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Foresight for European coordination: developing national priorities for the Forest-Based Sector Technology Platform

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Abstract: We explore what implications the geographical dispersion of foresight participants and their regional idiosyncrasies have for the management of foresight processes. Specifically, we argue that these kinds of multi-stakeholder processes place demands such as *scalability*, *modularity* and *dependability* on the design and deployment of foresight methodologies. We also report a Finnish foresight process to support the development of the Strategic Research Agenda (SRA) of the European Forest-Based Sector Technology Platform. This process was based on the *RPM Screening* methodology which consisted of the internet-based solicitation and assessment of research themes, identification of promising research themes through Robust Portfolio Modelling (RPM)[1], and several facilitated workshops.

Keywords: foresight; innovation policy; forestry; forest industry; multicriteria decision making; portfolio modeling; OMC; open method of coordination; technology platform.

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1 Introduction

Research on the systemic nature of innovation (Smith, 2000) and the performance of innovation systems (e.g., Edquist, 1997) has supported the emergence of coordination-oriented approaches to policy management (Metcalfe, 1995; Könnölä et al., 2006). This trend has been coupled with the proliferation of participatory policy instruments for involving stakeholders in the development of common RTD activities. In broad terms, ‘systemic instruments’ (see Smits and Kuhlmann, 2004) of this kind subsume approaches like ‘constructive technology assessment’ (Schot and Rip, 1997), ‘strategic niche management’ (Kemp et al., 1998), ‘transformation management’ (Rotmans et al., 2001) and, most notably, ‘foresight’ (e.g., European Commission, 2002; Salo and Cuhls, 2003). Among these instruments, foresight is perhaps the most comprehensive one, because it can contribute to a range of objectives that pertain to improved systems understanding, enhanced networking and strengthened innovation activities, among others (Salo et al., 2004).

Despite the growth of foresight activities at the international level (e.g., Webster, 1999; Jewell, 2003), not much attention has been devoted to the challenges that are caused by geographical dispersion of participants or their multi-faceted backgrounds and interests; such challenges are manifest, for instance, in the coordination of European innovation policies. In this setting, we argue that embedded foresight activities (Salo and Salmenkaita, 2002) *within* specific coordination tools may help governmental agencies to institute multi-stakeholder learning processes that facilitate technological and structural changes (Metcalfe, 1995). The apparent lack of methodological support for this kind of international coordination is striking, in view of growing pressures from global markets where not only companies but also local, regional and national innovation systems are challenged to define and pursue their internationalisation strategies (Carlsson, 2006).

Europe has responded to the challenge of internationalisation by establishing the European Research Area (ERA) (European Commission, 2003). This 'Europeanisation' of national science, technology and innovation policies (innovation policies, in short) has been promoted through the 'Open Method of Co-Ordination' (OMC) which is an inter-governmental mechanism of voluntary cooperation of European innovation policies (Prange, 2003; Pochet, 2005). First applied in European employment and social policies (Pochet, 2005), the OMC approach does not rest on regulatory enforcement but, rather, on guidelines, benchmarking and sharing of best practices. In the context of innovation policy, it has been implemented by introducing new networks, stakeholder forums and policy processes or, more generally, *coordination tools* which encourage stakeholders to coordinate and self-organise the formation of common Research and Technology Development (RTD) agendas. Such coordination tools have been promoted, for example, within 'Integrated Projects', 'Networks of Excellence', 'ERA-NETs', 'European Technology Platforms' and 'Technology Initiatives', whereby the European Commission has provided general recommendations only, remaining cautious so as not to overtake stakeholder-lead processes (e.g., European Commission, 2005). Thus, while the coordination tools have enjoyed considerable freedom, they have received little methodological guidance on how consultative processes to support their management activities should be designed and implemented.

Considerable coordination challenges emerge from the fundamental transformation of national innovation systems to 'post-national' innovation systems and attendant complications for obtaining strategic intelligence in support of decision-making (Smits and Kuhlmann, 2004). Foresight can play a key role in addressing these challenges, for instance if judiciously embedded within the coordination tools that facilitate the development of the ERA at multiple levels of policy making. It is against this background that we describe the modular foresight process for developing the Finnish priorities for the Strategic Research Agenda (SRA) of the Forest Based Sector Technology Platform (FTP). We also discuss of the broader relevance of the chosen methodological approach and outline opportunities for related foresight processes in supporting the management of 'post-national' coordination tools.

2 Coordination challenges in 'post-national' innovation systems

Already in the FP5 the Commission implemented a strategic shift from the funding of technological development towards a more comprehensive innovation policy with considerable emphasis on coordination (Kaiser and Prange, 2004). In practice, these coordination efforts have had a chequered history, partly due to the fragmentation of innovation activities and the dispersal of resources. Indeed, because more than 80% of research in EU is financed at the national level (see European Commission, 2004a), European coordination tools must account for major variations among national and regional innovation systems which, in turn, are influenced by various legislative and budgetary powers and shaped by national coordination mechanisms within different institutional structures (Lundvall, 1992; Edquist, 1997). Hence, the further development of European coordination tools is likely to benefit from experiences from the vertical coordination of multi-layered innovation systems and also from the horizontal coordination between innovation and other policy areas.

2.1 Vertical coordination of multi-layered innovation systems

Experiences from the vertical coordination between local, regional and (inter)national levels provide insights into the challenges of managing multi-layered innovation systems. Such challenges have been attributed to the systemic nature of innovation (Smith, 2000; Smits and Kuhlmann, 2004), performance of innovation systems (Lundvall, 1992; Edquist, 1997), and even processes of regionalisation (Prange, 2003) which have resulted in complex multi-layered policies especially in Europe. In effect, this complexity differentiates innovation policy from other policy areas – such as social or employment policies – where the OMC has applied earlier on (Georghiou, 2001; Prange, 2003).

Historically, innovation policies have emerged through development paths that reflect the societal contexts of their path-dependent techno-institutional co-evolution. They have also evolved over a long period of time and are thus extraordinarily stable (Georghiou, 2001). At present, innovation policies are challenged by the global market conditions where Member States, regions or even industrial or local clusters compete for critical resources, such as knowledge, human resources, and foreign RTD investments (Kaiser and Prange, 2004). Driven by these competitive pressures, many Member States have created new institutional structures (e.g., committees and innovation-oriented agencies) in search of novel coordination-oriented policy approaches. They have also invested in the production of strategic intelligence by deploying systemic instruments, of which national foresights are but one example (Smits and Kuhlmann, 2004).

2.2 Horizontal coordination between innovation and other policy areas

Successful innovation processes can be facilitated by horizontal coordination between innovation and other policy areas (such as competition, regional, financial, employment and education policies) (European Commission, 2003). In effect, the adoption of innovation as a cross-cutting policy objective – which is prominent even in sectorally oriented policies – holds promise for the closer integration of innovation and other policies: for example, eco-innovations can contribute towards the realisation of the Lisbon Strategy which recognises economic, social and environmental aspects as key drivers of growth (European Commission, 2003, 2004b).

This notwithstanding, coordination-oriented innovation policy differs from other policy areas, because it has to account for context-and sector-specific differences that are caused by the dynamics of evolutionary processes with different phases of competing technological alternatives and emerging dominant designs (e.g., Unruh, 2000; Río González, 2005). In such settings, horizontal coordination efforts must seek opportunities for collaborative policy formation while recognising the relevance of multiple perspectives in relation to the goals of different policies. Methodologically, these efforts call for carefully organised multi-stakeholder processes, lest they be taken over by short-term policy agendas that foster position-based bargaining and claiming of value (Powell and DiMaggio, 1991).

2.3 Management of 'post-national' coordination tools

In order to deal with the European-wide challenges of vertical and horizontal coordination, the European Council re-launched the Lisbon Strategy in Spring 2005, whereby the planning of FP7 was started with major emphases on the OMC. To-date, the OMC has supported the greater convergence of innovation policies at different territorial levels through the active surveillance and fixing of common targets (Kaiser and Prange, 2004). Yet excessive concentration of innovation policy coordination with the Commission at its core may provoke national resistance (Prange, 2003; Kuhlmann and Edler, 2003). Conversely, loose decentralised coordination of innovation policies may lead to increased rivalry among regional actors, disintegration and widening of existing socioeconomic gaps (Kuhlmann and Edler, 2003).

Kuhlmann and Edler (2003) have identified a third and possibly more desirable scenario where 'post-national' innovation systems evolve towards centrally mediated policy-making for distributed but interrelated innovation systems. They view recent strategic efforts towards the creation of ERA as indicative of this scenario whose realisation would call for the coexistence of two partly competing policy targets, i.e.,

- the socio-economic cohesion of European regions in view of dimensions such as similar working conditions
- the adoption of the 'géometrie variable' concept where a varying number of Member States or sectors initiate their joint initiatives (Kuhlmann and Edler, 2003).

Effective coordination efforts must therefore be enacted within multi-actor governance structures, assisted by transparent and accountable intermediary interfaces that can be fostered through mutual learning processes and new collaboration activities (Kuhlmann and Edler, 2003).

The political momentum for the Commission's role as a facilitator is visible in several recent coordination tools. For example, the ERA-NET activities of funding agencies provide support for European coordination and mutual opening-up of national policies (European Commission, 2004a). Also Technology Platforms and Technology Initiatives provide new for a where companies, research organisations, funding agencies, and regulatory authorities are engaged in the definition of common research agendas and associated legal and regulatory conditions (European Commission, 2004a). Broadly seen, these initiatives are indications of the transformation of the EU innovation policy from the provision of financial resources to the facilitation and monitoring of stakeholder processes. There is, in effect, an ongoing shift from optimisation-oriented innovation policies for the mitigation of market failures towards coordination-oriented policies (Metcalfe, 1995; Könnölä et al., 2006) where policy-makers interact with other stakeholders in learning processes, thus creating new coalitions and institutions with distributed strategic intelligence (Smits and Kuhlmann, 2004).

While central to this transformation, coordination tools have been managed by the stakeholders largely through processes of self-organisation, whereby the Commission has provided documents only on general guidelines and routinely applied governance principles (e.g., effectiveness, coherence, accountability, participation and openness; European Commission, 2001). This may be one of the reasons why the specific demands posed by the management of coordination tools have received little attention, although these tools will undoubtedly encounter challenges in coordinating European policies within multi-layered innovation systems. Further complications are caused by the presence of different and even conflicting interests of national and industrial perspectives, to name but some examples.

Despite its strategic vision in initiating coordination tools, the Commission has taken few proactive efforts to assist the managers of these multi-stakeholder processes.

Such efforts can benefit considerably from the accumulated expertise on the deployment of systemic instruments (Smits and Kuhlmann, 2004). Foresight, in particular, has become increasingly central to future-oriented decision making processes – not only in the context of national innovation policy, but also in local, regional, and even international settings in different policy fields. It therefore appears that the managers of European coordination tools would most probably benefit from well-established foresight processes and methods.

To fulfill this promise, it is useful to examine what demands the European context is likely to place on foresight processes, apart from the 'usual ones' that pertain to national foresight activities (see, e.g., Martin and Johnston, 1999; Salo and Cuhls, 2003). Most notably, the European context results in a momentous increase in the number and complexity of vertical and horizontal coordination interfaces. This *multiplicity of interfaces* is a key factor which has important ramifications for the design of foresight processes:

- *Scalability* is needed to process contributions from stakeholders who are concerned with different facets of innovation systems at the local, sectoral, national and international level, and who may be accustomed to different levels of abstraction when considering regional, sectoral, national or European priorities. The notion of scalability has at least three subdimensions, i.e.,
  - *input scalability*, which makes it possible to involve varying amounts of contributions from a changing number of stakeholders
  - *geographical scalability*, which makes it possible to involve stakeholders regardless of the geographical distance between them
  - *administrative scalability*, which permits the decomposition of the foresight process into *manageable* sub-processes and facilitates transitions between different levels of abstraction by way of problem structuring and synthesis.
- *Modularity* refers to process design where analogous sub-processes – or modules – can be enacted relatively independently from the other sub-processes. This concept is key to the attainment scalability: for instance, input scalability can be achieved by carrying out modules of analogous foresight processes in different countries, where after further sub-processes can be conducted to interpret these processes, say, from the viewpoint of European priorities. Modularity also makes it easier to compare the results of sub-processes (because they are based on a similar methodology), and to achieve economies of scale (because they can be carried out repeatedly at a lower cost).
- *Iterative de/recomposition* contributes to scalability by permitting
  - the *decomposition* of complex problems into smaller manageable subproblems for subsequent analysis
  - the recomposition of results from such analyses through processes of interpretative *synthesis*.

  Typically, decomposition is involved when defining relevant 'units of analysis' that can be assessed by the participants by using internet-based group support systems, for instance (Shim et al., 2002). Recomposition, on the other hand, is required

- to identify *similarities* and interdependences between subproblems
- to generate holistic perspectives and shared action plans.

  Methodologically, this activity is often best supported via open-ended discussions in face-to-face meetings (Salo and Gustafsson, 2004).

- *Dependability* is vital when the process consists of several interdependent modules (e.g., sub-processes at the national vs. European level). In this case, it is imperative that the modules achieve their objectives on time and on budget; for otherwise failures in the performance of any individual modules may influence other modules adversely, which in turn may undermine the stakeholders' commitment to the process and the trustworthiness of the exercise at large. From the viewpoint of risk management, the presence of interdependencies suggests that it may be advisable to provide some 'slack' in scheduling, even if the process as a whole may then exhibit more inertia.

Building on the above discussion, we consider European Technology Platforms as one of the examples of European coordination tools. In particular, we describe how the FTP has sought to address coordination challenges by developing a multi-layered organisational structure and interdependent subprocesses for national priority-setting. We also describe our experiences in facilitating the development of FTP research priorities at the national level, based on the deployment of a novel foresight method.

3 Strategic research agenda development in the FTP[2]

Since 2003, the Commission has encouraged industrial stakeholders to set up European Technology Platforms which the European Council, too, has promoted as one of the coordination tools to set up European RTD priorities, action plans and timeframes (European Commission, 2005). Among nearly 30 parallel initiatives, the planning of the Technology Platform for the Forest-Based Sector (FTP) was started in autumn 2003 by the European Confederation of Woodworking Industries, the Confederation of European Forest Owners and the Confederation of European Paper Industries. In keeping with the general Commission guidelines (European Commission, 2005), the development of FTP was to follow a three-stage process:

- emergence and setting up, which was achieved by producing a vision document explaining the strategic importance of the FTP activity and its desired development objectives
- definition of a SRA consisting of agreed research priorities, including measures for enhancing networking and clustering of the RTD capacity and resources in Europe
- implementation of the SRA through the establishment of a new *Technology Initiative* or the application of Community research programs (i.e., FP7), other sources of European funding, national RTD programs, industry funding and private finance.

As a result of a European wide consultation of the key stakeholders, the *Vision for 2030* document on the key challenges, opportunities and strategic objectives for the sector was published in February 2005. This document served as the basis for the further preparation of the SRA process, organised through the platform management structure which consisted of the High Level Group, Advisory Committee, Scientific Council, National Support Groups and, finally, the Project Group which was the team that coordinated of FTP activities. Additions to this management structure included European value-chain working groups and three further groups for funding, education, and training and communication.

The SRA process design was prepared and approved by the High Level Group which consisted of industrial leaders, representatives from federations, working group chairs, and observers from the European Commission. The approved process consisted of four phases in 2005:

- the collection of prospective research themes from National Support Groups, confederations and other European stakeholders by June 15
- the synthesis of priorities based on collected research themes by the European value-chain working groups by September 15
- the elaboration of the strategic objectives of the SRA and the selection of most important European research themes by October 31
- the compilation of and consultation on the first draft of the SRA by November 30.

Following this plan, the development of the final SRA was organised by the Project Group. Work towards the implementation phase of the SRA was carried out with the aim of starting activities in 2006. To endorse this process plan, the corresponding guidelines for the preparation of SRA were compiled and communicated to key stakeholders in Europe. These guidelines reflected several vertical and horizontal coordination challenges:

- *Vertical coordination in FTP*. While European dimensions were well represented in the FTP management structure (e.g., through the representatives of multi-national companies, industrial confederations, and the Commission), the recognition of national, regional and local interests called for additional inputs from Member States. This was achieved by establishing National Support Groups which acted as 'mirror groups' of the European FTP also in that national value chain working groups were established. The National Support Groups consisted of representatives of industrial firms, research organisations and funding agencies with interests in the forest-based sector. They provided national views and inputs to SRA, and were in charge of mobilising the national SRA work.

  National activities were started in 17 Member States with rather different contexts: in Finland, for instance, the forest-based sector has traditionally played a more important role than in other Member States. Thus, reflecting the diversity of national innovation systems within Europe, the working practices of the National Support Groups varied from one country to another. Moreover, whilst the FTP process had been initiated in Nordic countries partly as a continuation of previous Nordic collaboration (e.g., establishment of joint RTD programs; see Salo and Liesiö, 2006), other countries had only varying degrees of involvement in international RTD cooperation. With the aim of promoting interaction between stakeholders from the different Member States, the High Level Group appointed an Advisory Committee which consisted of representatives from each National Support Group and also from industrial companies and federations.

- *Horizontal policy coordination in FTP*. As in many other Technology Platforms, the management of FTP was requested to design and coordinate an efficient consultation process and to search linkages to other policy areas and initiatives, too. Here, the FTP had close connections with about 4–5[3] other Technology Platforms, whereby responsibilities for synchronisation were assigned to its Scientific Council and Advisory Committee. The Vision for 2030 document was helpful in this regard, because it highlighted links with other policy areas and explicated impact dimensions that pertained to consumers, society, environment, energy use and competitiveness, among others. The general awareness of the FTP in relation to other policy areas was promoted through the coordination activities of the Communication Group.

The above process design and management structure provided a basis for the European SRA process. The consideration of national dimensions – especially the involvement of national actors and the coordination between national processes – posed some challenges due to the specific conditions of Member States. Here, the National Support Groups were responsible for mobilising national SRA processes with the help of the SRA guidelines that were made available to them.

4 The SRA process in Finland

In Finland, as well as in the other FTP countries, the national SRA process was coordinated by a National Support Group which consisted of representatives of industrial firms, research organisations and governmental bodies. This process was started in March 2005, with the objective of collecting about ten strategic priority areas as a key input to the European SRA process. This was to be achieved in a remarkably short three-month period by mid-June, 2005.

Several observations suggest the Finnish SRA process is of considerable interest. In 2004, the Finnish wood, pulp and paper industry exports accounted for 24% of national exports and 3,8 % of GDP. In consequence, the forest-based sector is in relative terms more important for Finland than for any other Member State. Finland is also one of the world leaders in the forest-based RTD activities (Finnish Forest Industries, 2006).

Because Finnish and other Nordic actors were initiators of the FTP, the national SRA process was started in Finland with particularly ambitious objectives. At the national level, the process was expected to contribute to an enhanced and shared understanding of strategic RTD needs and also to the mobilisation of national actors so that they would participate actively in the different phases of the FTP and other European activities. These objectives were to be achieved through a common strategy work and ensuing communication of results around Europe.

With the aim of developing a structured and systematic SRA process, methodological requirements were discussed between the National Support Group and the Support Team (the authors of this paper) at the Helsinki University of Technology. Earlier on, this Team had supported forest-based sector strategy processes (Salo and Liesiö, 2006) and developed a novel foresight methodology called *RPM Screening* (Könnölä et al., 2007). This methodology supports the solicitation, multi-criteria assessment, and mutual commenting of research themes, as well as the identification of potentially most relevant themes by using Robust Portfolio Modelling (RPM; Liesiö et al., 2006).

Starting from the Vision for 2030 document and the SRA guidelines, the plan for the national SRA process was drafted through the collaboration of the National Support Group and the Support Team. Shortly thereafter, the Support Team launched a project website[4] to facilitate the work of five value chain working groups of *forestry, pulp and paper products, wood products, bio-energy and specialities/new businesses*. Each value chain working group was given the opportunity to take part in the internet-based solicitation and assessment of research themes, the results of which were further analysed with RPM.

Results from the internet-based consultation process were to be taken as a key input to the value chain workshops where promising themes were to be discussed, with the aim of synthesising the ten most essential ones from the national process to the European SRA process. Apart from this core objective, the national SRA process was expected to help national actors participate in the European context, to offer an opportunity for methodological development, and to provide experiences about how national stakeholders could be best engaged in European coordination tools. It was expected that the process would attract interest in Europe, and hence English was adopted as a working language. Below, we describe the main roles and activities in this process, with an emphasis on process design and the consideration of multiple perspectives.

4.1 Roles and responsibilities

In the national process, several stakeholder groups were invited based on their expertise and managerial responsibilities. The *Coordinators* of value chain working groups served on the *Steering Group* and invited well over 100 leading researchers and industrialists into the process, either as *Respondents* or *Referees.* The *Support Team* at the Helsinki University of Technology helped in process design and provided the methodological expertise and the ICT infrastructure. This Team also produced tentative analyses of solicited and assessed research themes for the value chain workshops.

The roles and responsibilities of Respondents and Referees were explicitly defined. *Respondents* consisted of established researchers or research managers at universities, research institutes and industrial firms. Chosen on the basis of their ability to propose innovative research themes, they were requested to study the Vision for 2030 document and to propose related research themes for the value chain through the project website. *Referees* were highly competent researchers and industrial managers who were capable of assessing research opportunities in view of the Finnish and European forest-based sector. They performed the multi-criteria assessment of the research themes that were proposed by the Respondents.

Some participants had several roles in the process. For example, many Respondents were invited to participate in the value chain workshops and to contribute to the further analysis of the themes. Furthermore, although the roles and responsibilities were formally identified, the organisation was many-faceted with partly overlapping duties. For instance, the Coordinators participated both in management activities and expert workshops, while some value chains had experts who acted as Respondents and Referees alike, or even participated in several value chains. This created additional interactions between value chains and steps for enabling the efficient cross-fertilisation among value chains.

4.2 Iterative process design

The Finnish SRA process consisted of seven steps (see Table 1). These were fixed almost at the outset due to the exceptionally tight schedule and the need to support all value chains through the same methodology. The process design relied heavily on the use of internet-based group support systems, because it would have been impossible to organise a large number of face-to-face meetings within the seven-week period that was allotted to the process. A further reason was that internet-based distributed work can provide efficient and systematic support for stakeholder participation while permitting features such as anonymity and flexibility in terms of time and place (Salo, 2001; Salo et al., 2004; Salo and Gustafsson, 2004). Due to the limitations of the internet as a platform for social interaction, however, the process was run in conjunction with interactive face-to-face workshops.

Table 1 Steps of the Finnish SRA process

Process steps	*Weeks*	*Key participants*
Step I: Process design and identification of participants	1	NSG/Steering group and the support team
Step II: Internet-based solicitation of research themes	1–2	Value chain coordinators and respondents
Step III: Co-ordination workshop	3	Value chain coordinators and steering group
Step IV: Internet-based assessment of research themes	3–4	Value chain coordinators and referees
Step V: Multi-criteria analysis of research themes	4–5	Support team
Step VI: Value chain workshops for the formulation of relevant research areas	5–6	Value chain coordinators and invited respondents, referees and other experts
Step VII: Steering Group workshop for the formulation of Finnish SRA priorities	7	Steering group

Step 1: Process design and identification of participants

The process design was developed based on deliberations between the representatives of National Support Group (which was called the Steering Group in the Finnish process) and the Support Team. This design was influenced by the strict schedule, because only seven weeks were allotted to the national SRA process. Methodologically, *RPM Screening* was deemed suitable in view of promising results from an earlier foresight process where this approach had fostered the systematic comparison of innovation ideas proposed by a large number of stakeholders (Könnölä et al., 2007).

Step 2: Internet-based solicitation of research themes

After *RPM Screening* had been demonstrated to the Coordinators, they all supported its application in the value chain working groups. Each Coordinator invited some 20–30 Respondents by e-mail and/or phone to consult their networks and to submit one to three research themes via the questionnaires on the project website; these questionnaires were implemented with the Opinions-Online© decision support tool.[5] Depending on the value chain, the actual number of Respondents was between 8 and 15.

The project website provided separate questionnaires for each value chain so that the Respondents could submit their research themes to the relevant value chain. For each theme, the respondent first gave a short descriptive name and then explicitly linked it to the Vision for 2030 document by choosing at most two impact dimensions and five challenges and opportunities mentioned in this document. In two last fields, the respondent described the theme in some detail (but with less than 200 words), its relationship to the Vision 2030 document, as well as relevant research methods and required competencies. The Respondents were requested to submit their themes within two weeks or less, although some value chain Coordinators permitted their Respondents to submit issues also later on. The value chain working groups produced between 16 and 40 research themes, and the total number of proposed themes was 146.

Step 3: Coordination workshop

The Steering Group convened for a day workshop to coordinate the activities of the five value chain working groups. At this workshop, each value chain Coordinator presented an initial synthesis based on the submitted themes and made preliminary proposals concerning the main research clusters of the value chain. This was useful for exploring linkages between the value chains and served to clarify the overall vision of the key research themes for Finland. The coordination workshop also gave an opportunity to discuss the European FTP process and on-going policy activities, which helped the Coordinators put their work in the proper European context. Also, the additional objective of identifying relevant research themes to be used as Finnish inputs to the preparation of the FP7 for the years 2007–2011 was placed at this workshop on the Finnish SRA process. The introduction of these additional objectives made the schedule even tighter and made it necessary to strive for a balance between the shorter-term objectives of FP7 preparations and the longer-term implementation of Vision for 2030. Arguably, the consideration of these additional objectives lent even more weight to the SRA process, and it may have increased the participant's commitment to it.

Step 4: Internet-based assessment of research themes

The structured format for the solicitation of research themes established a common framework for the collection of a body of material that could be meaningfully subjected to an evaluation with regard to a common set of criteria (Linstone, 1999). Starting from the SRA guidelines, and realising that the assessment effort had to be kept at a reasonable level, no more than three assessment criteria were defined, i.e., *feasibility, industrial relevance* and *novelty*. These criteria reflected the purpose of the Vision 2030 document; in particular, they were deemed meaningful for the assessment of different themes and also comprehensive enough for covering different assessment perspectives (Linstone, 1999).

Before the assessment task, compilation documents describing all the research themes per value chain were uploaded onto the website. The questionnaires for the assessment task were structured so that it contained the name of the research theme, its positioning along the selected two impact dimensions, five challenges and opportunities as well as the description and approach of the theme (see Box 1 as an example). The value chain Coordinators identified and invited about five to ten Referees to assess the research themes one by one using a seven-point Likert-scale. When making their assessment, the Referees were encouraged to supplement their numerical statements with written comments.

Box 1 An example of the assessment questionnaire in Step 4

SRA Phase 3: Forestry 3/36

*Title***:** New uses of wood and forests

Positioning:

- *Customer*: Expected response to future consumer needs.
- *Competitiveness*: Expected impact on the competitiveness of European industry/companies in global competition.

Challenges and Opportunities:

- Providing products and services that respond to changes in societal needs.
- Substituting non-renewable materials through innovative solutions from forest-based materials.
- Taking advantage in process and product developments of alliances with other sectors and of exploiting emerging technologies.

Description: Forest sector development is mostly based on process innovations (forestry, sawing, pulp and paper). Most of the process innovations are aimed for production or energy efficiency improvement. This is acceptable, but aside this main stream of research, more attention should be paid on developing radical innovations. They exist for example in wood chemistry (biofuel), health products (xylitol, benecol), energy (wood residuals for energy, afforestation) and health (lignan). These provide many opportunities for new spin-offs in forest industries, where many opportunities are lost because the new innovations are not at the core of business strategies. Relation to Vision 2030: Key challenge that the new products and services respond to the changes in societal needs.

Approach: The approach could be to announce open a research programme or similar at national or Eu level to invite proposals for establishing new uses of wood and forests => the new 'projects' initiated should then include R&D and perhaps enterprise incubators to really support for new livelihood. Methods for research vary according to the product or service in question. Competencies exist in universities and research institutes; the problem is rather on how to activate the competencies (like could be done with the mentioned research programme type of an instrument).

Feasibility – Are the research challenges raised by the theme such that they can be resolved through related research activities?

0 – no comments 1 – hardly feasible at all 2 3 – somewhat feasible 4 5 – very feasible 6 7 – extremely feasible

Industrial relevance – Is the industry interested in and capable of benefiting from research activities related to this theme, assuming that the research activities are successful?

0 – no comments 1 – hardly relevant at all 2 3 – somewhat relevant 4 5 – very relevant 6 7 – extremely relevant

Novelty – To what extent is the theme novel for the forest-based research and industrial activities?

0 – no comments 1 – hardly novel at all 2 3 – somewhat novel 4 5 – very novel 6 7 – extremely novel

Further comments

Send

Step 5: Multi-criteria analysis of research themes based on the assessments

The internet-based solicitation and assessment of research themes produced plenty of material on future research opportunities. To assist in the identification of most interesting themes, the Support Team calculated criterion-specific statistics for each theme (i.e., averages, standard deviations, and ranges of variation for specified assessments). The RPM methodology[6] was then employed to synthesise the Respondents' assessments, with the aim of identifying research themes which, in a sense, tended to perform well with regard to the three criteria.

Step 6: Value chain workshops

The results of RPM analyses were discussed at the value chain workshops. Each value chain Coordinator organised one or two workshops to discuss and identify interesting research themes and to synthesise five or so most essential research areas from them. In these workshops, the invited respondents, referees and other participants were first presented the RPM methodology and results from the multi-criteria screening of research themes. In this way, *RPM Screening* helped direct attention to the more promising themes, which catalysed discussions and helped in shaping important research areas.

Step 7: Steering Group workshop

The Steering Group held a workshop to formulate the Finnish SRA priorities based on the results of the value chain workshops. At this workshop, the value chain coordinators presented the research areas that were deemed important for European cooperation. The presentations provided a basis for the creation of linkages among research areas, the identification of crucial areas for the SRA process, the planning of later implementation activities and also for the development of contributions to FP7 preparations. The workshop benefited from contributions at two complementary levels of analysis: the collected research themes pointed to concrete needs at the project level, while the research areas from the value chain workshops summarised these needs at the aggregate level and lent additional structure to the analysis. This made it possible to link discussions to concrete opportunities (i.e., individual research themes) while forming aggregate priorities that could be transmitted to the European SRA process.

4.3 Methodological support for considering multiple perspectives

In the SRA process, the consideration of multiple perspectives was supported by multi-criteria assessments where the referees evaluated research themes with regard to three criteria (novelty, feasibility, and industrial relevance). This resulted in criterion-specific means for all criteria. However, the simultaneous consideration of multiple criteria lead to the question of how the relative importance of these criteria should be weighted: for example, research themes that are not very novel may still be industrially relevant and hence interesting.

Because it may be difficult if not impossible to justify 'exact' criterion weights, analyses for identifying 'most interesting themes' should arguably accommodate different interpretations of which criterion weights are feasible. This realisation was the rationale for adopting the RPM methodology in the analysis of research themes. In this methodology, different perspectives could be accommodated not only through the consideration of multiple criteria (means of the participants' assessment ratings), but also by incorporating different interpretations about the relative importance of the three criteria.

In its standard formulation, the RPM methodology (Liesiö et al., 2006) supports the selection of project portfolios subject to budget and other constraints. In the Finnish SRA process the RPM methodology was deployed by regarding research themes as 'projects' and collections of themes as project portfolios, respectively, subject to the constraint that only a subset of themes could be taken forward from the workshops. Thus, the task of identifying most promising themes for workshop discussions was framed as a project portfolio selection problem with incomplete information about the relative importance of assessment criteria. Here, we describe *RPM Screening* only at a general level; for a more detailed exposition of this methodology and its use in the screening of innovation ideas, we refer to Könnölä et al. (2006).

In the RPM analysis, the overall value of each research theme is expressed as the weighted average of its criterion-specific scores, and the total value of a portfolio is obtained by summing the overall values for the themes that it contains (whereby it is implicitly assumed that the themes are independent). The identification of 'most interesting' themes (or projects) supported by computing all non-dominated portfolios (i.e., portfolios such that there does not exist any other portfolio which would have a higher portfolio value for all feasible model parameters).

In *RPM Screening*, indications about the desirability of a research theme is offered by computing in how many non-dominated portfolios it is contained. This information is conveyed by the *Core Index* which is defined as the ratio between

- the number of the non-dominated portfolios that the theme belongs to
- the total number of non-dominated portfolios.

Thus, themes that belong to all non-dominated portfolios have a Core Index value of 100%, while themes that do not belong to any non-dominated portfolios have a Core Index value 0%. The former themes (Core Index 100%) merit close attention, because they would plausibly belong to the optimal portfolio of research themes even if more information about the relative importance of criteria were obtained. Likewise, the latter themes (Core Index 0%) seem less attractive, because they would not belong to the optimal portfolio even if additional preference information were to be obtained. The themes with intermediate Core Index value lie between these extremes. In this way, Core Index values can be harnessed to construct a structured agenda for the workshop discussions, whereby the more promising themes are given more attention.

The Finnish SRA process was based on a consensus-oriented approach which helped identify themes that performed reasonably well with regard to the three criteria (i.e., novelty, feasibility, industrial relevance) in view of their criterion-specific means, in the absence of more specific preference statements about the relative importance of these criteria. In addition, we produced three criterion-specific analyses which conveyed additional information about how well the themes performed with regard to the individual criteria (novelty, feasibility or industrial relevance).

Because the objective of each value chain each workshop was to characterise the five or so most essential research themes, the RPM portfolio analysis was carried by putting an upper bound of seven on the number of research themes in feasible portfolios. This constraint was partly motivated by the assumption that some value chains were tempted to exceed their 'budget' (in terms of the number of proposed research themes).

Moreover, the introduction of a slightly less restrictive constraint gave more room for devoting attention to the themes that were not among the very 'best' ones.

For the visualisation of results, histograms (see Figure 1) of Core Indices and criterion-specific means, and three graphs (see Figure 2) with criterion-specific means on the axes were produced to support the examination of themes from different perspectives. These visualisations were presented at the value chain workshops, where they were taken up in the discussions and used in the clustering of themes and formation of national SRA priorities. The RPM framework contributed to the legitimacy of the results, because this systematic methodology was also described in the project website.

Figure 1 Examples of the multi-criteria evaluations from the *Forestry* value chain: histograms of Core Indeces and criterion-specific means (see online version for colours)

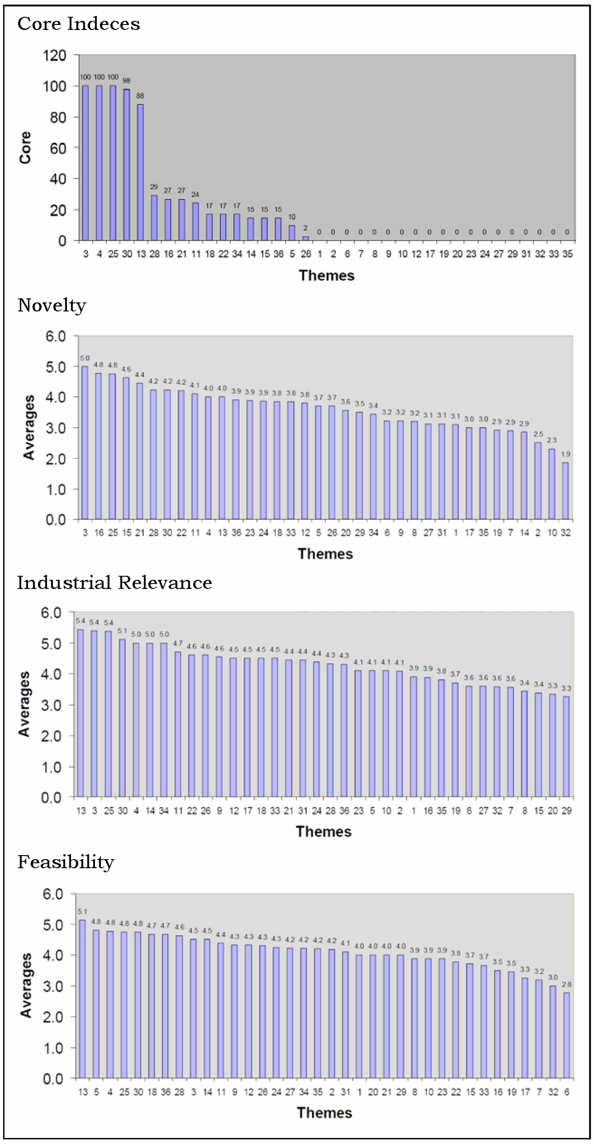

Figure 2 Visualisation of criterion-specific means on the 'industrial relevance – novelty' plane for the *Forestry* value chain (projects correspond to research themes). Similar visualisations were produced on the 'feasibility – novelty' and 'feasibility – industrial relevance' planes (see online version for colours)

Results from *RPM Screening* were used as supporting information only, because final syntheses and analyses were carried out in the workshops. This also made it possible to devote attention to overlaps and synergies between the proposed themes (i.e., interactions), which were not explicitly accounted for in the RPM computations.

In the *RPM Screening* process, the value chain Coordinators had a major role in the adoption and shaping of results. In each value chain workshop, approximately half of submitted research themes were taken up in discussions which guided the final decisions. In some value chains, themes with high Core Index and/or high novelty and/or industrial relevance were identified first, where after the final themes were defined by synthesising these themes. In some other chains, the coordinator had already developed a tentative clustering before the workshop so that the final themes were created by assigning the solicited themes to the proposed clusters. This helped identify missing themes and served to highlight what clusters were apparently important, apart from the solicited research themes.

5 Discussion

The Finnish SRA process provides some insights into the coordination challenges of 'post-national' innovation systems. The bottom-up solicitation of research themes, for instance, had to be linked to the European top-down perspectives in the Vision 2030 document, whereby it had to address issues of vertical and horizontal coordination challenges that are characteristic of multi-layered innovation systems. More generally, the process had to recognise inherent trade-offs between

- short-term policy goals vs. the long-term visioning (e.g., the continuity of RTD funding vs. the objectives of structural changes addressed in the Vision 2030)
- receptivity to additional policy objectives vs. adherence to original objectives (i.e., new expectations were addressed during the SRA process to make contributions to the FP7)
- strict observation of deadlines vs. fulfillment of the principles of good governance (i.e., extensive stakeholder participation remained a relevant objective even though the process had to be conducted over seven weeks).

There are several reasons for why the positive experiences from the deployment of *RPM Screening* in the Finnish SRA process are interesting from an international perspective. First, several analogous processes in other countries may be amenable to similar methodological support, for instance within European coordination tools that seek to respond to vertical coordination challenges. Second, methodologies such as *RPM Screening* can respond to horizontal coordination challenges by permitting the participation of different stakeholders, adoption of complementary criteria, and varying interpretations of the relative importance of these criteria. Third, the Finnish SRA process is relevant to the management of international foresight activities, because it did adopt processes of iterative de/recomposition, which is central to the attainment of administrative scalability.

The continuing transformation towards the ERA and 'post-national' innovation policies will be increasingly dependent on coordination tools and the methodologies through which these tools can be best managed. Here, it will be necessary to observe national differences while migrating towards scalable methodologies for empowering national actors in the development of shared agendas. It is therefore pertinent to revisit the methodological demands that derive from the multiplicity of interfaces in 'post-national' innovation systems:

- *Scalability* is a major concern in European other international processes due to the large number of participating stakeholders from different countries. Here, geographical scalability can be supported through the deployment of internet-based tools (e.g., Opinions-Online© in the Finnish SRA Process). Administrative scalability, in turn, can be supported by decomposing large complex and extensive problems into subproblems (e.g., value chains), the results of which are integrated through processes of recomposition (e.g., workshops).
- *Modularity* is a key design characteristic in responding to the requirement of scalability. In the Finnish SRA process, the modular structure permitted the allocation of work into manageable entities, but raised questions about linkages between the value chains. In this regard, the adoption of a modular process (e.g., strong focus on the same 'unit of analysis') supported comparability and interactions across among the value chains. Such a modular structure can be helpful even in view of horizontal coordination challenges, too: for instance, the value chain on *Specialities and new businesses* in the Finnish SRA process sought to identify

new opportunities in connection with other industrial sectors and policy areas. This suggests that interactions can be enhanced by defining pertinent modules which help engage participants from different policy areas, and by organising additional workshops for the purpose of synthesising the results.

- *Iterative de/re-composition* of problems helps analyse complex environments at a level that is accessible to the stakeholders. In the Finnish SRA process, for instance, the decomposition into the five value chains and the solicitation of research themes within each value chain produced comparable research themes that could be evaluated in view of multiple criteria. However, the consultation of the many stakeholders resulted in a wealth of information, which made it necessary to support synthetic recomposition by way of formal analyses (e.g., RPM; Liesiö et al., 2006) and ensuing face-to-face workshops.
- The *dependability* of large-scale foresight processes calls for the reliable execution of their constituent modules. Towards this end, it is necessary to agree on shared terms and definitions and to adopt a modular process plan that is approved by the stakeholders. At the international level, a clearly defined process may be all the more important, because national idiosyncrasies and reactions to on-going policy processes may create pressures to alter initial objectives and plans. There is, in effect, a need for a balance between receptivity towards stakeholder concerns and methodological rigidity. This can be attained through an iterative process design where rigid methodological frameworks (Helmer, 1983; Porter et al., 1991) are adopted within individual steps, while allowing for reflection and changes between the steps (Salo et al., 2004). In the Finnish SRA process, for example, the modular structure of different working groups and process steps ensured that the value chains employed similar processes in the collection, assessment and analysis of research themes, while a more flexible methodological approach was adopted in the synthesis phase at the Steering Group workshop.

6 Conclusions

The development of ERA and the transformation towards 'post-national' European innovation systems involves major challenges for the coordination of European innovation policies and their coordination tools. In this paper, we have discussed these challenges from the viewpoint of national foresight activities and, specifically, in view of recent experiences from the development of Finnish priorities for the Forest Based-Sector Technology Platform. These experiences point to the multiplicity of interfaces in foresight activities with inherent trade-offs between

- short-term policy goals vs. long-term visioning
- receptivity to additional policy objectives vs. adherence to original objectives
- strict observation of deadlines vs. fulfillment of the principles of good governance.

We have also argued that coordination tools may exert additional demands on methodological support, as exemplified through the scalability, modularity and dependability of foresight processes. Here, methodologies such *RPM Screening* can help establish a modular foresight architecture where results from specific activities serve as inputs to other processes in a transparent and systematic manner.

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References

Carlsson, B. (2006) 'Internationalization of innovation systems: a survey of the literature', *Research Policy*, Vol. 35, No. 1, pp.56–67.

Edquist, C. (Ed.) (1997) *Systems Innovation: Technologies, Institutions and Organisations*, Pinter Publishers, London.

European Commission (2001) *European Governance: A White Paper*, European Commission, COM(2001) 428, Brussels.

European Commission (2002) *Thinking, Debating and Shaping the Future: Foresight for Europe*, Final Report of the High Level Expert Group for the European Commission, 24 April, European Commission, Brussels.

European Commission (2003) *Innovation Policy: Updating the Union's Approach in the Context of the Lisbon Strategy*, European Commission, COM(2003) 112, Brussels.

European Commission (2004a) *Science and Technology, The Key to Europe's Future – Guidelines for Future European Union Policy to Support Research*, European Commission, COM(2004) 353, Brussels.

European Commission (2004b) *Stimulating Technologies for Sustainable Development: An Environmental Technologies Action Plan for the European Union*, European Commission, COM(2004) 38, Brussels.

European Commission (2005) *Report on European Technology Platforms and Joint Technology Initiatives: Fostering Public-Private R&D Partnerships to Boost Europe's Industrial Competitiveness*, European Commission, SEC (2005) 800.

Finnish Forest Industries (2006) Online resource: http://english.forestindustries.fi/, accessed 6.1.2006.

Forest-Based Sector Technology Platform (FTP) (2005) *Guidelines for Preparing the Forest-Based Sector Technology Platform's Strategic Research Agenda*, Forest-Based Sector Technology Platform, 15 May, Online: http://www.forestplatform.org/, accessed 6.1.2006.

Georghiou, L. (2001) 'Evolving frameworks for European collaboration in research and technology', *Research Policy*, Vol. 30, pp.891–903.

Helmer, O. (1983) *Looking Forward: A Guide to Futures Research*, Sage, Beverly Hills.

Jewell, T. (2003) 'International foresight's contribution to globalisation', *Foresight – The Journal of Futures Studies, Strategic Thinking and Policy*, Vol. 5, No. 2, pp.46–53(8).

Kaiser, R. and Prange, H. (2004) 'Managing diversity in a system of multi-level governance: the open method of co-ordination in innovation policy', *Journal of European Public Policy*, Vol. 11, No. 2, pp.249–266.

Kemp, R., Schot, J. and Hoogma, R. (1998) 'Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management', *Technology Analysis and Strategic Management,* Vol. 10, No., 2, pp.175–197.

Könnölä, T., Brummer, V. and Salo, A (2007) 'Diversity in foresight: insights from the fostering of innovation ideas', *Technological Forecasting and Social Change*, Vol. 74, No. 5, pp.608–626.

Könnölä, T., Unruh, G.C. and Carrillo-Hermosilla, J. (2006) 'Prospective voluntary agreements for escaping techno-institutional lock-in', *Journal of Ecological Economics*, Vol. 57, pp.239–252.

Kuhlmann, S. and Edler, J. (2003) 'Scenarios of technology and innovation policies in Europe: investigating future governance', *Technological Forecasting and Social Change*, Vol. 70, pp.619–637.

Liesiö, J., Mild, P. and Salo, A. (2006) 'Preference programming for robust portfolio modeling and project selection', *European Journal of Operational Research*, Forthcoming (available online: http://www.rpm.hut.fi, accessed 30.1.2006).

Linstone, H.A. (1999) *Decision Making for Technology Executives: Using Multiple Perspectives to Improve Performance*, Artech House, Boston/London, pp.31–76.

Lundvall, B-Å. (Ed.) (1992) *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*, Pinter, London.

Martin, B.R. and Johnston, R. (1999) 'Technology foresight for wiring up the national innovation system. Experiences in Britain, Austria, and New Zealand', *Technological Forecasting and Social Change*, Vol. 60, pp.37–54.

Metcalfe, J.S. (1995) 'Technology systems and technology policy in an evolutionary framework', *Cambridge Journal of Economics*, Vol. 19, No. 1, pp.25–46.

Pochet, P. (2005) 'The open method of co-ordination and the construction of social Europe. A historical perspective', in Zeitlin, J. and Pochet, P. (Eds.): *The Open Method of Co-ordination in Action. The European Employment and Social Inclusion Strategies*, Peter Lang Publishing Group, Travail & Société – Work & Society, Vol. 49, Brussels.

Porter, A., Roper, A.T., Mason, T.W., Rossini, F.A. and Banks, J. (1991) *Forecasting and Management of Technology*, John Wiley & Sons, New York.

Powell, W. & DiMaggio, P. (Eds.) (1991) *The New Institutionalism in Organisational Analysis*, The University of Chicago Press, Chicago, IL.

Prange, H. (2003) 'Technology and innovation policies in the European system of multi-level governance', *Techikfolgenabschätzung – Theorie und Praxis*, Vol. 12, No. 2, pp.11–20.

Río González, P. (2005) 'Analysing the factors influencing clean technology adoption: a study of the Spanish pulp and paper industry', *The Journal of Business Strategy and the Environment*, Vol. 14, pp.20–37.

Rotmans, J., Kemp, R. and van Asselt, M. (2001) 'More evolution than revolution. Transition management in public policy', *Foresight*, Vol. 3, No. 1, pp.15–31.

Salo, A. (2001) 'Incentives in technology foresight', *International Journal of Technology Management*, Vol. 21, No. 7, pp.694–710.

Salo, A. and Cuhls, K. (2003) 'Technology foresight – past and future', *Journal of Forecasting*, Vol. 22, Nos. 2–3, pp.79–82.

Salo, A. and Gustafsson, T. (2004) 'A group support system for foresight processes', *International Journal of Foresight and Innovation Policy*, Vol. 1, Nos. 3–4, pp.249–269.

Salo, A. and Liesiö, J. (2006) 'A case study in participatory priority-setting for a Scandinavian research program', *International Journal of Information Technology and Decision Making*, Vol. 5, No. 1, pp.65–88.

Salo, A. and Salmenkaita, J-P. (2002) 'Embedded foresight in RTD programs', *International Journal of Policy and Management*, Vol. 2, No. 2, pp.167–193.

Salo, A., Könnölä, T. and Hjelt, M. (2004) 'Responsiveness in foresight management: reflections from the finnish food and drink industry', *International Journal of Foresight and Innovation Policy*, Vol. 1, No. 1, pp.70–88.

Schot, J. and Rip, A. (1997) 'The past and future of constructive technology assessment', *Technological Forecasting and Social Change*, Vol. 54. pp.251–268.

Shim, J.P., Warkentin, M., Courtney, J.F., Power, D.J., Sharda, R. and Carlsson, C. (2002) 'Past, present, and future of decision support technology', *Decision Support Systems*, Vol. 33, pp.111–126.

Smith, K. (2000) 'Innovation as a systemic phenomenon: rethinking the role of policy', *Enterprise and Innovation Management Studies*, Vol. 1, No. 9, pp.73–102.

Smits, R. and Kuhlmann, S. (2004) 'The rise of systemic instruments in innovation policy', *International Journal of Foresight and Innovation Policy*, Vol. 1, No. 1., pp.4–32.

Unruh, G.C. (2000) 'Understanding carbon lock-in', *Energy Policy*, Vol. 28, No. 12, pp.817–830.

Webster, A. (1999) 'Technologies in transition, policies in transition: foresight in the risk society', *Technovation*, Vol. 19, pp.413–421.

Notes

[1]http://www.rpm.tkk.fi

[2]Factual information in Section 3 is largely based on the FTP (2005) and the website: http://www.forestplatform.org/

[3]Technology Platform on Sustainable Chemistry, http://www.cefic.org/

The European Construction Technology Platform, http://www.ectp.org/

Water Supply and Sanitation Technology Platform, http://www.wsstp.org/default.aspx

MANUFUTURE – Platform on Future Manufacturing Technologies, http://www.manufuture.org/

[4]http://www.sra.tkk.fi

[5]See http://www.opinions.hut.fi

[6]http://ww.rpm.tkk.fi