Submitted, September 30, 2002

Prospective Evaluation of a Cluster Programme for Finnish Forestry and Forest Industries

Ahti Salo, Tommi Gustafsson and Pekka Mild
Systems Analysis Laboratory
Helsinki University of Technology
P.O. Box 1100, 02015 HUT
Finland

Abstract: In this paper, we report a prospective evaluation process for a major research programme for the Finnish forestry and forest industries. To a significant extent, this process was based on fifteen participatory workshops where multicriteria methods and a group support system were deployed to help representatives from industry, research community and public administration assess socio-economic impacts and promising research topics. Apart from reporting experiences from this case study, we also analyze the preconditions, advantages and limitations of related participatory processes, especially in relation to the implementation of formative and summative evaluations.

Keywords: Decision support, multicriteria methods, research evaluation, technology foresight.

1. Introduction

There is a widespread consensus among researchers and policy-makers alike that the ability to innovate is crucial to the well-being of knowledge-based societies (Caracostas and Muldur, 1998; Kuhlmann et al., 1999; Smits, 2001). As a result, the importance of science and technology (S&T) policies has grown, in the recognition that these policies are crucial to the fostering of innovative activities and the strengthening of economic growth (see, e.g., OECD, 1999, 2001). In many countries, large-scale research programmes are a key instrument for the implementation of these policies: in Finland, for example, the Academy of Finland and the National Technology Agency fund an exten-

sive range of research programmes which provide not only an important source of project funding but also promote networking activities and subsequent exploitation of results (see, e.g., Salo and Salmenkaita, forthcoming).

Ex post evaluation has become a widely adopted practice in the management of publicly funded research programmes (OECD, 1997; Luukkonen, 1998). While external evaluators are often engaged to secure impartial and objective findings, the presence of complex feedback loops among the users and producers of new knowledge implies that the significance of research (in terms of its socio-economic impacts) may be best understood by those who know the innovation system well (see, e.g., Andersson, 1998). Even so, the consideration of past activities does not suffice as the sole source of strategic intelligence, because the shaping of new S&T policies and research programmes needs to driven by future challenges as well (Coates, 1985; MacLean et al., 1998; Meyer-Krahmer and Reiss, 1992). The identification of these, in turn, calls for foresight activities which are typically organized through collaborative processes among participating stakeholders from the research community, industry and public administration (see, e.g, Grupp and Linstone, 1999; Héraud and Cuhls, 1999; Martin, 1995; Martin and Johnston, 1999). Indeed, there is a growing demand for a new type of a hybrid instrument – prospective evaluation – which relies on participatory approaches in order to combine evaluative and prospective analyses in support of S&T decision making (see also Geurts and Joldersma, 2001; Smits et al., 1995).

In this paper, we report a prospective evaluation of Wood Wisdom, a national research programme for the Finnish forestry and forest industries. Funded in 1998-2001, this programme was exceptionally large in terms of its funding volume and scope of topics. These and yet other characteristics, together with promising experiences from the deployment of participatory approaches in other contexts (Salo and Gustafsson, forthcoming), suggested that a prospective evaluation was called for. We therefore designed and implemented a process which engaged the key stakeholders into a structured debate concerning past accomplishments and future challenges. This process also benefited from a variety of methodological tools, most notably the use of a group support

system (GSS) as a platform for multi-criteria decision analysis (see, e.g., Beroggi, 1998; Hämäläinen, 1991).

The remainder of this paper is organized as follows. Section 2 gives an overview of Wood Wisdom, outlines the evaluation objectives and identifies associated challenges. Section 3 describes the design and implementation of the evaluation process and reports feedback from the stakeholders. Building on this feedback, Section 4 discusses the preconditions, advantages and limitations of participatory evaluation processes.

2. Wood Wisdom Cluster Programme

2.1 Programme Characteristics

After a severe recession in the early 1990s, the Finnish Government decided in 1996 to allocate some EUR 500 million from State property sales to research and development (Prihti et al., 2000). Further to this decision, so-called cluster programmes were created as a new S&T policy instrument which was, in part, inspired by the work of Porter (1990). All in all, seven cluster programmes were established, in order to bring universities, research institutes, firms and funding agencies into closer collaboration and to undertake concerted efforts in support of long-term S&T-based competitiveness.

The largest of the cluster programmes was *Wood Wisdom* (1998-2001) which covered practically all areas of research relevant to Finnish forestry and forest industries. In particular, Wood Wisdom spanned the whole value chain from the production of raw materials to markets, whereby it sought to foster interdisciplinary collaboration among research groups and to enhance the market orientation of R&D efforts. Towards this end, Wood Wisdom contained not only a wide variety of basic and applied research projects but, in addition, product development activities and market studies as well.

The total funding of Wood Wisdom was about EUR 33 million. The largest share of this (44 %) was supplied by the *National Technology Agency (Tekes)* which promoted mostly applied technological research with a view towards commercial exploitation of new S&T knowledge. Industrial companies made a significant contribution as well (33 %), while

the *Academy of Finland*, in turn, (15 %) funded basic research projects (15 %). In addition, the *Ministry of Agriculture and Forestry* (7 %) and *the Ministry of Trade and Industry* (2 %) also provided funds. This presence of several funding organizations was one of the ground-breaking features of Wood Wisdom. In hindsight, it can be seen as an attempt to mitigate the risk of systemic failures (see, e.g., Salmenkaita and Salo, 2002).

For the purposes of administrative management, the 156 projects in Wood Wisdom were organized into 4 four major research areas which were further divided into 21 thematic groups and 34 research consortia. Typically, these consortia comprised three to five projects with related and complementary objectives. Advisory Boards – which consisted typically of about ten S&T experts, industrial R&D managers, and representatives of funding organizations – were appointed to the consortia, with the remit of providing guidance to the research work and fostering the later uptake of research results.

2.2 Evaluation objectives

The objectives for the prospective evaluation were derived from the unique role that was ascribed to Wood Wisdom in the development of the industrial cluster. Specifically, the following considerations shaped the design and implementation of the process:

1. *Assessment of socio-economic impacts*: A key rationale for Wood Wisdom was that research should, in part, be motivated (and hence also be evaluated) in view of its long-term socio-economic impacts. The evaluation process was therefore expected to give a better understanding of these impacts and to suggest measures through which they might be best realised.
2. *Appraisal of networking benefits:* During the early stages of Wood Wisdom, it was expected that considerable networking benefits could be reaped by transcending some of the prevailing boundaries between the users and producers of research. The appraisal of these benefits was therefore an important part of the evaluation.
3. *Guidance for the preparation of later programmes*: Because the cluster programmes were first established during the 1997-2001, the funding organizations were keen on knowing to what extent these new programmes had fulfilled the expectation that

had been placed on them and, moreover, what focal research topics should be stressed in further programmes.

2.3 Methodological Implications

The above concerns had several methodological implications:

1. *Adoption of a participatory approach:* The consideration of socio-economic impacts suggested that multiple stakeholders should be consulted, in order tap into a combined pool knowledge which be sufficient to produce informed judgements on realised and anticipated impacts. Also, a participatory approach, based on the organization of a series of workshops, seemed adequate for the appraisal of networking benefits and the development of recommendations for future activities.
2. *Simple, comprehensive and adaptable evaluation framework*: Since Wood Wisdom was exceptionally large in terms of its scope, the evaluation framework had to be comprehensive enough to be applicable to different kinds of research projects, yet adaptable enough to be meaningful in the context of different kinds of projects.
3. *Process repeatability*: The call for a fair and equitable treatment of research projects meant that the same evaluation framework should be applied to them in the same way. This feature – or *repeatability* – also facilitated comparisons between different workshops and entailed cost benefits because it permitted the recurrent use of supporting documentation, for instance (e.g., instructions).
4. *Balance between formal evaluation statements and informal comments*: Because the evaluation framework had to remain rather relatively general (cf. the second remark above), formal evaluative statements would have be validated and complemented through informal comments which would also lend more depth to the evaluation results.
5. *Solicitation of anonymous inputs*: To reduce the risk of undesirable characteristics of conventional face-to-face meetings (see, e.g., Janis, 1982; Mennecke and Valarich, 1998), it was felt that the participants should be given the opportunity to provide anonymous feedback. Here, a group support system was seen to hold considerable potential in terms of (1) expediting the process of obtaining evaluation inputs, (2) ensuring that all participants would have an equal chance of providing these inputs

and (3) extending the range of qualitative and quantitative information conveyed by these inputs (see, e.g., Bongers et al., 2000; Mennecke and Valacich, 1998; Zigurs and Buckland, 1998).

3. Evaluation of Wood Wisdom – Framework and Process

The design of the evaluation framework and ensuing process was driven by the selection of those two 'units of analysis' that would be subjected to a formal evaluation, i.e., (1) research consortia and (2) research projects. One of the reasons for this was that the consortia-specific Advisory Boards had the authority, S&T expertise and competence to make statements on these two units of analysis. Furthermore, projects and consortia had clearly identifiable persons (i.e., project managers and consortium coordinators) who could be invited to give presentations at the workshops.

In parallel with the process described here, the Academy of Finland invited an international panel of scientific experts to review of the scientific quality of those projects to which it had provided funds. Also, before the participatory workshops, we administered a survey study in which project managers were requested to answer questions concerning the main objectives, accomplishments and anticipated impacts of their projects, among other things. However, because both the peer review and the survey were not particularly novel from the methodological point of view, we focus here mainly on the participatory elements of the evaluation.

3.1 Evaluation Framework

The formal framework was structured around a *multi-criteria decision model* (see Figure 1; Salo et al., forthcoming), organized in the form of a value tree which consisted of attributes that were relevant to research projects regardless of their specific topic. In particular, a distinction was made between objectives that pertained to (1) the strengthening of resources and those that dealt with (2) the development of collaborative networking, either through the creation of new networks or the strengthening of earlier one. Despite its conceptual simplicity, the value tree made it possible to ask, for in-

stance, (1) to what extent the research results could be attributed to the availability of additional resources, as opposed to enhanced networking, and (2) what kind of research should be emphasised in the future, as characterised by the attributes contained in the value tree. Since the evaluation framework was rather general, it had to be specifically interpreted in the context of each consortium, to ensure that it would 'make sense' to the participants. Towards this end, questions such as 'What do we mean by applied research in the context of this research area?' were addressed at the outset of each workshop.

INSERT FIGURE 1 ABOUT HERE

At the project level, the project managers and the members of the Advisory Boards were asked to evaluate (using a 5-point Likert scale) how well the project had attained the objectives that corresponded to lowest-level attributes of the value tree. In addition, each project manager was asked to specify the most important objectives of their projects. Towards this end, he or she was requested to assign weights to the attributes, first by dividing 100 points among the two highest-level attribute, then proceeding to the next lower level in the same way, until each attribute received a number of points which reflected its perceived importance.

Within each consortia, the same weighting approach was employed in developing profiles for future research needs. Here, all workshop participants were to requested to consider the relative importance of the attributes by dividing 100 points first among the highest level attributes and then among the ones at the next lower level, until all the lower level attributes had a received weight. These points were solicited using a GSS. They were results were synthesized in the workshops 'on the spot' and presented to the participants for purposes of interpretation and validation.

For instance, the profile in Figure 2 – which is taken from the workshop on modified wood – suggests that there is need to achieve a balance between basic research, applied research and product development while improved networking is also called for, especially in view of international collaboration. In this way, the weighting procedure yielded indicative profiles as to what *kinds* of research efforts and networking activities should

be promoted within the consortia. The resulting profiles were then complemented by asking the workshop participants to submit with the help of the GSS verbal descriptions of three *specific* research topics that should be pursued in the future. In the workshop on modified wood, these topics included research into the environmental emissions from the thermal modification process, the treatment's effects on the long-term strength properties of wood and the suitability of various surface treatments for thermally modified wood, among others. Taken together, the combined inputs from this procedure (i.e., specification of research profiles and identification of specific topics) provided a rich set of statements which could then be discussed and debated.

INSERT FIGURE 2 ABOUT HERE

In addition to the value tree outlined in Figure 1, evaluative statements were solicited from the participants on (1) how effective the Advisory Boards had been in guiding the projects and (2) what kinds of impacts the projects would probably lead to by the years 2005 and 2010, respectively. This latter question was structured around the four dimensions, i.e., strengthening of competencies, economic impacts, environmental impacts and societal impacts; in addition, the participants were allowed to specify other impacts as well.

Although this approach yielded approximate profiles of likely impacts, most workshop participants found nevertheless considerable difficulty with it, not least due to the high uncertainties that are inextricably linked to future innovations and the difficulties of making clear-cut distinction between different kinds of impacts. This suggests that, instead of attempting to analyse likely impacts 'in the aggregate', it may be more meaningful to assess impacts by subjecting a subset of projects to a much closer scrutiny than what is possible in a workshop setting or, alternatively, by seeking insights from ex post analyses of comparable projects that have been completed earlier on, say, five years ago (see, e.g., Perrin, 2002).

3.2 Process Implementation

Building on positive experiences from earlier workshops (Salo and Gustafsson, forthcoming), the evaluation process was implemented by organizing a series of fifteen workshops. The themes for these workshops were selected by the funding organizations, based on their prior assessment of which consortia and projects would benefit most from such an evaluation. The number of projects addressed at the workshops ranged from three to five and, with few exceptions, they came from the same consortium. The other consortia and projects were excluded from the evaluation due to limited resources. The workshops thus covered roughly two-thirds of the programme.

The workshop were usually attended by eight or so participants from the research programme. The *consortium coordinator* and the *project managers* presented the consortium and the projects, respectively. The *members of the Advisory Board* acted as the evaluation panel, while the *programme coordinator* raised issues that might otherwise not have been dealt with. On the organizing side, the *process facilitator* gave a brief introduction to the workshop, facilitated the process but did not make evaluative statements (see, e.g., Schein, 1987). The *technical facilitator* assisted participants in the use of the GSS, recorded the workshop and took the minutes. A *rapporteur* took additional notes in view of developing the final evaluation report.

The workshop agenda consisted of six phases (see Table 1). Before evaluation activities, ten to fifteen minute presentations made, followed by short discussions, in order to ensure that the workshop participants had sufficient information on which to base their judgements. Evaluative statements on research projects were solicited from the members of the Advisory Boards with the help of a GSS, whereafter these statements were aggregated and displayed to the group as a whole. Towards the end of the workshops, all participants were invited to submit profiles of future research needs (i.e., by assigning weights to the attributes), to identify promising research topics and to supply any other relevant arguments to the debate.

INSERT TABLE 1 ABOUT HERE

The above agenda was motivated by the following general considerations. First, the application of any formal evaluation tools was to be preceded by presentations and informal discussions thereon. Second, formal evaluative statements (based on the value tree framework) were elicited anonymously and simultaneously, whereby the participants were explicitly encouraged to motivate their statements through informal comments. Third, all evaluation results were systemically validated by synthesising and presenting them to the participants for subsequent discussion and elaboration. For instance, while the application of the evaluation framework was helpful in profiling future research needs, the identification of specific research was crucial in understanding what the participants really meant by these profiles.

From the viewpoint workshop dynamics, the interplay between presentations, use of the evaluation framework and ensuing discussions engaged the participants in diverse activities and, moreover, ascribed a specific role to each participant at any given stage of the workshop. It seems that due to this variability the workshops became more interesting than what had been the case if they had consisted of conventional presentations and discussions only. Also, the agreed agenda was helpful in that the facilitator was able to appeal to it, thus ensuring that the discussion would remain focused on relevant topics.

3.3 Workshop Feedback

After the workshops, the workshop participants were asked to fill in a questionnaire which contained, among other things, statements about the results (“The workshop results were useful and well-founded), the impacts of the GSS (“The workshops benefited from the GSS use”), and the potential of similar workshops in other research programmes (“Similar workshops should be organized in future programmes”). The 84 responses thus obtained confirmed that the participants had been quite satisfied with the process. For example, on a five point Likert scale (1 = strongly disagree, 5 = strongly agree), the averages for the above three statements were 4.00, 4.20 and 3.91, respectively, while the percentage of respondents who agreed with them was higher than 80%

(see also Salo et al., forthcoming). Thus, the feedback not only confirmed the usefulness of the GSS but was positive in other regards as well.

Furthermore, immediately after each workshop a semi-structured interview was carried out with one voluntary participant in order to complement the survey results. These interviews confirmed that the large majority of participants had indeed been satisfied with the workshops and the evaluation process at large. However, the interviews also pointed to some sources of dissatisfaction, most notably the absence of some key persons which in some cases undermined the perceived significance of the results.

4. Discussion

In view of the above feedback, participatory processes for prospective evaluation seem to hold promise even in other settings where strategic policy intelligence is required (see, e.g., Kuhlmann et al. 1999; Salo, 2001b). These include, for example, planning processes, evaluation activities and foresight exercises, all of which typically benefit from (1) enhanced communication, collaboration and commitment among the stakeholders and (2) the development of statements through which the outputs from the participatory process are codified. Yet, due to the particular organizational setting in which the Wood Wisdom workshops took place, the experiences reported here do not necessarily apply elsewhere. It is therefore pertinent to discuss contextual issues which cast further light on this case study and the preconditions and limitations of related processes.

4.1 Securing Access to Expertise

The prospective evaluation relied heavily on inputs from the Advisory Boards who – thanks to their close involvement with Wood Wisdom over its duration – were aware of the work that had been carried out within the consortia and research projects. This was one of the reasons for why the Advisory Boards were motivated and able to make informed statements on the consortia and the projects. This would probably not have

been the case, had their members been appointed just before the participatory workshops, without ensuring sufficient prior exposure to the projects.

To most participants, the process of appraising projects and emerging research needs in the light of a formal evaluation framework was a new concept. Also, even though preparatory material was sent to them beforehand, most participants developed a clear understanding of the participatory process only at the workshops, partly because the workshops made use of tools that could not be meaningfully explained in the preparatory material (e.g., the GSS). Because a clear process description is likely to dispel possible prior apprehensions, every effort should therefore be made to motivate and explain the process in advance of the workshops, in order to ensure high participation rates. In this regard, the situation would be quite different with groups which convene repeatedly.

Although vital in the assessment of the industrial relevance and socio-economic impacts, reliance on Advisory Boards or similar bodies as the main source of evaluative statements presumes that their members possess the required expertise and are willing to articulate their statements; these assumptions, however, cannot be taken for granted (see, e.g., Loveridge, 2000). Also, because industrial involvement in the managerial activities of research programmes is usually based on voluntary participation, the mere appointment of such an external body may not fulfil expectations unless it is matched by adequate incentives (such as learning, influence or compensation, for instance; see, Salo, 2001a; Salo and Salmenkaita, forthcoming). Indeed, owing to incentives and information asymmetries, the need to obtain feedback on the industrial relevance of research projects may be strongest such feedback cannot be otherwise readily obtained.

Related to the preceding observation, a potential pitfall in participatory evaluation is that if the members of the evaluation body are too closely involved with the projects, they may see themselves as partly responsible for the projects and may therefore supply optimistically biased statements. There is, in effect, an inherent tension between just how 'close' evaluators should be to the object that is being evaluated: if they are too close, risks for inadvertent collusion are higher; but on the other hand, if they act at a greater distance, they may lack much of the contextual knowledge that is needed

to understand the project in its proper environment. This suggests that evaluation bodies should ideally have a balanced representation which reflects the implications of this kind of proximity.

The Wood Wisdom workshops benefited from the presence of the programme coordinator who had substantive expertise in the research topics but who was not a direct representative of any of the funding organizations. Thanks to her expertise, she could pose questions on specific details, thus complementing the role of the process facilitator who managed the overall workshop process. Indeed, a senior industrial manager noted that workshops of this kind would profit from the presence of a 'devil's advocate' who would purposely challenge prevailing agreements, thus ensuring that the results would not be contaminated by consensual thinking or overly polite remarks. Interestingly enough, this observation is aligned with the suggestion that two facilitators with dialectical roles can assist in the development of system dynamics models for controversial topics.

The prospective evaluation was based on the notion of a 'research area' as a key unit of analysis (i.e., research consortium). While successful in most regards, this approach had its limitations, too: for example, it did not support the systematic exploration of interfaces between different consortia, or the explication of research topics that were relevant to several of them. Also, the otherwise successful elaboration of new research themes might be criticisised on the grounds that it was carried out by those who had been active in the *existing* research programme. Seen from the broader view, then, there may be a need for other workshops which are purposely designed so as not to reflect prevailing structures of programme management.

4.2 Linking Levels of Decision Making

The Wood Wisdom workshops can be better understood by realising that the innovation system can be regarded as a network of stakeholders who act at several levels (see Table). By analogy to Martin (1995), the most relevant for our purposes are (1) macro-level, which is concerned with the development of general S&T policies and their implementation; (2) meso-level, which aims to promote innovation within 'communities of practice', consisting of researchers and firms with interrelated and complementary in-

terests in the context of specific research areas; and (3) micro-level, where new S&T knowledge is generated in the context of individual projects.

Through their interactions the stakeholders at these levels generate and assimilate information on how the innovation system is performing and what further measures are called for to foster innovation. This information – which may be called strategic policy intelligence (see Kuhlmann et al., 1999; Smits, 2001) – is crucial for informed decision making. For example, without sufficient information about the competencies of different research groups, those R&D managers and programme managers who work at the meso-level would be ill-equipped in their attempts to initiate innovative projects, for instance.

Within the framework of Table 2, one of the functions that can be ascribed to prospective evaluation is that of transcending some of the 'gaps' that may exist between these levels. For instance, decision makers at the meso- and macro-level are crucially dependent on information about how the innovation system is performing. Often, such information is provided through summative evaluations where numerical indicators are brought to the fore (see, e.g., Roessner, 1985). Although useful, these indicators are deficient in that they do not readily transmit relevant contextual information (e.g., gradual changes in attitudes and aptitudes). Also, the task of generating indicators may be perceived as a burden by those from whom they are collected, which in turn may foster 'evaluation fatigue' and even undermine the quality of information that is generated.

Conversely, formative evaluations seek to give an impetus to the shaping of innovative activities, reflecting anticipated changes in the socio-economic environment in which innovations are created (see, e.g., OECD, 1997). By construction, formative evaluations thus have a strong future-oriented component and send specific signals to the stakeholders in support of their further activities. Towards this end, however, formative evaluations must be 'rich' in the sense that they reflect the diversity and impact of organizational contexts in which innovations come to fruition (e.g., possible tensions between small and large firms). As a result, quantitative methods may not suffice, unless

accompanied by information from semi-structured interviews and other qualitative sources.

Here, a consideration of incentives and information asymmetries point to the need for participatory activities which seek to bridge gaps between the micro-, meso- and macro level by combining summative and formative evaluations. On one hand, this is because the sheer complexity of innovation implies that no stakeholder group has all the requisite information; rather, this information has to be generated or at least validated through a dialogue process. On the other hand, any such process should respond to the information needs of all stakeholders concerned, wherefore there is a need for a strong formative component based on the consideration of future challenges. Furthermore, engaging stakeholders in a participatory process is useful in that (1) it contributes to the timely dissemination of information and (2) makes it possible to generate information on a wider range of topics that what would possible by relying on a conventional indicators only.

Overall, the Wood Wisdom workshops suggest that quantitative and qualitative methods fulfil complementary roles which serve different purposes: i.e., while quantitative methods are vital in the development of summative indicators, informal discussions and other qualitative approaches are needed to interpret them and lend more 'depth' to the analysis of what such indicators may signify in specific contexts. For example, in the consideration of future research needs, the value tree framework was helpful in profiling what kinds of research efforts and networking activities would be called for in the future; yet verbal descriptions, informal comments and ensuing discussions were crucial in elaborating the specific research topics to match these profiles.

5. Conclusions

In this paper, we have reported a case study which suggests that the concept of prospective evaluation – implemented through a series of computer-aided participatory workshops, for example – can supply (1) summative information to policy-makers and (2) formative statements which offer detailed guidance to the activities of innovating re-

search groups. Moreover, we have outlined a framework where summative and formative evaluations are linked to three levels of the innovation system. It is our belief that the explicit positioning of prospective evaluation within this framework can help in achieving an adequate balance between (1) formative and summative components, (2) the attendant use of quantitative and qualitative methods, and (3) the identification of participants whose expertise and informed judgements are required to support the process.

6. References

Andersson, T. (1998). "Managing a Systems Approach to Technology and Innovation Policy." *STI Review* 22, 9-29.

Beroggi, G.E.G. (1998). *Decision Modeling in Policy Management : An Introduction to the Analytic Concepts*. Kluwer Academic Publishers, Amsterdam.

Bongers, F.J., Geurts, J.L.A., Smits, R.E.H.M. (2000). "Technology and Society: GSS-Supported Participatory Policy Analysis." *International Journal of Technology Management* 19(3-5), 269-287.

Caracostas, P., and Muldur, U. (1998). *Society, the Endless Frontier: A European Vision of Research and Innovation Policies for the 21st Century*. European Commission, DG XII, Brussels.

Coates, J.F. (1985). "Foresight in Federal Government Policymaking." *Futures Research Quarterly* 2, 29-53.

Geurts, J.L.A., Joldersma C. (2001). "Methodology for Participatory Policy Analysis." *European Journal of Operational Research* 128, 300-310.

Grupp, H., and Linstone, H.A. (1999). "National Technology Foresight Activities Around the Globe." *Technological Forecasting and Social Change* 60, 85-94.

Héraud, J.-A., and Cuhls, K. (1999). "Current Foresight Activities in France, Spain, and Italy." *Technological Forecasting and Social Change* 60, 55-70.

Hämäläinen, R.P. (1991). Facts or Values – How Do Parliamentarians and Experts See Nuclear Power?" *Energy Policy* 19(5), 464-472.

Janis, I. (1982). *Groupthink, Psychological Studies of Policy Decisions and Fiascos (2nd ed.)*. Boston: Houghton Mifflin.

Kuhlmann, S., Boekholt, P., Georghiou, L., Guy, K. Héraud, J., Larédo, P., Lemola, T., Loveridge, D., Luukkonen, T., Polt, W., Rip, A., Sanz-Menendez, L., Smits, R. (1999*). Enhancing Distributed Intelligence in Complex innovation Systems*. Final Report of the Advanced Science and Technology Policy Planning Network Report, ISI-FhG, Karlsruhe.

Loveridge D. (2001). "Foresight – Seven Paradoxes." *International Journal of Technology Management* 21(7-8), 781-792.

Luukkonen, T. (1998). "The Difficulties in Assessing the Impact of EU Framework Programs." *Research Policy* 27/6, 599-610.

MacLean, M., Anderson, J., and Martin, B.R. (1998). "Identifying Research Priorities in Public Sector Funding Agencies: Mapping Science Outputs to User Needs." *Technology Analysis and Strategic Management* 10(2), 139-155.

Martin, B.R. (1995). "Foresight in Science and Technology." *Technology Analysis & Strategic Management* 7(2), 139-168.

Martin, B.R., and Johnston, R. (1999). "Technology Foresight for Wiring Up the National Innovation System." *Technological Forecasting and Social Change* 60, 37-54.

Mennecke, B. E., Valacich, J. S. (1998). "Information Is What You Make It: The Influence of Group History and Computer Support System on Information Sharing, Decision Quality, and Member Perceptions." *Journal of Management Information Systems* 15(2), 173–197.

Meyer-Krahmer, F., Reiss, T. (1992). "Ex Ante Evaluation and Technology Assessment – Two Emerging Elements of Technology Policy." *Research Evaluation* 2, 47-54.

OECD (1997). *Policy Evaluation in Innovation and Technology: Towards Best Practices*. OECD, Paris.

OECD (1999). *Boosting Innovation: The Cluster Approach*. OECD, Paris.

OECD (2001). *Innovative Clusters: Drivers of National Innovation Systems*. OECD, Paris.

Perrin, B. (2002). "How to – and How Not to – Evaluate Innovation." *Evaluation* 8(1), 13-28.

Prihti, A., Georghiou, L., Helander, E., Juusela, J., Meyr-Krahmer, F., Roslin, B., Santamäki-Vuori, T., Gröhn, M. (2000). *Assessment of Additional Appropriation for Research*. Sitra Reports, Sitra, Helsinki.

Porter, M.E. (1990). *The Competitive Advantage of Nations*. The Free Press, New York.

Roessner, J.D. (1985). "The Multiple Functions of Formal Aids to Decision Making in Public Agencies." *IEEE Transactions on Engineering Management* 32(3), 124-128.

Salmenkaita, J.-P., Salo, A. (2002). "Rationales for Government Intervention in the Commercialization of New Technologies." *Technology Analysis and Strategic Management* 14(2) 183-200.

Salo, A. (2001a). "Incentives in Technology Foresight." *International Journal of Technology Management* 21(7-8) 694-710.

Salo, A. (2001b). "Concluding Remarks on Strategic Intelligence." In: A. Tübke, K. Ducatel, J.P. Gavigan. P.Moncado-Paternò-Castello (eds.), *Strategic Policy Intelligence: Current Trends, the State of Play and Perspectives*, Institute of Prospective Technological Studies, Joint Research Centre of the European Commission, Report EUR 20137/EN, December 2001, pp. 65-72.

Salo, A. and Gustafsson, T. (forthcoming). "A Group Support System for Foresight Processes." *International Journal of Technology Management*.

Salo, A., Gustafsson, T., Ramanathan, R. (forthcoming). "Multicriteria Methods for Technology Foresight." *Journal of Forecasting*.

Salo, A. and Salmenkaita, J.-P. (forthcoming). "Embedded Foresight in RTD Programs." *International Journal of Technology, Policy and Management*.

Schein, E.H. (1987). *"Process Consultation Volume II – Lessons for Managers and Consultants,"* New York: Addison Wesley.

Smits, R. (2001). "Innovation Studies in the 21st Century: Questions from a User's Perspective." *Technological Forecasting and Social Change* 69, 1-23.

Smits R., Leyten, A., den Hertog, P. (1995), "Technology Assessment and Technology Policy in Europe: New Concepts, New Goals, New Infrastructures." *Policy Sciences* (28), 272-299.

Zigurs, I., Buckland, B.K. (1998). "A Theory of Task/Technology Fit and Group Support Systems Effectiveness." MIS Quarterly, September 1998, 313–334.

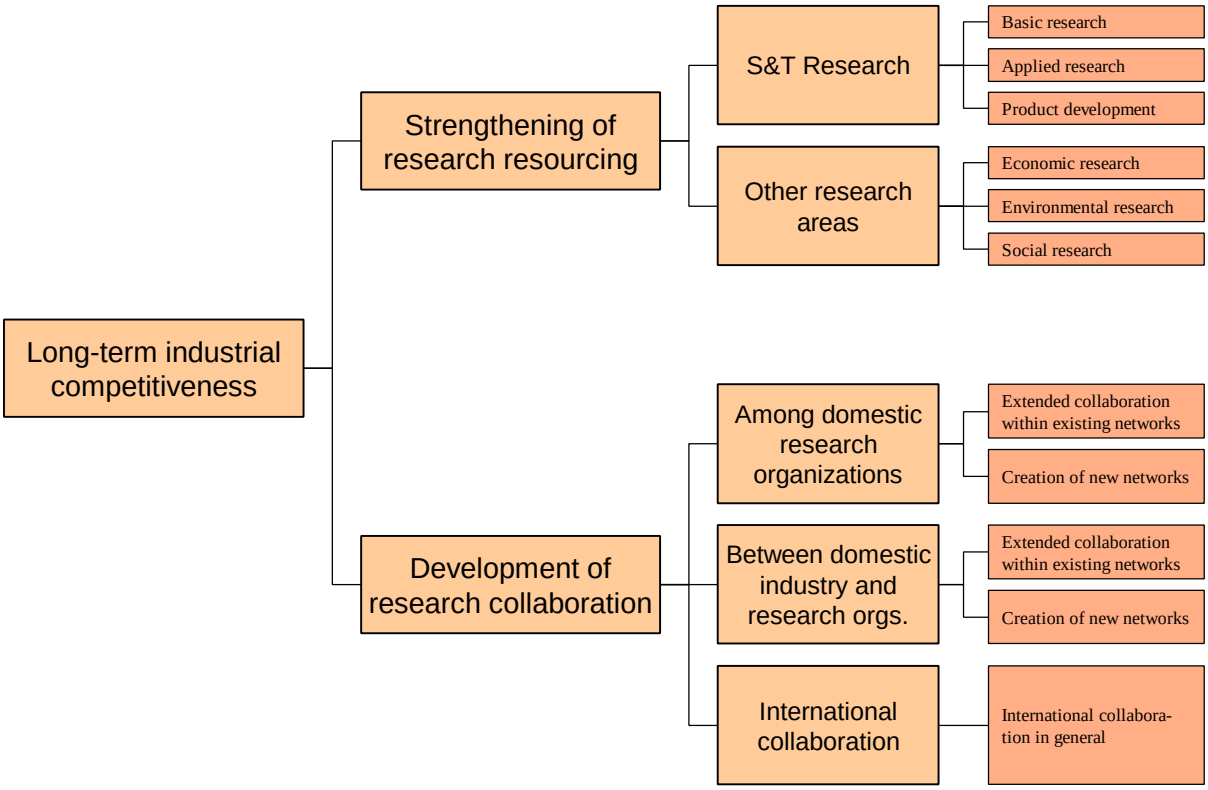

Figure 1. The evaluation framework.

Phase	Activities	Persons
1. Opening Motivation, introduction of the agenda Presentation of facilitators and participants Elaboration of evaluation frameworks	Presentation	Facilitator
2. Presentation of survey results	a. Presentation	Facilitator
	b. Discussion	All
3. Presentation of consortium Summary of completed and planned activities	Presentation	Consortium coordinator
4. Project appraisals *(repeated for each project)*	a. Presentation	Project managers
Attainment of objectives	b. Discussion	All
Assessment of socio-economic impacts	c. Assessment	Advisory Board
5. Validation of project appraisals	a. Display	Facilitator
Elaboration and validation of evaluation statements	b. Discussion	All
6. Consideration of research needs within consortia	a. Assessment	Project managers Advisory Board
Specification of research profiles Identification of focal research topics	b. Display	Facilitator
	c. Discussion	All

Table 1. The workshop agenda.

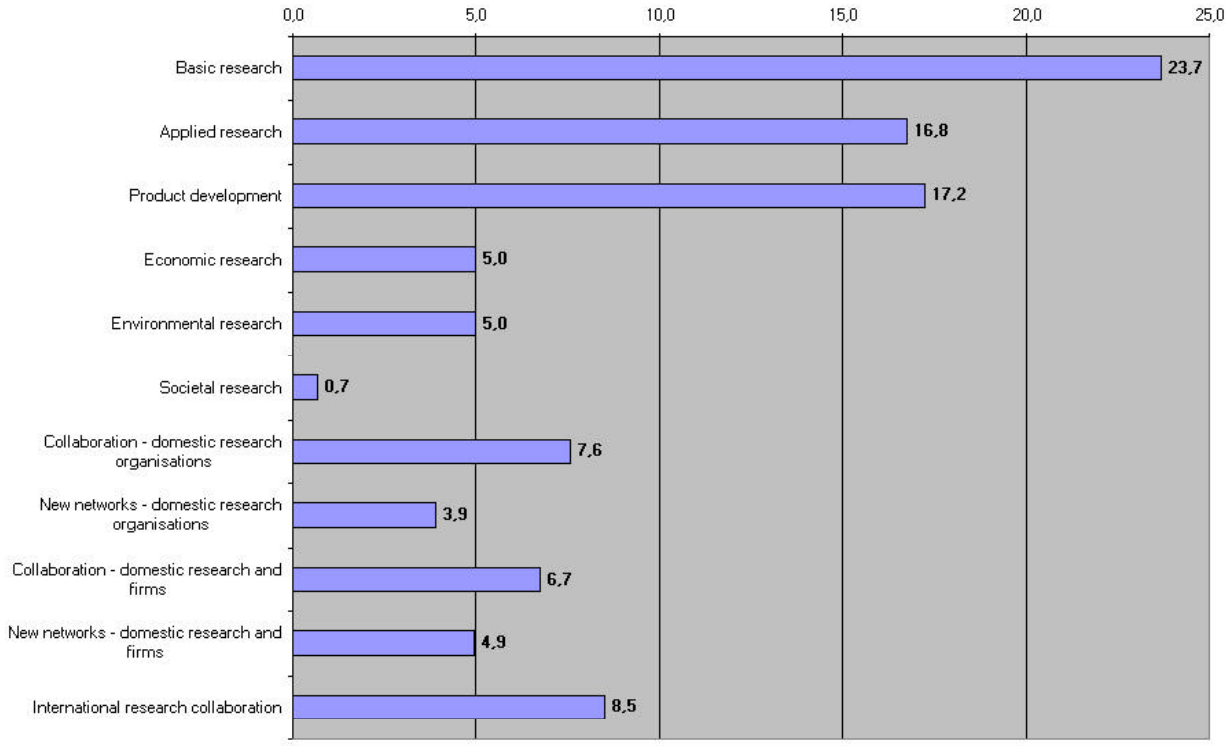

Figure 2. Profile from the consortium on modified wood.

Level	*Wood Wisdom*	*Focus of activities*	*Summative evaluation*	*Formative evaluation*
Macro-level	Industrial cluster	Shaping of policies to enhance the performance of the innovation system	⇑ Information on socio-economic impacts of S&T policies ⇑ Delivery of aggregate data on performance measures	⇓ Interpretation of policy objectives within specific research areas ⇓ Setting of research priorities (e.g., for-
Meso-level	Research consortium	Strengthening of 'communities of practice' and their abilities to innovate	⇑ Attainment of objectives vis-à-vis agreed objectives ⇑ Information on S&T outputs (e.g., theses, patents)	⇓ Constructive feedback to research projects ⇓ Preparation of collaborative networks and research activities
Micro-level	Research project	Creation of new S&T knowledge and innovations		

Table 2. Linking levels of an innovation system through summative and formative evaluation.