

# Research strategy for sustainable spatial planning

Report on a government mandate to Formas in collaboration with the Swedish Construction Sector Innovation Centre (BIC)





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## Background

According to the appropriation document for 2003, Formas shall, in collaboration with the Construction Sector Innovation Centre (BIC), draw up a research strategy for sustainable spatial planning within the framework of "Construction, housing and management for the future". The document shall be submitted by 31 December 2003.

## Introduction



*Research strategies for environment, agricultural industries and spatial planning* are the title of the contribution of Formas to the background material, which the government intends to use in the forthcoming Research Policy White Paper. This material, which was submitted to the government on 10 November 2003, shall also be seen as an updating of Formas' current research strategy for the period 2002-2005. The background material contains a section on Spatial Planning, which reflects the priorities of Formas regarding the part of Formas' activity, which is related to construction. This section deals with issues to do with environment and health, materials, buildings and civil engineering installations, urban and rural development. The research strategy for sustainable spatial planning, which is set out in this document, is a complement to, and to some extent an in-depth review of, the research strategy of Formas. Formas and BIC want to strongly emphasise the great significance that the construction sector has in regard to the ability of society to achieve sustainable development. The sector accounts for 40 percent of energy use and for more than 50 percent of material consumption. The role, which the sector plays in relation to sustainable development in social and cultural, respects in indisputable. The sector manages a very high proportion of the national wealth, and because of the proportion of the national economy that the sector represents; conscious development within the sector may result in very large positive effects on the ability of society to create economic growth. The State, county councils and municipalities carry out about one half of all procurement within the sector, and a vigorous and conscious investment in the development of a sustainable spatial planning is therefore a strong policy instrument for the sustainable development of society.

The collaboration between Formas and BIC is based on a declaration of intent which was signed on 12 December 2002; this states that Formas and BIC intend to make a joint effort to ensure that Swedish building research achieves a high status nationally and internationally

in the work for sustainable development and economic growth through sustainable construction. The promotion of research of high scientific quality and relevance at universities and research institutes comes within the sphere of responsibility of Formas within the framework of the above collaboration. The spheres of responsibility of BIC can be said to comprise the initiation, coordination and implementation of innovation processes within the construction sector in a broad sense. Formas regards BIC as a consultation and collaboration partner for issues that concern the entire construction sector. This does not exclude cooperation with other players by either Formas or BIC. The parties jointly make the general assessment with regard to building development related research in Sweden that universities should make further investments in research of high quality and in greater internationalisation of this activity. At present, the universities in Sweden account for a limited share of fundamental research within sustainable spatial planning, and a high share of applied research and direct development work which in other countries are carried out by research institutes and companies. This can be partly explained by the fact that the Swedish educational system has reduced support for research and that the Swedish system for performing R&D has relatively few and small research institutes compared with the other EU countries, and also in a greater international perspective.

### **The "Construction, housing and management for the future" dialogue**

According to the government mandate, the present strategy for sustainable spatial planning shall be placed within the framework of the dialogue, which the government and the business sector have carried out under the name "Construction, housing and management for the future". Twenty companies and four municipalities have taken part in this dialogue. In the first stage of the dialogue, the participants developed a vision and a strategy and goals for sustainable development within the construction and property sector. In the second stage of the dialogue, six working groups have worked on proposals for specific inputs. The six working groups have set out their results in a number of reports on the following subjects:

- Planning for sustainable construction of the built environment
- Use of best possible technologies and development of new ones
- System choice and procurement with a whole life perspective and a holistic approach
- Quality and efficiency in the construction and management processes
- Classification of housing and non-residential premises – energy, environment and health
- Management for a better built environment

### **The Construction Commission**

The Swedish State Construction Commission (Dir 2002:24) took as its starting point the following problems in the Swedish construction sector:





- The construction sector exhibits unsatisfactory growth in productivity
- New forms of cooperation are required to solve issues associated with liability and funding
- Competition must be improved
- Client competence must be improved
- Knowledge regarding whole life cost calculations must be developed
- Quality management systems must be developed
- There must be greater investments for a sustainable society and better environment.

### The research strategy of Formas and BIC

The aspiration of Formas and BIC with this research strategy is to try to identify important targets for Swedish building research and the means that must be developed to reach these targets. The strategy is based on an overview of needs and is linked to what may be judged to be important options for developments in the construction sector nationally and internationally. Both the Construction Commission and the "Construction, housing and management for the future" dialogue have also been based on ideas and proposed changes that are current in the construction sector internationally. The strategy for sustainable spatial planning shall therefore be regarded as one of several contributions in the work to build up the competence and international competitiveness of the Swedish construction sector. It is also the aim to emphasise the importance of an innovation systems approach where both research and implementation of the results achieved are essential components.

Formas and BIC are of the opinion that the reports on the "Construction, housing and management for the future" dialogue reflect problem perceptions, lines of development and strategic approaches that are well embedded in the Swedish construction sector, to judge from the reports produced by different expert groups, reference groups and national research programmes. The reports of the "Construction, housing and management for the future" dialogue are important documents seen from an implementation perspective, but they are in far too general terms to be considered as research programmes. As mentioned before, in the collaboration between Formas and BIC the responsibility for implementation rests with BIC, even though there is also a strong coupling to research, which is the sphere of responsibility of Formas. In consultations with the management team for the "Construction, housing and management for the future" dialogue, the now presented Research strategy for sustainable spatial planning will therefore be primarily associated with proposals and ideas developed in expert groups, reference and strategy groups. In the opinion of Formas and BIC, these reflect quite well the relatively unanimous view concerning future problems, possibilities and challenges to be found in the Swedish construction sector and its groups of players with regard to sustainable spatial planning. As a complement to the construction related part of the Formas research strategy, this document ought to create a solid basis for a successful joint action concerning vital research issues.

## Summary of Formas' background material for the research proposal

The construction sector is an important part of the national economy and has a great influence on employment, public health, environmental development and the use of natural resources. The construction sector deals with the technical infrastructure in the form of buildings, installations for water and sewerage, energy supply, transport and communications. As regards the technical infrastructure, there is a division of responsibility between the different national funding agencies on the one hand and Formas on the other. The rapid developments in the form of new materials, deregulation and changes in regulations, changed forms of funding and a greater demand for consideration of the environment have also given rise to new research needs. These issues can also be broadened into the considerably larger issue of who it is that has the power over construction.

The concept of sustainability indicates a development where the needs of today must be met without jeopardising the conditions for the life and welfare of future generations. Economic development and social welfare shall go hand in hand with the protection of the environment and natural resources. A successful strategy for ecologically sustainable development must therefore be compatible with a favourable social and economic development.

In the strategy of Formas, the focus regarding environmental and health issues is mainly on research into the integration of environmental issues into the construction process, the way people perceive and view the indoor environment, and the causes of building related health effects. The creation of synergistic effects between energy and building development issues will also be an important research task. One of the great challenges faced by the construction sector is integration of environmental issues into a sustainable construction process.

The background material of Formas also emphasises the importance of materials science. Research should mainly focus on new smart materials, durability and whole life properties and the environmental and health risks of materials, but research also aims to improve and develop already existing materials.

Owing to their macroeconomic importance, buildings and civil engineering installations are an important area in the research strategy of Formas. Focus is mainly placed on the function and energy efficiency of buildings and civil engineering installations, and the way the built infrastructure of society affects, and is affected by, changes in the environment. Emphasis is also given to the environmental risks associated with underground processes, and to certain



incentives. It is also stressed that it is necessary for the players of the construction sector to continue the change to techniques and processes that contribute to a sustainable development.

Urban development is also a part of the Formas research strategy, with a strong focus on what may be regarded to constitute sustainable urban development. There is also a need for more extensive analysis by the researcher community of the significance of different players for the realisation of a sustainable urban development. Consideration of the players and arenas and a greater emphasis on environmental social science research are important elements in the research strategy of Formas. The relationship between town and countryside is a research area of increasing importance.

Rural development is the last area in town and country planning in the Formas research strategy. The focus is on population movements and their consequences, the relationship between town and country, and the need for integrated economic, social and physical spatial planning.





# Research strategy for sustainable spatial planning

The construction sector has a fragmentary structure and is characterised by a long and complex value chain. The strategy presented here therefore emphasises the need for a holistic approach comprising the entire construction and management process from planning, via design, construction, management, operation, maintenance and renovation of buildings to their decommissioning. This extended value chain gives rise to a clear need to steer development towards the functional requirements and wishes of the final customer. The products of the construction sector have a long life. The importance of adopting a whole life perspective and facilities for rational maintenance and flexible conversion and extension are therefore stressed in this strategy for sustainable spatial planning. The research strategy also points out that new important knowledge must be developed, but also that it must be implemented in product and process development, applied in pilot and demonstration projects, standardisation, training, etc. The research strategy is thus closely associated with innovation processes, which should produce rapid results in the form of greater efficiency and renewal of construction and management processes. The research strategy proposed by Formas and BIC within the framework of the "Construction, housing and management for the future" dialogue has the following arrangement:

## **Prioritised targets**

- New planning instruments for sustainable spatial planning
- Reduced use of resources in an environmental, eco-cyclic and whole life perspective
- Reduced energy use and a healthy indoor environment
- Increased performance, lowered costs, contributions to sustainable economic growth in society

## **Prioritised means to reach these targets**

- Integration of construction processes
- Utilisation of information and communication technology (ICT)
- A holistic view of the client function
- Internationalisation of building research
- Forms of support

**Formas and BIC prioritise:**

- Research into new municipal planning instruments since the present ones tend to become increasingly inadequate to manage a reality of increasing complexity
- Research that supports a sustainable spatial planning that is multi-disciplinary and focuses on humans and human activities in relation to the ambient environment
- Research that considers not only the function, properties and energy performance of buildings and civil engineering installations, but also creates knowledge of their effects on health and the environment and of the way they will be influenced by future climate changes
- Research into urban development and the relationship between town and countryside

## Prioritised goals

### New planning instruments for sustainable spatial planning

In Sweden, public bodies have exercised control over housing construction, planning of the physical environment and the infrastructure of society. During the 1990s, however, this trend was disrupted. Housing construction was deregulated and subjected to changed regulations and was also relieved of detailed specifications, while at the same time the State housing subsidies were reduced. Co funding of large infrastructure projects by the State and the business sector became more common. Planning of the physical environment acquired a greater element of advance planning in which different interest groups initiated and promoted developments in construction. Public planning is now focusing to a greater extent on improving and developing small urban areas and towns. A research strategy for sustainable spatial planning must take this development into consideration. It will give rise to a number of interesting new research areas where very little knowledge has been developed at present.

How can public control be secured and how can public participation and planning democracy be safeguarded and reinforced? There is reason for research to take note of a situation where municipal structure plans are not, as before, used as a guide for the construction of the built environment, and where detailed planning is characterised, to a greater extent than before, by advance planning in which strong interests exert considerable influence. The traditional municipal planning instruments tend to become increasingly inadequate to deal with a reality of greater complexity. Other instruments may have to be developed, and this development will presumably require new roles, new expertise and perhaps also new organisations.

Sustainable construction of the built environment poses a number of new demands for spatial planning and its planning process. The evident development towards increased privatisation of public spaces is an important issue which gives rise to new questions. What happens when public spaces are privatised? What rules govern this activity and what happens to freedom of assembly, freedom of the press, free speech, etc? These issues should also be of interest for research of a social science orientation. Planning research regarding sustainable spatial planning should be multidisciplinary in its character and should focus on humans and human activities in relation to the ambient environment. Both Formas and BIC are of the opinion that construction related research pays too little attention to the final customer. It is now high time to put people in the centre.

Planning for a sustainable construction of the built environment demands not only knowledge of the function, properties and energy performance of buildings and civil engineering installations, but also knowledge of their effects on health and environment and the way in

which they will be affected by future climate changes. Incentives and opportunities for the many players of the construction sector to change to techniques and processes, which contribute to a sustainable development, are an important research area. It is likely that new forms of cooperation and new opportunities to utilise information and communication technology (ICT) will give rise to new issues and new areas of research.

In the judgment of Formas and BIC, greater significance should be given to research that focuses on the engineering infrastructure in the form of installations for water and sewerage, energy supply, transport and communications inclusive of ICT. This is a field where many research funding agencies should cooperate. Research into the consequences of climate change in the already constructed town, and the way systems and dimensions may have to be altered in conjunction with new construction is therefore important. In response to a government mandate, Formas and a number of other players have jointly submitted a proposal for a national climate research programme that is appropriate in this context. It is becoming increasingly important to develop better methods for the analysis and management of different types of risk inclusive of health and environmental hazards. There is also a great need for research on pollution in the soil. In the light of the fact that new construction today is increasingly carried out as infill development and on land that had been used for industrial activities, this is an area of great urgency.

Urbanisation. Sustainable societal development is also highly dependent on the way towns and smaller urban areas are developed, since more and more people are concentrated in towns and urban regions, both in Sweden and internationally. Urban research has therefore assumed increased importance, and new knowledge must influence the future planning methods. In research, the town is seen as a system comprising many superimposed structures in the form of building development structure, transport structure, business structure and green structure, etc. Other methods of approach are coming to the fore which place a stronger emphasis on the significance of the place and see the town and the region as consisting of interacting nodes in a complex network at different levels. It is therefore felt that the term community planning is no longer fully adequate to describe the complicated processes, which are already transforming and reshaping our physical environment today, the driving forces of which are often outside the control of the public.

In the background document of Formas for the forthcoming research policy proposal, the terms urban development and rural development are used to describe these transformation trends. To bring together the different sustainability dimensions, ecological, health related, economic and sociocultural, necessitates a systems approach and system thinking. The Swedish urban and rural areas are subject to an intensive and rapid process of change. Research should capture the dynamics of these migration flows between town and countryside and the new problems of social and economic character, which arise in consequence.

### Formas and BIC prioritise:

- Effective measures in existing buildings for the effectivisation of the use of resources.
- Research inputs in the field of materials, which concentrate on the most relevant products. The reason for this is the large number of materials and the fact that certain materials are difficult to replace but contain harmful compounds.
- Integration of health and environmental requirements in the construction and management process, inter alia with the help of social science research methods.
- Research inputs concerning evaluation methods for buildings and management processes which are unambiguous and make it possible for requirements to be specified in order that negative health and environmental impacts may be reduced.
- Research that helps create a classification system in the construction sector on the basis of information on indoor environment and health, energy use and the use of other resources.

### Effective use of resources in an environmental, eco-cyclic and whole life perspective

Sustainable spatial planning necessitates environmental and eco-cyclic considerations in relation to the choice of materials, structures and installations in new construction, modernisation, building extension, renovation, re-use, disassembly and demolition. Environmental assessments must be made on the basis of a holistic approach. Whole life judgments are essential for quantification of environmental impacts. Methods must also be developed for assessing the properties of the materials used and their future behaviour prior to new construction, modernisation and demolition. There is also a need for a holistic assessment and the development of both traditional materials of good eco-cyclic properties, and technologies and behaviours that make possible the re-use and recycling of materials and waste products without any risk of unfavourable health and environmental effects.

A large number of initiatives have recently been developed by different groups of players with the aim of strengthening the role of the construction and property sector in the work on developing long term sustainability in general, and environmental and eco-cyclic issues in particular. Comprehensive work has been done in the different initiatives to define needs, and the assessments are remarkably unanimous in regard to research needs. Most of the initiatives apply a holistic approach to the environmental adaptation of the construction and property sector, while others have a more limited perspective.

The necessity to have a holistic approach is underlined in the national environmental goals and also in the "Construction, housing and management for the future" dialogue and in the project Sustainable Spatial Planning (HÅS). Data and statistics regarding building development are called for in the Swedish environmental goals, and also in the Energy Foresight, HÅS and in the Eco-cycle Council for the Building Sector. Both the Council and the "Construction, housing and management for the future" dialogue call for environmental classification of buildings, and emphasise the need for environmental databases. Operation and management of existing buildings is an important area, as emphasised in the "Construction, housing and management for the future" dialogue, the Energy Foresight and the Construction Commission. Finally, the importance of knowledge about whole life costs and the need for whole life analysis are emphasised in both the "Construction, housing and management for the future" dialogue and in the report of the Construction Commission.

Formas and BIC are both of the opinion that a number of important measures are required in order that a desirable development should occur in the field of environment and eco-cycling. A broad knowledge base can be created through research of good quality. This, in turn, can be used to develop a holistic and system approach in the work on environmental and eco-cyclic adaptation in construction and management. It is also necessary to promote

implementation of research results and to bring about collaboration among different areas of expertise and, in particular, to achieve collaboration among the players in these areas. Individual, consumer and player perspectives must be given prominence. There is also need for a knowledge base which shows how environmental and resource effectiveness in construction and management can be enhanced while retaining the performance requirements specified in a whole life perspective.

In order that the effect of various environmental technologies, systems and methods may be assessed, access to evaluation methods such as models and data is essential. User and consumer requirements must also be analysed from the medical, ecological, behavioural and social science standpoints. The present stock of buildings and installations will for a long time constitute the bulk of our built environment, and there is great potential for the improvement and effectivisation of existing buildings and installations.

Energy use during the life cycle of a building causes extensive impoverishment of resources, and is also the largest single contribution to the environmental impact of a building. Energy economy and energy effectiveness are factors of key importance that can reduce the environmental impact of buildings. Environmental and eco-cyclic aspects must be considered with reference to a holistic view and to other factors such as indoor environment and health, function, flexibility, economy. It must also be possible for environmental and eco-cyclic aspects to be ranked. In this context, the environmental impacts of construction and management, user requirements, technology and environmental adaptation methods, and also methods of evaluation, are important problem areas.

According to the report on the "Construction, housing and management for the future" dialogue, environmental management and environmental classification are an important field of research. Companies and organisations in the construction and property sector are increasingly using environmental management systems in planning and managing buildings. This provides a basis for a holistic approach to environmental issues, where indoor environment and health, the use of energy and materials are considered in an overarching context. The "Construction, housing and management for the future" dialogue, and especially the investigation Classification of residential and non-residential premises, highlight a number of issues associated with construction which must be further elucidated by research before a classification system can be implemented.

Owing to the multiplicity of materials in the indoor environment, there are often complex mixtures of compounds in the emissions to indoor air that subject the occupants to exposures which are difficult to assess. Both the construction stage and the management stage are important. Since buildings have a long life and are subject to renovations and maintenance, property

management is an important factor for the long term properties of the buildings in these areas. With regard to the use of energy and other resources also, management is a key issue. Research should result in effective and knowledge based tools so that the complex exposures and their environmental, health and comfort effects may be assessed in the different stages of the construction and management process. Appropriate health and environmental criteria and analytical methods must be produced to assess how construction products and system solutions in different applications affect the indoor environment and health, comfort, recycling, the use of natural resources and cultural assets.

There is great awareness within the construction, property and civil engineering sectors of the need for new knowledge to tackle the existing and potential environmental problems, the difficulties of developing the right knowledge and ensuring that it is implemented. There is a need for contacts and cooperation among the different areas of expertise, between both different scientific disciplines and between research and business. Formas and BIC therefore want to promote contacts, which provide an opportunity to focus research associated with typical cases and innovation processes.

### **Effective energy use and a healthy indoor climate**

The recently completed project Energy Foresight, Sweden in Europe shows in its future scenarios that there is still great potential for effectivisation of energy use in buildings. The challenge, as Formas and BIC see it, lies in a substantial reduction in energy use in buildings without jeopardising the health of the occupants and a good indoor climate. Research should focus on elucidating the possibilities and any associated risks and on creating better conditions for a reduction in the environmental load and resource use associated with energy use in buildings. One future scenario is that the average specific energy use for heating, domestic hot water and services in buildings can be reduced by 50 percent over a 40 – 50 year period, and that annual use of electric heating can be cut by at least 20-25 TWh.

For this to be possible, there must be vigorous effectivisation of energy and electric power, reduced biological, physical and chemical pollution load on the indoor environment, and use of kinds of energy other than electricity for heating and cooling. A number of other measures to reduce energy use will also presumably be required so that the future scenario may be realised. In the opinion of Formas and BIC, research should concentrate on two principal areas. It is necessary to develop strategies, methods, technologies and health risk assessments from a system perspective, which will in turn provide greater knowledge of what action is required. It is also necessary to develop tools for better control instruments, implementation and decision making processes which take into consideration the roles of players and the behaviour of users.





In a Strategy for sustainable societal development, environmental, health and indoor climate issues have an important role. The EU has recently initiated a unified strategy for environment and health, which will have great significance within European environmental health work. There are strong indications of a relationship between building factors, indoor environment, community noise and ill health, but limited knowledge of direct causal relationships and of the exposures that cause ill health. The percentage of children with some kind of allergy or hypersensitivity is on the increase. Regardless of whether or not this increase is building related this development among the young gives rise to greater sensitivity, which, in turn, means that requirements for the indoor environments of tomorrow will be more stringent.

One prerequisite for the realisation of the environmental goal A good built environment is that there should be adequate knowledge of the relationships between a satisfactory indoor environment, the degree of ventilation, and chemical compounds in construction materials and in the indoor environment. A coordinated environmental and energy labelling scheme and phasing out of unsuitable chemicals in construction materials and the indoor environment are also necessary. To create background data for this work, there must be research and development of test methods for the assessment of construction materials, equipment, textiles and furniture, which may emit biological, physical and chemical contaminants into the indoor environment. Increased demands for the re-use of materials necessitate research into the way in which products for buildings and fittings and furnishings shall be designed and produced so that they can be recycled more easily without jeopardising safety and health. For the implementation of the results of research into health and environment in buildings, communication issues in project organisations are a key issue. The players in the construction sector need up to date knowledge of the health and environmental problems caused by the buildings of today and tomorrow. They need updated guidelines as to how good health and environment shall be achieved through the work on design, construction and management. Satisfactory systems are required for product information, verifications and other quality assurance.

There is still a lack of knowledge of what is good air quality. New criteria should be established which relate air change and airflow rates to emissions. Continued research into the indoor environment, which focuses on finding solutions to problems, is therefore necessary. This research should be multidisciplinary and interdisciplinary, involving the collaboration of researchers in architecture, behavioural sciences and other social sciences, environmental medicine and technology. The new research focus should stimulate cross-fertilisation between different sciences and research cultures. Scientific interchange should be stimulated between environmental, building development and health risk research. Methods must be developed to enable analyses of critical emissions, techniques, environments and user reactions to be

#### Formas and BIC prioritise:

- Research that is instrumental in reducing energy use in buildings without jeopardising a good indoor climate
- Research that focuses on reducing the environmental load, health risks and waste of resources connected with energy use in buildings
- Research that supports a co-ordinated environmental and energy labelling scheme and phasing out of unsuitable chemicals in construction materials and in the indoor environment
- Research that increases knowledge of good air quality, inclusive of new criteria where air change and air flow rates are related to emissions
- Research into the indoor environment that is multi-disciplinary in character
- Increased research links to architectural and design issues
- Research cooperation and platforms where architects, engineers, doctors, biologists and behavioural and social scientists can together develop good design, function and technologies

undertaken rapidly. More knowledge is needed regarding susceptible groups, sensitive environments and interaction effects, and the significance of these in selecting building technology solutions.

Formas and BIC jointly make the assessment that architectural and design issues need a much stronger research association than is the case in the Swedish construction sector today. There are research areas which are important for a sound development of construction but which, for different reasons, are not formulated and do not prosper. They may lie in the borderland between different research cultures, each of which is in itself strong. They may contain methods, which contravene traditional ways of organising research. This is often a matter of the coupling between architecture and engineering, both of which demand the ability to empathise with the needs of humans and activities, and require advanced understanding of the properties and mode of action of materials and techniques.

There is an urgent need for the construction sector to create platforms where architects and engineers can together hold a constructive dialogue concerning form, function and technology. One challenge for architects is the question regarding their role in the construction process. The report of the Construction Commission indicates that a stronger role for architects in the construction process may be a means of improving the situation in the construction sector. In a research programme, ARKUS (a private foundation for architectural research and development) calls for studies, which aim to describe the design process and elucidate its character and conditions. It is well known that the early stages in the process receive too little time and that much is changed in the course of construction, there are alterations and disputes, which often means that architectural and other qualities which make for a sustainable construction may be lost. Architectural quality is greatly affected by the way the tendering for the project is carried out. Studies of the procurement process with regard to the outcome in relation to intentions and expectations should provide clear indications of the forms of contract, which are most appropriate for the creation of good architecture.

One issue that the Swedish construction sector will have to face in the future concerns the feasibility of increasing the scope of industrialised construction. This is mainly needed to reduce costs. But there is also a strong need to combine architectural expertise with technical, social, medical, ecological and cultural expertise within the entire field comprising construction systems, components and product development.

### **Increased performance, lower costs, contribution to sustainable economic growth in society**

Swedish construction related research and the results that are created make an active contribution to improving the products, which are offered to the final customers. This is self-evident and is an essential goal for the players in the construction sector. Improvements may take

the form of lower prices, more value for money in the form of better performance, better solutions to the specified performance requirements in a number of areas. They may relate to health, perceptions, technology, comfort, facilities for user control, safety, risk management, etc. In these respects, the construction sector is no different from any other industrial sector in society. International competition is also becoming much keener.

One fact that is of great significance for the way the sector works is that it is only to a limited degree that the individual final customers can influence the end product they buy or use. Detailed specifications and regulations define the products to a high degree, and this delays and limits the opportunities for development and for direct responses to the wishes of the final customers. A change to design and procurement based on performance requirements is an important means of creating increased performance/lower costs. Products based on performance requirements increase the freedom of choice of the final customers, make for better competition and provide an impetus for development and innovation. What are important in this connection are the greater opportunities for in-house developments which performance requirements provide but which detailed specifications prevent. In this area there are still issues that demand continued research support.

Another characteristic of the construction sector is that units within different public sector functions procure more than half the products and services of the sector. This is particularly the case for infrastructure in the form of roads, railways, water supply and sewerage systems, etc. And to a large extent also for housing, premises for schools, hospitals, social care, culture, sports, etc. Owing to the complexity of the scope of construction products and the interaction that they necessitate, planning issues clearly exert a large measure of control.

One of the most important areas in the construction sector for the development of better performance and lower costs is material technology and materials management. The construction sector accounts for 50 percent of material use in society, and substantial progress has been made in the natural sciences, which make effectivisation in the field of materials possible. It appears that the greatest potential for development at present is in nanotechnology where new scientific instruments have created the conditions for greater insight into the function of the smallest constituents of materials. This has opened up opportunities for industrial modification of materials at nano scale, which, in turn, has given new opportunities for macro properties to be customised. Several of the successful innovations in the construction sector in recent times are based on utilisation of nanotechnology. Development of materials of enhanced performance, together with their optimum utilisation in structures, products and systems, as well as their design with respect to service life requirements, is therefore an urgent goal for research in the construction sector.

#### Formas and BIC prioritise:

- Research that actively contributes to improving the products which are offered to the final customers of the construction sector
- Research that facilitates a change to design and procurement based on performance requirements
- Research that develops materials of enhanced performance for optimum utilisation in structures, products and systems
- Research that utilises the potential of nanotechnology

## Prioritised means to reach these goals

### Formas and BIC prioritise:

- Research that helps achieve a higher degree of customer satisfaction
- Research that helps achieve better quality assurance
- Research that makes lower construction and management costs possible
- Research that reduces negative impacts on environment and health

### Integration of construction processes

Nationally and internationally, the construction sector has in recent years discussed and subjected to critical scrutiny the need for changes, and tried to identify the driving forces which can bring about these changes. The report "Pull up your socks, boys" of the Swedish Construction Commission is one example. In the UK, the projects "Rethinking construction" and "Accelerating change" have identified important factors for change. A more integrated construction process has been called for which prioritises an in-depth collaboration among the many players in design, construction and management, and where customer demands for quality and cost effectiveness are given great importance.

A strong focus on the significance of the construction and management processes as an important tool for sustainable development with a whole life perspective can also be noted. This may occur in different types of programme development work in conjunction with the action areas of Formas or documents from various expert groups associated with national programmes of the type Construction IT or Property 2002, The healthy building or Competitive Building, etc. Increased customer values at all stages of the processes, through new services, which are effective, reduce costs and are of high quality, are another priority requirement, which the players in the sector have to satisfy. Development of a first class quality system is stated to be important, and one factor for progress is good recruitment of labour with the relevant skills at all levels. Management systems, and also the activities as such, need development. A greater element of industrial thinking is often called for, and there are great expectations of improvements through construction of increased industrialisation.

**Formas and BIC are of the opinion that process issues are of key importance in meeting several of the challenges in the field of construction. Examples of these are:**

- Higher degree of customer satisfaction
- Improved quality assurance
- Lower construction costs and management costs
- Reduced environmental impact

All the above challenges have been met by various means, but they all have a more or less strong coupling to research and development. Research into process issues should be intensified. In addition, greater internationalisation of research should be endeavoured. Research into

forms of activity and organisation is of key importance. It may refer to forms of procurement, which must be developed to create new and better forms of cooperation among clients, contractors and users, with unimpaired competition and improved client competence. It is also essential to create clear incentives for development in regard to process issues in both housing and civil engineering construction. As regards civil engineering construction, a number of expert groups have highlighted the need to study and develop the acceptance process, i.e. the relationship between an installation and its environment. The design process shall be dynamic so that it can cope with the variable conditions, which civil engineering projects often face. Access to well functioning innovation systems including a positive innovation climate is essential for development of the process issues.

### **Use of Information and Communication Technology (ICT)**

In order that the construction and management processes may be developed, the sector should make innovations in the form of new products, services, working procedures and quality assurance. In today's society, Information and Communication Technology (ICT) is an obvious means of facilitating and supporting changes in processes, products, working procedures and organisations. For the technology to be developed and implemented in a fruitful way, it is necessary to have a fundamental understanding of the environments in which the technology is to function and the contexts, which it shall support. In this respect, research continues to play an important role. The cornerstones in the development of ICT for the construction and property sector are therefore knowledge of the sector's processes, freed from subjective considerations, aspects of cooperation among the players, and information management in relation to the physical and human resources.

Formas and BIC make the assessment that the following areas should be accorded priority in the field of ICT. Effectiveness and cooperation must be created. In construction and management there are a great number of players active. One of the most central tasks in both project and process oriented work is to select and combine appropriate capabilities for cooperation. It is a matter of both bringing about an effective flow of information, and of preparing for the growth in knowledge, which is the aim of the combination of capabilities. In a short time, digital communication has been established as a form of information exchange among the players in the construction and management process.

Databases on the Internet, computer aided document management and digital modelling have created new opportunities for the design and decision making processes, and also for effective production and management. At the same time, a number of new questions regarding communication have come to the fore. These relate, inter alia, to working procedures, roles, responsibility and copyright. In an increasing number of contexts there is a new order. Where the players were previously supplied with selected background material, each player is now

### **Formas and BIC prioritise:**

- Research that helps create ICT support for innovations in the form of new products, services, working procedures and quality assurance
- Research that provides the basis for the use of ICT for the renewal of the construction sector by investigating, testing and evaluating new economic, legal, organisational and logistic forms of activity. By its very nature, such research is multidisciplinary
- Further research into Construction Informatics and Management Informatics

expected to search for relevant information that is made available via a database on the Internet. One important question is how data and information shall be arranged so that they are multilaterally available for communication among the users who make use of different systems. Examples are dialogue and the exchange of information with customers, tenants, users and authorities. ICT makes possible clear presentation and visualisation for dialogue with those who are affected by planned changes.

Information must also be structured and arranged so that it is platform independent and usable over the whole service life of the building. It is only in this way that the facts concerning the properties of building components and the environmental properties, emissions and re-use of construction materials can be linked to the systems used by managers for operation and maintenance. Utilisation of ICT in construction and management demands fundamental and scientifically based classification and a system specially adapted for the purpose. Information standards, which combine standards from the construction and management domain and the IT domain, are necessary. Construction Informatics and Management Informatics are two important fields for further research.

New business models for the development, funding and execution of projects and for the supply of services and premises for activities constitute a large proportion of the sector's development potential. ICT can be expected to be an integral part of the solutions to manage such models. The industry is unique inasmuch as it was a forerunner in "virtual production environment" which is worth developing and which can also make a contribution to other industries in inter-sectorial cooperation. The products in the form of buildings and civil engineering installations, which the industry delivers to its customers, are expected to have an increasing ICT content. The development of smart buildings and installations presents great opportunities for new thinking. Apart from technical solutions for operation and maintenance, it is possible through combinations of communication and local intelligence to support both the production process and the daily use of premises and installations, as well as the use by the customers of a broad spectrum of services. ICT as an aid in the design and innovation process is vital for the creation of entirely new products with new properties.

In both new construction and management, improved logistics and material supply can provide significant gains. Apart from the economic gains in the activity, this can have an effect on the overall resource management of society. Even small changes can exert an effect nationally. Logistics systems which handle the complete chain from client/specifier, through producer to user, and which is also able to handle materials information in a whole life perspective, should be able to make such contributions. The Swedish construction and property sector has a considerable international activity today. The knowledge and relatively high degree of development within ICT in Sweden can be used to enhance international competitiveness. International experiences can also be utilised in the transfer of new knowledge.



## Holistic view of the client function

To judge by the reports of both the "Construction-Housing" dialogue and the Construction Commission, the client function is a research task of increasing importance. Formas and BIC make the same assessment. A new focus for research can be formulated in terms of The client as an agent of change. In this respect, research should contribute by providing knowledge that enhances the ability of the client to develop the construction sector and to help bring about long term sustainable development of the built environment (with respect to social conditions, health, economics and ecology).

The client as an agent of change represents a vision of an active and competent player who provides the impetus for a necessary change of the construction sector and the sector's products towards a sustainable development of the built environment, as regards both the environmental goals of society and social and health aspects and economy in a broad sense. The client as an owner and financier determines what long term quality is offered to the customer, and the way in which the requirements of customers and society shall be met. The client as the purchaser of the services and products of the construction sector is the person who steers the process from concept to execution and the person who in this way creates the conditions for the use and technical management of buildings and installations during their long service lives. Through his/her choice of collaboration partners, the client is the person who shapes the competences involved in the process. In this way, the client function, with its holistic approach, plays a key role for sustainable development in the sector.

Clients who have the will and competence have great opportunities to act in a customer oriented market. An active client function is thus of decisive importance in leading the development of the sector towards greater accountability, better quality and increased productivity. It is therefore urgent and of strategic importance to strengthen the client role and to develop the competence of the client function. The need to build up competence is associated with an increasing insight of the significance of a holistic approach in issues concerning compliance with requirements posed by activities and the environment and in issues concerning technical systems, areas of competence and players, and the attitude that each building and installation is a unity from concept to realisation, use, alterations and finally demolition.

Research on the client role is therefore of strategic importance for society as a whole, for the owners and customers, and for the players and interested parties of the construction sector. It implies both a change in attitudes and processes, and development and implementation of methods and technologies, which contribute to greater effectiveness, and economical management of labour, capital and raw material resources. The aim of this research is to create knowledge of the client function as such, knowledge and competence to act in a client function, irrespective of the form in which this is carried out, and to bring about greater

## Formas and BIC prioritise:

- Research into the client role since this is of strategic importance for society as a whole and for the different groups of players and interested parties of the construction sector.
- Research that facilitates quality control and quality management in the construction sector.
- Research that results in forms of procurement where competition between, and improvement of, products and processes is encouraged without the intended function or goal being disregarded.

insight among the clients of the importance of taking an active part in R&D and of utilising the results of R&D.

**The overarching goal should be to ensure that:**

- the requirements of owners, customers and society are satisfied in a resource effective way, but with sufficient margin for mistakes
- available technology for the achievement of sustainable development is integrated in a systematic and quality assured manner in construction and management
- effective forms for control and management of quality are established in the sector
- procurement of services or products is carried out in such forms that competition between, and improvements of, processes and products is encouraged without the intended function or aim being disregarded

The client role is to be exercised in a client function, which shall develop the project from concept to execution in such a way that the requirements of owners, customers and society are satisfied. The client function must have a broad competence, with the ability to understand the specified requirements, their mutual relationships and different consequences, and the ability to communicate these via inter alia programmes, to select forms of implementation and to make the necessary procurements. There is also a need for competence to guide the process in such a way that the finished object is handed over for management and use with the right quality in relation to the requirements specified regarding function, execution, time and cost. Some strategic aspects that can be associated with the future client role are listed below.

- |   |  |
|---|--|
| ■ The customer aspect                   | ■ Management of requirements and goals in the design process |
| ■ The owner aspect                      | ■ Cooperation and competition                                |
| ■ The societal aspect                   | ■ Management systems for management and control of quality   |
| ■ The sectorial aspect                  |  |
| ■ Innovation aspects in the client role |  |

**Internationalisation of building research**

Most of the building research in Sweden and in most other countries is wholly or partly financed by public funds and is therefore fully accessible to the public. It is probable that one of the reasons for this great openness is that construction issues have such wide societal implications that access to research by all is considered to be of great importance. Another reason is that the construction sector in all countries has a strong tradition of detailed regulations and detailed specifications, with the result that the industry has had little impetus for its own research as a basis for product development. This openness has given considerable opportunities for international research cooperation. However, this has not always been particularly effective

since regulatory frameworks, standards, testing practices etc in the different countries are different, which makes it difficult to transfer research results between countries. It has therefore often been necessary to repeat research at local and regional level.

Developments in the past decade in a number of political and other areas have changed the picture, and there is reason to have a new approach to the international dimension of building research. EU has been a driving force in this context. Owing to a radical change in the function of the regulatory frameworks, there is a marked reduction in the number of mandatory regulations, which are now mainly set out in CPD – Construction Products Directive – and apply over the whole EU area. This provides greater opportunities for alternative technical solutions, which, in turn, stimulate research and development. The fact that the regulations are common to all EU countries makes for greater international cooperation. Another important effect of the change is that there is greater incentive for the industry itself to conduct active research. International building research is therefore no longer an internal matter in the research community but is increasingly an issue for the industry also.

In addition to regulations, standards have also been harmonised in Europe. This makes it much easier to use research results from other countries. The requirements are the same, the same test methods are applied, work is based on the same analytical principles, and all this facilitates cooperation across the frontiers. The internationalisation of companies, elimination of obstacles to trade, free mobility etc reinforces the trend towards greater internationalisation of building research. Another component in this process of change is the establishment of joint European research projects. This has in a very tangible way showed the way towards international cooperation in both research and development in both the research community and industry.

Yet another factor that changes the conditions of research and particularly the international dimension is the growth of information and communication technology. Research results from practically the whole world are immediately available at the click of a button. Intensive discussions among researchers in the whole world can be held over the web. Despite the many research reports, however, there is a great shortage of evaluated and summarised assessments based on scientific consensus. The construction sector is therefore to a greater extent dependent on the scientific summaries and assessments made within inter alia the International Council for Research and Innovation in Building and Construction (CIB), the World Health Organisation, US Environmental Protection Agency (EPA), the EU Commission, organisations such as the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) and the International Society of Indoor Air Quality (ISIAQ), as well as the working environment, construction, health, chemical and environmental authorities in Europe and the Nordic countries. Evaluations of this kind are essential for the research

#### Formas and BIC prioritise:

- funding for research of high quality that is relevant to the construction sector.
- an increase in the volume of research in building research through co funding.
- a concentrated effort, by means of integrated collaboration in projects and scientific consensus work, to create new knowledge with short lead times and to assess this, and to make sure that new knowledge yields practical benefits.
- increased Swedish participation in EU research programmes.
- promotion of strong research environments.

results to be correctly implemented. The work is resource intensive since it necessitates the participation of the most highly qualified researchers.

All in all, the most recent years may be said to have greatly increased the motives and the opportunities for an internationalisation of building research. This change yields very high potential gains in quality, cost effectiveness and in the form of shortened lead times. Because of the changes, there is a marked increase in competition between researchers since the research customers can receive answers from several sources. The opportunity to have access to the cutting edge expertise of others demands in all research cooperation that some other valuable expertise can be given in exchange. Without this opportunity for exchange, all that can be done is to passively read published research, which, in view of the increasingly shorter lead times that apply in research, is a substantial drawback. Real participation in international research cooperation therefore demands one's own cutting edge research of high international standard. On the other hand, it is seldom that any breadth is expected in the work.

Formas and BIC agree that international developments during the past decade necessitate a stronger international focus in Swedish building research. The following are important elements in this:

- Utilisation of international knowledge and participation in scientific consensual assessments
- International research collaboration in projects
- Participation in international research consortia, especially in EU projects
- Creation of cutting edge expertise of high international standard
- Participation in the work of international research organisations

An important strategic issue within the framework of Swedish membership of EU relates to cooperation at programme level. One such prioritised involvement is participation in the creation of a unified European Research Area. Formas and BIC are unanimous in their resolve to promote international programme collaboration within the framework of the ERA network. Nordic building research cooperation is also important. It is an important network, not least in relation to the EU research programmes. The International Energy Agency IEA is also an important collaborative organisation as regards energy research connected with buildings. Formas will continue to participate actively in this work.

### **Forms of support**

The opportunities, which Formas and BIC have to carry out their intentions in the research strategy regarding sustainable spatial planning mainly, reside in the forms of research support and co funding that can be established nationally and internationally, particularly with the

EU. It is essential to create favourable conditions for the researcher community and also for the construction sector to enable them to influence research priorities and the allocation of funds, and to be able to carry out research and innovation work effectively and with a long term approach. Formas and BIC also have a joint responsibility to ensure that innovative and forward looking research ideas and new approaches can be developed.

The research that is supported shall be of high quality and relevant to the construction sector. It shall be performed in collaboration among the research units and the different sectorial players in order to ensure that knowledge creation and implementation of the knowledge in everyday work occur in an integrated manner and with the shortest possible lead times. The preparation process, which has been established for the assessment of applications, with a majority of scientifically well qualified researchers, ensures quality is tested. Relevance is ensured by the participation of the representatives of those concerned in the preparation process. Formas is also ready to support scientific consensus work when the construction sector needs guidance on how research results are to be assessed before they are implemented in full scale.

The different forms of support employed by Formas comprise both allocation of funds for individual projects that are applied for in open competition, and calls for applications for funds within action programmes where the framework for the research content has been specified. In order to satisfy the demand for renewal and internationalisation in research, support can also be given for the employment of postgraduate students and young researchers (defined as a person who has received a doctorate over the past five years) as research assistants and with post-doc stipends.

In the joint field of activity of Formas and BIC, there may be a need to develop forms of support to promote strong research environments. The creation and maintenance of strong Swedish participation in internationally competitive research environments demands collaboration within the entire research funding system. This means that a joint effort should be made in collaboration with other funding agencies, and also with the universities.

Formas and BIC jointly decide what form of support shall be given for each area so that the needs of research and society may be best promoted. The principles governing the choice of the form of support for different areas at a certain time must be gradually developed as a result of this cooperation and the experiences gained from the process of calling for, and dealing with, applications. Formas and BIC will make strategic investments by calling for applications for funds in prioritised areas and will endeavour, through the agency of BIC, to persuade the players in the construction sector to enter into co funding arrangements.

#### **Formas and BIC shall:**

- promote internationalisation of Swedish building research
- prioritise building research cooperation in the greater Europe
- continue Nordic building research cooperation







Forskningsrådet för miljö, areella näringar och samhällsbyggande, Formas

*The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning*

Birger Jarls Torg 5, P.O. Box 1206, SE-111 82 Stockholm, Sweden

Phone: +46 (0)8-775 40 00, fax: +46 (0)8-775 40 10, [info@formas.se](mailto:info@formas.se), [www.formas.se](http://www.formas.se)