even as one which might give Japanese strategic insights into the French innovation system. [4]) As the idea picked up momentum, with TFPs launched in other Northern European countries during the 1990s, the European Commission got behind the approach. It supported ForSTI exercises of its own, and encouraged countries seeking EU membership to undertake their own TFPs as part of modernisation of their STI systems. International organisations such as UNIDO also began promoting the approach, funding training programmes and ForSTI exercises.

The UK TFP experience was particularly influential in the later 1990s.[5] (Indeed, the notion of "Fully Fledged Foresight", as set out above, was very much informed by the experience.) Launched in 1994, it had a very tight timetable, since it was intended to inform major science policies planned for introduction and implementation in the next year. It succeeded in doing this, and while the scale of the impact was a matter of some debate, practically all observers agreed that it was substantial. "Technology" was dropped from the title after a while, as it was seen to deter potential participants in less technology-intensive sectors of the economy. The TFP became known as the UK Foresight Programme, and a Foresight Office has been based in the UK government ever since. (Its exact institutional location has varied over the course of time.)

The UK TFP was explicitly developed round the recognition that the tools that had been effective in Japan should not simply be transplanted to other countries

[3]The introduction of research evaluation techniques, and efforts to reorganize links between public research and private industry, were also part of this effort.

[4]Conflict among two French ministries as to whom should be leading in foresight and prioritisation did not help here, either. An alternative Critical Technologies approach was more securely established.

[5]For a detailed account of the background and origins of the exercise see Martin (2010).

without modification. The tools had been designed and configured within a particular social environment, in which they meshed into social networks and institutions—the Japanese innovation system, to be precise. The UK's innovation system, in comparison to that of Japan, featured relatively poor linkages between the scientific research base and industry; the TFP would need to address the problem. Thus not only Delphi, but also extensive networking via Panels and other meetings, were built into the Programme. Such stress on the participative nature of the programme, as compared to more traditional consultancy studies and expert panel reports, was also a theme in the Dutch and several other national programmes in EU countries in the mid-1990s. If anything, subsequent developments, such as the high levels of public concern around risks and ethics associated with biotechnology (and around other issues in food and agriculture, and in environmental affairs), coupled with emerging concerns about topics such as artificial intelligence, automation, and surveillance, have reinforced the case for widening participation. This has extended the scope of the notion of ForSTI stakeholders—they include not only narrowly conceived users and suppliers in the innovation system, but also the much wider communities seeking solutions to social challenges and/or being liable to experience the results of STI efforts.

ForSTI in the EU is in many respects quite distinct from activities in the USA. Contemporary US activity rarely involves the stress on broad participation that is prominent in much European work—especially when participation involves more than a matter of enlisting experts into Delphi surveys. Forecasting and other futures approaches are, of course, applied in the US context—numerous consultancies provide services ranging from trend-watching and computer simulation to scenario analysis and running futures workshops. The Japanese ForSTI model itself involved "Japanisation" of tools largely developed in the USA in the 1950s and 1960s, where the evolution of methods such as Delphi and scenario analysis was largely driven by the stimulus of military and space programmes. The complex problems addressed by these programmes led their leaders to reason that systematic marshalling of expertise was required in order to grasp future possibilities: quantitative extrapolation and the forms of modelling then available could not readily deal with qualitative change, the coevolution of strategies across actors and domains, and the like.

Japan faced complex challenges too, in terms of moving beyond "catching up" to becoming an industrial leader. Japanese practitioners acquired methods in the US and made them their own, and then people in other countries sought to emulate Japanese methods (This was also the case for methods of industrial modernisation such as quality control and just-in-time). Arguably, the Delphi method as used in Japan can be seen to have been structured so as to emphasise and promote consensus.[6] Many commentators have seen this as a prominent and enduring feature of Japanese society (though other commentators propose more nuanced views). The effort could be seen as one of developing appraisals of future prospects

[6]E.g. the way in which results were aggregated in providing feedback to respondents tended to stress majority opinions, rather than explore the outliers.

that are relatively widely shared, and that can serve as guidance for cooperating policy, industrial and research partners can be viewed in the same way.

Europe, of course, already had its own tradition of futures work, so it is not as if Japan's model of ForSTI was presenting a completely new set of approaches. Though the futures movement of the 1960s was strongest in the US, several European countries had been fertile ground for futures studies (on the whole, interestingly, the UK had been less engaged than most[7]). The futures movement claimed and aimed to be more holistic than traditional forecasting exercises, which feeds into a key element of contemporary ForSTI. The sorts of problems that ForSTI deals with involve highly complex phenomena and overlapping policy domains. Grasping the future was not just a matter of modelling or extrapolating a narrow set of trends. Such forecasts can be useful if examined critically, but analysis of a broader set of factors may indicate developments that undermine a trend or its drivers. And in a complex world, with numerous agents developing and pursuing their own strategies, futurists seek to envisage alternative futures—rather than simply to predict the future.

This particular element of the philosophy was strongly voiced by many European futurists, who were often explicitly motivated by the desire to find alternative futures to the visions proffered by the USA and USSR. This probably lies behind the attention given to scenario analysis (both multiple and normative[8] scenario development) in European ForSTI. Such attention has more recently been echoed in Japanese activities (which show, in several respects, signs of reciprocal policy learning back from Europe).

The initial broad aim of many TFPs was to identify those emerging generic technologies that would be likely to yield the greatest economic and social benefits, but ForSTI more generally covers multiple activities and purposes. Therefore, for the sake of clarity, it is important to stress not only what is common to TF activities but also the ways in which they differ. In terms of purpose, various goals for ForSTI may include:

- ***Exploring future opportunities so as to set priorities for investment in science and innovation activities***. The degree to which priorities can emerge from ForSTI varies from "critical technologies" exercises, where the whole discourse is focussed on a priority list, through more general programmes from which priorities are derived, to targeted Foresight where the priorities are in effect set before Foresight begins.

[7]Cf. Miles (2008). The UK was host to one of the leading journals in the field—*Futures*—but lacked the sorts of large scale enquiry into the Year 2000 that appeared in other countries. It is interesting, too, to compare the lively Science Fiction scenes of the era in the UK and other countries—British SF featured "cosy catastrophes" that can be seen as reflections upon imperial decline. (see Aldiss and Wingrove 1986; Greenland 1983) *The Entropy Exhibition: Michael Moorcock and the British 'New Wave' in Science Fiction*. London: Routledge & Keegan, 1983.

[8]We discuss the exploratory-normative distinction in the next chapter.

- ***Reorienting the STI System***. This goal goes further than priority setting, to shape the structure of the system that sets priorities and undertakes initiatives in STI. For example, there may have been a preliminary diagnosis that the science and innovation system does not match the needs of the country. This was a common perception in parts of Central and Eastern Europe in the immediate post-Communist period when, apart from severe resource difficulties, capabilities reflected an industrial system that no longer existed. In this context it has been proposed that ForSTI can be used as a tool to re-orientate away from more traditional fields of STI (e.g. some classic forms of materials research) and towards emerging fields (e.g. nanotechnology, life sciences); and it can be used to explore new institutional structures (e.g. the institutional location of R&D across Universities, government laboratories, private and third sector research organisations).
- ***Raising the Profile of the Science and Innovation System***. In this context ForSTI becomes a "shop window" to demonstrate the technological opportunities that are available and to assess the capability of science and industry to fulfil that promise. Sometimes the emphasis will be on developments in a particular field, such as Information Technology, where ForSTI is used to generate appraisals of the modernisation of a region, country, or social organisation through the application and further development of the knowledge involved. While this sort of effort can come dangerously close to Public Relations exercises, and is often undertaken by firms interested in developing markets or regulatory frameworks that advance their own interests, it is possible for such efforts to be employed so as to promote and provoke wider debate and engage wider sets of stakeholders in the appraisal process.
- ***Bringing new actors into the strategic debate***. A growing tendency is the use of ForSTI as an instrument to broaden the range of actors engaged in science and innovation policy (This builds on the last points of the preceding bullet). One example is the inclusion of major stakeholders, such as particular professional communities, or even sections of the general public such as youth. It is particularly relevant where established social institutions are confronting major challenges in terms of demand, supply and expectations—as is the case in public health services in many advanced industrial societies, where changes in demographics, technology, and approaches to service delivery are all creating considerable uncertainty. New ethical challenges—often involving bioethics around, for example, genetic modification of human beings, but also in fields as diverse as human enhancement through pharmacology and prosthetics, and the evolving balance between security, surveillance, privacy and civil liberties—are also topics where ForSTI can help to shift discussion away from immediate controversies to longer-term challenges.
- ***Building new networks and linkages across fields, sectors & markets or around problems***. A ForSTI activity may be explicitly aimed at creating new networks and/or clusters that break out of long-standing disciplinary, departmental or sectoral ties. For instance, people concerned with nutrition, sports, social

marketing, and health may all have (unexplored common) interests in developments in related life sciences.

2.3 ForSTI as a Process

ForSTI is an activity that usually takes place over an extended period of time, measured in months and often years. It is helpful to view this in terms of a series of phases, as depicted in Fig. 2.2. Here we merge two slightly different depictions of the cycle, drawing on Miles (2012) and Saritas (2013). These phases do not constitute a rigid schema; we do not intend to suggest that ForSTI has to be pursued in a specific sequence of steps. There can well be reiterations of specific phases, and the sequence may need to be very flexible (Consider some examples Ongoing Intelligence is required throughout the process, scanning for emerging phenomena that need to be taken into account. Decision makers may request advice from the ForSTI—here placed in the Intervention phase—at earlier stages in the process—even though final conclusions may not yet be available, provisional ones and useful insights may well be).

The phases are:

- **Initiation**: sometimes known as PreForesight, in this phase, the need for the activity is examined, and the scope and intended uses and users are established. This may start the whole process off, or follow on from an Impact phase of an

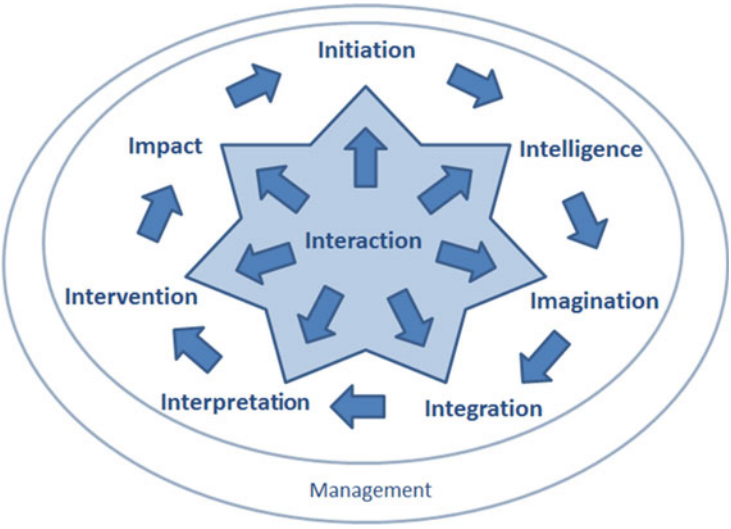

Fig. 2.2 Phases of ForSTI. *Note*: these are not to be taken as a strict sequence. There may well be both "snakes"—jumps back to "earlier" phases—and "ladders"—jumps forward to later phases—in practice

earlier ForSTI activity. In the Initiation phase, plans for the other phases need to be put in place.

- **Intelligence**: Scanning and surveying phase, establishing basic knowledge about trends, about the results of other studies and the views of major stakeholders, etc. While this is liable to be most intensive early on, some ongoing activity of this sort will be required through the exercise, since new developments may come into view. Indeed, the activities associated with all of the phases may be undertaken "out of sequence" as occasion demands.
- **Imagination**: Creativity and modelling phase, in which efforts are made to grasp the underlying dynamics of the focal object(s) of the ForSTI activity.
- **Integration**: Appraisal and visioning phase, in which the possible futures arising from the dynamics and developments that have been considered are delineated.
- **Interpretation**: Strategy and prioritisation phase, in which the implications of the preceding steps are examined, especially in terms of what these mean for achieving the major objectives of the sponsor and other stakeholders.
- **Intervention**: Action phase, where proposed strategies, priorities, and next steps are outlined and communicated to—or deliberated with—key actors.
- **Impact**: Evaluation and embedding phase, where the extent to which the ForSTI activity has been useful, and achieved its objectives, is assessed and specification for follow-up or extended activity is laid out.

In addition, and somewhat outside the cycle of the other phases, is:

- **Interaction**: this is not so much a specific phase as a continual activity that takes different forms across the exercise, for example it particularly involves Recruitment of stakeholders early on, and engaging their ongoing Participation later. It is put at the centre of the diagram because various forms of interaction are required at successive phases of the ForSTI process.
- The process also needs to be **managed** throughout; this is another form of interaction, but because of its pervasive nature it is represented here as enclosing the whole process.

The chapters of this book roughly follow this schema. Accordingly, the Initiation phase, in which the decision to undertake a ForSTI exercise is being taken, and its broad parameters established—what the objectives and topics are to be, what resources will be available, who is responsible for what—will be considered in the next chapter, when we will also touch upon some more general management issues that span the whole exercise. We then discuss some general methodological issues surrounding Interaction, especially matters connected with engagement and participation. Then, the following chapters each tackle a method, or a range of methods, associated with the later phases of the process—though many methods can be applied in more than one phase.