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Final Report of the FORMAKIN Project

TSER Programme
Stage II

Work Package 5/6
Jan 2001

Foresight as a Tool for the Management of Knowledge Flows and Innovation (FORMAKIN)

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Contents

Part 7. Annexes (Country Case Studies)

See separate volume

Abstract

This is the Final Report of the FORMAKIN project that evaluates the role of foresight as a tool in the management of future-oriented innovation. Foresight is located within a wider analysis of innovation, forming an important element of future-oriented co-ordination activities. Configurational dynamics are described as either close or loos-knit and are on the one hand shown to be determinant of foresight's utility yet also disturbed or enhanced by foresight. The empirical analysis demonstrating this is based on studies of configurational relations and foresight-type processes in health informatics and genetics fields in the Netherlands, Spain and the UK. A number of implications for the model of Foresight, its relation to technology fields and its evaluation are derived, as are key policy conclusions, including a challenge to the notion of a European Foresight programme.

Part 1

Executive Summary

1. Introduction

National science and technology policy regimes have engaged in various foresight activities as a means of stimulating innovation and growth. However, how foresight affects the technology strategies of organisations in specific innovation systems and subsequently how these changed strategies link up to a more co-ordinated innovation system is little understood.

The FORMAKIN project fills this gap by analysing the use of foresight around the development of medical technologies in the Netherlands, Spain and the United Kingdom. The study shows how an understanding of inter-organisational dynamics provides us with a much better grasp of those contexts within which Foresight is *more*, or *less*, likely to play a role in managing innovation.

For the FORMAKIN project, the following working definition of Foresight has been formulated: foresight is *a purposefully organised process bringing together expectations of diverse actors about a technology, to formulate strategic views about the future that take into account broad soc*ial and economic developments. The FORMAKIN project considers foresight as part of a wider category of *future oriented co-ordination activities (FOCA)*.

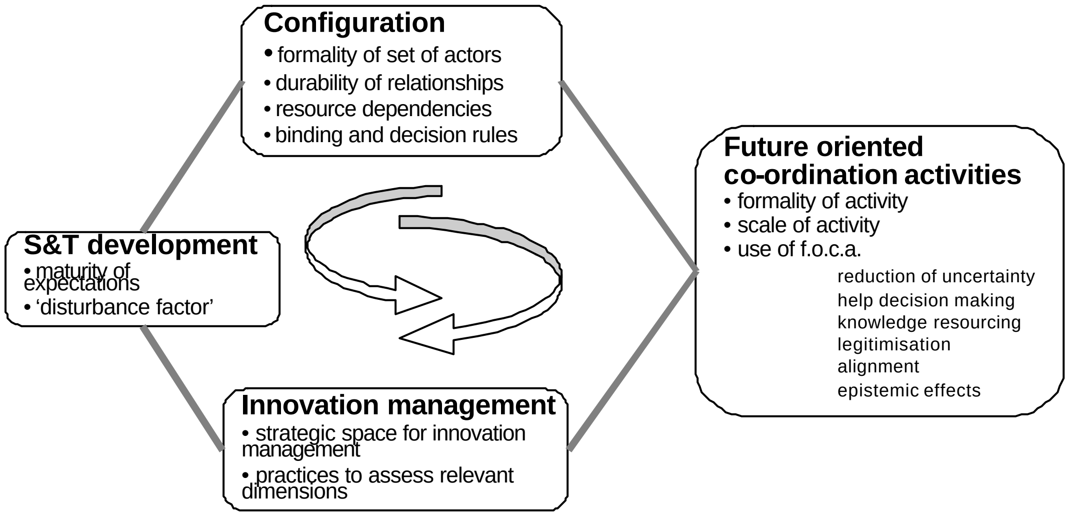
1.1 Project objectives

The main objectives of the FORMAKIN project are:

- to understand how socio-economic actors deal with complex foresight environments and the impact these environments have on the specific development of innovation, principally with regard to health informatics and new genetics in the health and life sciences.
- to understand the formal and informal processes and practices associated with foresight in managing innovation and knowledge in distinct European contexts, comparing those having and those still without a formal Foresight Programme
- to determine the role of foresight in balancing the priorities of different public and private constituencies involved in innovation
- to determine the context dependence of future-oriented coordination and to provide recommendations relating to an improved use of foresight

The *country* case selection (the Netherlands, Spain and the U.K.) was made in relation to the 'differentiated systems' design which is based on a set of cases which are highly diverse but among which the analysis traces similar processes of change.

Chart 1: FOCA in the Context of Innovation



1.2 Conceptual framework

The project is based on a thoroughgoing analysis of innovation, since this is the target for FOCA-type practices such as Foresight. We argue that there are, primarily, four core dimensions to the process of innovation, *viz.* the scientific and technical level of development within a specific field or sector, the opportunities for and management of innovation spaces that open up in that field, the pattern and subscription to future oriented co-ordination found therein and the configurational, or inter-organisational relations that characterise the area. These four are seen to interact and shape the relative significance of foresight as a tool for managing innovation.

The chart below summarises the model developed during the FORMAKIN project to characterise the key dynamics of the innovation system.

Foresight is found within the *FOCA* dimension to be deployed to serve innovation management purposes and as such be seen to be mobilised across an existing configuration, or to help in building a new configuration, perhaps in this way acting as a means through which innovation actors construct a stable account of the future.

The fourth dimension, *configuration*, is especially important for it emphasises those transorganisational dynamics that determine the significance of foresight as a tool for the management of knowledge and innovation. We focus therefore on the relationships between organisational innovation and what we want to call the 'configurational' arrangements in different countries for different medical-technological developments.

Configurational relations can be distinguished in terms of two ideal types, one we call 'close-knit' and one 'loose-knit' in terms of the overall degree of integrative and co-ordinating dynamics embedded within it. A close-knit configuration is made up of a stable, complex network of public and/or private organisations with high levels of alignment, regulation and co-ordination. A configuration made up of loose, transorganisational de-centred relations displays weak institutional integration and underdeveloped regulation and governance structures. There may be configurations that exhibit a mix of dimensions: this is particularly likely during the early stages of development of a new technological regime where formalised standards may have been established but are yet to guide localised practices or rules of behaviour.

Table 1 **Configurational Type**

	Close Knit	**Loose Knit**
Formality of relations	Extensive	Limited
Durability	Long-term	Transitory
Resource dependency	High	Low
Binding rules	Articulated/strong	Weak

The importance of the distinction is that we might expect differences in the way close and loose knit configurations respond to innovation and are sensitive to the outcomes of foresight activities, which is what we are trying to understand. Close-knit configurations may in fact be resistant to innovation if they generate overly specialised, closed networks: such networks can become a barrier to knowledge sharing since experts tend to have their own knowledge bases, language and approach to problems and opportunities. In contrast, loose-knit forms may be unable to build innovative momentum.

1.3 Methods

In order to generate data that are related to the range of variables identified above, we used two main techniques: semi-structured face-to face interviews, and telephone interviews (c. 150 in total). Interviews were transcribed locally in domestic languages, but the first level of data analysis was exchanged across the research teams. The interview protocol was created in such a way as to allow us to secure data relating to each case, and within each in terms of the key analytical categories thrown up by the operationalisation of our four core conceptual dimensions - scientific and technical development, innovation management, FOCA, and configurational relations. Other sources of data include secondary literature, and attendance at both academic and respondent-based conferences or events. These techniques were deployed within the context of a number of case studies.

1.3.1 Case studies

The research design focused on two areas in the informatics and genetics fields, *viz*. the electronic patient record (EPR) and telemedicine in health IT, and genetic diagnostics and gene therapy in the genetics sector. The selection of the two fields allowed us to cover the clinical, managerial and research-driven agendas of the constituencies as they engage with and shape the new technologies; they are also areas which encompass both public and private sector actors, notably in a *transorganisational* dynamic, thus enabling us to determine the emergence of new networks and transorganisational rules binding actors within new configurations. These case studies were chosen to allow for a longitudinal analysis of the role and use of future oriented co-ordination activities for innovation management purposes.

1.3.2 The Fields

The accounts of the two broad fields given below are based on claims and projections made by actors in each of the technology areas of the promise and potential that they have. They are powerful social narratives that have worked to define and redefine the promises found in each of the areas.

1.3.2.1 Genetic diagnostics and therapeutics

Genetic diagnostics is the generic term for a number of diagnostic techniques that are related to the detection and prediction of, and possible remedies for, congenital and hereditary diseases. The most striking feature of these techniques is that they make it possible to foretell the presence of future pathologies, whether in the foetus or adult, long before symptoms are expressed. These new anticipatory techniques have created circumstances in which 'at risk' individuals can be presented with complex reproductive decisions, based on probabilistic genetic information, aimed at limiting the inheritance of pathologies. It is for this reason, undoubtedly, that genetic diagnostics is expected to have an enormous impact on the future of health and medicine.

Foresight studies on the future of genetics can be seen to depict a clear trajectory from the present diagnostic practices towards an understanding of the mechanisms of diseases at the molecular level and the development of genetic therapies affecting these mechanisms. The overall picture these reports give is that though technological developments are uncertain, clear expectations exist on the promises of genetic diagnostics and treatment. These expectations exhibit a specific trajectory in time, though some barriers and uncertainties for future genetic technologies are generally acknowledged, especially in the societal reception, regulation and infrastructure for the technologies.

1.3.2.2 Health Information Technology

The second field is that of health information technology. This technology can be characterised as a diverse set of activities oriented to the management and circulation of medical information amongst clinical providers and research communities. These activities are all based on the shared expectation that information will increasingly shape the management, delivery and diagnostic capacities of health care and the life sciences. It is possible to characterise the field in terms of three – increasingly related – areas of activity, medical informatics, telemedicine, and the electronic patient record. For the FORMAKIN project the last two provide the basis for our case studies, since both have been particularly rich sites where transorganisational, inter-professional and patient interests have been articulated.

The defining attribute of telemedicine is the extent to which applications of health information technology centre on spatial and temporal changes to health/medical organisation, referral and patient consultation. The second area, the Electronic Patient Record (EPR), is a key part of the health information agenda of most advanced contemporary healthcare. The electronic patient record (EPR) is increasingly seen as both a means of organisational transformation in the integration of care services (across primary and secondary care) and also, a means of enforcing equitable parity in standards. Most scenarios for future healthcare draw particular attention to the increasing shift away from paper-based records and towards an information infrastructure able to safely sustain the health records of whole populations.

1.4 The use of foresight in different configurations

Chapter 4 of this report examines the use of foresight-type practices in different organisational contexts and configurations discussing the role of formal practices as vehicles for future oriented co-ordination. We pay particular attention to the configurational dimension since it concerns those transorganisational dynamics which we argue are most significant in shaping the circumstances in which Foresight might be *more*, or *less*, useful as a tool for managing innovation. Transorganisational dynamics have to be examined through reference to the national settings within which health R&D and delivery occurs.

In the *Netherlands* while the organisations that comprise the health RTD and delivery systems are distinct and have their own agendas and sets of priorities for health delivery and RTD. The generally high level of institutional aggregation that prevails has generated a situation in which co-ordination and priority setting derive from a dense, intermediate network exhibiting strong interdependency. This in turn creates strong pressures towards institutional stability such that developments in fields such as the new genetics and informatics will - as far as possible - be incorporated within existing arrangements.

Thus, health genetics and especially diagnostics have been the preserve of clinical genetics network centred around a small number of national centres for testing which have been central to setting the agenda for genetics and containing and managing the wider public uncertainties and expectations that are associated with it. More recently, this monopoly has been challenged by the arrival of new interests through networks keen to explore multifactorial diseases led especially by researchers in oncology, pathology and specialists in coronary heart disease in academic hospitals throughout the country. Furthermore clinical chemists in regional hospitals have been successfully challenging the monopoly, now that DNA diagnostics is not necessarily a complex technology and now that DNA diagnostics does not necessarily imply ethical questions linked to heredity (as is the case for somatic DNA diagnostics). This may have the result of opening up the well-established professional domain of clinical genetics and, or creating a discrete novel network with its own alignment dynamic at work, so opening up and mobilising new expectations for the future.

In Dutch informatics, there is an important difference between the development of telemedicine and the development of the Electronic Patient Record. Apart from some not so influential departments within the Ministry of Economic Affairs, there are hardly any attempts to promote telemedicine. For the Electronic Patient Record the situation in the Netherlands is fairly comparable with that for telemedicine in the UK. The Ministry of Health is the most important promoter while the enrolment of healthcare professionals will determine the development of the field; considerable socio-technical work is being done to develop standards and create alignment - though it is highly problematic to achieve these; moreover, the development is very resource extensive with resource dependencies spread across a wide, heterogeneous set of actors; and pilot projects act as important testing grounds for building shared expectations and agendas.

In *Spain*, the organisational structures for health RTD and healthcare delivery are quite different. On the one hand, healthcare delivery is made up of component parts enjoying considerable degrees of autonomy from each other because of the separate regional healthcare services. On the other hand, priority setting for health RTD and funding sources are co-ordinated by the central government. Overall, this produces a loosely co-ordinated system with strong regional autonomy. Consequently, the developments in fields such as genetics and informatics are conditioned by these environments, especially in terms of technology adoption and diffusion.

Spanish genetics can be characterised as a "science push" sector where expectations are created by the research actors, and the development of the sector is highly dependent on the clinical genetic researchers themselves. Most units and centres have emerged as a specialisation within other medical fields: notably biochemistry, obstetrics, paediatrics, clinical pathology and haematology. The creation of genetic services and research in health genetics (diagnostics and gene therapy) are the result of the initiatives of key individuals with a personal interest in promoting and pursuing research and development in this field. These research actors must overcome difficulties due to the lack of health policies to manage or control these genetic services and the fact that formal training in clinical genetics must be obtained abroad. Private interest and investment in genetics is minimal. As a result health genetics is a relatively loose–knit configuration of primarily public research groups.

As for informatics, the innovation strategies of firms are highly dependent on the policies of regional healthcare services. While telemedicine has been more experimental in nature, some hospitals in Spain have adopted or are developing electronic patient records systems. Because of the highly independent regional healthcare services, opportunities and local initiatives have flourished. Both configurations are relatively close knit and their inter-organisational FOCA centres on the professional association of health informatics (Spanish Society of Health Informatics, SEIS).

In the *UK*, there has been considerable energy invested in health policy circles to co-ordinate health research and delivery across the NHS, driven in particular by a discourse of rational and effective health intervention. Co-ordination does not, however, simply depend on the adoption of best medical practice since the NHS is made up of discrete interest groups - public health, service delivery, operational research, medical professions, policy units and so on - that can define priorities and problems in quite distinct ways. Nevertheless, the advent of clinical evaluation agencies such as NICE (National Institute for Clinical Excellence) and future technology groups such as NEAT (New and Emerging Applications of Technology) indicates the health Department's desire to manage both the promise and costs of health innovation. In the case of the impact of new genetics, for example, the Department has recently undertaken a strategic review (to be published in December 2000) on the implications of genetics for the NHS.

Health genetics has a strong, resource intensive network aligning the pharmaceutical, academic, health care and government constituencies that are closely involved in arrangements for the production and sourcing of data and the development of clinical trials. Extensive formal and informal links, allied to a high degree of contractual and proprietorial rights reflects both strong steering and aggregation processes at work. However, there is considerable attention being given to enrolling the public and patient groups into the genetics agenda, since they are seen as most likely sources of resistance to the new technology.

In health informatics, reforms introduced by the new Labour government in 1997, have led to considerable socio-technical work invested in building a consensus around standards. Nevertheless, there is still considerable unevenness in the clinical response to and take up of telemedicine, even though in its informational form - i.e. as NHSDirect - this has almost achieved national coverage. While diagnostics is resource intensive, telemedicine is much more resource extensive with resource dependencies spread across a much wider, heterogeneous set of actors at national, regional and local levels within the NHS. Many of these actors will be new to the health care market - such as ICT/telecomm firms - engaging with the sector through pilot projects which act as important testing grounds for building shared expectations and agendas. Purchaser-supplier links are, therefore, important conduits through which expectations can be mobilised. In light of the this, Table 2 below summarises the broad pattern of configurational relations for each field and their two sub sectors for the three countries.

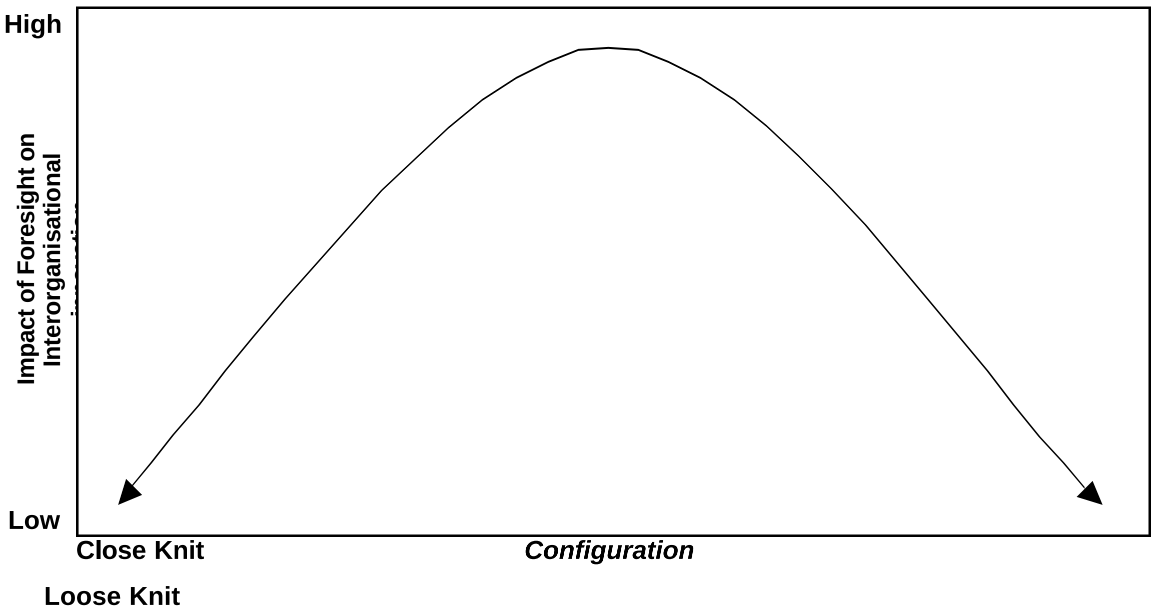
Table 2: Configurational relations in the Netherlands, Spain and the UK Genetic Technologies & Informatics

<table>
<tr><th></th><th>Genetic diagnostics</th><th>Gene therapy</th><th>Telemedicine</th><th>EPR</th></tr>
<tr><td>Netherlands</td><td>Close knit (but opening up)</td><td>Loose knit (but becoming more close knit)</td><td>Relatively loose-knit</td><td>Relatively loose knit</td></tr>
<tr><td>Spain</td><td colspan="2">Loose knit</td><td>Relatively close-knit</td><td>Relatively close-knit (though tensions between regional/national levels)</td></tr>
<tr><td>UK</td><td>Relatively close-knit</td><td>Close knit (though centred on a small number of groups)</td><td>Relatively loose-knit</td><td>Relatively close knit</td></tr>
</table>

The exploration of these patterns enables us to understand how configurations relate to the utility and impact of formal Foresight programmes in fostering and managing innovation. While the basic technical characteristics of a specific field - such as informatics - may be common across countries (given the increasing globalisation of markets and standardisation and regulation of products and processes at the international level), our research shows that the pattern of future oriented innovation strategies for behaviour in these fields is quite distinct *within* and *between* countries because of the different configurational relations we have found. The role of Foresight in close-knit configurations in shaping innovation management or in influencing or changing the positioning of actors - such as the traditional health genetics community in the Netherlands - is very low. The actors, although aware of the developments, have a strong sense of being in control resulting in the remarkable situation that genetic technologies have hardly been adressed by foresight activities in the Netherlands. At the other end of the configurational type, the loose knit configuration, we find a similar difficulty for Foresight having a role in the innovation processes, but for different reasons. For example, in the case of Spain, although the actors link up with the broad expectations on genetic technologies, the interorganisational structures are too thin to foster any move towards or perceived need for further co-ordination at a national or regional level nor do the foresight results from abroad have sufficient impact to develop such interorganisational relationships.

If the relationship between configuration and the role of foresight was a linear one, the results at the two extremes would imply that foresight was not of any use. However, the real examples where foresight is of use in innovation management at the level of configurations can be found in between these two extreme configurational types. In these configurations we find patterns of developing interorganisational co-ordination or of opening up of close networks in order to respond to external developments. Examples are found in the case of telemedicine, where Foresight and related future oriented coordination activities have helped to bridge innovation agendas and interests in telematics and the various actors in the health sector. The consequence is that the relationship is something like a bell shaped curve as in Chart 2 below. This chart shows a simple curve which describes the different ability and motivation of close and loose knit interorganisational configurations to engage with and find value in Foresight activities.

Chart 2: Relationship between the relevance of FOCA and the configuration



The shaping of configurations by Foresight

While the Chart above suggests how configurations as the independent variable might determine the utility of Foresight, we also argue that foresight itself can *change* configurations: through foresight, configurations might become more flexible and robust at once, and actors are able to reposition themselves within that configuration. We show this by exploring the two fields through six thematic cases that examine different factors shaping the fields' development and the role that Foresight has in this regard.

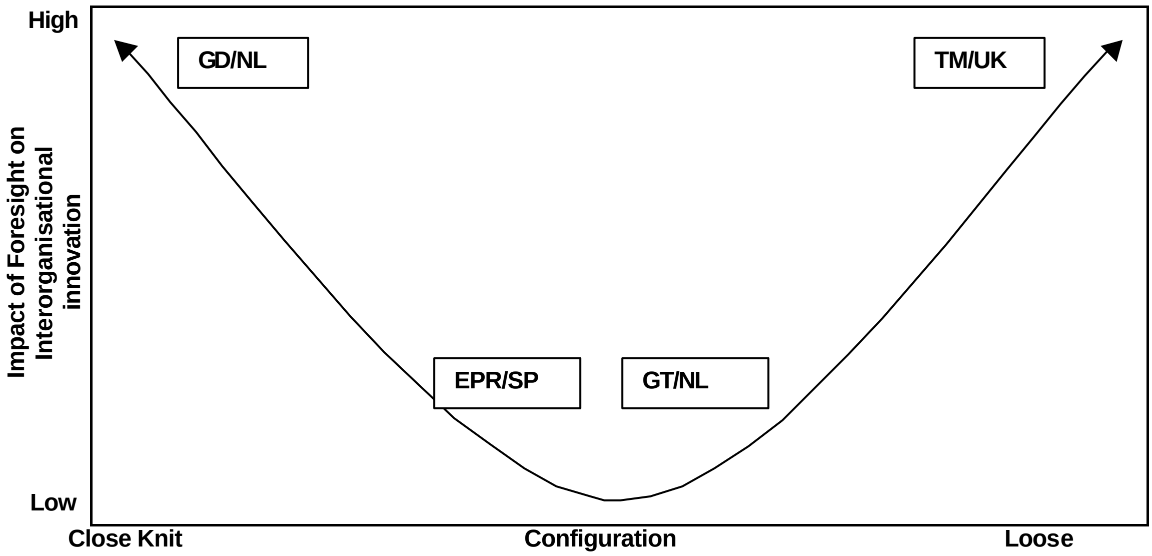
These **six thematic cases** discuss the role of foresight in:

- repositioning a field under threat (UK gene therapy)
- the construction of new 'social' markets (UK telemedicine)
- repositioning over-ambitious expectations (Dutch gene therapy)
- helping to bridge between the innovation ambitions of economic and academic actors and the institutional constraints of health service delivery (Spanish EPR and telemedicine)
- the play of professional interests in framing a new field (Dutch and Spanish diagnostics)
- the internal and external strengthening and creation of relationships within firms and between them and public constituencies (UK diagnostics).

In each of these the focus is on the degree to which formal foresight or FOCA practices help to redefine configurational relationships. In some cases - such as in UK telemedicine and Dutch and Spanish diagnostics – it is shown that FOCA have had a significant impact, but that elsewhere - for example, in Dutch gene therapy - there is some disjunction between expectations among actors in the configuration.

The analysis of thematic cases leads us to conclude that we can identify a broad relationship between foresight practices and changes in interorganisational relationships as summarised in Chart 3 below.

Chart 3



In those configurations which are dysfunctionally too close or too loose or fragmented, foresight can act to either break up - as in Dutch clinical genetics - or converge - as in UK telemedicine, or, to a slightly lesser extent, UK diagnostics, for example - the relations between innovation actors. Where configurational relations are - at least according to the idealised model represented here - intermediate betwen these two extremes, FOCA is likely to have very limited impact on interorganisational dynamics since we can expect it either to be merely echoing already existing forms of FOCA, or, as in the case of Dutch gene therapy and Spanish EPR, play a more marginal role in a context where relations exhibit relatively high levels of *resource dependency* but where *binding and decision rules* within the configuration are yet to stabilise.

1.4 Conclusions and policy implications

There are a number of important conclusions of the study:

- Foresight as a form of government-sponsored future oriented co-ordination activity has little impact on the management of innovation *within* organisations, whether they be public or private

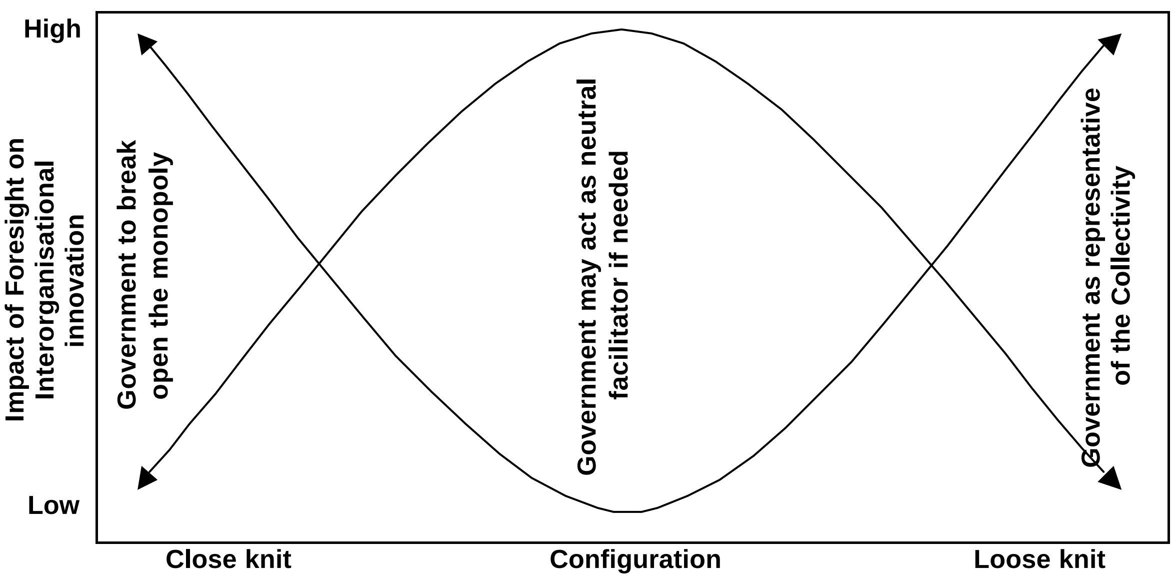
- Its impact on inter-organisational innovation relations will depend heavily on the type of configurational relations found therein (between the ideal types of close- and loose-knit forms)
- It can, however, have some important influence on configurational patterns themselves, and disturb, enhance or help co-ordinate relations between different innovation constituencies
- In short, its real value lies in its capacity to foster new forms of *inter*-organisational co-ordination.

1.4.1 Implications for the role of government in Foresight

There are some configurational contexts where formal FOCA-type initiatives orchestrated by government, such as Foresight, might well be redundant inasmuch as they are duplicative of similar types of future-oriented innovation strategy and discourse. Elsewhere, however, they can play a major role in disturbing configurational relations and fostering innovation.

The contexts where we find these two circumstances were represented graphically, and respectively, by Charts 2 and 3. These representations need to be brought together since configurational relations are dynamic, and shaped by developments in the three other dimensions of innovation. Chart 4 does this and immediately points us towards those contexts where actors derive most benefit from Foresight.

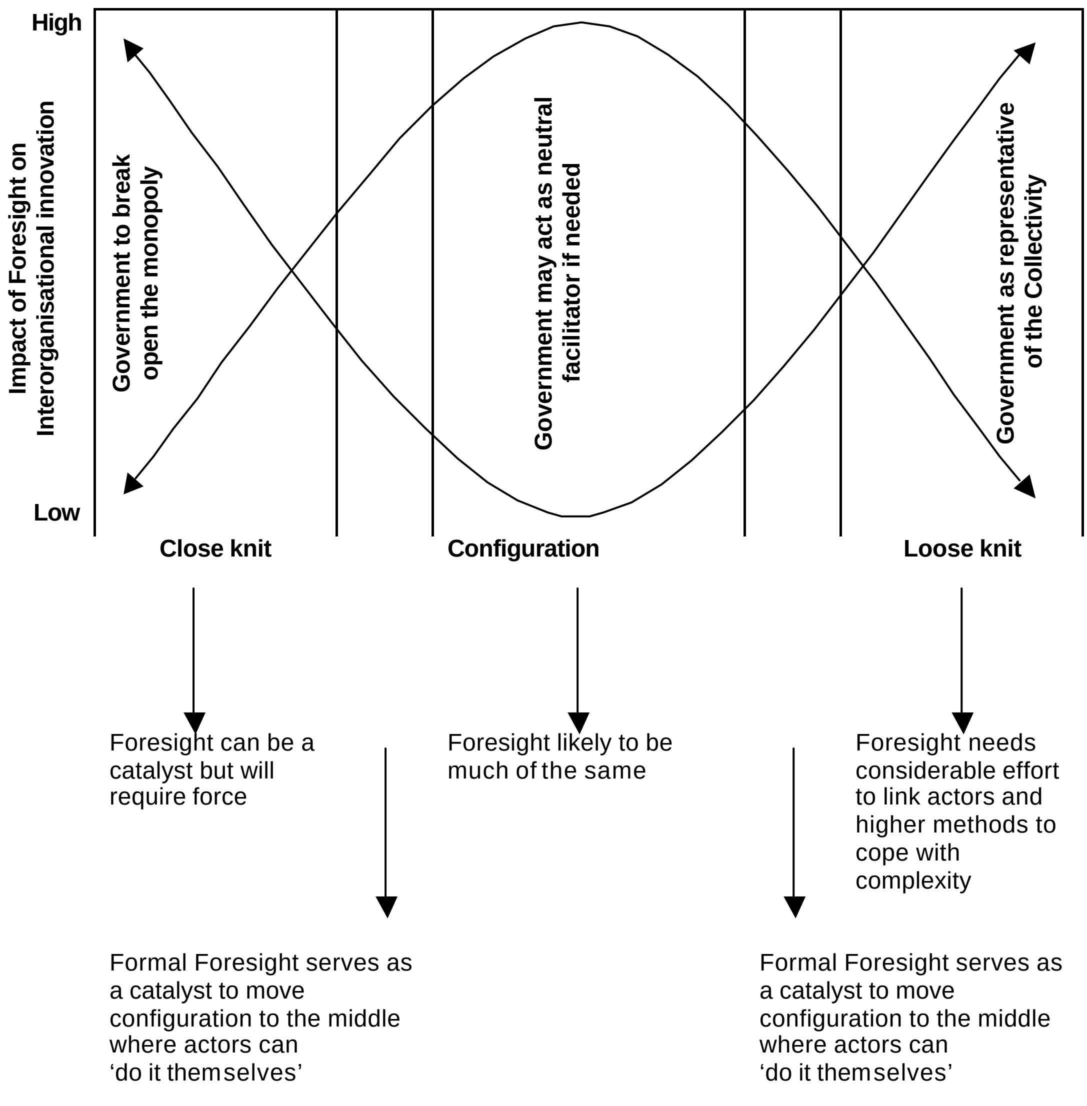
Chart 4



At those points on the graph where the two lines meet we would expect to find the *highest* return. These areas represent those configurational relations that are most susceptible to FOCA as a way of managing innovation. In other words, we can expect that the four aspects of configuration – binding rules, formality of ties, resource dependencies and decision-making - are either open to disturbance or to more effective co-ordination.

The Chart also reveals those contexts where investment in Foresight-type activities is likely to have very *little* real impact. Finally, configurational relations found within the intermediate region, suggest that formal government-sponsored FOCA is likely to have very limited influence.

Chart 5 - The Impact of Foresight



Method	(positive/negative)				
Panel	neg	pos	pos	pos	neg
Delphi	neg	neg	pos	neg	neg
Scenario	pos	pos	pos	pos	pos

1.4.2 Implications for the deployment of Foresight methods

What implications does our analysis have for the methods that might be more usefully deployed in different configurations? We can answer this question graphically by mapping conventional foresight techniques onto different parts of our existing account. Chart 5 does this in some detail and shows how *selective* use of foresight methods is to be encouraged since some, rather than others, are more appropriate to the prevailing configurational relations.

So, for example, in a close-knit configuration (such as Dutch genetic diagnostics) where the configuration sets fairly tight boundaries as to both its reference group and future R&D agenda both Panel and Delphi initiatives simply reconfirm such an agenda. However, scenario studies might well generate some important institutional and organisational issues that anticipate the erosion of the configuration's monopoly. Government-supported scenario work would, therefore, be the more relevant activity in this set of circumstances.

These arguments mean that foresight-type activities should not be seen simply as a range of tools sitting on the policy shelf that can be deployed one after another, or simultaneously, or as part of a broad foresight movement that will have additive effects in a single, positive direction. On the contrary, apart from the situation defined by the middle area of the chart, it is evident that some tools might well work against each other and undo the value of each other. Instead, these tools need to be chosen only after some consideration has been given of the actual character of the configurational type into which they are to be introduced.

There are three broad sets of implications we want to argue derive from our study: these relate to the Foresight model itself, specific fields of technology, and how foresight activities are to be evaluated.

With regard to the **model**:

- Foresight policy should explore the innovation potential of technology fields by understanding the configurational relations therein, based on a recognition that across countries, the 'same field' might have quite *different* futures in different member states. The temptation to 'import' Foresight analyses and agendas from other countries should be discouraged by the Commission.
- a common European Foresight programme is untenable given the variation across countries in configurational types
- it is inappropriate for all member states to adopt a formal government sponsored programme to ensure FOCA informs innovation management

In terms of our **understanding of technology fields:**

- it would be sensible to look at the capacity within innovation networks for self-co-ordination by actors in a public/private innovation 'niche'
- the four dimensions should help to reveal which networks fall into what category such that the most appropriate method for foresight-led intervention can be adopted

- interventions in either loose or close-knit contexts require considerable policy investment at national and regional levels.
- the approach taken in our analysis applies to non-health fields too: configurations are neither country nor sector specific, and thus we are able to recommend the use of the configurational approach as a methodological 'tool'

In terms of how we **evaluate** Foresight:

- changes need to be measured in terms of quantitative assessment of network links and resource mobilisation and qualitative assessment of network durability over time and the emergence of new rules of network membership
- the relative utility of different Foresight methods should be determined in different configurations to construct a more sophisticated intervention strategy
- 'moments' in configurations where movement from modest to more expansionary innovation steps are taken should be explored to ask whether Foresight has played a key role in helping these changes to take place

There are a number of ***policy recommendations***

- it is more sensible for Foresight initiatives to *focus less on technological and more on social priorities which can be served by appropriate technologies*
- it would be worth *looking at sectors from different analytical* perspectives to determine how Foresight might best be deployed in helping to manage future co-ordination
- *priority should be given* not to assisting firms with new technologies per se, but *to helping firms stabilise networks and so markets*
- *argue against* the suggestion that it is possible to build *a pan- European Foresight programme*
- we recommend *a more selective use of foresight methods* should be encouraged.

1.5 Dissemination

During the period of the project the dissemination strategy has comprised a series of academic papers, presentations to policy communities and networking through Foresight agencies with which the team is linked, either formally or informally. The strategy has been to explore results as they have emerged at regional, national and international levels through formal and informal meetings with policy practitioners, academics, industrial representatives and health agencies where appropriate.

At the international level, presentations have been made to IPTS, Seville, the FOREN STRATA network (Rome), an international research workshop on Foresight hosted by the University of Twente, an EU conference on Foresight at Madrid and at European Association for the Study of Science and Technology conferences in Lisbon (1998) and Vienna (2000).

At the national level, the Dutch team has disseminated results through links with the Royal Academy of Arts and Sciences, the Advisory Council on Science and Technology Policy, the two bodies formally responsible for foresight in the Netherlands, on the results of the study and on consequences for their role in foresight and the NWO (Dutch Research Council). The Spanish team have developed close links with the Fondo de Investigaciones Sanitarias (FIS), which manages the research and training funds and activities of the Spanish Health Ministry's R&D Programme, with the pharmaceutical sector through the association with FARMAINDUSTRIA, and with the Ministry of Industry and the CDTI (Centro para Desarrollo Technologica Industrial). The team has also been advising the Spanish government (The new Ministry of Science and Technology) on Foresight issues and S&T policy planning. As a result the team has been appointed as members of the EU high-level expert groups for the ERA and VI FP. The UK team has participated in telemedicine and health biotech networks in the UK eastern region, were contracted by the European Parliament to review the future development of Bio-informatics in Europe, as well as by the UK's ESRC to provide a report on the future of biotechnology and ICTs in the UK. They were also recruited to the UK government's Foresight Health Care.

Outputs: Ten academic papers, one book and 15 presentations have been made related to the project (see full report for details).

Dissemination during 2001 is summarised in the following chart.

Output	***Lead***	***Activity***
Results	*Co-ordinator*	*Disseminated through FP V's IST and Quality of Life (especially 'socio-economic aspects of life sciences and technologies') programmes;*
	All partners	*Dissemination of results through national policy agencies*
	All partners	*Dissemination via international Foresight event and regional development, Rome, 2001*
	All partners	*Web-based dissemination via partner institution's home pages and links to CORDIS sites as appropriate*
Planned papers	*All partners*	*The comparative construction of the utility of Foresight exercises across countries and sectors*
	SATSU	*Foresight , utility and in the non-medical sectors*

Part 2

Final Report: FORMAKIN results and analysis

Chapter 1: Foresight - understanding its impact

Over the past decade or more, different national science and technology policy regimes have engaged in various foresight activities as a means of stimulating innovation and growth. The basic idea of foresight is that key actors of the national innovation system are brought together and that through the formulation of scientific and technological challenges and economic and societal research needs, co-ordination within the innovation system improves and as a result a country's economic competitive position. The inspiration of most of these activities goes back to the two seminal studies of Irvine and Martin in which they map early foresight and foresight-like experiences in a number of countries, and in which they specifically pictured Japanese foresight experiences as a model for other national S&T policies.[1]

Since then, a range of articles and policy studies have appeared on the new foresight processes. Most of these studies describe the formal processes through which expectations and interests of a wide range of actors are brought together and translated into lists of critical technologies, research priorities and recommendations for S&T policy and the like. Few studies have tried to analyse and understand the dynamics by which foresight would impact on the technology strategies of organisations in specific innovation systems (especially, but not only, sectoral ones), and subsequently how these changed strategies link up to a more co-ordinated innovation system.

The FORMAKIN project fills this gap by analysing the use of foresight activities around the development of medical technology in three European countries, the Netherlands, Spain and the United Kingdom. Our objective therefore has not been to represent foresight as a universally necessary mode of Science and Technology policy. Instead, this study shows how an understanding of those inter-organisational dynamics provides us with a much better grasp of those contexts within which Foresight is more, or less, likely to play a role in managing innovation. That is, by identifying the specific interorganisational features of differing innovation contexts, policy is better equipped to determine when foresight-type initiatives are or are not likely to be of relevance in stimulating innovative activity.

This report, Workpackages 5/6 of the FORMAKIN-project, presents the results of the eleven case studies from the analytical framework that has been developed during the project, and proposes a model that can be used to determine the potential and actual utility of Foresight.[2] It offers in

[1] Irvine, J. and B.R. Martin (1984) *Foresight in Science: Picking the Winners*, London: Pinter Publishers; Martin, B.R. and J. Irvine (1989), *Research Foresight: Priority Setting in Science*, London: Pinter Publishers.

[2] We defined four case studies for each of the three countries, but because two case studies in Spain were

the final chapter, a number of policy recommendations (as WP6) the Commission and its member countries should consider, based on a more targeted delivery of Foresight itself.[3] Through an enriched understanding and consequently better use of foresight, the management of innovation by public and private actors (industry, government, universities, public groups, and intermediate organisations) can be improved.

1.1 What is foresight?…

"Foresight is a process by which one comes to a fuller understanding of the forces shaping the long-term future which should be taken into account in policy formulation, planning and decision-making. Foresight includes qualitative and quantitative means for monitoring clues and indicators of evolving trends and developments and is best and most useful when directly linked to the analysis of policy implications. Foresight prepares us to meet the needs and opportunities of the future. Foresight in government cannot define policy, but it can help condition policies to be more appropriate, more flexible, and more robust in their implementation, as times and circumstances change." (Coates 1985, pp 30 and 33)

This often quoted definition of foresight from Coates is helpful in presenting foresight as a possible tool for S&T policy. It gives less insight, however, into the dynamics of foresight and the way it accomplishes its promises. How are futures defined through the various means? How do they relate to organisational strategies? And why is it that policies become more flexible as well as robust over time? To answer such questions, a definition of foresight is needed which captures the *processes* of foresight, rather than its different elements and ambitions.

For the FORMAKIN project, the following working definition has been formulated: foresight is *a purposefully organised process bringing together expectations of diverse actors about a technology, to formulate strategic views about the future that take into account broad social and economic developments.*

Hereby we restrict the meaning of 'foresight' to a limited set of undertakings, which are usually designated by a specific term and usually, but not necessarily, involve specific methods. The FORMAKIN project considers foresight as part of a wider category of *future oriented co-ordination activities (FOCA).* This term is meant to refer to a rather general set of processes, events and products, which have in common the fact that they bring together, or co-ordinate, different views and centre on future expectations. These might include, for example, a national forum organised around the battle against the millennium bug; a meeting of a university's department heads to determine a common research development strategy; but also a five-year plan for the Malaysian economy. Therefore, FOCA is a group of social and organisational activities or practices whose objectives are co-ordination and connection of the present with the future.

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not sufficiently independent for a comparative analysis the total number of cases is eleven, rather than the twelve we intended.

[3] Chapter 6 also forms Workpackage 6 of the FORMAKIN project

Within this category of future oriented co-ordination activities, there is a certain portion that is of central importance in the FORMAKIN project. The phenomena that are studied in the project – albeit together with a much wider context, that thus also belongs to our domain of study – can be described as follows: *the bringing together of expectations on developments related to one or more specific field(s) of technological innovation*. It is clear that those exercises in S&T policy that are usually identified as foresight are part of these. But the definition allows us to include similar processes found within S&T policy in our analysis, which, although not called foresight, are as important for organisations for their strategic positioning and as future oriented as the explicit foresight exercises.

1.2 …and how to understand its impact

The research project develops from the assumption that foresight-type activities have a sustained prominence in contemporary science and technology policy, but with, as yet, an underdeveloped knowledge of its context-dependent utility value. Foresight is typically seen as an information tool to align innovation strategies of different organisations in innovation systems, to improve the capability of actors dealing with innovations and, as a consequence, to improve the competitive position of the system and its actors. The objectives behind foresight spring from the perception of technological innovation as an organisational process, taking place within (national) systems of innovation. Foresight activities assume that these innovation processes can be optimised by stretching the time horizons of the actors and by aligning expectations or scenarios of technological development.

The FORMAKIN project interrogates these assumptions by focussing on two medical technologies, genetic technology and health informatics, which are thought to have a considerable impact on innovation, on the market for health technology and on health care practices. Although there is general consensus around the significance of these technologies for health RTD and practice, the extent of the actual impact is indeterminate and especially in respect to long term implications. Medical technology is also a field in which innovation depends on the activities of universities, firms, governments and health care organisations alike. In other words: if there is a role for foresight as a tool to improve the management of knowledge and innovation, it certainly should be in these two fields.

Moreover, although one can identify a consensus on the general aim of medical innovations (i.e. to improve quality of life and recoup capital investment), actors within the innovation systems have different views and interests attached to that common goal. Medical researchers within academe combine these goals with an interest in moving the frontiers of knowledge and acquiring reputation within scientific fields. Firms are aiming at developing new markets and strong positions within these new markets to ensure profits and the continuity of the firm. Although many governments support these economic activities, they also have an interest in keeping the medical system effective, efficient and keeping overall budgets within reasonable limits. Within health care itself, doctors, patients and insurance companies are likely to have different perspectives on the organisation of the new care practices enabled by new technologies. Thus, there are serious questions about whether shared expectations can be developed, and if so, whether they will result in a well co-ordinated innovation trajectory among actors in the innovation field.

The conceptual framework here is built upon the assumption of foresight processes as a specific phenomenon, and frames them as a phenomenon of modern innovation processes. This implies not only that we have to investigate the assumptions of foresight, we also have to locate it within the overall dynamics of inter-organisational innovation processes and to assess its usefulness for organisational management practices, regardless of the policy assumptions. In particular, new policy tools may induce unintended effects, which can be worthwhile to maintain or even to elaborate instead of or in addition to the original objectives.

This analytical positioning of the FORMAKIN project informs the core objectives with which the project began, as in Box 1 below.

Box 1: Principal objectives of the FORMAKIN project
The main objectives of the FORMAKIN project can be summarised as follows: · to understand how socio-economic actors deal with complex foresight environments and the impact these environments have on the specific development of innovation, principally with regard to health informatics and new genetics in the health and life sciences. · to understand the formal and informal processes and practices associated with foresight in managing innovation and knowledge in distinct European contexts, comparing those having and those still without a formal Foresight Programme · to determine the role of foresight in balancing the priorities of different public and private constituencies involved in innovation · to determine context dependence of future-oriented coordination, and given this, to identify good and best practices and prepare recommendations relating to an improved use of foresight in the medical sector

The ***country*** case selection (the Netherlands, Spain and the U.K.) was made in relation to the 'differentiated systems design[4] which is based on a set of cases which are highly diverse and among which the analysis traces similar processes of change. In addition, the desire was to guarantee variation in the dependent variable, foresight thus avoiding a 'selection bias' that may weaken causal inference[5]. Therefore, we recognise that the countries differ significantly in many more variables such as size and population, income per capita, industrial capabilities and implicit models of democratic government, not to mention the three different modes of healthcare, research and innovation organisation. A thorough analysis of these country comparative attributes was undertaken and completed in Work Package 2 of the FORMAKIN

[4] Pzeworski, A. and H. Tune (1970) *The Logic of Comparative Social Inquiry*. New York: John Wiley.
[5] Geddes, B. (1990) "How the cases you choose affect the answers you get: selection bias in comparative politics" in *Political Analysis* vol. 2 (ed. J.A. Stimson) Ann Arbor: Univeristy of Michigan Press, p.131-150.

project. The analysis successfully demonstrated the usefulness of the country selection for comparative research into foresight where the central goal is to develop concepts and generalisations at a level between what is true of all societies and what is true of one society at one point in time and space.[6]

At the same time we had to conclude that looking more closely at interorganisational innovation dynamics, foresight-like activities at lower levels of aggregation appeared as important and as interesting to understand the dynamics of foresight processes. In addition to the comparison of three *national* cases, we concluded that it was needed to compare in-depth how within these three countries foresight-type practices could produce changes in technology strategies around four more specific defined medical technologies. The comparative dimensions of this study assume that, in any of its many varied forms, foresight is contingent upon specific *inter*-organisational dynamics.

1.3 Overview of contents

The aim of this report is to present the main conclusions from the analytical and empirical work we have done in the project, without presenting and repeating too much of the details of previous work packages. Our empirical work has been concentrated on the medical sector and specifically how organisations position themselves within a perspective on a further use of genetic technologies and of information and communication technologies. The eleven case studies provided us with rich material and each in itself is worth while reading. We have however decided to locate most of these case studies in the appendices, and concentrate the argument around the fundamental question: "what is the impact of foresight-type activities in the inter-organisational context of RTD actors?".

As the terms of references of the FORMAKIN project (as summarised in Box 1) have made clear already, this simple question requires some elaboration before it can be researched and consequently be answered. And as we want the answer to be more general than just be valid for the cases we explored, we also had to develop a more general framework for understanding foresight processes. The next chapter presents the conceptual model that we have developed during the project. It discusses the principal variables of the four crucial dimensions that we have identified as relevant for understanding the processes behind the development of foresight and its use: the development of science and technology, the configuration of actors in which the foresight exercise takes place, the characteristics of the foresight process itself, and the innovation management of the various actors. The chapter also summarises the methods used for data generation and coding, which were developed to compare the case studies systematically along those dimensions.

The subsequent chapters (forming Part 3) present the findings of the research project. The third

[6] Bendix, R. (1963) "Concepts and Generalizations in Comparative Sociological Studies", *American Sociological Review* vol. 28, p. 532.

chapter describes in general terms the development of genetic technologies and ICT in the medical sector as they are foreseen in many international studies on the future of technology. As such the chapter describes the arena of S&T developments in which the organisations in the three countries are developing innovation strategies, which are more or less informed by foresight processes.

In chapter four we present the eleven cases systematically and describe how foresight did (or did not) impact on the production or adoption of innovations around genetic technologies, genetic diagnostics, telemedicine and EPR in the three countries. Our case number is eleven (and not twelve, as the reader might expect), for the research on informatics in Spain indicated that both EPR and telemedicine shared a similar analytical position in our configurational categorisation. A distinctive characteristic of foresight processes is that it brings together heterogeneous actors to co-ordinate their innovation strategies and improve interorganisational relationships. Therefore we concentrate our comparative analysis on the relationship between the configuration of these actors and the impact of foresight. As a conclusion of that chapter a first part of the answer on the question on the impact of foresight is given by identifying configurational kinds in which it is more likely that foresight has some impact and identifying configurations in which foresight might be less relevant as a tool for innovation management at a systemic level.

While chapter four presents a rather linear relationship between two main variables in the conceptual scheme, chapter five analyses in greater depth the complexities of foresight dynamics. Making use of the specificity of each of the eleven cases, it analyses how expectations that are elaborated, developed and diffused within foresight processes are taken up by certain actors as a key instrument to change organisational configurations and create space (or in some cases less space) for innovation. As such the chapter results in further insight into the impact of foresight on the strategies of actors.

It is clear that our research project implies that, although we give clear evidence of the impact of foresight practices, it is not a uniform impact over the eleven cases. In the last chapter we assess the policy consequences of this result. This assessment of policy consequences concentrates on two questions, one more reflexive and one more instrumental. The more reflexive one questions the role of government in foresight: should in every configuration type the government take the lead for initiating foresight, or might we expect organisations to organise such processes themselves? The instrumental question is about the methods of foresight: are some methods more appropriate in certain configurations than in others?

Part Three
Scientific Description of the Project Results and Methodology

Chapter 2: A conceptual model of Foresight and foresight-type activities

In this chapter we set out our conceptual model through which we propose to locate and explain the role of foresight within the innovation system. We shall argue that there are, primarily, four core dimensions to the innovation process, viz. the scientific and technical level of development within a specific field or sector, the opportunities for and management of innovation spaces that open up in that field, the pattern and subscription to future oriented co-ordination found therein and the configurational, or inter-organisational relations that characterise the area. These four will be seen to interact and shape the relative significance of foresight as a tool for managing innovation. The chapter starts with a number of observations about the way we should understand the role of expectations in shaping innovation, since innovation actors' expectations underpin and bring to life the play between the four dimensions, in association with other elements such as interests or capabilities.

2.1 The generic role of expectations

Van Lente and Rip have argued that co-ordination of technological development around expectations has become a feature of the contemporary research system.[7] Researchers, firms, and governments tend to legitimise claims and strategic action by claims or promises about the development of technology. The result is a dynamic of expectations in which the rhetorical space that is created through these claims and promises, gradually evolves into a reality that shapes the strategic actions of the actors. The dynamic of expectations and the resulting co-ordination rests on the aggregation and circulation of information, knowledge and artefacts through journals, workshops, conferences, bilateral exchanges, in which individual expectations are communicated. If aggregation and circulation continue, convergence of individual expectations in a shared 'foresight' will be the result. Eventually, this may result in a reversal: first expectations arise as a result of local knowledge and interactions and, in turn, local knowledge practices and interactions become structured by the expectations.

Such mechanisms can be found within different contexts of technological development, ranging from a firm's R&D strategy, through technological fields, to national technology policies.[8] Deuten and Rip discuss how within processes of product development, narratives shape and structure

[7] Van Lente, H., and A. Rip (1998) "The Rise of Membrane Technology", *Social Studies of Science* vol. 28, no. 2, pp. 221-255.
[8] Van Lente, H. (1998) *Promising Technology.* Enschede: Twente University Press.

collective goals.[9] Narratives express the ongoing future-oriented process of product development, in a certain sequentiality (plot). Prospective stories create incentives and foster the commitment of the narrative's elements to its unfolding plot.

Through the dissemination of such stories, one can also find oneself committed to the plots of others. In the process of being shared and acted upon, expectations can achieve higher degrees of 'firmness' and specificity. A promise or shared metaphor can develop into a scenario, an agenda and eventually a script. In this process, it changes in character from being rather general, flexible, mobile and heuristic to more closely bounded and prescriptive. Once an expectation has become an agenda, it contributes to a certain organisational inertia[10]: it would be difficult to stop a project without an acute legitimacy crisis. The success or failure of an expectation varies according to whether it is simply an actor's projection (their future alone) or is integrated across all socio-technical dimensions of the case. In the end, the agenda may become what Akrich has defined as a script.[11] A declaration of others' motives, aspirations, and commitments, inscribed into the expectations of the new technology. Such scripts are deployed to predetermine a future world through socio-technical prescription and impose specific actions on the constituencies.

2.2 Conceptualising foresight and its impact on innovation

The various studies just discussed, using various approaches, give an understanding of the role of expectations in shaping innovation consistent with previous economic insights on "technological expectations" and sociological literature on "self fulfilling prophecies". However, here we are interested in more concrete issues such as: How might these general processes of the co-construction of expectations and agendas figure within and between the worlds of particular organisations? How might the process of the construction of expectations determine the course of action of actors? We can answer this by turning here to a discussion of each of the four dimensions of innovation we noted above that form the basic framework of our conceptual model.

2.2.1 Development of S&T

First, in terms of *scientific and technological development* we want to argue that expectations about the development are as important for the behaviour of actors as the development itself. These cognitive elements include assessments of the maturity or 'firmness' of expectations, promises or scenarios presented. Key variables to explore here are the stability and pace of change in the field (with respect to the technology adoption, diffusion), perceived barriers to an

[9] Deuten, J. and A. Rip (1997) "Telling yourself forward, telling the product innovation forward, OR: Agency as a productive illusion and the fundamental role of narration", *Proceedings of the EIASM Conference "Organising in a Multi-Voiced World", Leuven (Belgium), 4-7 June 1997*. Vol. 1.
[10] Van Lente, see note 7.
[11] Akrich, M. (1992) 'The Description of Technical Objects', in: Bijker, W.E. and J. Law (eds.) *Shaping Technology/Building Society: studies in sociotechnical change*. Cambridge MA, MIT Press.

ongoing development, whether there is a clear sense of an emergent product design or product trajectory, the sense actors have of appropriate points to enter the field (notions of 'good timing' and 'opportunity' are important here), how far standards have been agreed in a field, and whether actors have medium and longer term (5 and 10 year) expectations of the maturation of the area. The other important variable of technological development is the 'disturbance factor' or extent by which organisations are forced to re-evaluate and adjust their strategies, this will depend on whether the developments are regarded to change existing relation patterns and practices and whether changes are regarded as radical or incremental. The higher the disturbance factor and thus the uncertainty, the more organisations will be pressed to develop explicit innovation strategies and the more they may be interested in future oriented co-ordination activities. We do not want to imply that there is a simple, direct relationship between uncertainty and innovation strategies. Strategies are also based on capabilities, competencies, needs, and not just on the perception of uncertainty itself. But we suggest that uncertainty is among the factors that influence innovation strategies, and one that is most likely to be affected by foresight.

2.2.2 Innovation management

In regard to our second dimension, the transformation of expectations from sheer promises into a prescriptive agenda effects the *space for decision making on innovations* within organisations. Typically, a focus on decision processes within organisations leads to a consideration of forms of rational choices between different options. Basically, we are confronted with two types of rationality that can be supposed to guide decision-making: substantive or economic rationality and normative rationality. Major differences can be established, as the former will be motivated by efficiency issues while the latter will be based on legitimacy and social justification.[12] Institutional and organisational settings emphasise different choice constraints of such norms and traditions. A normative rationality based on social legitimation and the symbolic character of decision-making has often been viewed as a corruption of substantive rationality. In contrast, we suggest that the symbolic properties of information within organisational settings will help us to understand the conditions from which foresight emerges and especially the forms and ways it is used within organisations. Foresight reports and exercises, as many other information pieces, are also symbols in the overall context of policy making. To have, to possess information is a symbol and a representation of competence for the decision making exercise. Moreover the stock and quality of information and its use for justifying the decision-making process is a way of symbolising or signalling that the process is legitimate, particularly when the decisions taken depart significantly from organisational and institutional habits and routines. Foresight has taken root in a context in which a good decision-maker is one who makes decisions in a proper way, who exhibits expertise and uses generally accepted information.[13]

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[12] Oliver, C. (1997) "Sustainable Competitive Advantages: Combining Institutional and Resource-based Views", *Strategic Management Journal* vol. 19, no. 9, pp. 697-713.
[13] Sanz -Menéndez, L. and C. Cabello, (2000) "Expectations and Learning as Principles for Shaping the Future" in N. Brown, B. Rappert and A. Webster (edss.) in *Contested Futures,* Ashgate, London.

At the same time, having decision-making competency does not necessarily mean an individual has full control over decision-making processes: within institutional settings in general, and concerning complex policy choices in particular, we find that there is a reduced ability of any particular actor to determine a decision. Such contexts do not offer actors strong incentives to become informed and to make intensive use of the information available. Moreover, this may also reduce the motivation of policy makers to allocate cognitive resources to the building of new scenarios and improving information on future technological scenarios. In this context, cognitive costs are understood as the costs involved in the acquisition and interpretation of new data and information, plus the social costs associated with seeking new alternatives that will differ from habits and routines. [14]

However, relations between information and decision may be even more complex, especially for those making policy in either a public or private arena.. Policy-makers face not only bounded rationality conditions, uncertainty, information asymmetries and limitations, and heuristic biases, but also institutional limitations and social judgement. Critical choices are made in institutional settings, that require a better understanding of the ideologies and normative models that have guided these choices. For private firms, market studies or foresight type activities that have contributed to longer term market decisions are driven by the need to maintain a competitive edge, secured primarily through their being able to sustain a distinctive position in the market place. For public sector organisations – such as hospitals or research centres – the drivers are much more to do with the need to manage innovation and keep pace with the ‘state of the art’ to ensure best use of resources in as distributed and institutionally coherent a way as possible. These primary drivers – given their own forms of expression in private and public settings – are the internal strategic space for innovation related decisions, and the established practices to determine the main criteria for decision making on innovation. For firms the latter can be specified as the size and potential growth rate of the market for the new technologies; the assessment made by R&D departments of the likely technical demands of the new technologies, and whether they have the tools and resources to meet these; how these technologies relate to existing, well-established alternative technologies; whether exogenous factors - e.g. regulatory or ethical standards - will impact on the field and the capacity of actors to influence their regulatory environments; and whether organisations adopt a ‘learning by doing’ approach to these new technologies.

At a more general level, both public and private actors will – as a reflection of the wider configuration – have more or less strategic space for innovation management. This may be especially true for new entrants to a field who find the terms of engagement already well defined.

[14] Sanz-Menéndez, Cabello, Garcia (2001 forthcoming) "Understanding technology foresight: the relevance of its S&T policy context" in *International Journal of Technology Management*.

2.2.3 Future oriented co-ordination activities

Our third dimension consists of *future oriented co-ordination activities* (or FOCA) themselves. These can vary in terms of formality and scale. The formality and scale of future oriented co-ordination activities can be measured in terms of the existence of formal procedures for anticipating future circumstances and the range of actors involved, the organisational resources available and the texts, scripts and plans that are thereby constructed to which others are expected to respond. The use of future oriented co-ordination activities as a tool for managing innovation might include the reduction of uncertainties, the alignment of actors to build new innovation networks, assisting in decision-making, the sourcing of knowledge related to innovation requirements, and to legitimate planning scripts related to innovation - that is, to establish the priorities for the future.

Actors engage in future oriented co-ordination activities for a variety of reasons. They can be used, consciously or otherwise, to further a number of goals. First of all, we expect organisations to engage in future oriented co-ordination in order to reduce uncertainty – either because they gain better knowledge of ongoing developments and other actors' strategies, and/or because they can influence the development of others' expectations and thus stabilise the future environment for their products or policies. The information about developments gained in this process will usually be used to support decision making: the future oriented co-ordination activity then acts as a knowledge resource. But also the exchange of (policy) views and analyses with other actors can help shape decisions. In addition, future oriented co-ordination activities can serve to legitimise policies and (lack of) interventions towards others. Especially formal undertakings will serve in this way as a symbolic resource. They can also be used to improve the reputation of the organisation. Future oriented co-ordination activities can yield certain 'process benefits', as has often been emphasised for Foresight exercises. Both the outcomes and the process may add to alignment between various parties in a certain field or sector. Finally, a future oriented co-ordination activity can have so-called 'epistemic effects': the sector may come to have a shared understanding of the (future) technology it is involved with, or a common understanding of the dynamic of the innovation concerned. All these aims and effects of future oriented co-ordination activities are important variables of the foresight activities: if we consider Foresight as a tool, we want to be able to tell 'for what' it is as a tool. Often an activity will have more than one aim, use and effect. Crucially, though, we want to stress the *co-ordinative* element of FOCA as its defining feature, in order, for example, to distinguish between FOCA and simply thinking about or anticipating, or getting information about the future.

2.3.4 Configurations

Our fourth and final dimension shaping innovation draws attention to and places considerable emphasis on those transorganisational dynamics are likely to influence the role of foresight as a tool for the management of knowledge and innovation. Our focus here, therefore, is on the relationships between organisational innovation (say at the level of the firm) and what we want to call the 'configurational' arrangements in different countries for different medical-technological developments. To some extent this concept may be seen to be similar to that of 'techno-economic network' or social network theory and work in the network analyses of firms. While there are some shared interests here - inasmuch as all explore the direct and indirect relations between a range of innovation actors - our notion of configuration points to possible different structures to network relationships that reflect the relative significance and play of four key variables that frame network relationships.

These relationships and interactions are seen here as configurations that can be defined by a set of actors and the relative formality of their relationship; the durability of these relationships; the kinds of resource dependencies that prevail (where resources comprise prestige, authority and policy influence as well as information, materials and funding); and the existence of certain binding rules for decision making within and between actors in the configuration[15].

Configurations can then be defined in terms of four key variables:

- The ***formality*** associated with the configuration ***of the set of actors***: this refers to the degree to which actors are linked via formal relations (interorganisational or not)- which may be contractual, legal, commercial, regulatory (such as those related to shared standards or requirements of a new technology) where this may be regional or at the national level. Such relations are expressed in terms of how far there are well-defined forms, patterns and places of interaction, and in terms of the 'hardness' of shared agendas, membership of formal associations, well-defined routes through which actors are enrolled and recruited, and established patterns of power brokerage which favour the interests of some actors over others.
- The ***durability of relationships:*** this refers to the relative permanence of inter-actor relations over time which may be measured in terms of relationships that prevail beyond any specific innovation or particular network pattern with which actors are engaged at present, and relationships that have emerged as a consequence of specific innovations; here we also refer to the degree of momentum over time, associated with the maturation of a set of agendas or expectations.
- ***Resource dependencies between actors*** within the configuration: this refers to the relative levels of formal and informal material, cultural and institutional resources upon which actors depend on to enter into and manage socio-technical innovation within a specific field of health; these resources can be measured in terms of human capital needs, knowledge sourcing and technical inputs, material and financial requirements, political resourcing in the form of state support and the wider mobilisation of support for the area, and - especially in terms of the latter - levels of public support that may need to be enrolled within the innovation environment.

[15] Scharpf, F.W. (1997) *Games Real Actors Play*. Bopulder CO: Westview Press.

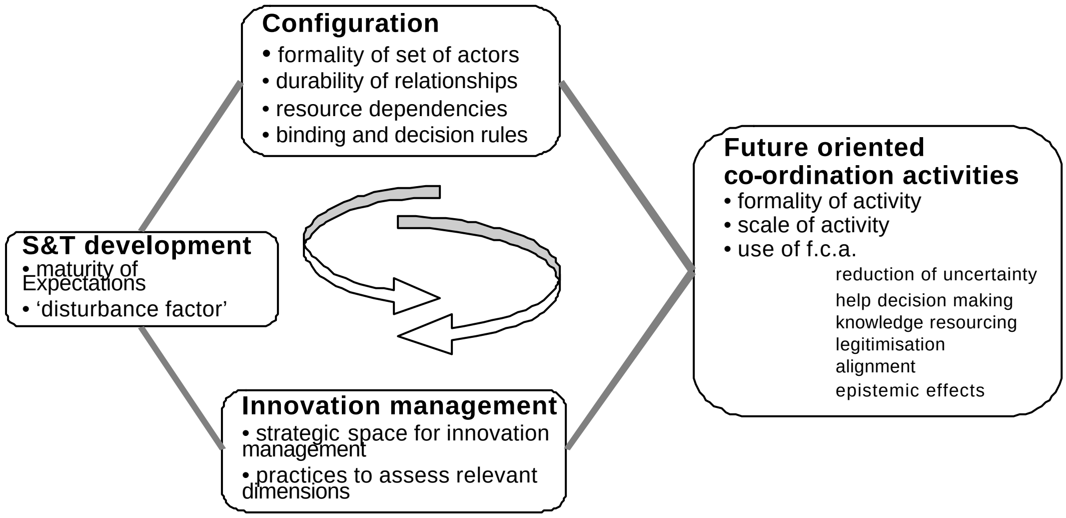


CHART 1: FOCA in the Context of Innovation

- ***Binding and decision rules*** within a configuration: this refers to the degree to which there are constraints, positive and negative sanctions and related institutional rules (whether formal or informal - such as trust) that effect the expectations actors have of each other; most importantly, how far can actors expect others to follow these rules and how much latitude is there for independent action within a configuration?; how can actors construct and build new binding rules in response to changing circumstances?

2.3.5 The relationships between the dimensions

Chart 1 above provides an overview of the principal analytical dimensions that form the focus of this project. From our explanation of the analytical dimensions, it is clear that they are inter-connected. Variation upon one of the dimensions is likely to occur together with variations along other dimensions. More specifically, we can hypothesise that scale, formality and rationale for future oriented co-ordination activities will depend on the configuration and on the innovation management. As one possible form of future oriented co-ordination activity, formalised Foresight can be deployed to serve these and other purposes by civil servants, private firms, public research agencies and so on, and as such be seen to be mobilised across an existing configuration, or to help in building a new configuration, perhaps in this way acting as a means through which innovation actors construct a stable account of the future. Moreover, innovation management strategies depend on the perception of the technological development, the organisation's relation to other organisations and its view of their mutual relations. Yet the link from innovation management to the configuration is mediated by the future oriented co-ordination activities: these activities are exactly the setting in which an organisation adjusts its strategy to the 'surrounding' configuration.

The dynamic relationship across the four dimensional schema described above has been interrogated in relation to a number of key attributes which, we will later propose, have a key bearing on the utility value of foresight as a mechanism for determining certain patterns of innovation. These attributes can be understood in respect to the formal and informal links between innovation actors; how these may be more or less durable and prevail even though the field may change over time; the nature of any resource dependencies between actors whether material, financial or institutional in nature; and how far the configuration carries relations marked by more or less powerful normative, regulatory, ethical or broader cultural rules of behaviour which are both pro- and prescribed, typically informally but perhaps also formally via codes of conduct, professional standards, and so on.

The description of configurational dynamics which encompasses the other two dimensions, S&T development and innovation management, is our independent variable. This leads us to suggest that we can distinguish between two ideal types, one we can call 'close-knit' and one 'loose-knit' in terms of the overall degree of integrative and co-ordinating dynamics embedded within it. A close-knit configuration is made up of a stable, complex network of public and/or private organisations with high levels of alignment, regulation and co-ordination. A configuration made up of loose, transorganisational de-centred relations displays weak institutional integration and underdeveloped regulation and governance structures. There may, of course, be configurations that exhibit a mix of dimensions: this is particularly likely during the early stages of development of a new technological regime where formalised standards may have been established but are yet to guide localised practices or rules of behaviour.

Configurational Type

	Close Knit	**Loose Knit**
Formality of relations	Extensive	Limited
Durability	Long-term	Transitory
Resource dependency	High	Low
Binding rules	Articulated/strong	Weak

The importance of the distinction is that we might expect differences in the way close and loose knit configurations respond to innovation and are sensitive to the outcomes of foresight activities, which is what we are trying to understand. Close-knit configurations may in fact be resistant to innovation if they generate overly specialised, closed networks: such networks can become a barrier to knowledge sharing since experts tend to have their own knowledge bases, language and approach to problems and opportunities. In contrast, loose-knit forms may be unable to build innovative momentum.

2.3 Methods

In order to generate data that are related to the range of variables identified above, we have used two main techniques: semi-structured face-to face interviews, and telephone interviews. Other sources of data include secondary literature, and attendance at both academic and respondent-based conferences or events. These techniques were deployed within the context of a number of case studies.

2.3.1 Case studies

Our substantive case studies were chosen to allow for a longitudinal analysis of the role and use of future oriented co-ordination activities for innovation management purposes. This ensured that we bolster our accounts from interviews where actors describe changes over time, with real-time narratives based on actual change over time, most importantly allowing us to follow the evolution of expectations into binding agendas for action.

The value of longitudinal study

Real-time study of processes has enabled us to monitor changes, instead of having to distil them from interviewees' accounts. As noted above, Deuten and Rip[16] propose a framework for understanding the role of prospective statements (where interviewees set a scene or describe a future) and retrospective statements (where interviewees reconstruct the history of how a future was drawn up and evolved). In this way we have similarly been able to situate changing variables (public-private, linkage, the dissemination of expectations) within a changing 'plot,' without being uncritical of the future-oriented rhetorical accounts offered to us by innovation actors.

Also, issues of irreversibility and mobility are significant for studies of foresight and future oriented co-ordination activities. In the second work package, properties of country health care systems were distinguished which set parameters to the feasibility of expectations. Our research instruments allowed interviewees to comment on the relationship between socio-technical irreversibility and limits to the circulation of a scenario across contrasting constituencies. On the other hand, we also wanted to see which factors contribute to the future-oriented momentum of a scenario or expectation. Some expectations become hardened into formally codified inscriptions; certain scenarios are foreclosed or ruled out in translation, by insisting upon necessary agreement. In the Formakin project, we have studied how scenarios are rendered mobile, not just spatially but temporally – and to what extent this depends upon initiatives like Foresight.

In discussing the genetic diagnostics and health IT fields, we developed a research design that focused on two areas in each sector, viz. the electronic patient record (EPR) and telemedicine in health IT, and genetic diagnostics and gene therapy in the genetics sector. This strategy was deployed in all three country contexts, allowing 11 cases in all, discussed more fully in the accompanying Appendices. The rationale for this selection of these cases is that it allowed us to cover the clinical, managerial and research-driven agendas of the constituencies as they engage with and shape the new technologies; they are also areas which encompass both public and private sector actors, notably in a *transorganisational* dynamic, thus enabling us to determine the emergence of new networks and transorganisational rules binding actors within new configurations.

[16] Deuten and Rip, see note 9.

2.3.2 Interviews

Within the units of analysis provided by these cases, each participating country conducted interviews with leading actors in the fields of genetic diagnostics and therapeutics and health IT in each of the four constituencies, totalling a minimum of fifty interviews per country. The interviews were semi-structured, organised around the four main dimensions of our analytical framework (see immediately below for interview schedule)., Interviews were transcribed locally in domestic languages, but the first level of data analysis was exchanged across the research teams. This meant that coding at the analytical level at least, needed to be shared by all participants to the project (see below). The interview protocol was created in such a way as to allow us to secure data relating to each case, and within each in terms of the key analytical categories thrown up by the operationalisation of our four core conceptual dimensions - scientific and technical development, innovation management, FOCA, and configurational relations. Below we have reproduced one interview protocol as an illustration of the instrument we used during fieldwork.

FORMAKIN Interview protocol

I. **Background**

- Respondent's current position in the firm/organisation and their route into it?
- Any significant changes to the role over recent past/anticipated in future
- Familiarity with/specific interest in technology field (genetics/ health IT)
- Nature of personal involvement in GD/health informatics?
- Principal area of knowledge/expertise/discipline deployed by respondent

II. **Configuration**

- Perceptions of dominant players in area; changes in patterns of power broking
- Identify principal patterns of interaction within and outside of organisation
- Relationships that prevail beyond any specific project or particular network pattern with which actors are engaged at present
- Membership of formal associations
- Current network associations /role of network members in facilitating R&D
- Relative ease of building new networks
- Arrival of new players; perception of constraints on/requirements for entry into field for newcomers
- Human capital needs, knowledge sourcing and technical inputs
- Financial requirements anticipated for development of field/likely sources
- Expectations about state support for area, financial or otherwise
- Public response to field: anticipated reactions/needs
- Innovation opportunities perceived in field/how open is the innovation agenda at present?
- Perceived constraints on action set by other players in the field (government, regulatory agencies, public etc.)

III. The science and technology fields (of genetic tech. and health IT) in wider context

- Perceptions of the stability and pace of change in the field
- Perception of growth of R&D;
- Whether changes are regarded as radical or 'merely' incremental
- What developments are expected / considered important in genetic technology/health IT Within 5 years? After 10 years?
- Can respondent provide a concrete illustration of what this will be like?
- Is there a clear sense of an emergent product design or product trajectory which many actors are beginning to focus down on?
- Does the respondent regard their entry into the field as well timed, fortuitous or necessary?
- How far standards have been agreed in a field; are there clear procedures in place?
- Has respondent sought to influence standardisation processes; if so how

IV. Innovation management within organisation

- What are the possibilities of the respondent’s organisation to respond to the opportunities/challenges/threats of the new technological developments?
- Does respondent have a clear idea of the range of technical and knowledge based requirements the new field makes? (this applies to public and private actors equally)
- How do you determine and implement strategic actions to meet those requirements
- What is the likely scale of growth of demand for the new technologies? (for firms this is related to the perceived size and potential growth rate of the market for the new technologies; for public sector health care and research organisations this is related to perceived clinical demand for new interventions based on the new technologies)

FORMAKIN Interview protocol (continued)

- What factors are likely to shape that demand
- Perception of the way these technologies relate to existing, well-established alternative technologies
- Whether organisations adopt a 'learning by doing' approach to these new technologies.
- How is uncertainty reduced, and how far through future-oriented co-ordination activities

V. Future oriented co-ordination activities

- The existence of formal procedures for anticipating future circumstances (e.g. horizon scanning etc)
- Sourcing knowledge for future planning - any specific strategies here [Probe for: reports, formal/informal contacts with others, Internet, workshops/conferences. Add things like any ongoing foresight-like activity or organisation we know of]
- How do ideas become 'firmed up' over time within the organisation: are there formal steps through which initiatives move from being one among a range of ideas, to a favoured priority?
- Priority-setting process: how is this undertaken (judgements based on cost, time scales, criteria for determining between competing priorities etc?)
- How are Foresight-type activities a particularly important element in this process?

Chapter 3: Developments in health technologies

The aim of this chapter is to give a description of each of the fields of science and technology in which we choose our case studies. Such descriptions cannot be regarded as ‘givens’, accounts that are in some way incontestable. The accounts given below are in fact based on claims and projections made by actors in each of the technology areas of the promise and potential that they have. For our purposes they are heuristic, paradigmatic, as well as somewhat normative, commentaries that may not prove, ultimately, to be fully realised or ‘true’. Nevertheless, despite being socially constructed in this sense, they are powerful social constructions that have worked to define and redefine the promises found in each of the areas.

3.1 Genetic diagnostics and therapeutics

Genetic diagnostics is the generic term for a number of diagnostic techniques that are related to the detection and prediction of, and possible remedies for, congenital and hereditary diseases. Such pathologies are either the result of chromosomal abnormalities, which can be visualised by conventional microscopy, or of mutations in DNA (the chemical basis of hereditary characteristics). The development of DNA diagnostics, in what we can already describe as ‘the early days’ of new gene science, principally focussed on single-gene disorders which are inherited in a Mendelian fashion. The focus has now largely switched to multi-factoral diagnostics. Multi-factoral diseases are disorders which are the result of the complex interaction between a genetic susceptibility and certain (mostly unknown) environmental factors. Vis-à-vis this development, many researchers who previously worked on biochemical aspects of genetic disease have moved into the area of DNA analysis. Within the last two decades, developments within molecular and cell biology fed into the development of a number of laboratory techniques for the diagnosis of both chromosomal abnormalities and hereditary abnormalities within human DNA. The most striking feature of these techniques is that they make it possible to foretell the presence of future pathologies, whether in the foetus or adult, long before symptoms are expressed. These new anticipatory techniques have created circumstances in which ‘at risk’ individuals can be presented with complex reproductive decisions, based on probabilistic genetic information, aimed at limiting the inheritance of pathologies. It is for this reason, undoubtedly, that genetic diagnostics is expected to have an enormous impact on the future of health and medicine. Besides very rare disorders such as Huntington’s Chorea or Duchenne’s muscular dystrophy, genetic elements are now causally related to a wide range of pathologies including cancer, diabetes, coronary heart disease and mental illness.

The future impact and significance of genetic diagnostics will increasingly be shaped around the politics and findings of the *Human Genome Project* (HGP). The HGP is the internationally co-ordinated project to map and sequence the entire genome of the human species. The project is expected to generate an explosive increase in the knowledge of the structure and function of

100.000 human genes. Mapping will then, it is widely thought, lead towards new treatments and preventative possibilities.

Although the HGP and new diagnostic techniques promise arguably ambitious advances, it is noted that we are still a long way from understanding the complex interactions between genetic, social, environmental and psychological factors. For example, basic protein defects of both common and rare disorders (the aetiology of disease) have been largely neglected. As a consequence, effective interventions lag far behind the ability to detect disease and increased susceptibility to disease. Therefore, whilst genetic services are directed towards predictive diagnostics and reproductive counselling, effective treatment is rare. In the US and in the UK the authorities have accepted protocols for gene therapy trials. But the number of patients remains limited. In 1995 the NIH (National Institutes of Health, US) concluded that clinical efficacy had not been definitively demonstrated in any of these gene protocols.[17] On the way to the clinical use of genetic therapy, significant problems have to be solved, especially in the developing gene delivery vectors

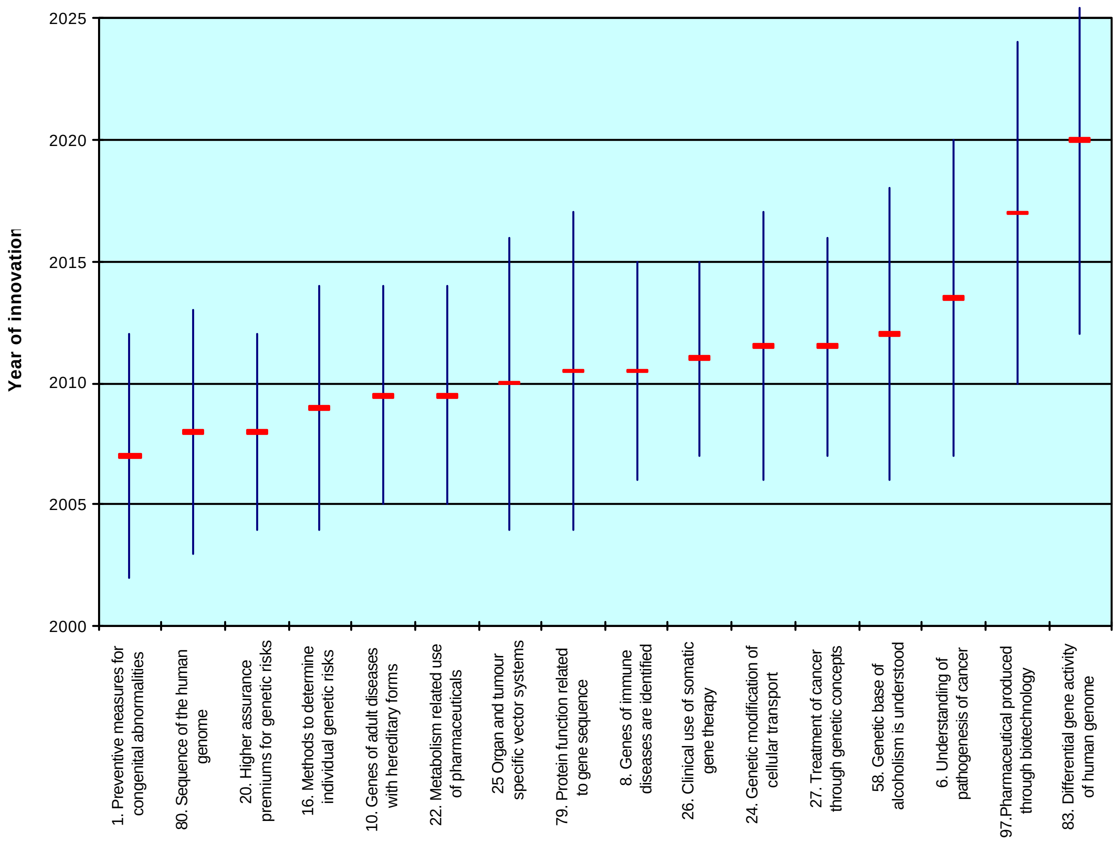
Foresight studies on the future of technologies can be seen to depict a clear trajectory from the present diagnostic practices towards an understanding of the mechanisms of diseases at the molecular level and the development of genetic therapies affecting these mechanisms. In the most recent Delphi study of Germany, at least seventeen items within the category 'Health and Life processes' refer to the development of gene technology.[18] A Delphi foresight study usually consists of specific items of technological innovation. Each of the items itself is quite specific, but together they picture the broader developments of a technology. The choice of the items by expert groups that constructed the questions, as well as the answers of the experts that responded, give an impression of the expectations on genetic diagnosis and therapy.

Table 1 lists the items, showing that innovations in genetic R&D are expected to have an impact on all areas of the health system. The opinions on the importance of the innovations reveal a consistent pattern. Almost all innovations are deemed to be of considerable importance for the progress of knowledge, the economy, as well as society. Table 1 lists the expected importance related to the constituencies we identify in this study. The high importance for society reflects the overall score for the items in this theme. (Other themes often score much lower here.) The importance for the progress of knowledge and for the economy is a bit lower, but this reflects the overall score of other health and life items. Most innovations are judged to require international co-operation, and to a lesser extent an improved R&D infrastructure and new regulation.

[17] OECD (1998) *Economic aspects of biotechnologies related to human health Part II: Biotechnology, Medical Innovation, and the Economy: The Key Relationships.* OECD: Paris.
[18] Fraunhofer Institut für Systemtechnik und Innovationsforschung (1998*) Delphi 1998, Zukunft Nachgefragt. Studie zur Globalen Entwicklung von Wissenschaft und Technik*. Fhg-ISI, Karlsruhe.

Table 1. Expectations on Genetic diagnostics and related developments. **(Source: Delphi ’98 *Zukunft Nachgefragt*)**			
Expectation	**% of experts (in first round) who indicated item is of importance for**		
	Progress of Knowledge	**Economy**	**Society**
1. Preventive measures are used to impede congenital abnormalities that develop at the embryonic and prenatal phase.	52	13	80
6. The pathogenesis of cancer is understood through the identification of most of the genes that are responsible for the development of cancer, as well as the dynamics of the external factors.	81	44	83
8. The genes, molecules and external factors, responsible for the development of immune diseases (e.g. allergies, auto immune diseases), are identified as well as their function.	82	43	75
10. The groups of genes related to diabetes, hypertension, and arteriosclerosis (diseases of adults with hereditary forms) are identified and the molecular causes of the diseases are understood.	76	40	84
16. Wide use of methods based on gene analysis to determine individual risks of genetic related diseases (e.g. cancer, high blood pressure).	60	34	84
20. When gene diagnostic tests are developed that can indicate increased individual risks for specific diseases, individuals with a high risk have to pay a higher insurance premium.	7	35	77
22. Because of knowledge of the state of individual metabolisms (patient pas) pharmaceuticals can be used selectively. At the same time, new pharmaceuticals will be used that depending on the metabolism are effective or toxic.	55	52	67
24. Genetic modification of known receptors / ion channels / enzymes / proteins of the intra-cellular transport of signals is used for effective new therapies.	76	47	66
25. For gene therapy there are several organ specific and tumour specific vector systems.	69	51	72
26. General clinical use of somatic gene therapy for diseases that are a result of defects in single genes	61	38	76
27. Clinically, cancer can be effectively treated through therapy concepts that affect directly the immune system and the activity of genes involved in the development of cancer.	67	48	79
58. The neurochemical mechanism of alcoholism and its genetic components are understood	57	42	83
79. It will be possible to relate the gene sequence to the protein function, through large scale DNA and protein sequence databases and related software	91	55	49
80. The complete sequence of the human genome is known	89	48	65
83. The process of differential gene activity in the human genome is understood from the fertilised ovum to the adult phase.	88	22	52
97. More than half of all chemical synthetic pharmaceuticals are replaced by pharmaceuticals made through biotechnological and gene technological based processes	43	77	50

Figure 1 maps the trajectory in time according to the expectations of the experts in the German Delphi study. Seen against other foresight studies, the question hardly seems to be whether the innovations will be possible at all. The uncertainty seems to
be concentrated on when and who will make certain medical possibilities real. The Delphi shows that the uncertainty about the time of realisation of most of the innovations is about ten years. The other major uncertainty is about the impact and implementation of the innovations. For almost every item, about 90% of the experts indicate possible social and cultural problems.



Results German Delphi Study

A recent OECD study on the economic aspects of human health related biotechnology, including genetic diagnostics and therapy, indicates these uncertainties as well.[19] Although there seems to be a well-established research trajectory towards a better understanding of the genetic bases of diseases, this is not the case for the implementation of this knowledge into health care practices and society.

> *The rapid advance of scientific knowledge and technological innovation in health care has not been matched by a similar pace of change in society. Frameworks, infrastructure and regulations needed for appropriate and equitable application of some of the most advanced biotechnologies have not yet been established, nor even adequately identified* (p. 27.).

The overall picture these documents give is that though technological developments are uncertain, clear expectations exist on the promises of genetic diagnostics and treatment. These expectations exhibit a specific trajectory in time. Barriers and uncertainties for future genetic technologies are generally expected, especially in the societal reception, regulation and infrastructure for the technologies. In terms of our selected case studies, we have used this account as a way of contextualising the more specific developments and expectations associated with genetic diagnostics and gene therapy, as will be seen below in both the thematic discussion and later in the Appendices.

3.2 Health Information Technology

Our second account covers the field of health information technology. Health information technology can be characterised as a diverse set of activities oriented to the management and circulation of medical information amongst clinical providers and research communities. These activities are all based on the shared expectation that "*there will be a rapid penetration of information into health care and the life sciences - not only for data management, but also as a tool for insightful analysis, modelling and interpretation*."[20] The range of nomenclatures used to describe IT capacities in health and medical fields varies considerably. The term *medical informatics* is somewhat older than *Health informatics* and has been used to refer to systems deployed in the service of medical research science. The latter is a somewhat more recent term denoting "… the acquisition, organisation, analysis, evaluation, synthesis, management, communication, and dissemination of information as well as technological literacy".[21] Our use of 'health information technology' is intended to apply to both these areas of activity and includes health information management, telemedicine and systems used by clinical research

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[19] OECD (1997) *The Economic Aspects of Biotechnologies related to Human Health Part 1: Biotechnology and Medical Innovations: Socio-economic Assessment of the Technology, the Potential and the Products.* OECD: Paris.
[20] Office of Science and Technology (1995) *Technology Foresight, Progress through Partnership.* Health and Life Science Panel Report. HMSO. London.
[21] Lunin and Ball (1989) "Perspectives on information science and health informatics education. Introduction and overview", *Journal of the American Society for Information Science*, 40 (5), pp. 365-367.

communities. As such, health information technology innovations can be said to map onto various institutional, professional and disciplinary arrangements within and between different healthcare contexts. Notwithstanding these comparative differences, some generic expectations can be identified.

In the first place, it is important to observe the long-term dynamics that have reconfigured the boundaries between historically distinguishable forms of healthcare information management. These dynamics reflect the fact that various constituencies have begun to depend upon greater degrees of information interdependence. How much this has occurred, however, has depended upon the degree of technical integration and organisational alignment between actors.[22] To some extent, and bearing in mind uneven tendencies towards integration, it has been possible to characterise health information technology in terms of three – increasingly related – areas of activity, medical informatics, telemedicine, and the electronic patient record. For the FORMAKIN project it is the last two that we have chosen as the basis for our case studies, since both have been particularly rich sites where transorganisational, inter-professional and patient interests have been articulated.

The subsector of Medical Informatics deals with information technology regarding:

- Patient generated clinical data;
- Administrative managerial systems relating to service scheduling, service monitoring, auditing, ordering and purchasing (health information management);
- Clinical information including the formulation of epidemiological demographics to inform effective planning;
- On-line access to decision support systems, library information, pharmacological developments and standard treatment protocols; and
- Consumer Information systems which sometimes include shared (patient-clinician) decision support services.

Key actors in the provision of health informatics are concentrated within the following key groups: professional clinical organisations; university-based departments of health informatics; academic and specialist medical libraries; larger hospitals and health authorities. In many cases SMEs emerge from alliances between both public-clinical and commercial-nonclinical actors; large communications firms have invested heavily in the medical informatics sector.

Consumers of health informatics services are correspondingly varied though mainly clustered within public health care provision. However, neatly distinguishing between consumers and providers in the sector is less than straight forward since, given the experimental or pilot state of the sector, innovation normally depends upon strong alliances between clinicians, specialist academic researchers, and established IT companies. Indeed, consumer/provider or stakeholder/roles frequently switch when alliances sell their IT-innovation on to other institutions or health informatics consumers.

[22] MacDougal, Brittain and Gann (1996) "Health Informatics: An Overview", *Journal of Documentation*, vol. 52, no. 4, pp. 421-448.

"In the future, hospitals will be networked environments. Aspects relating to the patient, medical *staff*, operating rooms, ambulances and other hospitals are linked together, creating a single infrastructure."[23]

As the boxed quote indicates, there are some ambitious expectations associated with the development of medical informatics. Many of these are derived from the desire to reduce the costs of patient diagnosis and management, and to move from a static model of the delivery of clinical services to one based on a more dynamic understanding of patient pathways and flexible delivery. Much depends on ensuring the 'networked environment' is actually built, especially between the primary and secondary sectors. Mobilising expectations that it should and will be built has been a task undertaken by national and regional health authorities in all three countries studied here. However, it is clear that organisational and institutional barriers have made the realisation of these expectations more problematic.

For the sake of our own analysis and case study selection, it is the next two areas that have formed the empirical focus of the FORMAKIN project.

3.2.1 Telemedicine

The defining attribute of Telemedicine is the extent to which applications of health information technology centre on spatial and temporal changes to health/medical organisation, referral and patient consultation. Present and expected applications include:

- Multimedia real-time exchange of data (remote message, voice and visuals) between remote clinical centres;
- Remote diagnostic medical imaging;
- Remote expert consultation and conference systems;
- Public health promotion; and
- Home-care arrangements, pager devices and remote monitoring.

There is considerable crossover between informatics and telemedicine and this is increasingly likely to be the case as actors search for higher degrees of integration and monopoly opportunities. However, it is still conventional to refer to multimedia technologies (remote message, voice, and visuals in real time) as telemedical (Telecare) rather than informatics. Many of the applications are run by clinical and academic research centres but drawing upon software and hardware supplied by small businesses. As in the wider informatics sector, commercial ventures are the results of 'spin-offs' from alliances between academic departments, SMEs and clinical professionals. The sector, at present, tends to be extremely experimental, quite unstable and criticised for being entrenched in a pilot stage of development. Until a more operational status is established, enterprises are largely funded through public (academic) research routes.

[23] Philips Electronics (1996) *Vision of the future*: http://www.design.philips.com/vof/vofsite4/vof4main.htm

Nevertheless, as the boxed quotation below suggests, there are a range of expectations about the diagnostic and monitoring potential of telemedicine which have prompted considerable interest in the area. Again, much of this is driven by public sector needs to develop technologies which demand fewer relative resource inputs per development, to cope with an absolute increase in the demand for healthcare.

> "The operating room is linked up to provide tele-surgery possibilities, on-line diagnostics and monitoring. Scanning, monitoring and diagnostic equipment will be linked for data retrieval and remote viewing."[24]

3.2.2 Electronic Patient Record (EPR)

Scripted into the health information agenda of most advanced contemporary healthcare systems is the conception that treatment records and other patient data can be translated into a more readily accessible and spatially dispersed electronic format. The electronic patient record (EPR) is increasingly seen as both a means of organisational transformation in the integration of care services (across primary and secondary care) and also, a means of enforcing equitable parity in standards. Most scenarios for future healthcare draw particular attention to the increasing shift away from paper based records and towards an information infrastructure able to safely sustain the health records of whole populations.

> "If integrated primary care is to work effectively it is important for all information about an individual patient to be drawn together into a single record that can be read, and added to, by any health professional involved." BMJ 1998;317:579-582

The strategies for implementing an EPR differ greatly between healthcare contexts and actors involved. Most of this variation revolves around the way in which healthcare systems manage several key bottlenecks in implementation including: systems of coding whereby agreed clinical terms and nomenclatures prevent clinical actors using inconsistent terms; security arrangements for safe and confidential access to personal health records; protocols whereby clinical practitioners can be sure that information is presented in a familiar format thus aiding navigation and utilisation of data; negotiation around new distributions of administrative responsibility and labour (for example, shifting responsibility for the ongoing maintenance of patient records from secretarial support staff to clinical practitioners).[25] Even, so, within all three of our countries, EPR is seen to have great potential, as is illustrated by the commentary from the UK in the box overleaf:

[24] *Ibid*.
[25] Powsner, S.M., Wyatt, J.C. and Wright, P. (1998)' Medical records: Opportunities for and challenges of computerisation', *The Lancet*, 352: 1617-22

UK Information Management and Technology (IM&T) strategy and EPR

"One of the cornerstones of the new IM&T strategy is the creation and easy access by healthcare professionals of patient's episodic health records (the Electronic Patient Record, EPR) and of patient's summary healthcare record (the Electronic Healthcare Record, EHR). Up till now suppliers have concentrated on developing small scale record keeping systems and information retrieval systems because that is relatively straightforward and what the NHS appeared to require. The new IM&T strategy makes it clear that the next generation of hardware and software will be required to accommodate many more records possibly containing multimedia information and be able to provide it quickly via the Internet, or an Intranet such as NHSnet, to an authorised user."

Source: Curry, 1999.

Chapter 4: The use of foresight in different organisations and configurations

This chapter examines the use of foresight-type practices in different organisations and configurations: here we are primarily discussing the role of formal practices as vehicles for future oriented co-ordination. We pay particular attention to the configurational dimension since it concerns those transorganisational dynamics which we argue are most significant in shaping the circumstances in which Foresight might be *more*, or *less*, useful as a tool for managing innovation. However, first, we need to say something briefly about the actual national contexts within which the configurational dynamics shaping genetics and informatics are to be found - a theme developed in considerable detail in WP2.[26] Each of the countries exhibits quite distinct organisational structures and institutional cultures, and these determine the pattern of links between the various parts of their exceedingly complex health RTD and delivery systems. This is important inasmuch as these variations engender quite different transorganisational relations especially with regard to patterns of co-ordination and priority determination of health policy and S&T policy. FOCA-type activities are, of course, closely associated with both coordination and prioritisation (of RTD actors, of R&D policy, and of S&T policy).

In this section, then, we draw on some of the material from WP2 to summarise the institutional arrangements and organisational structure of the healthcare system and RTD system which condition the way the technological sector in each country appears. Our discussion of "configuration dynamics" comes later when we consider a number of specific cases in more detail.

4.1 National contexts

In the *Netherlands* while the organisations that comprise the health RTD and delivery systems are distinct and have their own agendas and sets of priorities for health delivery and RTD in , the generally high level of institutional aggregation that prevails has generated a situation in which co-ordination and priority setting derive from a dense, intermediate network exhibiting strong interdependency, seen especially among organisations such as the medical sections of the Royal Netherlands Academy of Arts and Sciences and of the Netherlands Research Council, the health care research funding organisation, ZON, and the advisory council for health research, RGO.

This in turn creates strong pressures towards institutional stability such that even though organisations are aware of important changes in the field of technology, and perhaps even of a transformation of our entire understanding of health and sickness, they will try to maintain their

[26] See Work Package 2: 'Mapping Institutional Arrangements Relating to Science,. Technology and Innovation in the Health Sector', January 1999, (FORMAKIN report to TSER ProgrammeEuropean Commission, DGXII).

function and responsibility for oversight in a particular area. This means that developments in fields such as the new genetics and informatics will - as far as possible - be incorporated within existing arrangements; it is precisely because of this tendency that the mid-1990s foresight initiative in the Netherlands was encompassed by and embedded within existing institutional cultures and strongly consensual in character. However, as we shall see shortly, foresight type activities have been deliberately deployed more recently to open up Dutch agendas in the genetics field where the configurational relations can be seen to be overly 'close-knit'.

In *Spain*, the organisational structures for health RTD and healthcare delivery are quite different. On the one hand, healthcare delivery is made up of component parts which enjoy considerable degrees of autonomy from each other, especially in terms of health policy because of the separate regional healthcare services. Meanwhile, priority setting for health RTD and funding sources are co-ordinated by the central government through the National R&D Program and FIS (National Health Research Fund). In many respects, the Spanish RTD health research pattern resembles that found in France inasmuch as both research and delivery areas are distributed across a trilateral structure made up of hospitals, universities and research centres, assuming the differentiated functions of patient care, teaching and basic research. Overall, this produces a loosely co-ordinated system rather than one, as in the Netherlands, where actors are strongly networked through overlapping organisational fora.

In addition, there is strong regional autonomy with 17 regional governments and their respective ministries pursuing localised agendas in science and technology, albeit with attempts at co-ordination by the newly created Ministry of Science and Technology. Furthermore, the geographical, political and organisational differentiation of healthcare carries with it a similar spread of incentives and localised institutional priorities. As a result, while there are a variety of national priorities set for innovation in health (and other areas) their translation to the local level is mediated and so diluted via the complex pattern of relations found in the wider atomised healthcare delivery system.

Consequently, the developments in fields such as genetics and informatics are conditioned by these environments, especially in terms of technology adoption and diffusion. Genetic research is highly affected by the overload of responsibilities on medical professionals, where teaching and patient care take up most of their time. As for informatics, the innovation strategies of firms are highly dependent on the policies of regional healthcare services.

New health technologies need to be mobilised and require strong networks to do so: in the Spanish context, as discussed more fully below, the development of health genetics has been slower than elsewhere because of the relative absence of corporate activity and lack of co-ordination in policy and research. Not surprisingly, we find the emergent health genetics constituency in Spain appealing to a wider network at the international level and deploying the Foresight discourse to do so, in order to mobilise expectations within Spain itself.

In the *UK*, there has been considerable energy invested in health policy circles to co-ordinate health research and delivery across the NHS, driven in particular by a discourse of rational and effective health intervention. Much has been made on the turn to evidence-based clinical delivery, and in one sense, co-ordination and priority setting seem to be shaped by subscription to innovation that can be seen to be 'working'. Co-ordination does not, however, simply depend on the adoption of best medical practice since the NHS is made up of discrete interest groups - public health, service delivery, operational research, medical professions, policy units and so on - which can define priorities and problems in quite distinct ways. The power of medics and especially GPs and consultants to frustrate nationally determined health delivery plans mean that mobilising new technologies through planned FOCA type activities is highly problematic.

Nevertheless, the advent of clinical evaluation agencies such as NICE (National Institute for Clinical Excellence) and future technology groups such as NEAT (New and Emerging Applications of Technology) indicates the health Department's desire to manage both the promise and costs of health innovation. In the case of the impact of new genetics, for example, the Department has recently undertaken a strategic review (to be published in December 2000) on the implications of genetics for the NHS. The discourse of audit and control is now extremely strong in the UK and those who seek to foster new technologies - for example in gene therapy - have to draw on the language of its long term promise given its failure thus far to deliver significant health improvement: Foresight is an important resource in such circumstances.

4.2 Comparing configurations

These, then, are the brief characterisations of the general organisational and institutional factors at work that shape patterns of co-ordination and prioritisation in the Netherlands, Spain and the UK. They are of course at quite a high level of generality. What we need to do is to explore the much more specific configurational dynamics as they shape future oriented co-ordination with regard to genetics and informatics and their subfields of diagnostics and gene therapy, and EPR and telemedicine. A detailed description and analysis of these four with regard to our complete model and for each country is located in the Appendices accompanying this report. Here we want to focus on some key themes that have emerged from our analysis, that relate specifically to the utilisation of Foresight.

Prior to discussing these, it is valuable to have a summary of the issues which our respondents have had to address in common when engaging with the fields of genetics and informatics, for these provide the wider context within which more specific future-oriented practices in diagnostics, therapy and EPR/telemedicine are to be found.

In chapter 3 above, the significance of the 'new genetics' today lies in its ability to determine the multifactorial (as opposed to single gene) basis of disease. The potential impact this may have has been described as the 'geneticisation' of medicine, where both the health research and delivery system embrace a radical - and reductionist - agenda in the search for hereditary risk factors. That this reductionism is in practice highly questionable - for example, there are over 700 mutations for the gene that 'controls' for cystic fibrosis and an increasing number found in breast cancer - has not deterred those in corporate and public sectors anticipating major changes in health care in the future based on a discourse of more targetted, ‘precise’ medicine, accompanied by genetic therapies that may not attack genetic mutation *per se*, but the source of various disease, notably in cancer research (such as leukaemia).

The pharmaceutical industry as well as those firms supplying the bio-informatic needs of gene-chips, have become the most important drivers of genetic diagnostics and associated diagnostic kits. There are especially crucial to the advent of pharmacogenetics that will be reliant upon accurate diagnostic technologies being developed for the clinic. To achieve this, firms will need to require access to large repositories of genetic and genomic data, from both public and private sources (epitomised perhaps in the Human Genome Project and Celera respectively). In addition, existing biochemical data will be revisited to determine whether shelved compounds may well reveal that they have value in helping to build new markers for genetic tests.

Finally, these developments will have major social ethical and legal implications for patients and the 'worried well' subject to diagnostic tests. They may, for example, create a 'pharmacogenetic underclass' for whom conventional sets of drugs can no longer be given because such patients are genetically found to be poor metabolisers of the active compound (though, of course, it is also worth noting that avoiding exposure to adverse drug reactions is itself of benefit to such patients). Other concerns relate to the risk of those who have - either through screening or diagnosis - been identified as carrying genetic disorders which may - or may not - result in illness in later life. Insurance companies may well refuse cover or demand higher payment consequently. In the UK, the government (uniquely in Europe) announced in October 2000 that insurance firms can require clients to reveal information about genetic tests.

While the singularity evoked by the notion of geneticisation fosters a sense of a clear field for genetic diagnostics, informatics is much more fragmented. Again, as noted in Chapter 3, the term 'informatics' covers a range of meanings and activities, including the use of interactive videos for remote clinical consultation, real-time monitoring devices, the use of ICTs in treatment and in its more informational senses, the basis for developments such as the electronic patient record (EPR), tele-electronic sources of advice (such as the UK’s NHSDirect and NHS Online) and the storage and retrieval of patient information between clinicians working in both the primary and secondary sectors.

Many of the technologies currently used in telemedicine are adaptations of ICTs devised for wider purposes. As such, R&D on core telemedical technologies is not conducted specifically with the clinic in mind, though the use of ICTs for medical applications does raise issues about the quality of imagery that might not be as high priority in other areas. The links between users and manufactures in this area are more aptly characterised in terms of customer-supplier links rather than R&D collaborations, which characterises genetic diagnostics. Unlike diagnostics, there is not the pre-existing research system in place that can integrate telemedicine into long-standing industrial-clinical relations. While the relationship between clinicians and developers should not be thought of as a linear one, there is some degree of separation in competencies and roles. As some indication of the R&D activities currently underway, academic research into telemedicine specifically is not so much geared around advancing underlying scientific and technical knowledge, but conducting pilot trials and assessments.

These pilots test the utility of telemedicine in the context of existing clinical practice and wider community health settings. As such it can be seen as both a threat to existing practice as well as a vehicle for new medical delivery. Moreover, as with most other health resources, its availability within countries - such as those studied in the FORMAKIN project - is uneven. One of the most difficult trans-institutional sites on which its future will depend is that which links the primary and secondary sectors. This will be especially demanding where telemedicine is promoted as a vehicle not only for the transfer of record-based information, but also for convergent diagnosis and treatment across the two sectors.

Following this summary of the country- and field-specific contexts we can link the two together, so proving a more instructive set of comparisons of the configurational dynamics at work.

First, in the *UK*, health genetics has a strong, resource intensive network aligning the pharmaceutical, academic, health care and government constituencies which are closely involved in arrangements for the production and sourcing of data and the development of clinical trials. Extensive formal and informal links, allied to a high degree of contractual and proprietorial rights reflects both strong steering and aggregation processes at work. However, there is considerable attention being given to enrolling the public and patient groups into the genetics agenda, since they are seen as most likely sources of resistance to the new technology (not least as a result of the migration of risk perception from other fields, such as GM crops).

In the *Netherlands*, health genetics and especially diagnostics have been the preserve of a much more restricted clinical genetics network centred around a small number of national centres for testing which have been central to setting the agenda for genetics and containing and managing the wider public uncertainties and expectations that are associated with it. More recently, however, this monopoly has been challenged by the arrival of new interests through networks keen to explore multifactorial diseases led especially by researchers in oncology, pathology and specialists in coronary heart disease in academic hospitals throughout the country. Furthermore clinical chemists in regional hospitals have been successfully challenging the monopoly, now that DNA diagnostics is not necessarily a complex technology and now that DNA diagnostics does not necessarily imply ethical questions linked to heredity (as is the case for somatic DNA diagnostics). This may have the result of opening up the well-established professional domain of clinical genetics and, or creating a discrete novel network with its own alignment dynamic at work, so opening up and mobilising new expectations for the future.

In *Spain*, genetics can be characterised as a "science push" sector where research actors create expectations, and the development of the sector is highly dependent on the clinical genetic researchers themselves. The development of genetic services has been a continuous bottom-up process but has lacked strategic centralised planning within healthcare services. Most units and centres have emerged as a specialisation within other medical fields: notably biochemistry, obstetrics, paediatrics, clinical pathology and haematology. The creation of genetic services and research in health genetics (diagnostics and gene therapy) are the result of the initiatives of key individuals with a personal interest in promoting and pursuing research and development in this field. These research actors must overcome difficulties due to the lack of health policies to manage or control these genetic services and the fact that formal training in clinical genetics must be obtained abroad. Private interest and investment in genetics is minimal. As a result health genetics is a relatively loose–knit configuration of primarily public research groups.

In regard to health informatics, in the *UK* sweeping reforms in the health service especially since the Labour administration gained office in 1997, mean that it will be the enrolment of health care professionals - rather than patients - that will determine the roll out of the technology. There has been considerable socio-technical work invested in building a consensus around standards which has been achieved more quickly through negotiating around the adaptation and extension of existing rules, to accommodate as wide a variety of actors as possible. Nevertheless, there is still considerable unevenness in the clinical response to and take up of telemedicine itself, even though in its informational form - i.e. as NHSDirect - this has almost achieved national coverage. While diagnostics is resource intensive, telemedicine is much more resource extensive with resource dependencies spread across a much wider, heterogeneous set of actors at national, regional and local levels within the NHS. Many of these actors will be new to the health care market - such as ICT/telecomm firms - engaging with the sector through pilot projects which act as important testing grounds for building shared expectations and agendas. Purchaser-supplier links are, therefore, important conduits through which expectations can be mobilised.

In the *Netherlands*, as opposed to other European countries, there is an important difference between the development of telemedicine and the development of the Electronic Patient Record. Apart from some not so influential departments within the Ministry of Economic Affairs, there are hardly any attempts to promote telemedicine. This can easily be explained from the fact that telemedicine is typically a technology for countries with large remote areas and has little additional value for densely populated countries such as the Netherlands.

For the Electronic Patient Record the situation in the Netherlands is fairly comparable with that for telemedicine in the UK. The Ministry of Health is the most important promoter while the enrolment of healthcare professionals will determine the development of the field; considerable socio-technical work is being done to develop standards and create alignment - though it is highly problematic to achieve these; moreover, the development is very resource extensive with resource dependencies spread across a wide, heterogeneous set of actors; and pilot projects act as important testing grounds for building shared expectations and agendas.

The general development of health informatics in *Spain*, that is of hospital information systems (HIS), has been highly dependent on the availability, willingness, and purchasing power that has been exercised by various healthcare services (INSALUD, plus the others). Multinational firms (especially American) play a key role in adapting systems developed elsewhere for the Spanish market, and in addition, the relationship of these firms with INSALUD and hospital administrators is critical because all technology is purchased through public tenders. While hospitals have in general fairly well developed HIS, primary care (until recently) has been ignored.

Development in the electronic patient record and telemedicine can be characterised as shared expectations among policy makers, firms and public researchers especially in the future scenario of integrating primary and secondary care through these developments. Both configurations can be characterised by formal ties that link supplier–client relations, as well as collaborative research projects between public research centres and firms. But while telemedicine has been more experimental in nature, some hospitals in Spain have adopted or are developing electronic patient records systems. Because of the highly independent regional healthcare services, opportunities and local initiatives have flourished. Both configurations are relatively close knit and their inter-organisational FOCA centres around the professional association of health informatics (Spanish Society of Health Informatics, SEIS).

How, therefore, can we describe these configurations in terms of the ideal type models noted above? The configurations are themselves a result of the play of institutional arrangements, the development of the field, and how the actors have responded to these conditions. Yet the models provide us with a heuristic classification - no more - of the broad patterns found within each configuration and field. They also help point to changes in the configuration, as can be seen in the Table below.

Table 2 does this in summary form for the 11 case studies across our three countries. We should note that simply because an institutional configuration generates a specific pattern in one sector we should not assume this is shared elsewhere in another. Nor should we assume that the *same* technology sector is associated with the same configurational pattern across countries. Thus we can see in the Table that informatics in Spain is relatively close knit while in the other two countries much less so. The different technologies do not necessarily exhibit the same configuration in all countries and neither does the same configuration characterise both sectors in the same country. There is, in this regard, a relationship between two of our core dimensions, namely scientific development and configuration: for example, in the case of Dutch gene technology, the relative maturity of genetic diagnostics as compared to gene-therapy is an important factor influencing the configurational character.

Table 2: Configurational relations in the Netherlands, Spain and the UK Genetic Technologies & Informatics

	Genetic diagnostics	**Gene therapy**	**Telemedicine**	**EPR**
Netherlands	Close knit (but opening up)	Loose knit (but becoming more close knit)	Relatively loose-knit	Relatively loose knit
Spain	Loose knit		Relatively close-knit	Relatively close-knit (though tensions between regional/national levels)
UK	Relatively close-knit	Close knit (though centred on a small number of groups)	Relatively loose-knit	Relatively close knit

4.3 Future oriented co-ordination within configurations

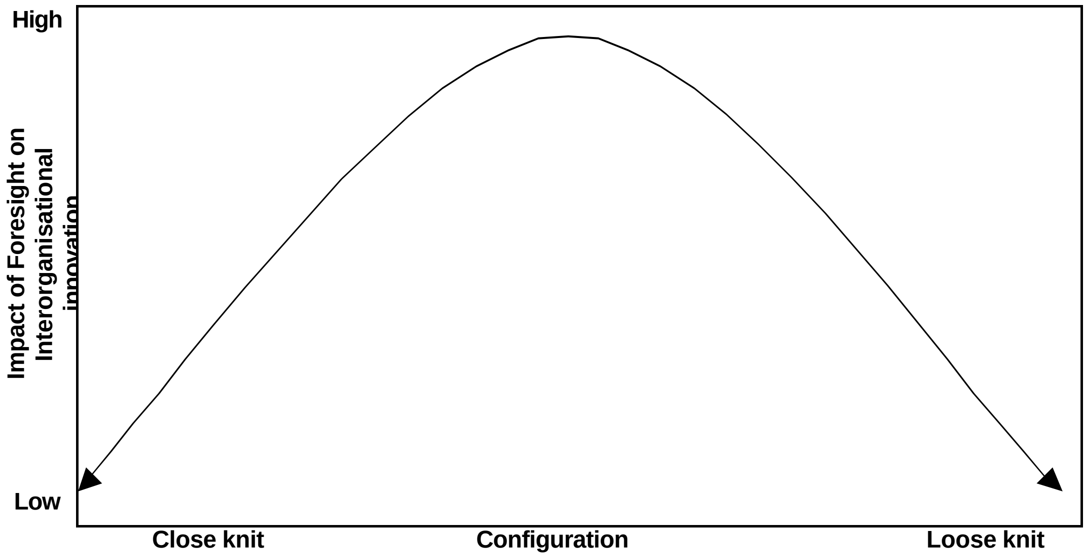
Much of the emphasis in the policy community has been on the value of Foresight *within organisations*, such as SMEs and research organisations, in promoting long-term planning, such that organisations are encouraged to respond to national foresight outcomes. However, our interviewees univocally found that formal Foresight programmes or exercises are not valued locally within firms. Firms have much stronger tools to develop internal strategies and the results of foresight are often too general in relation to the in-depth knowledge and expectations within the organisation. Firms, researchers, policy makers and the like engage with foresight because they feel that their future strategies depend on *other* actors and that in addition to their internal strategies, inter-organisational co-ordination is needed. In the case of genetic technologies this need is very much related to the role of the government in securing quality of health care, to health organisations, public and private, in creating the markets for new therapies and to the growing importance of public acceptance. In the application of information technologies, the co-ordination is needed because the real values of tele-medicine and EPR are only to be realised at the level of the system

But within innovation studies one can find sufficient evidence that these case-specific needs for innovation co-ordination are much more general. The consequence is that at a policy level the legitimisation of foresight should refocus on the emphasis on inter-organisational dynamics, the relationship between and among actors. The substantive focus of any Foresight programme should be less on setting technical agendas for the future and more on the socio-technical, inter-organisational relations (sharing strategies, communication, interaction) - whether configurations are close or loose-knit for example - that prevail in specific fields within different countries. Consequently the impact of foresight has to be sought in the dynamics of inter-organisational relationships. In terms of the conceptual scheme, this means those dynamics at the configurational level: the future oriented coordination activities act upon the innovation management only to the extent that management of external relationships and management of the organisational environment is part of the innovation management.

The exploration of the configurational relations enables us to make a first step in understanding how configurations relate to the utility and impact of formal Foresight programmes in fostering and managing innovation. While the basic technical characteristics of a specific field - such as informatics - may be common across countries (given the increasing globalisation of markets and standardisation and regulation of products and processes at the international level), our research shows that the pattern of future oriented innovation strategies for behaviour in these fields is quite distinct within and between countries because of the different configurational relations we have found. The role of Foresight in close-knit configurations in shaping innovation management or in influencing or changing the positioning of actors - such as the traditional health genetics community in the Netherlands - is very low. The actors, although aware of the developments, have a strong sense of being in control of the situation resulting in the remarkable situation that genetic technologies have hardly been adressed by foresight activities in the Netherlands. At the other end of the configurational type, the loose knit configuration, we find a similar difficulty for Foresight to have a role in the innovation processes, but for different reasons. For example, in the case of Spain, although the actors link up with the broad expectations on genetic technologies, the interorganisational structures are too thin to foster any move towards or perceived need for further co-ordination at a national or regional level nor do the foresight results from abroad have sufficient impact to develop such interorganisational relationships.

If the relationship between configuration and the role of foresight was a linear one, the results at the two extremes would imply that foresight was not of any use. However, the real examples where foresight is of use in innovation management at the level of configurations can be found in between these two extreme configurational types. In these configurations we find patterns of developing interorganisation co-ordination or of opening up of close networks in order to respond to external developments. Examples are to be find in the case of telemedicine in the three countries, where Foresight and related future oriented coordination activities have helped to bridge innovation agendas and interests in telematics and the various actors in the health sector. The consequence is that the relationship is something like a bell shaped curve. Chart 2 below provides a first simplified model. This chart shows a simple curve which describes the different ability and motivation of close and loose knit interorganisational configurations to engage with and find value in Foresight activities.

Chart 2: Relationship between the relevance of FOCA and the configuration



In a way, the chart is a rather mechanical rendering of the eleven cases summarised in Table 2 into a simple model, which explains or makes understandable, why foresight was of use in a specific context. The costs of such abstraction from the cases is that the more dynamic and complex patterns where foresight is of use are veiled by the suggestion that every configuration gets the foresight it deserves. That denies the crucial point of our argument that foresight actually can *change* configurations and that behind the curve the eleven cases show how, through foresight , configurations might become more flexible and robust at once, and actors are able to reposition themselves within that configuration. The next Chapter focuses on a number of cases that reveal such dynamics at work.

So, in the following Chapter we want to turn our attention to the way in which foresight can be of value either in close or loose knit networks, not because it influences agenda-setting in a direct manner, but because of the impact it has on configurational dynamics or inter-organisational relationships. We provide a discussion of the way in which configurational relations in each field have implications for the role and significance of foresight. We want to offer a commentary that avoids a mechanical rendering of all 11 cases (since such synopses are in the Appendices) but instead take the opportunity to develop a number of analytical themes that tell much about the configuration/foresight relation across (rather than exclusively within) each) of our cases.

Chapter 5: The Dynamics of Foresight

The analysis in chapter 4 shows that the main impact of FOCA is on the inter organisational relationships between actors in the innovation fields under consideration. Our approach there was to consider configuration as the independent variable to explain the uptake of foresight. However, we have stressed that configurational relations are themselves subject to the other dimensions of our model, and here in this Chapter we want to turn the analytical focus somewhat and examine the ways in which formal FOCA acts upon configuration itself, in order to show the relative impact of it within the innovation system.

We want to do this by exploring our various technological fields through a number of thematic examples that pick up different factors shaping the fields' development and the role that FOCA has in this regard: in some circumstances we find that FOCA can have a significant impact, in others much less so. We have chosen our themes in light of our earlier discussion (in Chapters 1&2) of the dynamics of innovation and transorganisational processes.

Theme 1. Mobilizing expectations and the repositioning of a field in order to build up or find new niches : The case of gene therapy in the UK

Gene therapy across Europe has grown considerably over the past five years, and in terms of capital invested, number of firms, and the proportion of papers published globally, Europe is becoming much more competitive with its main rival, the US, which dominates the field. though in one important respect - in the number and range of clinical trials - Europe is still some way behind[27]. The UK is one of three countries (along with Germany and France) that take the lead within Europe: for example, 32% of all gene therapy papers originate tin the UK. In terms of links made, UK academics collaborate with US and European firms on a roughly equal basis, either on basic research or the development of gene vectors that carry DNA to correct a genetic defect, or repair diseased cells.

The growth of gene therapy in the UK since 1995 has been concentrated within a number of dedicated gene therapy firms, the major pharmaceuticals, and a small number of government funded (especially via the MRC) university research centres. In the earlier part of this period, FORMAKIN respondents from academia, the patient charities and funding councils noted that there was little coordination between the few groups undertaking research, but that those in the field sought to secure institutional and economic resources through mobilising expectations of the contribution gene therapy would make to curing disease. A new coordinating committee overseeing three academic centres of excellence, at Edinburgh, Birmingham and London was established in 1995 whose objective was to develop synthetic vectors for the delivery of DNA to specific sites, both for single gene disorders (such as cystic fibrosis) and cancers. By 1997, however, progress on gene transfer and the repair of genetic mutation was much more limited

[27] P.A Martin and S. Crowther (2000) *Gene Therapy in Europe: Exploitation and Commercial Development*, EC BIOTECH Programme, SPRU, University of Sussex.

than anticipated and the coordinating committee was disbanded. Subsequent fallout from the controversy in the US resulting from the death of a young University of Pennsylvania student (Jesse Gelsinger) in September 1999 who was participating in a gene therapy clinical trial raised ethical, conflict of interest, and informed consent issues which damaged the public reputation of the field, a damage that could not be restricted to the US.

Prior to this, Foresight exercises on gene therapy in the UK had - as we shall also see below in the Netherlands - created ambitious expectations for the field, especially through anticipated developments in viral vectors. That these have not been realised has caused some credibility problems for the area, and led to much more deflated expectations for it as well as a reduction in real terms of government funding, though private companies continue to invest in the field. Moreover, the committee overseeing clinical trials in the UK, GTAC, specified (in November 1998) a number of principles which set a range of fairly restrictive terms on which gene therapy can be deployed in a clinical setting

These six principles[28] are that:

> 'a. gene therapy is [to be regarded as] research and not innovative treatment;
> b. only somatic [and not germ line] therapy should be considered;
> c. in view of safety and ethical difficulties germ line interventions are off limits at present;
> d. gene therapy should be restricted to life threatening disorders where no current alternative effective treatments are available;
> e. patients should take part in gene therapy research trials only after a full explanation of the procedures, risks and benefits and after they have given their informed consent, if they are capable of doing so; and
> f. recognising that some people, including young children, may not be able to give such consent, therapeutic research involving such patients must not put them at disproportionate risk.'

Gene therapists have responded to this framing of their work and its place in health research and delivery by distancing themselves from earlier Foresight inspired claims, and seeking to reposition the field through a new range of FOCA, building links between new research fields. These links are being used in an attempt to construct a different future discourse for gene therapy to act as a delivery system rather than method for directly targeting genetic disease: for example, protein therapeutics - related to insulin or growth hormone protein - typically rely on injection, whereas gene therapy could be used as an alternative to this by encouraging cells to produce such proteins *in vivo*.

This activity repositions gene therapy more firmly as a field whose value lies in its being a technique which can aid and assist other, more traditional areas of clinical research and intervention. There is a much weaker expectation now that efficient and effective delivery of genes to target cells is will be possible, and growing concern over the use of viral vectors - such as retroviruses - as agencies of delivery, given their potential for pathogenicity and impact of the immune response. Academic researchers report attempts to strengthen their

[28] GTAC (Gene Therapy Advisory Committee, 1998, *NETS Report on in utero gene therapy*, London.

transorganisational and transprofessional links with researchers in oncology, physiology and protein biochemistry. The hope is that this type of alliance will foster a more modest, yet acceptable and potentially more expansive role for gene therapy techniques, where the proscriptive language of GTAC might be replaced by a more prescriptive range of work for the field. Paradoxically, then, it is a set of more modest future oriented claims - compared with those of the past - that may be effective in building new transorganisational and disciplinary links, and open up a new configurational niche for gene therapy. Whether the commercial exploitation of gene therapy will, as a result, require the creation of new types of product and market is yet to be seen. It is, of course, always possible for both public and private researchers to collaborate internationally and cash in on different governance regimes abroad. Even these globally cosmopolitan regimes, however, still have to be translated into forms of practice at the local level, which, as is shown in our discussion of Theme 4 below, may be problematic.

Theme 2. The mobilization of cosmopolitan agendas and expectations by local innovation networks: The case of Telemedicine in the UK

The UK Telemedicine case is a particularly good example of an innovation area where actors have placed strong emphasis on the need to translate their local expectations to the more cosmopolitan level. The reason for this is directly related to the configurational character of the UK health RTD system and therefore offers a very striking illustration of the value of configurational analysis in determining the likely utility of Foresight.

One of the most significant configurational dimensions of telemedicine is that it is an extremely loosely defined set of technical propositions and, as a consequence, relationships between relevant actors are equally diffuse, especially in terms of binding rules. In many respects, telemedicine is a generic set of propositions about the potential organization of healthcare with a seemingly limitless number of possibilities. The technology *per se* is as potentially diverse as the clinical and healthcare context itself. This is also a reflection of the range of actors involved in the innovation networks and the increasing differentiation of firms involved in telemedical 'production'. Hence, because the definitional and functional scope of telemedicine is so broad, innovation actors have found themselves having to put considerable investment into animating scenarios about, as well as a sense of opportunity for, telemedicine at the cosmopolitan and public policy level. Industry in particular finds itself in the role of 'hand-holding' healthcare actors through defining and exploiting various opportunities for the innovative application of telemedicine in clinical contexts. Although, to be sure, this does not mean that agenda-setting is the exclusive preserve of firms. Rather, specialist clinical constituencies too have had to engage in a number of initiatives whereby relationships can be fostered and relevant knowledge sourced. On the whole, this has resulted in an extremely high profile for telemedicine in public policy discourse and government White Papers on the near term (<2005) future of the UK healthcare context.

The second reason for a high degree of FOCA activity by local innovative actors is related to the changing composition of the configurational relationships between UK telemedical actors. That is, both industry itself and the NHS in particular exhibit an acute degree of fragmentation that is responsible for stifling innovative and cooperative activity. Taking industry first, in the immediate period following the first UK Foresight rounds in 1995 many of the larger UK (and US) healthcare ICT actors dedicated substantial investment in developing systems for the NHS in the anticipation of substantial new market opportunities. At this time, telemedicine was seen to be an as yet untapped resource which the NHS and related services were poised to exploit. Whilst these expectations remained high, the cumbersome realities of procurement bureaucracy and tendering arrangements led to increasing disaffection amongst the larger ICT vendors. Even if industrial actors managed to secure contracts (after lengthy tendering procedures), contractual relationships tended to be characterized by acute insecurities. With very little slack in the financial system, scarce health service revenues are subject to redistribution at a moment's notice as new and unexpected resource demands arise. By 1997/98 much of the early interest by larger ICT firms had been scaled down to reflect the actual rather than ideal value of the UK's telemedical market. In turn, this has created greater room for more highly specialized-local SMEs. In general, these actors tend to service the requirements of specialist clinical services. Opportunities for creating networks are highly flexible and numerous given that relationships between ICT vendors and purchasers are relatively recent and not based on long-term service arrangements.

In sum, a high degree of fragmentation, and loose configurational relationships in addition to a loose definitional identity for the telemedical product itself has necessitated a high degree of FOCA activity. That is, exploiting the flexibility of the telemedical market relies on a considerable amount of activity whereby actors can demonstrate potential applications and establish new configurational relationships. For example, the roll out of the national information resource NHSDirect is one application of the telemedical agenda which has spawned new types of transorganisational relations between industry, the professions and government health agencies. FOCA act in broad terms to enable the social construction of new markets, a 'social' process inasmuch as the success of telemedical innovation will depend on the building of new institutional arrangements that distribute and co-ordinate the development of the field across a range of public and private actors. It is therefore conceivable that Foresight would have a greater utiltiy value in this type of configuration, given the need for actors to establish relationships upon little or no long-standing basis. This 'research extensive' configuration combines with a loosely defined identity for telemedicine itself, producing conditions characterised by intensive FOCA-type activity.29

Theme 3. The capacity and limitations of FOCA and foresight to define the promise of research areas: The case of gene therapy in the Netherlands

Over the past ten years the revolutionary expectations - seen in the Netherlands as in the UK - for gene-therapy have changed into a more diverse set of promises. Expectations now differ according to the disease area. Gene-therapy is no longer seen as a revolutionary therapy that

[29] This role of FOCA has importance for recent work in economic sociology that is exploring the arrival of 'distributed innovation systems'. See, for example, J.S. Metcalfe and A.Warde (2000) *Frontiers of Evolutionary Economics* (Edward Elgar, London).

can be used to cure all diseases. It is more and more seen as a technology that can be used under certain conditions and often as an additional therapy; a novel form of drug therapy, whose future is now also said to be dependent on the development of alternative conventional therapies (such as cytostatica for cancer therapy). We have seen earlier how, in the UK, firms and research groups within genetic therapy have repositioned themselves in response to this tempering of expectations

The Dutch case of gene therapy sheds light on another phenomena, addressing the quality and robustness of expectations in different contexts and especially at a cosmopolitan level. In the Netherlands, FOCA-activities seem to serve societal management of genetic therapy development very well. But they seem less suitable for adjusting established future expectations to recent developments. There is a clear tension between the expectations used at local levels for strategy development and those used within inter-organisational contexts, esp. in relation to financiers, policy and the public. In a recent interview prof. Gunning-Schepers, professor in Social Medicine and member and future chair of the board of the Academic Hospital Amsterdam, expects large benefits of genetic therapy for the treatment of rare diseases:

"Gene-therapy is interesting for public health, because probably it will be able to change the origin of disease. (…) A second important aspect is the relatively easy production of gene-therapy medicines. (…) It is nearly as easy to develop therapies for very rare diseases as it is for common diseases. The production of orphan drugs will become much easier."[30] At the same time one of our interviewees claims that *"gene therapy is a discipline that has known an enormous hype (…) and absolutely has sold fried air".*

To some extent the tension reveals the very immature nature of the scientific field, which inherently results in uncertainty about the future developments. But resource dependencies developed on the ferment of the high expectations play a crucial role as well. Researchers in gene-therapy and spin off companies rely on external financing and public support and trust. Both external financing and public support can be raised by revolutionary promises. Researchers therefore have little incentives to express what they consider as more realistic future promises outside the research community, e.g. at meetings and in FOCA-committees. Several of our interviewees admit that gene-therapy researchers tend to sketch too promising futures in order to raise financial resources and public support. The different expectations and promises are thus not the result of non-communication between research and policy cycles, but seem to be purposefully maintained to create a supportive environment.

For the understanding and appreciation of foresight, the important point is not that experts make use of different repertoires to justify local research activities. Opportunistic strategies can be found everywhere. What is crucial here is that through foresight and related activities revolutionary expectations get a life of their own, as it were, and continue to justify public policies despite recent developments. The development of a revolutionary repertoire about the development of science and technology through foresight at a cosmopolitan level, creates a

[30] NRC Handelsblad 24-6-2000

situation in which not only can researchers easily develop opportunistic strategies, but one in which it is difficult to check and control their claims.

Over the last five years two reports have been published on gene-therapy, which can be considered as FOCA: the Health Council's Report on Gene-therapy (1997)[31] and the TNO report (2000)[32] on the feasibility of a central facility for vector production. Interestingly enough both reports have had considerable influence on the gene-therapy configuration[33]. But neither of the two reports has tempered revolutionary expectations that still live in the wider (research) policy and public context. For that, there is a very simple explanation: both the Health Council's and TNO report give only very limited attention to expectations on scientific and technological future developments.[34]

Two reasons for this limited attention have been given above: The immature nature of the scientific field results in uncertainty, which makes it difficult to predict future developments; and resource dependencies discourage gene therapy researchers from stressing more modest future expectations. A third factor needs to be addressed here. The general emphasis in Dutch foresight studies on the ethical and societal impact of new technologies further reduces the attention for foresight on technical and scientific expectations. Besides it further increases the dependency on public support. Inflated and optimistic promises by researchers can then be a counter force to ethical worries.

One of the values of foresight is that it can bridge expectations of different constituencies, and, in a way, the success of the gene therapy promises corroborates that claim. However, we here see the flip side of the coin as well. Once inter-organisational co-ordination is established through these expectations and formalised in public policy, actors' interests get established as well, and instead of improving the quality of expectations, foresight activities re-use "old" but still revolutionary expectations.

Theme 4. The role of global and local expectations in promoting and aiding the delivery of healthcare services: EPR and Telemedicine configurations in Spain.

[31] Health Council of the Netherlands: Gene Therapy Committee. *Gene Therapy*. Rijswijk: Health Council of the Netherlands,1997: publication no. 1997/12.

[32] Davidse, W., P.H.A. Quax, R. Naaborg, *Haalbaarheid Centrale Faciliteit voor Vectorproductie*. Leiden: TNO Preventie en Gezondheid, 2000: publication no. PG/VGZ/2000.022.

[33] Following the committee's recommendations, assessment of gene-therapy protocols by a central commission (CCMO) is now legally regulated. Furthermore the Dutch Association for Gene-therapy has been using the report in their lobby for a central production facility.

[34] Only one page of the Health Council's report concerns the paragraph "future prospects". The paragraph gives recommendations however, not future prospects. The paragraph is based on an NIH-report (1995). In predicting the future demand for vectors, the TNO-report simply extrapolates into the future and refers to some general developments like the Human Genome Project. The assumption is made that the demand for vectors will grow, although 'uncertainty' is also mentioned.

The Spanish cases for both EPR and Telemedicine illustrate how global expectations on the future development in the areas of health informatics have been successfully translated into localised initiatives and innovation strategies to promote healthcare delivery in the Spanish healthcare system. These close knit configurations, although constrained by institutional arrangements in the healthcare system, through FOCA initiatives primarily organised by the Spanish Health Informatics Society, have prioritised the importance of telemedical systems and EPR in Spanish hospitals.

The dynamics of both configurations, telemedicine and EPR in Spain, can be characterised by a clear supplier – client relationship between firms and hospitals as well by a financial resource dependency of the RTD actors on public funds for innovation and technology development. The firms ability to produce, develop and sell depend on the public health care budgets that designate (often restricted) amounts for purchasing new technologies, and as a result technological adoption and diffusion is dependent on the national healthcare system. The research groups obtain funds for their RTD projects through the public research programs that follow priorities set at the national level. Consequently, it is well recognised that the development of the healthcare informatics sector is highly dependent on the public sector which thus gives it a privileged position to enhance or inhibit the development and diffusion new technologies. Both configurations exhibit high resource dependencies as well as strong binding rules that constrain or enhance their activities.

In terms of S&T development, both EPR and telemedical fields are fairly well developed in terms of RTD and to some extent the adoption of a market orientation. Formal RTD ties have been established in both configurations. On the one hand, there are the "newcomers" in the telemedicine configuration, which are the telecommunications firms, who establish collaborative relationships either with other firms or research groups to develop pilot projects in telemedicine. On the other hand, in the EPR configuration, new links are being established between the more “traditional” medical informatics software firms and the electromedical devices companies to set up integrated hospital systems for patient data access and management.

However, we cannot ignore the role played by the intermediate organisations such as the consulting firms or technology assessment agencies who are influencing the decision making system, with various studies and reports that are commissioned by healthcare officials. These intermediate actors make judgements and evaluations on technological innovations, setting scenarios for how the future of the hospital may appear. In addition, the interactions among actors within both configurations depend somewhat on important informal ties (personal contacts and friendships) that have developed over time because the same people are moving within these organisational settings (between firms, public administration and research groups).

Therefore, the dynamics of expectations that mobilise actors in different directions depend on their interactions that either encourage or inhibit technology adoption and diffusion where these interactions rely on both formal and informal linkages. As a result we witnessed that, first of all, hospitals pressure the regional healthcare services with their demands and their needs. Second, firms use their marketing strategies to introduce innovations by creating the demand (convincing hospital directors and healthcare professionals of their needs). Finally we have public researchers and academics who are in contact with other actors outside of Spain and who import promises and expectations from the international context[35].

The general discourse centres on the need to integrate more effectively primary and secondary care, based on scenarios built around telemedicine and EPR particularly. Actors see telemedical techniques connecting primary healthcare centres to hospitals (to reduce overloading in hospitals, to avoid unnecessary movement of patients of elderly people or in low density regions) employing tele-diagnostics, tele-monitoring, specialised tele-radiology, dermatology, cardiology, etc.) and also the use of EPR (to reduce paperload, increase or improve accessibility throughout the hospital or even by the primary care centre, and so on).

Nevertheless, although the discourse is about integration of the healthcare system as stated above, the underlying dynamic is the matching of needs with opportunities. The fact is that these configurations are built on resource dependencies, controlled by the national healthcare service, whose main concern is to promote healthcare but at the same time to reduce and control increasing costs. The opportunity for health informatics is the promise that by investing in these new technologies cost saving through increased efficiency is achieved thus improving and promoting overall delivery of healthcare services.

The expectations about informatics are a result of international scenarios and promises, general trends, but the question we pose is why have these expectations become important and in what conditions have they become influential in the Spanish context. The key actor (although not perceived as such by the actors themselves) is the Spanish Society for Health Informatics (SEIS). Both the EPR and Telemedicine configurations are close knit because this institutional organisation acts as an aggregator and co-ordinator of actors and serves to converge and align expectations.

Through many of the FOCA activities organised by the SEIS, these have brought together actors from both primary and secondary care. The need to improve communication and set long term commitments has brought optimism to the healthcare delivery in many local healthcare areas. SEIS has been a key actor in the general dynamics of these configurations by mobilising and enrolling the actors to share promises and expectations in the development of the

[35] For example: Actors consider EPR as something that is necessary (and inevitable) and also since they perceive that other countries are already moving in that direction, here in Spain they should too. The promise is that EPR will help healthcare delivery. International expectations are adopted (and adapted) at the local level, that is each hospital tries to move closer in that direction (many EPR type initiatives in hospitals all over Spain). However, unlike the Netherlands, there is no scenario for "The EPR" or one national level EPR, but rather more localized initiatives are being development.

healthcare sector in general, with the overall mission to improve and promote healthcare delivery.

In summary, scenarios are built and expectations are created as a result of the interactions among the actors in the configurations where FOCA is mediated by the SEIS through information exchange and interaction among actors. Future developments in healthcare delivery centre around integrating and improving the connection between primary and secondary care through information and communication technologies applied to the health sector. Still, the "passage" point for all these developments depends highly on the healthcare services. And, even though they have recently increased their budgets in investment for new technology, there still is a long way to go. However, FOCA has shown to be a necessary but not sufficient condition to completely change the configurational dynamics.

Theme 5. Professional networks and their relation to Future Oriented Co-ordination Activities (FOCA): The case of genetic diagnostics in the Netherlands and in Spain

The development of DNA-diagnostic tests in the Netherlands started in the early 1980s in the then already well-established strong professional network of clinical genetics. This network of clinical geneticists provided a close-knit configuration with strict entrance boundaries (Nelis, 1998)[36]. In certain cases such close-knit configurations may be resistant to innovation. Foresight type activities can then be deliberately deployed to open up the configuration and to further innovation. Two recent FOCA-reports will be discussed here to support this claim.

During the first fifteen years of DNA-diagnostic development ('1980-'95) neither the configuration nor FOCA changed much in character. Future uncertainties – of a technological, societal and organisational nature - were handled within the boundaries of the professional network. Health Council Committees played an important role as 'local' FOCAs to promote aggregation and alignment and to reduce future uncertainties.[37] In such a stable situation, the close-knit character of the configuration accounts for the fact that genetic diagnostics, in contrast to the UK, did not appear on national foresight agendas (Nelis, 2000).[38] [39]

During the second half of the 1990s, the promise of DNA diagnostics for multi-factorial diseases and tumordiagnostics, induced a number of dynamic interdependencies between our four key

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[36] Nelis, A. (1998). *DNA-diagnostiek in Nederland : een regime-analyse van de ontwikkeling van de klinische genetica en DNA-diagnostische tests, 1970-1997*. Enschede, Twente University Press.

[37] *"(I)t is the spokespersons from the genetic community who participate in and chair these committees and, as such, have a strong influence on the content of these documents. As was mentioned before, although the Health Council is supposed to advise on state of the art science, it has proved to have a substantial influence on the future organisation of health care in the Netherlands* (Rigter, 1992). *As such, it is an important source of future co-ordination."* (Nelis, 2000)

[38] Nelis, A. (2000). Genetics and Uncertainty. *Contested Futures: a sociology of prospective techno-science.* N. Brown, B. Rappert and A. Webster. Ashgate, Aldershot.

[39] For the actors within the configuration, there simply was no need to put genetic diagnostic research on the national foresight agenda.

dimensions, *viz*, the configuration, FOCA, innovation management and science and technology development. As early as 1994, Prof. Galjaard, a leading clinical geneticist, took the initiative to write a Healthcouncil report on DNA diagnostics[40], in which explicit attention was given to the new promises in DNA diagnostic esearch. In anticipation of future configurational shifts, the Health Council decided to incorporate actors from outside the clinical genetic network as members of the committee who wrote the report.

Both the relatively early anticipation on the multi-factorial shift and the broad Health Council Committee can be explained from configuration characteristics. In a strictly regulated context such as the Netherlands, the pressure to anticipate changes that would result from the development of genetic tests for multi-factorial diseases was felt very strongly. Two main drivers can be identified as causing the need for change. In the first place the anticipated need for change has been induced by the increasing number of genetic tests that would be requested for multi-factorial disorders. In the second place it is induced by the complexity of the issue. DNA-testing for multi-factorial disorders often is followed by preventive measurements such as operations or life-style changes for which clinical geneticists have to rely on other professionals such as gynaecologists, pathologists, oncologists, surgeons and so on. DNA testing for multi-factorial disorders, in other words, should take place in multi-disciplinary settings. Legal restrictions and closed network boundaries could hinder both the necessary provision of test capacity as well as the multi-disciplinary co-operation that was necessary for future innovative capacity.

The Health Council Committee for DNA Diagnostics published an advisory report[41] that made possible the opening up of the close-knit network (i.e. to extend the licensing of the centres for clinical genetics to the academic hospitals). The report was not, however, one which was welcomed by the community of clinical geneticists. Clinical geneticists felt that their discipline was under threat.

Clinical geneticist's reactions to a FOCA study by the Dutch Institute for Technology Assessment[42] were even more hostile. "The core reasoning in the study was that predictive medicine is different in character from symptom-related medicine. (…) The principle of autonomy, which allows the patient to decide whether or not to undergo treatment, does not work very well in predictive medicine. (…) The principle of autonomy of the patient does not provide any protection, thus according to the study – active political measures are necessary.

[40] Though, formally, it's the Minister of Health, who commissions a Health Council Report.
[41] Health Council of the Netherlands: Committee on DNA-diagnostics. *DNA-diagnostics.* Rijswijk: Health Council of the Netherlands, 1998; publication no. 1998/11.
[42] Horstman K., G. H. de Vries, et al. (1999). *Gezondheidspolitiek in een risicocultuur. Burgerschap in het tijdperk van de voorspellende geneeskunde.* Den Haag, Rathenau Instituut.

(…)"[43] Autonomy, as Nelis (1998) has claimed, is one of the key-rules of the regime for clinical genetics. Therefore it is not surprising that clinical geneticists were critical of this study.

Both the report and the subsequent critique are indicative of the transitional state of the genetic configuration. Former outsiders are contributing to the societal discussion and questioning the key rules of the traditional regime of clinical genetics. In response, clinical geneticists are trying to protect the boundaries of their professional network. In reaction to the severe criticism, the Rathenau Institute decided to organise a workshop with these critics. The workshop did not settle the differences in opinion. "It was found that the dilemmas experienced, associated with predictive medicine were not shared by the group of medical professionals".[44] Though the critique did cause some delay, the Rathenau Institute finally decided to publish the report.

To summarise we can say that close-knit configurations might be resistant to innovation. Actors within such configurations might be hostile towards attempts to open up these networks. Outsiders (such as governmental actors or technology assessment institutes) can play an important role in overcoming these innovation constraints.

In Spain, although we see that the professional organisations are playing a key role in the development of genetic technologies as in the Netherlands, how they play this role is quite different. That is, instead of engaging in a process of opening up, professionals are using FOCA to aggregate and link the loose knit configuration that already exists.

Genetic technologies in Spain are a case where research actors play a leading role in the development of the sector, in terms of its research and technological advancement. There are very few firms dedicated to RTD in genetics, and there no are specific health policies in genetics.

The field of human genetics has been created as a bottom up process and, as a result, genetic services in hospitals are specialist-based practices. These departments have been created not only as services but also as support mechanisms for specific R&D activities that meet the particular preferences of clinical/research professionals. These genetic departments in return for their services obtain financial, infrastructural, human, etc. resources for R&D. The effect is an atomised sector of isolated groups, which however perform high quality research that is linked to others internationally (since training for genetics is obtained abroad, mainly in the USA and UK).

Nevertheless, due to recent trends in the international community and the high expectations of clinical potential that the human genome project has generated, Spanish research policy has had to address the importance given to the field. In the recent National R&D and Innovation

[43] Rathenau Instituut (2000). *From micro-electronics to mega-ICT, Information and Communication Technology. Annual Report 1999.* The Hague, Rathenau Instituut.
[44] See note 8.

Programme, genomics and proteomics where considered priority areas for funding research and in addition, policy instruments have been set up to help facilitate the creation of biotechnological "spin off" firms from these types of academic research groups.

Although the genetic technology sector is a loosely knit configuration there are professional associations that attempt to bring actors together. The Spanish Society for Human Genetics is one network that serves to bring together those who work mainly in the genetic services that provide prenatal diagnostics. The main purpose of this association is to act as a lobby to resolve the difficulties currently facing the sector (such as training problems, lack of formal recognition, etc.). Another professional organisation, although smaller in number, is the Bioinformatics Network. This network has shown increased interest in trying to aggregate research actors (who share concerns in the area of bioinformatics) so that they can find a niche within the field of genetics to contribute to the advancement in knowledge.

> Some leading researchers in the field have recently brought to the attention the need to align expectations and aggregate efforts in order to co-ordinate initiatives and research lines in Spain so that they can have increased influence within the wider international research community in genetics.

There appears to be a general consensus that although Spain has played a very minor to role in the sequencing of human genome (HGP project) there is still the opportunity to take advantage of the tools and groups doing good research separately. The idea is to come together and contribute to the next step in genetic research, that is genomics and proteomics (areas of interest and current research). However, only through collaboration could any significant advancement be made possible. The promise is that through international legitimation, and the aspiration that "we can be somebody", more recognition and therefore more resources will be obtained.

> What we witness here essentially, are efforts to mobilise expectations through professional associations to aggregate actors and co-ordinate activities towards a common goal, although currently only through small scale FOCA. In this case, we see a space or opportunity for a government led FOCA that would reach more actors, but as opposed to opening the configuration as in Netherlands, tightening it up, and therefore improving and co-ordinating endeavours that are beginning to gain momentum.

Theme 6. The use of FOCA to reshape intra and inter-organisational relations: The case of genetic diagnostics in UK pharmaceuticals

Within pharmaceutical firms, especially ‘big pharma’, work on genetic diagnostics has conventionally fallen between the intra-organisational stools of research and development departments in the firm. In one element of the fieldwork within the FORMAKIN project we explored the emergence of genetic diagnostics within a major UK pharmaceutical we have called Pharmaco: it was clear that the relatively small number of staff working in genetic diagnostics were somewhat marginal to the core decision-making R&D structures and processes operating within the firm. Some had tried to secure a more important position in the firm and secured a review agreed by the Board of diagnostics and its impact on the company’s future R&D strategy. The recommendations of the Foresight Health and Life Science Panel and related Foresight activities that staff at Pharmaco took part in helped substantiate the importance of diagnostics. From that review came the suggestion that a core group on diagnostics should be formed, with responsibility for raising awareness and understanding of diagnostic opportunities and building linkages with current and emerging diagnostic companies. The formation of such group was done in the hopes of changing the mindset of R&D. As one member explained the need for this:

> We do a lot of stuff already that could yield valuable diagnostics but we just don't realise it. We are doing a lot of stuff looking at protein expression in disease tissues to see what does this tell us about the disease, where are the targets. If you're looking at that you say well are any of these secreted into plasma?: it's the same technology and we've got the information already we just don't think about it in that way...

At the same time, we found that one of the most significant organisational questions is how to incorporate sociological and ethical considerations within the planning and development processes. As the director of group investigating the clinical implications of new genetics argued:

> [My background] is biochemistry. So the whole idea of clinical research is normal to me, but that is a disadvantage because many of the issues we are facing are ethical and sociological. If you are going away with one message that is the one I would like you to have. It is ethical and sociological issues which are important. We have basically had to rewrite our understanding of research...

Those within Pharmaco attempt to anticipate the sociological and ethical consideration that will affect the uptake of diagnostics and treatments within the NHS. Given the arguably fragmented status of NHS policy, the view of the future of genetic diagnostics in the Service is not clear[45]. There is considerable debate within the NHS of how genetics may shape research and service delivery and recognition of the need to anticipate new training, resource and other demands on the service. The debate is one which is being undertaken with the Human Genetics Commission formally established in 2000 (though built on an earlier committee). Moreover, Pharmaco is aware of the need to address cultural variation across countries and have made a number of links with social scientists across Europe and the US. A key concern is what will be the public response to genetic testing and, from an income generation perspective, how might this therefore shape the market for diagnostic tests?. Since setting up the new Genetics Directorate within the firm, the directors of corporate affairs within the global offices of the firm have been instructed to align with those parties who are crucial to the public debate. As the Dutch Director of corporate affairs explains:

> ..as a matter of fact, those are societal developments we try to link to whereby we say ‘there is an enormous risk if a negative attitude emerges’. Say, the Netherlands would, for example, be opposed towards biotech patenting. We would then get into a very peculiar position. That is a situation we just want to avoid. And we have to do something about it. So, we have to be publicly active as to align the different ideas

45 A strategic review of genetics and its impact on the NHS is to be prepared by January 2001 as an internal document for the Department of Health and UK Cabinet Office.

and views (our translation).

In short, in order to deal with the uncertainties of diagnostics new alignments and networks that are outside of the traditional 'value-chain' of innvoation development have had to be created. Pharmaco actors attempt to align with the agendas of all kind of public organisations.46 However, they similarly align with numerous of professional bodies, such as bio-ethicists. Again, the real issue for them is how to find the 'relevant networks' in which they can find and foster a shared vision of the future.

In the case of Pharmaco, Foresight has provided a mechanism for negotiating the relation between the formal organisation of the company and building justifications for a core group on genetics which beforehand only existed informally. This can take place by bringing together organisational activities that are not otherwise brought together, providing a basis for linking with other organisations, and situating local activities within wider organisational issues. At the same time, Foresight has enabled Pharmaco senior staff to access a range of actors normally outside of their area of linkage or competency, but whom are crucial sources of information for understanding the take-up of diagnostics. In these two respects the function of Foresight in signalling genetic diagnostics is not simply helping to legitimise certain actions, but taking part in the mutual positioning of actors within and between organisations.

These **six thematic cases** illustrate the role of FOCA in:

- repositioning a field under threat (UK gene therapy)
- the construction of new 'social' markets (UK telemedicine)
- repositioning over-ambitious expectations (Dutch gene therapy)
- helping to bridge between the innovation ambitions of economic and academic actors and the institutional constraints of health service delivery (Spanish EPR and telemedicine)
- the play of professional interests in framing the exploitation and regulation of a new field (Dutch and Spanish diagnostics)
- the internal and external strengthening and creation of relationships within firms and between them and public constituencies (UK diagnostics).

In each of our illustrations, our focus has been on the degree to which FOCA or formal foresight practices help to redefine configurational relationships. It is evident that in some cases - such as in UK telemedicine and Dutch and Spanish diagnostics - FOCA have had a significant impact, but that elsewhere - for example, in Dutch gene therapy - there is some disjunction between expecations among actors in the configuration. This suggests that FOCA are more effectively mobilised and 'harmonised' when they are able to redefine configurational relations in a dynamic way.

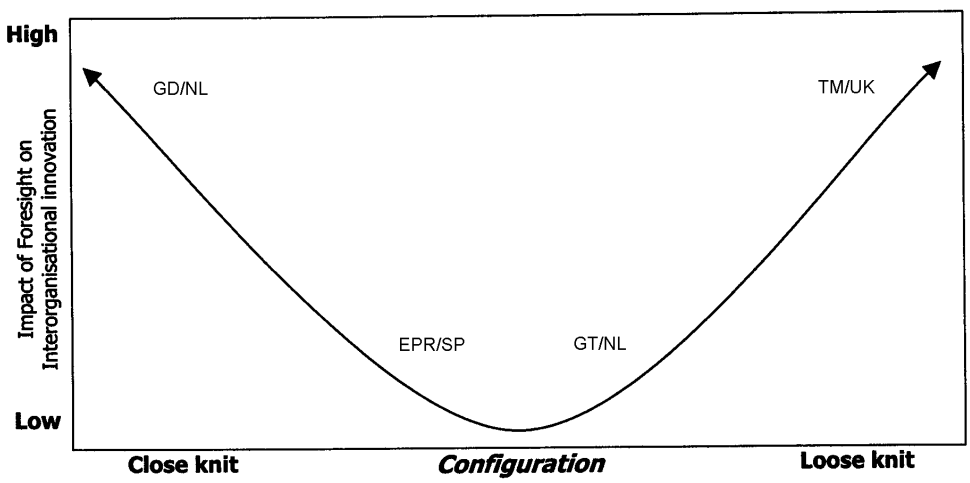
This discussion of thematic cases leads us to conclude that we can identify for heuristic purposes, a broad relationship between foresight practices and how these may induce changes

46 The aforementioned Dutch Director of Public affairs, for example, now shows up at every meeting on genetic testing as is organised for example by patients organisations, the Dutch Technology Assessment Organisation (Rathenau), the Society for Future Scenarios of health care (STG) and so on. Since the Netherlands is rather small, it is not unusual to run into the same people at every single meeting.

in interorganisational relationships. We can summarise this in Chart 3 that follows below.

Chart 3 (see below) shows the correlation between the relative impact of FOCA or foresight on interorganisational innovation. In those configurations which are too close or too loose or fragemented, foresight can act to either break up - as in Dutch clinical genetics - or converge - as in UK telemedicine, or, to a slightly lesser extent, UK diagnostics, for example - the relations between innovation actors. Where configurational relations are - at least according to the idealised model represented here - intermediate betwen these two extremes, FOCA is likely to have very limited impact on interorganisational dynamics since we can expect it either to be merely echoing already existing forms of FOCA, or, as in the case of Dutch gene therapy and Spanish EPR, play a more marginal role in a context where relations exhibit relatively high levels of ***resource dependency*** but where ***binding and decision rules*** within the configuration are yet to stabilise.

Chart 3



Conclusion

We can see from our discussion in this Chapter that we have moved a long way from the traditional approaches to the evaluation of the role of foresight in fostering long-term innovation. The centrality of interorganisational dynamics in determining the significance of Foresight should be evident, and how this significance varies within and between technology fields from country to country should also be apparent. This should enable us to propose a more targeted Foresight strategy and methods to support the renewal and opening up of innovation agendas and development paths.

Part 4. Conclusions and policy implications.

Chapter 6: Implications for Foresight methods and policy

This Report on the FORMAKIN project has examined the dynamics of Foresight and foresight-type activities across a number of health technology fields within three European countries (NL, ES, UK). Our analysis has led to a number of important conclusions (as in Chapters 4 and 5) that can be summarised as follows:

- Foresight as a form of government-sponsored future oriented co-ordination activity appears to have little impact on the management of innovation *within* organisations, whether they be public or private
- Moreover, its impact on inter-organisational innovation relations will depend heavily on the type of configurational relations found therein (between the ideal types of close- and loose-knit forms)
- It can, however, have some important influence on configurational patterns themselves, and disturb, enhance or help co-ordinate relations between different innovation constituencies
- In short, its real value lies in its capacity to foster new forms of *inter*-organisational co-ordination.

Nevertheless, besides government sponsored foresight activities, we recognise that organisational actors use future expectations in a systematic way to anticipate technological development and determine the strategies of other key actors. Certain forms of FOCA are always in play when actors make decisions about the allocation of scare resources, when they make investments or exploit specific capabilities. This is especially the case within highly complex environments where even highly resourced actors are under strain in their attempt to control the actions and decisions of others.

In this last chapter we assess the policy consequences of these findings. As we noted in our opening chapter we shall do so through asking two types of question, one more reflexive and one more instrumental. The more reflexive one asks about the role of government in foresight: should the government take the lead for initiating foresight in every configuration type, or might we expect organisations to organise such processes themselves? The instrumental question relates more to the methods of foresight: are some methods more appropriate in certain configurations than in others?

6.1 Implications for the role of government in Foresight

In terms of our first question, the analysis of our empirical cases discussed in Chapter 5 (and elaborated at greater length in the Appendices) leads to the strong conclusion that there are some configurational contexts where formal FOCA-type initiatives orchestrated by government, such as Foresight, might well be redundant inasmuch as they are duplicative of similar types of future-oriented innovation strategy and discourse. Elsewhere, however, they can play a major role in disturbing configurational relations and fostering innovation.

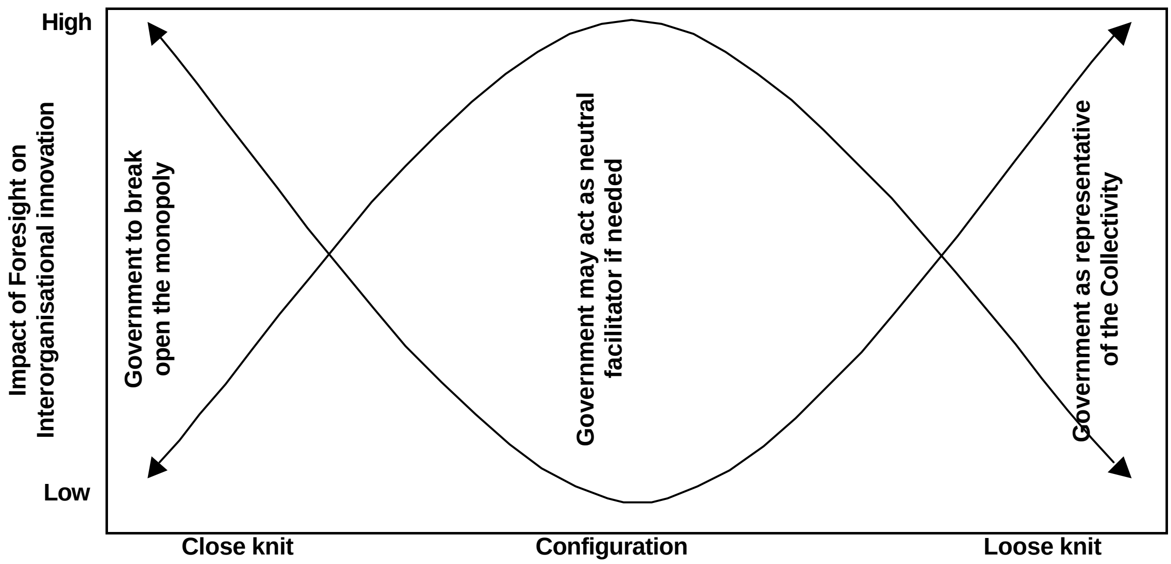
In broad terms, the contexts in which we can find these two circumstances were represented graphically, and respectively, by Chart 2 and Chart 3. The first of these describes the situation from the point of view of the innovation actors, and as such tracks the relative propensity to link with and perceived value of Foresight activities, while the second describes the role that Foresight might play from the point of view of the policy actor.

These rather schematic representations of what is a more complex innovation environment need to be brought together since, as we have argued throughout, configurational relations are dynamic, and shaped by developments in our three other dimensions: these developments may in practice disturb, constrain, or reshape trans-organisational networks, or at least, provide some socio-technical momentum for this to happen. Certain developments in the pattern of innovation management could, for example, open up new options or at least new questions that disturb the prevailing configuration. Thus, while close knit configurations may well exhibit powerful epistemological, professional and organisational homogeneity and so resistance to ideas that challenge this, they may be unable to withstand what Funtowitz and Ravetz call a 'post-normal' science (1993)[47] wherein scientific agendas are set by a much wider (non-scientific) range of social actors, where facts have become pliable and beyond the control of science, and where lay knowledge itself has to be not merely considered but built into decision-making processes. The influence of diverse patient groups, among others, has played such a role in redefining the agenda of genetic diagnostics in the Netherlands. In such circumstances, it is quite possible for Foresight to play a role in redirecting the R&D effort to address both the opportunities and uncertainties new agendas bring.

[47] Funtowitz, S. and J. Ravetz (1993) Science for the Post-normal Age', *Futures* vol. 25 no 7, 739-55.

If we bring these two charts together we find areas where Foresight might be particularly likely to play a role which will be not only regarded as of value to the innovation actor but also ensure greater return to the policy actor too. Chart 4 combines Charts 2 and 3 and immediately points us towards those contexts where both actors derive most benefit from Foresight. It points to those areas where the impact and use of Foresight are relatively high and, more importantly convergent processes, such that investment by policy makers in these – rather than other - configurational contexts is likely to yield greater policy dividends.

Chart 4



At those points on the graph where the two lines meet we would expect to find the highest return. These 'points' represent those configurational relations that are most susceptible to allow FOCA activities to gain centrality as a way of managing innovation. In other words, we can expect that the four aspects of configuration – binding rules, formality of ties, resource dependencies and decision-making - are either open to disturbance or to more effective co-ordination.

The Chart also reveals the opposite, of course, those contexts where investment in Foresight-type activities is likely to have very little real impact. Configurational relations found within the intermediate region between these two extremes, suggest that formal government-sponsored FOCA is likely to have very limited influence since we can expect it either to be merely echoing already existing forms of FOCA in relatively well co-ordinated innovation regimes such as the Spanish EPR, or, as in the case of Dutch gene therapy, play a minor role. In both these last two cases high levels of ***resource dependency*** on third parties (particularly government) may prevail but ***binding and decision rules*** within the configuration are yet to stabilise.

Our definition of FOCA which we provided in chapter 1 was '*a purposefully organised process bringing together expectations of diverse actors about a technology, to formulate strategic views about the future that take into account broad social and economic developments.*

This is a definition which emphasises the co-ordinative elements required for contemporary innovation systems, even if, or perhaps indeed precisely because, innovation networks are becoming more 'distributed' [48].

Despite this need to attend to transorganisational relations, increasing weight is being placed in Foresight policy circles on developing FOCA-type 'tool-kits' which can be deployed by firms in order improve their ability to manage change through the alignment of expectations.[49] Yet, as we argued in Chapter 4, firms either have not only much stronger tools to develop internal innovation strategies but also the results of foresight are often too general in relation to the in-depth knowledge and expectations carried and mobilised within the organisation. Moreover, for SMEs foresight scenarios are much too long term and fail to consider the specificities of markets within which firms in different knowledge-based value-chains operate.

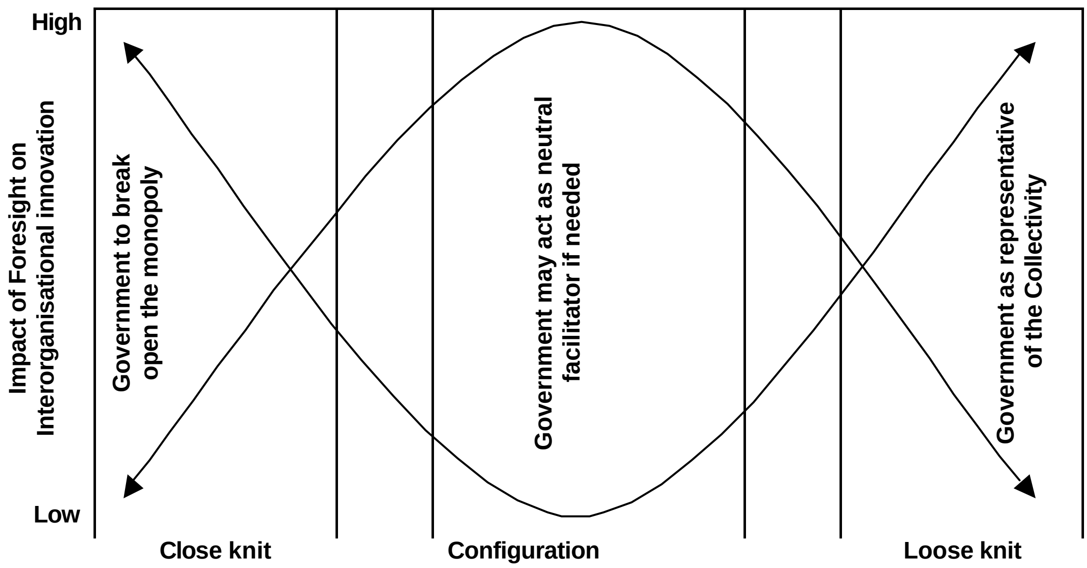
6.2 Implications for the deployment of Foresight methods

Turning to our more instrumental question, what implications does our analysis have for the methods that might be more usefully deployed in different configurations? Again, we can return to our Chart and try to answer this question graphically by mapping conventional foresight techniques onto different parts of our existing account.

Chart 5 does this in some detail and shows how selective use of foresight methods is to be encouraged since some, rather than others, are more appropriate to the prevailing configurational relations. We can see here that we want to argue that there are very specific foresight-type methods that are better deployed in some, rather than other settings.

[48] Coombs, R. et al. (2000)
[49] As is happening in the UK, and recently announced at the 'Foresight Festival' in December 2000.

Chart 5 - The Impact of Foresight



Foresight can be a catalyst but will require force

Foresight likely to be much of the same

Foresight needs considerable effort to link actors and higher methods to cope with complexity

Formal Foresight serves as a catalyst to move configuration to the middle where actors can 'do it themselves'

Formal Foresight serves as a catalyst to move configuration to the middle where actors can 'do it themselves'

Method	(positive/negative)				
Panel	neg	pos	pos	pos	neg
Delphi	neg	neg	pos	neg	neg
Scenario	pos	pos	pos	pos	pos

We have identified three main types of Foresight activity most commonly deployed by policy actors to foster innovation in new technology fields: Foresight Panels (typically made up of academic and non-academic members) whose task is to source a diverse range of information sources to produce an informed set of recommendations for a particular sector; Delphi studies which depend on large scale survey exercises to derive the opinion of the future potential of a particular field; and scenarios which construct alternative 'visions' of the future and ask public and private innovation actors to respond to the merits and implications of each scenario provided. We exclude those Foresight type activities (like reports on the state of the art technologies) that do not involve interaction between innovation actors through a process of consensus.

In a close-knit configuration (such as Dutch genetic diagnostics) neither Panel nor Delphi techniques would have a positive effect in opening up the innovation agenda of those in the configuration, since the configuration sets fairly tight boundaries as to both is reference group and future R&D agenda. In short, both Panel and Delphi initiatives, if taken, would be most likely to reconfirm such an agenda. However, scenario studies might well cause some problem for the configuration: although it might be regarded as an exercise in creative but harmless forward thinking, it might well generate some important and difficult institutional and organisational issues that anticipate the erosion of the configuration's monopoly. Government-supported scenario work would, therefore, be the more relevant activity in this set of circumstances. However, as we note in the chart, ensuring the disturbance effect of foresight actually occurs, government would have to deploy considerable institutional weight and policy resources to ensure change takes place.

Within the middle of the chart where configurational networks are most likely to be undertaking foresight-type action already, while government might find its own initiatives push at an open door, their additional value to what is already underway is likely to be modest, albeit positive in a relatively neutral sense of not being counter to FOCA within or between organisations. All three methods could be deployed here, often simply strengthening the FOCA orientation and agenda of the target configuration and its field.

At the extreme right side of the chart, in loose knit configurations – such as UK telemedicine – government sponsored FOCA can help strengthen and stabilise the binding rules among actors, and so make the network and its capacity to construct robust new markets that much stronger too. Again considerable effort would need to be expended by government to ensure this happens. In this set of circumstances, scenarios are again the more appropriate method to foster configurational links precisely because both of the two other techniques presume relatively strong and identifiable constituencies from whom a consensus on future technological development can be secured. By definition, loose knit configurations are much more pluralistic in terms of the diversity of actors and innovation agendas at work. Scenarios can, in these circumstances, help articulate the merits and demerits of different agendas and can begin to distil some transorganisational expectations, and help manage them and set aside other uncertainties. Even so, where the configuration is too loose and insufficient critical mass, the response to these initiatives may still be very limited.

Between these three ideal-type situations, we can identify two contexts within which Foresight can act to 'move' the configurational dynamic towards the centre of the chart, in other words to promote relations and agendas where the actors take their own responsibility for FOCA, thus increasing its role in managing innovation. Here, both Panels and scenarios are of most use, since in these circumstances, the operation and discourse of a Panel will promote a clearer articulation of an already emergent FOCA agenda, while scenarios should help to deepen understanding of and reflexivity about the institutional and transorganisational patterns that can both constrain and enable innovation. Together, these methods would help to strengthen the configurational network without it becoming too close-knit.

These arguments mean that foresight-type activities should not be seen as simply a range of tools sitting on the policy shelf that can be deployed one after another, or simultaneously, or as part of a broad foresight movement that will have additive effects in a single, positive direction. On the contrary, apart from the situation defined by the middle area of the chart, it is evident that some tools might well work against each other and undo the value of each other. Instead, these tools need to be chosen only after some consideration has been given of the actual character of the configurational type into which they are to be introduced.

Can our results be generalised towards other fields of S&T and towards the
European level?

The analysis here has been focused on the health RTD sector, and within that on some fields that are regarded as particularly complex. How far could we deploy our approach to other fields of science and technology? And what of the implications of our argument for Foresight-type activity at the European level? There are three broad sets of implications we want to argue derive from our study: these relate to a) the Foresight model itself, b) specific fields of technology, and c) how foresight activities are to be evaluated.

With regard to the **how we understand Foresight itself**, we want to make three points:

- Member countries need to reshape their approach to national Foresight exercises by moving away from the future impact of technology studies which have dominated thus far (as illustrated by the in the most recent set of Foresight reports to be published in the UK[50] (or the new future technologies watch approach used by the recent "*Prospectiva*" reports published in Spain). In place of this, they should endeavour to explore the innovation potential of technology fields by understanding the configurational relations therein, based on a recognition that across countries, the 'same field' might have quite different futures in different member states. The temptation to 'import' Foresight practices and agendas from other countries should be discouraged by the Commission.
- Secondly, and as a corollary of the first point, we would argue against the notion that has been emerging in recent years of a European Foresight programme: this would be untenable given the variation across countries in configurational types and their structuring of the innovation process within technology fields. Thus is we have found

[50] See DTI (2000), *Task Force Reports*, Department of Trade and Industry, HMSO, London. December.

that the feasibility and impacts of a European foresight at continental scale will be very uneven due the disparity of configurations across, and even within, different member States.

- Thirdly, even if European policy allowed for this diversity, it might still be inappropriate for all member states to adopt a formal government sponsored programme to ensure FOCA informs innovation management: we have seen in the case of Spain, that there are alternative vehicles open to government; nevertheless, it is also the case that some of the innovation actors within our Spanish cases did seek to draw on an internationally available discourse of Foresight to leverage additional resources for their area. Inasmuch as the policy domain is itself increasingly subject to internationalisation, even globalisation, we can expect to find this happening more and more frequently. Equally, we should be aware that foresight practices have also a symbolic value by facilitating the legitimacy of State involvement in Industrial policy.

Another broad set of implications relates to our **understanding of technology fields** themselves, as follows:

- Rather than explore the potential technological effects of innovation ten years hence, it would be much more sensible to look at the capacity within innovation networks for self-co-ordination by actors in a public/private (since both are typically involved) innovation 'niche'; Foresight methods, such as Panels, scenarios, Delphi studies and so on, need to be preceded by social science reviews of the field which can undertake this type of configurational mapping.
- The four core dimensions of configuration – binding rules, durability of relations, resources dependency and formality of links – make some fields more open to Foresight because they are loosely configured, or more in need of disruption by Foresight because of their monopolistic regime; the four dimensions should help to reveal which fall into what category such that the most appropriate method for foresight-led intervention can be adopted
- It needs to be recognised, however, that Foresight interventions in either loose or close-knit contexts require considerable policy investment at national and regional levels. As Cuhls (2000)[51] has observed about a possible shift to more complex Foresight interventions:

  > To introduce a structure into the puzzle, to keep the overview, to select the different parts and paths in more detail and then re-fit them into the whole is a difficult task

  The UK's most recent Foresight report on 'Health Care' (DTI, 2000)[52] though still keen to articulate a range of technology options for the future, is a much more sophisticated document than its predecessors, at least in the sense of seeking to locate such options in a wider debate about the 'broad social context' (p. 3). Even so, its commentary

[51]K Cuhls (2000) From Forecasting to Foresight processes – New participative Foresight Activities in Germany, EASST Conference, Vienna.
[52]DTI (2000), *Health Care*, HMSO, London. December. (see also www.foresight.gov.uk)

relating to genetics is more about managing the uncertainties that predictive and predispositional testing will bring and fostering ‘an environment favourable to industrial innovation and R&D’. A range of stakeholder interests and needs are identified, but how these might be related transorganisationally, and how such links might be conducive to or work against the creation of such an environment is missing.

- The FORMAKIN project focussed on a number of technology fields, but rather than this leading to constraints on the generalisability of the findings, we would argue that we chose these fields because they embraced the four key innovation constituencies (government, public research actors, private firms and organisational ‘users’ of S&T) that are found in *other* high tech fields, such as biotechnology. Moreover, our analysis was also sensitive to how transorganisational relations across these groups reflected the interplay of three differentiated systems - the national healthcare system, the industrial system, and the national RTD and innovation system. We showed (in WP2) how these systems interact yet, because of differences in their institutional structures, incentives and priorities also generate problems for future oriented co-ordination at a systemic level. We would argue that the approach taken in our analysis would apply to non-health fields too. Moreover, since we have found that configurations are neither country nor sector specific, then we are able to recommend the use of the configurational approach as a methodological ‘tool’ in other substantive areas and European countries. Indeed, we would expect the utility of this approach to apply in non-European states too. Some recent evidence of this can be found in a report on telemedicine in Japan in which the authors argue - in a way which has strong echoes of our configurational analysis,

  ‘ The extent of success or failure [of telemedicine] appears therefore not to hang on the quality of the technology, and not often on the evident importance of the social need, but on the overall coherence (‘alignment’) of the highly complex socio-technical system’.[53]

Finally, our analysis has implications for how we might **evaluate** Foresight, one of the more difficult of tasks that the policy sector has wrestled with over recent years. We would suggest the following criteria could help towards the development of a new methodology for this:

- Determine whether Foresight effects one or more of the four dimensions of the configuration: changes need to be measured in terms of quantitative assessment of network links and resource mobilisation and qualitative assessment of network durability over time and the emergence of new rules of network membership which include stronger subscription towards future-oriented co-ordinative action within the network

[53]M. Fujimoto and k. Miyazaki (2000) Industrial innovation, government and society: telemedicine and healthcare systems in Japan’, *Science and Public Policy*, vol 27 no. 5, 347-366. (p.364 cited)

- Measure the relative utility of different Foresight methods in different configurations to construct a more sophisticated intervention strategy in which methods are adjusted as the configurational pattern changes
- Identify 'moments' in configurations where movement from modest to more expansionary innovation steps are taken and whether Foresight has played a key role in helping these changes to take place.

6.3 Recommendations for policy

There are a number of ***emergent policy recommendations*** *that* can be summarised as follows:

- The utility of formal Foresight-type programmes is heavily dependent on their complementarity to the different types of innovation networks found in different sectors. Given the complications thrown up by sectoral variation, it might well be more sensible for Foresight *initiatives to focus less on technological and more on social priorities which can be served by appropriate technologies*, or, conversely, inhibited by factors not wholly technical. This move is to some extent already taking place in Germany with the new (1999) FUTUR Foresight programme which has opened up the agenda to wider sociological, ethical and political questions, within which decisions about technological options are to be located. A similar shift, at least in principle, can be said to characterise recent policy in the UK. However, in both cases, there is little real attempt to understand the transorganisational dynamic which ultimately determines whether and how options are identified and decisions made.

- Secondly, Foresight activities tend to generate technology options for the future that focus on discrete sectors: the FORMAKIN results suggest that it would be worth *looking at sectors from different analytical perspectives to determine how Foresight might best be deployed in helping to manage future co-ordination*. That is, Foresight agents need to discriminate between a sector's relative scientific maturity and stability and the sort of relationships found within the innovation network associated with it. So, for example, we have found that genetics is at a relatively immature stage in terms of real clinical delivery and technical stability in all three countries, yet the much closer (configurational) integration among traditional Dutch clinical genetics networks meant that localised FOCA has been regarded as being highly stable and unlikely to seek assistance from Foresight-type activities, whereas in the UK, the situation has been the reverse. This may point to the need for 'niche Foresights' that discriminate between such dimensions whilst also seeking to understand their relationship to one another. For example, in both the UK and Spain, Foresight might conceivably have a stronger role to play as a knowledge sourcing tool in heterogeneous networks like telemedicine where there is less technical novelty (than genetics) but more fragmentation.

- This last point about fragmentation refers in part, at least, to the role of SMEs in emergent innovation fields. The push across Europe to encourage SMEs to take up a more long-term perspective, and to enlist the agency of Foresight to do so, is understandable given that competitive edge is becoming more dependent on managing or planning for anticipated inputs and demands as generic technologies kick-in across supply-chain networks. Paradoxically, however, given what has been noted above *priority should be given not to assisting firms with new technologies per se, but in helping firms stabilise networks and so markets*. Telemedicine, for example, has various definitions and potentials for growth depending on how networks are beginning to define its role in health care. These definitions vary across Europe, so it would be most useful to undertake a *socio-economic* foresight activity which explored how the activities of different organisations involved in the production and delivery of telemedical services can be organised, given their different priorities, expectations and perceptions of risk.

- We would *argue against the suggestion that it is possible to build a pan- European Foresight programme*, since, if, as is likely, it were to be focussed on European scientific and technological competitiveness and potential growth markets for specific sectors, its utility would be very uneven across different countries, unless it were to incorporate careful consideration of the socio-technical configurations within participating members

- Finally, we recommend *a more selective use of foresight methods* should be encouraged since some, rather than others, are more appropriate to the prevailing configurational relations.

6.4 Conclusion

We hope to have shown the value of our configurational model and to have provided thereby a more sophisticated yet equally practical approach to determining the role of FOCA and, within that, formal Foresight, in mobilising and managing innovation. Our account of the four fields and the healthcare systems within which they are located has generated a rich body of data and analysis which we have discussed in this Final Report and in our earlier Work Packages. The approach we have taken towards the development of these fields opens up new questions for research as well, as we have seen above, various practical steps that should be taken in the policy community to fine-tune Foresight, its application and evaluation.

Part 5 Dissemination

During the period of the project the dissemination strategy has comprised a series of academic papers, presentations to policy communities and networking through Foresight agencies with which the team is linked, either formally or informally. The strategy has been to explore results as they have emerged at regional, national and international levels through formal and informal meetings with policy practitioners, academics, industrial representatives and health agencies where appropriate.

These findings have sought to offer a constructive critique of the application of Foresight methods and been successful, at least to some degree, in encouraging a more varied approach to the utility of foresight. Much of the most useful material has, however, been developed in the second half of the final year of the project, especially with regard to the models of utility reported on here. These will be used to mobilise interest in the project through the excellent contact all teams have with Foresight and wider policy constituencies in each country (see below for further details).

Activities relating to dissemination during the the project have been as follows:

B. van der Meulen, has made a contribution to an EU conference on Foresight in Madrid, and a Foresight Conference in Germany as a Panel member; the Dutch partner (CSSTS) also has strong links with the Dutch Foresight programme and had contact on several occasions with the Royal Academy of Arts and Sciences and with the Advisory Council on Science and Technology Policy, the two bodies formally responsible for foresight in the Netherlands, on the results of the study and on consequences for their role in foresight. The team has been participating in the current work on European Science and Technology Policy indicators and also has prepared a report for the NWO (Dutch Research Council) which argues for a movement away from a priorities focus towards an excellence-based strategy (this debate is part of the Dutch response to the EC consultation document 'Towards a European Research Area').

The Spanish team has been involved in various national policy fora where Foresight has been discussed, and members have participated in various seminars related to health informatics or genetics. The Spanish Partner has developed close links with the Fondo de Investigaciones Sanitarias (FIS), which manages the research and training funds and activities of the Spanish Health Ministry's R&D Programme, with the pharmaceutical sector through the association with FARMAINDUSTRIA, and with the Ministry of Industry and the CDTI (Centro para Desarrollo Technologica Industrial) responsible for the R&D programme in the pharmaceutical sector. The team has also been advising the Spanish government (The new Ministry of Science and Technology) on Foresight issues and S&T policy planning. As a result the team has been appointed as members of the EU high level expert groups for the ERA and VI FP. The team discussed results at the Human Genome: Genomics and Proteomics Bioinformatic Approaches" organised by Foundation of the University of Madrid.

The UK team has participated in a network based in the Cambridge on a pilot scheme to build informatics/telemedicine services into a new town being developed in the South Cambridgeshire area; they are also members of the Eastern Region Biotechnology Institute a firm-based genetics/informatics group; they were contracted by the European Parliament to review the future development of Bio-informatics in Europe, as well as by the UK's ESRC to provide a report on the future of biotechnology and ICTs in the UK. Webster and Brown of the SATSU team were recruited to the UK government's Foresight Health Care Panels 'Task Forces' relating to innovative health technologies, while Webster has been a participating member of a successful STRATA bid to the Commission which will bring together Foresight researchers and those working in regional development across Europe suggesting ways in which Foresight activities might be given more utility, while also suggestions where Foresight policy investment might be misplaced. This has led to invitations from the UK OST to advise the new Director on foresight policy. During the project the UK member joined the Diagnostics Club (primarily oriented to SMEs) to disseminate the work of the project.

The partners organised a Foresight workshop at the EASST 1998 international conference in Lisbon with invited speakers from government, commercial and academic sectors. The partners also arranged their January Co-ordinating Group meeting in Seville to take advantage of an opportunity to disseminate the FORMAKIN work to members of the IPTS JRC who themselves had recently completed a report on Foresight for the Spanish government. Co-ordination of an international Workshop at Twente in 1999 helped develop some of the key methodological requirements of the project.

Other outputs:

Papers/Books:

1998

B. van der Meulen, Science policies as principal-agent games, *Research Policy* vol 27

1999

B. van der Meulen, Foresight and co-ordination, *International Journal of Strategic Management*; A. Nelis and A Webster**,** Foresight in the UK: Rhetoric into Practice? *Constructing Technology Futures;* B. Rappert, Rationalising the Future?: Foresight in Science and Technology Policy Co-ordination, *Futures*; L. Sanz-Menendez, Foresight and decision-making, *International Journal for Technology Management*; A Webster, Innovation, the Risk Society and Foresight: Healthy Futures? 'Technologies in Transition, Policies in Transition', Special Issue, *Technovation*, 19, 6;

A. Webster and A. Nelis ' Regulating the gene: from genetic consumption to regulatory trust', *Health, Risk and Society,* vol 1 no. 3

2000

N. Brown, B. Rappert and A. Webster (eds.) *Contested Futures*, Ashgate, London; B. Rappert and N. Brown (2000) Putting the future in its place: comparing innovation moments in genetic diagnosis and telemedicine. *New Genetics and Society*, 19, 1, 49-75

Conference presentations/research seminars

1998

B. van der Meulen, ‘Institutional constraints on and the conditions for the development of use of Foresight’, EASST, Lisbon; *A. Webster*, 'Evaluating Technology Foresight', Open University Business School; ‘Foresight and the new genetics’, University of West of England; 'Innovation and health futures', PREST, Manchester; *L Sanz Menedez*, ‘Foresight and policy’, ARBOR; ‘Foresight and decision-making’ VI Congreso Espanol de Sociologica, Madrid.

1999

L. Sanz Menendez & C. Cabello, 'Institutional Dynamics of the Spanish Science, Technology and Innovation System in Healthcare, RICTES Conference; *A. Webster*, ‘Foresight and Knowledge Flows’, Institute for Prospective Technological Studies, Seville, January 1999; 'Health and future risk', University of Sussex; *A. Nelis*, Foresight and Knowledge Management’ European Context of UK Science Policy, London;

2000

Barend van der Meulen ‘Foresight as a political tool and its impact’, Foresight Network Enlargement Countries Conference, Warsaw, June 28-30; F. Merkx ‘The role of hybrid fora in taking or delegating responsibility for a desirable future of genetic diagnostics’, EASST 2000 Vienna.

A. Webster, ‘Knowledge management, institutional regimes and Foresight in health genetics and informatics’, UMIST Research Seminar Series, Manchester; ‘Regulation as a Form of Social Practice: Different ways of regulating the Gene’, EASST 2000 Vienna (co-author, A.Nelis); ‘Foresight and the Future of Health care, DTI Seminar series London.

Future dissemination

There are various activities planned for the period beyond the formal completion of the contract with the Commission. These relate to the production of short papers that will disseminate the results to international and national groups, plus more academic papers that will target the innovation studies, science and technology studies and science policy literature.

The following table summarises these plans and the lead partner who will take responsibility for them:

Plans for dissemination during 2001.

Output	***Lead***	***Activity***
Results	*Co-ordinator*	*Disseminated through FP V's IST and Quality of Life (especially 'socio-economic aspects of life sciences and technologies') programmes;*
	All partners	*Dissemination of results through national policy agencies*
	All partners	*Dissemination via international Foresight event and regional development, Rome, 2001*
	All partners	*Web-based dissemination via partner institution's home pages and links to CORDIS sites as appropriate*
Planned papers	*All partners*	*The comparative construction of the utility of Foresight exercises across countries and sectors*
	SATSU	*Foresight , utility and in the non-medical sectors*

Part 6 Acknowledgements

The FORMAKIN project team would like to acknowledge the following colleagues and collaborators:

Dr Annemiek Nelis, Research Fellow, Clinical Genetics, University of Amsterdam, Anne Löhnberg, Fina Anton, Maria Rosales all former Research Assistants to the project, Ronan O'Brien, EC Scientific Officer to the project, those academic colleagues who attended the 1999 workshop *New health technologies and future oriented co-ordination: the role of expectations in medical innovations* held at the University of Twente, and all the interviewees who gave their time to us so freely.