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Research Programme for Ecological Construction

EVALUATION REPORT

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Preface

In 1994, the Academy of Finland launched the Research Programme for Ecological Construction, EKORA. The goal of the programme was to complete a wide-reaching study of built-up areas and building production from the point of view of sustainable development (The goals of the research programme, Appendix 2).

The programme had two application rounds. There were 55 applications in the first round, of which 11 research applications were accepted for 1995-1998 for a total of FIM 8.25 million. In the second round, 10 applications out of 33 were selected for 1996-1999 for a total of FIM 4.25 million.

The Ecological Construction Programme was multidisciplinary and included the fields of architecture, urban and landscape planning, civil and environmental engineering, materials technology, wood science, and ecology.

The panel of experts invited by the Academy of Finland gave the written evaluation of the Ecological Construction Programme based on the self-evaluation reports by the project leaders (Self-evaluation form, Appendix 3).

The experts were asked to consider the following issues in their evaluation report:

1. What were the achievements of the programme?
2. To what extent were the goals of the programme met?
3. What were the problems of the programme?
4. How should the research in the field be developed and focused in future?
5. How should researcher training in the field be improved and increased?
6. What measures should be taken to raise the field to the international level?
7. New goals and recommendation

The valuable evaluation work was carried out by Professor Kimmo Lapintie, Chair (Department of Urban Planning and Design, Helsinki University of Technology, Espoo), Professor Klas Cederwall (Department for Land and Water Resources Engineering, Royal Institute of Technology, Stockholm), and Research Professor Asko Sarja, (VTT Building and Transport, Strategic Technology Development, Espoo). The main emphasis of the assessment was to evaluate the programme as an entity, not as individual research projects.

Helsinki, December 10, 2001

Professor Marja-Liisa Riekkola
Chairman, The Programme Committee of EKORA

1. What were the achievements of the programme?

The basic strategy of the programme seems to have been to collect a rather wide range of projects under a less precise concept, “ecological construction“, in order to support both interdisciplinary research and a hoped-for link between theory, applied research, and product development. In addition, the research teams were supposed to disseminate information concerning their results and understanding to other experts, policy makers, and the general public. This has also made our work in evaluating the results somewhat problematic: the objective was to evaluate the programme, not the individual projects, at the same time as the results seem to be focussed on the projects.

There are some interesting features of the programme that should be noted, such as the phrase, “ecological construction“, which was used to cover a wide variety of topics including the perspective of integration in several projects (as, for instance, in combining environmental psychology and urban planning). Some interesting, though hardly ground-breaking, results have been achieved and, above all, some clearly promising young researchers have been able to qualify within the programme. The achievements of the EKORA programme can be classified pertaining to the following three hierarchical levels:

– the built environment
– (ecological) construction concepts/methods, processes, and systems
– materials and components.

At the general theoretical and architectural level of the built environment, there are multidisciplinary architectural, sociological, and geographical discussion papers on principles and solutions of town planning from the ecological point of view. Moreover, some conclusions are drawn from the different reports. A specific and innovative viewpoint is that of children, which can be integrated into town planning and the planning of building concepts. The results at the level of town planning, as a whole, represent a good state-of-the-art analysis and provide new ideas for this theme in Finland and also partly internationally. The results can be used as a starting point for more intensive analysis, modelling, and comparisons of different town planning principles and solutions.

The more technically oriented research projects on the level of built-up areas have resulted in quite extensive and important analysis and conclusions on the travel behavioural effects of the location of housing, workplaces, and services, as well as the effects of changes in transport systems, in different land use, transport system, and service system scenarios. The main focus is on the functional side, but no direct ecological aspects have been included in the analysis. These results can serve as an excellent basis for the ecological analysis and comparison between different town planning models and their traffic systems. Another engineering area, which has been addressed, is the examination of fishways and the effects of pollution in water-regulated rivers. This examination has resulted in proposals for improving migration corridors and the survival of salmon in the built rivers.

There have been quite a few research projects on the level of building/construction concepts.They include descriptions of the existing methodology of life cycle analysis, as well as the general analysis of the environmental impacts of buildings and building markets, strategic and operational development, and the development of market procedures. With regard to energy consumption, future-oriented solutions on building concepts, with the integration of photovoltaics and solar facades, have been scheduled, described, and analysed. These results are aimed at supporting the future technical development of minimum-energy and zero-energy buildings.

Following the goals of the programme, the research projects on building materials have been mainly related to wood materials and wood technology. The results can be divided into the following classes: moisture measurements and control, and the effect of moisture on manufacturing processes and in use, potential micro-organisms in wood, and recycling of materials in construction. The results include applications of measurement methods, analysis of the moisture in the mechanical, physical, and biological behaviour of wood and wood products, and descriptions of past and current recycling methods of wood and ceramic products. The quite extensive research work on the low temperature drying method and process has resulted in the analysis of the drying process, and the effects of this type of drying on the strength and quality of wood products. These results serve the optimisation of drying wood in practice, which is also related to ecology through energy saving.

In conclusion, in an interdisciplinary programme aimed at covering a wide range of issues, at least three levels of analysis can be distinguished: the product development level, the technical systems level / conceptual modelling level, and the integrative and theoretical level. One should, however, point out that the levels are somewhat different in social and planning studies, where “conceptual“ usually refers to the most abstract theoretical level, not to the intermediate level of modelling, for instance. Irrespective of the labelling, however, there should be communication between the levels, and the more general the level, the more coordination it would require.

The level of product development is covered by relatively few, but individually successful, projects. There are many interesting ideas and attempts at the conceptual level, but not much in the way of results. The number of conceptual projects has been rather limited in comparison to the holistic and product level projects. This intermediate level should be the strongest, not the weakest.

2. To what extent were the goals of the programme met?

The first objective, to find both theoretical and concrete solutions for the concepts of ecological and lasting development in both construction and the use of built-up areas, is, as mentioned above, very ambitious, since it suggests that the concept of ecological construction should be given a wide interpretation (not only energy conservation and biodiversity, for instance, but also cultural and social sustainability), but the essential theoretical and methodological differences between engineering sciences on the one hand, and cultural and social science on the other, is not given due attention. Consequently, the borders between the two cultures are not crossed: the social scientists, geographers, and architects discuss the role of sustainability in a contemporary situation, whereas the engineering scientists reduce themselves to developing very clearly defined but limited results and products. What seems to be missing is rigorous theoretical work. There are also rather isolated studies that are loosely connected to the overall scheme of the programme. The programme was launched as an attempt to promote research capacity in an important field, but so far the overall impact is limited. The international co-operation has also been rather weak, due perhaps to too few resources allocated for travelling. International publishing in the projects has been uneven, and cannot be considered sufficient.

3. What were the problems of the programme?

Despite the undisputed value of inter-disciplinarity and practice-orientation, the objectives of the programme, compared to the size of it (FIM 12.5 million) clearly seem to have been over-ambitious. This was clearly expressed by most of the team leaders, who felt that there either was not enough active coordination and no common ground, or not enough resources for interaction within the programme. Consequently, most of the individual projects have concentrated on their own work, and thus many of the achievements of the programme have also remained at the individual project level. Although some clear co-operation between different disciplines is visible (for example, between biology and construction technology, architecture and geography, and planning and sociology), there seems to have been rather few, if any, attempts at developing novel interdisciplinary methodologies or crossing theoretical borders. There could also have been, in addition to the many case studies, more comparative studies to give a wider and more general view.

The dissemination of research results has been rather traditional and quite minimal, that is, seminars and private discussions, as well as publications. A more conscious use of the new media such as the Internet, as well as innovative co-operation with policy makers, could have been expected, although it is by no means easy with limited resources, particularly at the end of the programme. Resources and attempts to produce broadly-focussed joint seminars and/or publications should be provided for. This problem is partly related to the vagueness of the concept of ecological construction.

It is typical in Finland, that research in the construction sector is very strongly directed towards the practical development of products and production. Real theoretical basic research is traditionally at a good international level in some sub-areas, like materials research, mechanics of structures, reliability theory of structures, buildings system theory, application of information technology in the construction sector, and some parts of the theory of production processes. More holistic research, which would be able to carry out high-level theoretical and creative research on new issues like ecological construction, has been weak, and was mainly lacking at the time EKORA was started.

Research in architecture and planning, on the other hand, has a rather heterogeneous tradition, ranging from theoretically informed general discussion to more technical and practice-related, as well as descriptive studies, for example, in architectural and planning history.

These underlying factors have been the main reason why most of the EKORA projects have had to start with a basic state-of-the-art analysis and general discussions on the selected research issues. This is especially the case when highlighting central areas of theoretical and concrete solutions for the concepts of ecological and sustainable development in both construction and the use of built-up areas. During this first programme period, the research has been unable to reach the theoretical level and the capacity for providing new ecological solutions. There have been some interesting

attempts to initiate multidisciplinary co-operation. The preliminary discussions have been good, but it has not been possible to reach real co-operative and creative multidisciplinary research on this specific theme.

The materials research has a good tradition and is at an international level and, thus, the results are also satisfactory on those subjects that have been treated. Some of the materials research projects are, in fact, more product development projects, which would better belong to the financing of Tekes. There has been little theoretical and scientific materials research of an international level of quality in this programme. In the EKORA programme, the materials research has been practically limited to wood and, thus, there is lacking a more comprehensive and generic research and methodology for supporting construction through materials development: optimal combinations of materials, and the selection of materials for each specific performance requirement.

To summarise, we can state that starting from a beginning of competence development in ecological research with the purpose of supporting the theoretical capability of selected research areas, the research efforts have not always succeeded in producing a sufficiently high level of international results and theoretical skills during the EKORA programme. Only some specific projects have been successful, primarily because they were based on considerable existing theoretical skills and research traditions.

The principle of applying a model, in which basic research, applied research, and product development advance in collaboration, has led some technical research projects to a situation where the product development is dominant, and the basic research aspect weak. This is often the case in Finnish technical research. However, for a long-term advance, effective basic research should also be carried out and directed into new areas.

If the scientific level is too narrow, which is related to the basic education, for example, of civil engineers and architects, it is difficult to achieve the results hoped for in programmes like this. Multidisciplinary work was attempted, not always successfully, in many projects. More research at the intermediate conceptual level would have been needed, informed, for example, by systems analysis, logistics, or risk analysis.

An active coordination of research and different supplementary programme activities to strengthen the scientific environment and its applicatory capacity is clearly needed for a programme like this. Such efforts should already begin in the planning and initiating phase of the programme.

4. How should the research in the field be developed and focussed in future?

A clearer focus with sub-programmes in only a limited number of disciplines might be more productive. However, we want to emphasise the value of combining basic theoretical research with practical problem-solving. A solution to the clearly experienced cultural barriers might be to introduce specific “pioneer-projects“ aimed at crossing the difficult borders.

It is extremely important to continue to create theoretical research in this area. This activity naturally belongs to the Academy of Finland. The research, which is funded by the Academy of Finland, should be directed to theoretical and applied research. Because there is a tendency in theoretical research to continue with traditional methods and areas, new and more holistic theories, methodologies, and methods of basic research, as well as applied research, should, in particular, be supported. In technology, this means exploitation of new methods from natural, mathematical, and technical sciences.

The principle of combining basic research, applied research, and product development in the same programme is not working well, but is leading to a dominance of product development without a new theoretical basis. Therefore, these development phases should be separated, and the development process should be built as a sequential process. The area of product development should be shifted to Tekes.

It is a great challenge to develop shared concepts and, if possible, also a common theoretical framework. Moreover, the promotion of effective communication and contacts within the academic community, as well as with societal interests, should be already stressed in the project proposals. There is a clear need for a stronger and active scientific programme coordination, which could be organised even before the projects are chosen, so that the coordinator could be already present at the planning phase.

5. How should researcher training in the field be improved and increased?

The lack of a well-balanced scientific structure for the basic educational curriculum of civil engineers and architects, in terms of methodological aspects, systems theories, mathematical modelling, optimisation, risk analysis, etc., social sciences, sustainability issues, is a likely reason for the difficult start of young researchers. This is often accompanied by a lack of competent supervision in many departments. It is of utmost importance, therefore, to form viable research teams and scientific environments, where the project leaders and senior researchers are also physically present. The teams should have multidisciplinary profiles, and work over several successive projects. International co-operation from the very beginning of the projects is recommended. Creating a graduate school for sustainable infrastructures/ construction development could be an appreciated component in a research programme of this nature.

6. What measures should be taken to raise the field to the international level?

Creating networks of graduate schools, with Nordic and other countries, should be considered. The Virtual University launched in 2000 is a possible way of integrating post-graduate education internationally. International scientific development is a matter of communication based on acquired theoretical skills, the challenge to be competitive, benchmarking to create effective quality awareness and the ability to attract the interests of targeted groups ranging from students and research scholars to society at large.

Supporting individual/single researchers, who have the potential to do basic research, is also something that should be of strategic interest for the Academy. Such talented young researchers will, in due course, be senior scholars participating in team development, and, ultimately, be the leaders of interdisciplinary groups themselves.

Supporting research in this field should review the existing networks, starting perhaps with a new set of several successive programmes by first choosing the coordinator. This could support the accumulation of skills and knowledge between the programmes.

7. New goals and recommendations

Developing programmes with an ambitious set of objectives is not an easy task. We conclude that the logic of programmes like this should be solider, with strong mediating forces between the most general and down-to-earth approaches. This concerns both the scientific structure of the programme, where the conceptual level should be strengthened, and the scientific and practical coordination of the programme. Research teams should first be able to provide a vision, and then targeted research actions should be designed step-by-step to fulfil the stated objectives. Establishing the value base of ecological construction is essential: we have to understand the incentives for all involved and concerned with the development of environmentally friendly technological systems in society.

The construction sector is closely tied to all sectors of sustainable development in society: human and social needs, the economy, culture, and ecology. Therefore, all these aspects should be treated in the future programmes interactively. This would lead to the emergence of integrated approaches in the process of construction.

APPENDIX 1

Objective of the research programme

To implement a comprehensive study of the built environment from the point of view of ecological and sustainable development looking for both theoretical and concrete solutions in planning, construction, and use of the built-up areas.

Structure and character of the programme

21 multidisciplinary research projects in the fields of architecture, urban and landscape planning, civil and environmental engineering, transport engineering, building physics, ecology, materials technology, and wood science.

Architecture:

- Locality and continuity – lifespan of the built environment
- History of architecture – building conservation

Architecture/Urban planning:

- Environmental psychology (children as citizens)
- Sustainable development in different communities
- Densification of urban structures
- Ecological modernisation of urban regions

Transportation Engineering:

- Sustainable transport systems

Civil and Environmental Engineering:

- Environmental conditions in regulated rivers

Building Physics:

- Indoor climate – moisture damage and microbial growth (rehabilitation measures)
- Building facades – multifunctional and optimised ecological solutions
- Unheated buildings – thermal and moisture behaviour/service life

Materials Technology:

- Wood science, wood physics, timber technology, and the drying of timber
- Wood science – moisture and decay effects in wood products
- Wood science – cracking and deterioration due to weathering
- Wood science – methods to prevent discolouration by bluestain fungi
- Ceramics and design – colour formation/waste material

Ecology:

- Ecological engineering – impact of infrastructure
- Ecology and its metrics in construction – evaluation of ecological performance
- Ecological housing – case study/sustainability/criteria, priorities and models

APPENDIX 2

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EKORA – RESEARCH PROGRAMME FOR ECOLOGICAL CONSTRUCTION

The goals of the research programme for ecological construction

1. To find theoretical and concrete solutions for the concepts of ecological and lasting development in both construction and the use of built-up areas

2. To advance research that supports ecological construction, and to raise the level of Finnish research on ecological construction to the international level

3. To increase the value of ecological construction, to disseminate information concerning the importance of the research to both experts and the general public thus bringing the research results to a wide audience

To achieve the goals, one has to stress basic research, as well as integrating research and education together with applied research and development work.

Co-operation with the Ministry of the Environment and the National Technology Agency is, therefore, an important part of the research programme and its aims. The goal is a model in which basic research, applied research, and product development advance in collaboration.

The research programme is multidisciplinary combining technology and architecture, as well as natural sciences and social sciences.

The programme also includes the advancement of wood usage through research in wood science and technology, as well as wood construction.

APPENDIX 3

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EKORA Research Programme

SELF-EVALUATION OF THE RESEARCH PROJECT AND PROGRAMME

Name of researcher:

Name of project:

Research field:

Years: 199 - 199

EVALUATION CRITERIA
1. Goals and focus
1.1. What were the goals and focus of your project? 1.2. To what extent did you achieve them?
2. Scientific standard
2.1. What are the new scientific results achieved by your project?

2.2. Publications
This includes publications in scientific journals, as well as the dissemination of information in other public areas.

a) National

b) International publications connected to this project

2.3. Education

a) Number of university degrees received by researchers while working on the project.
   – Master´s
   – Licentiate
   – Doctorate

b) How were the researchers employed after the project finished?

1. Research and development work in private companies and industry
2. Academic research and teaching (same field)
3. Academic research and teaching (different field)
4. Other publicly financed research and development work
5. Teaching outside university
6. Administration work
7. Other, specify

2.4. Other effects

a) Did the afore-mentioned results bring about some concrete effects in societal decision-making, e.g. legislation, new safety regulations, etc.?

b) Do you think the results brought some extra value to society, for example, in education and research?

3. Co-operation

3.1. Was there any co-operation, and what was the level of it, between individual projects in the research programme?

3.2. Was there any co-operation, and what was the level of it, between researchers and the relevant national organisations/businesses?

4. Project funding

Year	*1995*	*1996*	*1997*	*1998*	*1999*
Universities					
Internal funding					
Academy of Finland					
Tekes (National Technology Agency)					
Business funding					
Other national funding (foundations, public administration, etc.)					
International funding					
Other, specify					

5. Multidisciplinary research

Were there multiple fields of research represented in the project and if so how were they represented?

6. Dissemination of information

a) Collaboration with policy-makers. How were the results of your research disseminated to the relevant policy-makers?

b) Did you get any feedback from the policy-makers?

c) What was the feedback?

d) Integration of science, societal processes, and policy-making. Which instruments were used to disseminate the results to the general public and special interest groups?

7. Strengths and weaknesses

a) What were the inner strengths of the programme?

b) What were the weaknesses of the programme?

c) Suggestions for improving the programme?

d) What are the research opportunities in ecological construction in Finland?

e) Are there any present or future threats to your field of research in Finland ?

8. Recommendations for the future

a) How would you raise the level of research in ecological construction in Finland

b) How would you compare the level of research in your field in Finland to other countries?

c) What are the greatest short-comings, problem areas, and needs in ecological construction research ?

d) What kind of research is currently lacking in Finland in your field?

e) What is the most urgent requirement to ensure Finnish research reaches a high international level?

Date _____

Signature _____