INNOVATION & SMEs PROGRAMME

CONSTRINNONET

PROJECT

FINAL REPORT: ANNEX 1

(Project Deliverable D1-3)

Innovation Issues, Successful Practice and Improvements

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1 Introduction

The present document and its various appendices constitute the final deliverable (D1-3) of CONSTRINNONET WP1, namely "Final Report on Innovation Issues, Successful Practice and Improvements".

1.1 Background to the Report

The European construction industry is being challenged to produce a built environment in which the European Union (EU) can become "the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion" by the end of the first decade of the 21st century. Innovation in construction is a means to that end. By producing better buildings and better infrastructures the industry can make a positive contribution to the future success of the EU economy and its Member States. But innovation in construction is commonplace. A step change in the performance of the industry is required.

1.2 The Research Problem

Regulations, procurement systems and business support are three of the main mechanisms which the EU and its Member States can use to promote innovation in construction. Many studies of construction regard the traditional system of contracting as a major barrier to innovation, and advocate the use of various alternatives.[1] Other studies demonstrate the positive role that particular building regulations and particular approaches to building regulation have played in promoting innovation in small and medium-sized construction enterprises (construction SMEs).[2] Both regulations and procurement are framework conditions for innovation in construction. Adjustments in these conditions can promote innovation. An alternative approach is also being pursued. This involves actively supporting improvements in the capabilities of construction firms, so that they are better able to produce the buildings and infrastructures of tomorrow. Numerous initiatives and measures have been taken to promote innovation in construction firms, covering research and development, advanced practices and experimentation; performance and quality improvement; and take up of systems and procedures.[3] But the relevance and accessibility of many of these initiatives for construction SMEs is debateable.[4]

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[1] See, for example: Atkin, B. (1999) *Innovation in the Construction Sector* (Brussels: ECCREDI); Gann, D.; Matthews, M.; Patel, P; & P. Simmonds (1992) *Construction Research & Development: Analysis of Private and Public Sector Funding of Research and Development in the UK Construction Sector* (London: Department of the Environment); and Miozzo, M. & C. Ivory (1998) *Innovation in Construction: A Case Study of Small and Medium-Sized Construction Firms in the North West of England* (Manchester: UMIST).

[2] See, for example: Gann, D. (2000) *Building Innovation: Complex Constructs in a Changing World* (London: Thomas Telford).

[3] See Manseau, A. & G. Seaden (eds.) (2001) *Innovation in Construction: An International Review of Public Policies* (London: Spon)

[4] Sexton, M.G., Barrett, P. & Aouad, G., (1999), *Diffusion Mechanisms for Construction Research and Innovation into Small to Medium Sized Construction Firms*, CRISP – 99/7 (London).

The specific research objectives underlying this report were:

- to identify mechanisms behind successful innovation in construction SMEs, and
- to develop strategies to transfer these into practice

The research methodology is described in Section 2.

1.3 The Justification for the Research

Construction projects typically require collaboration between many diverse construction firms, ranging in size from micro to large. The ambition to bring about a step change in the performance of construction must engage small and large construction firms. This is further emphasised by the extent of SME involvement in the industry. SMEs represent 99.8% of on-site construction firms, account for 81% of on-site construction activity, and employ 89% of the total construction workforce.[5] They also dominate the design professions and have a significant presence in other, construction-related fields, such as the manufacture of construction components, tools and systems.

Although research has been undertaken to examine issues of importance to construction SMEs[6], little attention has been given to the ways in which governments can actively engage those issues, either at regional, national or European level. Indeed, very little research has been done on the impact of business support on the performance of construction SMEs.

1.4 Overview

This section of the report has set out the background and focus for the report. The next sections will outline the research methodology; discuss the issues arising from the field study; present a general perspective on the problem of promoting innovation in construction SMEs; and identify areas for improvement in business support.

[5] Eurostat (2000) *Panorama of European Business* (Brussels). All the figures refer to construction (NACE Rev. 1 45) in the EU-15. Figures for economic activity refer to turnover. The figure for the relative number of SMEs is taken from national accounts, see Carassus, J. (ed.) (2004) *The Construction Sector System Approach: An International Framework*, CIB Report No. 293 (Rotterdam: CIB). Very small enterprises (less than 10 employees) make up 93% of construction enterprises, account for 34% of construction turnover, and 50% of construction employment.

[6] See, for example, Barratt, P.S.; Sexton, M.G.; Miozzo, M.; Wharton, A.P.; & E. Leho (2001) *Innovation in Small Construction Firms*, Base Report for the EPSRC / DETR: IMI Construction – Link (UMIST / University of Salford)

2 Research Methodology

This report is based on the results of a three-year project to promote innovation in construction SMEs (CONSTRINNONET). The project ran from May 2001 to May 2004, and had two main objectives:

- to identify mechanisms behind successful innovation in construction SMEs, and develop strategies to transfer these into practice; and
- to develop and strengthen methods to spread and support the use of innovation mechanisms by construction industry SMEs.

These objectives were addressed directly by two work packages: WP1 and WP2. The first objective was largely pursued by WP1; the second objective by WP2. This report is based largely on the results of WP1.

2.1 Objectives and Methodology[7]

WP1 had two main objectives:

- to identify mechanisms behind successful innovation in construction SMEs, and
- to develop strategies to transfer these into practice

These objectives were pursued through two main phases: a field study phase and a data development and analysis phase.

The field study phase ran to September 2002 and had two parts. The first part involved gathering data from construction SMEs, business support organisations and other key stakeholders as a basis for regional and supra-regional pilot actions. The second part involved gathering general data on innovation policy and innovation practices, which could be used to contextualise the results of the case studies.

The data development and analysis phase ran to the end of the project. This involved identifying key issues and themes from the case studies, and using data from the general surveys to develop a general perspective on those findings.[8] In effect, WP1 took a multiple perspectives approach

[7] There are two descriptions of WP1. The original description (see *Contract No. IPS-2000-00002*) applied until 17 July 2002, effectively the end of the first phase of the project, and the end of WP1. This description explains the methodology, the activities and much of the output of WP1. The revised description (see *Addendum No. 2 to the Contract No. IPS-2000-00002*) reflects the outcomes of the activities and outputs up to July 2002 and helps to explain the structure of the present report.

[8] The results were disseminated internally and externally, and resulted in: *Annex V. WP1 "SME Context, Needs and Services" (Deliverable D1-2(a & b))* of *CONSTRINNONET Project: Progress report (01.06.2002 – 30.11.2002)*; and the present report.

of combining emergent theory from the data with insights from a range of perspectives.[9] This approach is typical of exploratory research, and was considered appropriate for the grounded development of effective pilot actions.[10]

Two tools were used during the field study. A semi-structured interview questionnaire provided the main tool for engaging with SMEs and other stakeholders, and gathering suitably grounded and rich, qualitative data. The questionnaire had a small number of open questions about the main subjects: innovation in construction SMEs, mechanisms behind successful innovation, and strategies for spreading the use of these mechanisms.[11]

Templates were used to collect and record data on policy and practice. The "innovation policies" template was designed to gather information on the objectives and methods of various policies and policy initiatives. The "innovation studies" template was designed to gather data on the objectives, methods and results of various studies of innovation. The templates and questionnaire were accompanied by basic and provisional definitions of the key concepts.

The field study was carried out by each of the partners in their respective regions. Interviewees were selected on the basis of their willingness to take part in the project (to exchange information and to engage in pilot actions), their availability, and their suitability. The following section provides details of each partner's activities and outputs.

2.2 Partner Activities and Outputs [12]

The WP1 activities of Belgian Building Research Centre (BBRI) were focussed on promoting the creation, development and commercial application of technologically new-to-construction products and processes in Belgium. They interviewed six SMEs (four product manufacturers and two contractors) using a semi-structured questionnaire; and hosted a national brokerage event, "Opportunities for SMEs in the 6th Framework Programme for European Research", which was attended by 35 representatives of regional, Belgian and European federations related to construction. They also produced three reports: "Public Policy & Policy Instruments in Belgium", "Construction Research in Belgium" and "Studies of Innovation in Construction in Belgium"; and contributed two case studies of innovation in construction SMEs: "Recycling of Stainless Steel Slags" and "The Development of an Acoustical Wall Ventilation Grid".

As part of their commitment to WP1, VTT Building & Transport investigated the system of support for technological innovation in construction in Finland. They interviewed four of the main service providers in Finland (VTT, the National Technology Agency (TEKES), the Employment and Economic Development Centre (TE-Centre), and the Finnish Export Association (Fin-pro)), one special interest group (the Confederation of Finnish Contractors), and one SME, using a semi-structured and customised questionnaire. They also produced two reports, "Public Policy and Policy

[9] Barratt, P. & C. Stanley (1999) *Better Construction Briefing* (Oxford: Blackwell Science).
[10] See, also, Strauss, A. & J. Corbin (1998) *Basics of Qualitative Research*, Second Edition (London: SAGE).
[11] The structure of the interviews was ultimately left to each partner.
[12] Detailed information about partner activities can be found in the CONSTRINNONET project's Progress Reports. Reports and case studies are contained in *Annex 1.0, Innovation Policy and Practice: Reports*, and *Annex 2.0, Case Studies of Innovation in Construction SMEs.*

Instruments in Finland" and "Services Available to SMEs in Finland"; and contributed three case studies of innovation in construction SMEs, "LIFA AIR Ltd.", "Specifinn Oy" and "XTec Oy".

Centre Scientifique et Technique du Bâtiment (CSTB) concentrated their WP1 activities on the promotion of technologically new-to-industry products and processes in France. They engaged with three regional business support organisations (Centre d'Information sur les Produits et Process Innovations dans la Construction (CENTREX), Direction Regionale de l'Equipement (DRE) Midi-Pyrénées, and Chamber of Commerce of Nantes-Saint Nazaire (GILA)), who helped to identify SME manufacturers and SME contractors, and interview them, using semi-structured questionnaires. They also produced one report, "Studies of Construction Innovation in France"[13]; and contributed two case studies, "Diese Telecom" and "André Mestdagh".

Paragon used WP1 to develop the idea of a single-entry point system of business support for technological innovation in construction SMEs in Greece (see pilot action). They interviewed five construction SMEs. They also produced four reports, "Innovation Policies in Greece", "Studies of Construction Innovation in Greece", "State-of-the-Art Report on the Innovation Environment and Processes in Greece", and "Report on Programme TECHNOBROKERAGE: Development and Networking of Service Providers on Issues of Technology Transfer and Innovation"; and contributed two case studies (DEKA and ISORAST).

Like most of the other partners, Vilnius Gediminas Technical University, Lithuania (VGTU) concentrated their investigations on the promotion of research and technological development (RTD) as a pre-condition for technologically advanced innovation in construction SMEs. They interviewed eight SMEs (3 contractors, 1 supplier, 1 manufacturer, 1 designer and two facilities management/property management enterprises), the Association of Lithuanian Contractors, and three service providers. They also produced five reports, "Public Policy and Policy Instruments in Lithuania", "Support for Innovation in Construction SMEs in Lithuania", "Short Background Information about the Innovation System in Lithuania", "Studies of Innovation in Construction in Lithuania" and "Development of the Innovation Decision Web-based Support System"; and contributed one case study, "Eternit Akmene".

In Spain, Carsa sought to promote support for the implementation of technologically new-to-construction products and processes in construction SMEs, principally: manufacturers and distributors of technology. They interviewed seven SMEs (including suppliers and traditional firms), one large enterprise, five federations/associations (including the Association of Wooden House Builders) and seven service providers (including RTD providers, a technology transfer agency and regional governments), using various media (meetings, telephone and e-mail); and promoted the Constrinnonet project at four conferences: three "Go Digital" conferences and a Spanish Innovation Week in Pamplona. They also produced one report "Support for Innovation in Construction SMEs in Spain"; and contributed two case studies of innovation in construction SMEs, "Servicios y Obras Canarias S.A." and "TRAMAT".

[13] Further information on innovation policies and instruments in France can be found in Manseau, A. & G. Seaden (eds.) *op. cit.*

For its part, the University of Salford (USAL), the Work Package Leader, concentrated on gathering information about innovation in construction SMEs, the mechanisms behind successful innovation in construction SMEs, and ways to spread and support the use of those mechanisms. They interviewed four SMEs (one contractor, one architect, one engineer, one researcher), two special interest groups (National Federation of Builders, and Institute of Chartered Engineers), and five innovation service providers (Centre for Construction Innovation, Centre for Knowledge and Information in Building Technologies, Chamber Business Enterprises, Construction Industry Training Board, and Rethinking Construction); and held a workshop, attended by three SMEs, two business support organisations, and one special interest group. They also produced three reports on UK-related matters: "Public Policy and Instruments in the UK", "Support for Innovation in Construction SMEs in the UK" and "Studies of Innovation in the UK and Elsewhere"; and contributed four case studies of innovation in UK construction SMEs, "Richards, Moorehead & Laing", "Xetal Consultants", Marshall Architects" and "Contract Services".

3 Field Study (Interviews): Issues Arising

The interviews with key stakeholders addressed three main subjects: innovation in construction SMEs; mechanisms behind successful innovation in construction SMEs; and ways to spread and support the use of those mechanisms. The issues arising were inevitably determined by the partners (interviewers) and the stakeholders (interviewees); by their respective definitions (explicit or implicit) of the key concepts (innovation in construction SMEs, and mechanisms behind successful innovation in construction SMEs) and their practical interests in promoting innovation in construction SMEs. For example, many of the interviews focused (explicitly or implicitly) on how to promote the commercial application of technologically new-to-construction products and processes in construction SMEs, and, in particular, on how to promote research and technological development in SME manufacturers of construction technology. Moreover, the identified mechanisms for promoting innovation in construction SMEs were, almost exclusively, specific types of business support, or, more specifically, the type supplied by the partner organisation. All of this means that the issues arising were highly case-specific, so that many of the implied actions relate to specific cases, rather than, say, the promotion of innovation in construction SMEs in general. The next section (Section 4) of the present report puts these cases into perspective by taking a broader view of innovation in construction SMEs and the mechanisms behind successful innovation in construction SMEs. This helps to explain the more general conclusions of the report. However, many of the pilot actions and specific recommendations addressed the particular interests of the partners and the needs of their existing or prospective construction SME clients.

At this juncture, it is useful to identify some of the issues arising from the interviews – not least because it helps to justify the broader view taken in Section 4. On the question of innovation in construction SMEs, the main issues concerned the definition of innovation in construction, the nature of innovation in different types of construction SMEs, and the barriers to innovation in construction

SMEs. There seemed to be some debate, for example, about where to draw the line between the actual commercial implementation of existing knowledge and the creation and development of knowledge. It was noted that, in construction, formal RTD is usually a pre-condition for innovation on-site, rather than an adjunct of it. It was also apparent that construction is a complex process involving many activities distributed across a range of distinct and specialist enterprise, including designers of construction works, the executors of construction works and various suppliers of construction materials, components and tools, and thus that innovation in the form of problem-solving is a common feature of construction projects. It was also noted that construction SMEs contribute to this process various ways, depending on their role in the construction process, since many construction enterprises are SMEs, especially those who work on construction projects. It was also noted that innovation in construction SMEs also refers to improvements in their general (technological or organisational) capabilities. A number of barriers to innovation in construction SMEs were identified. It was noted that many SMEs do not have enough time or funds to develop their capabilities or to engage in risky problem-solving related to specific projects.

On the question of which mechanisms support successful innovation in construction SMEs, it was apparent that this depended on the type of innovation in construction SMEs and the type of construction SME (e.g. contractor, designer, manufacturer). Most of the interviews concentrated on public-sector support for RTD. It was clear that few contractors and architects made use of RTD support, but that other types of construction SME, notably manufacturers and engineers, did make more use of it. The main barriers identified included the cost of RTD (especially testing), the size and business strategy of the SME, awareness of business support, technical training, access to information and knowledge (e.g. regarding the intellectual property rights), and the supply of finance. In some regions, "the path of innovation development" was well-established, comprehensive and transparent (e.g. Finland), but not so in many other areas. Indeed, in many countries, there was evidence of over-complex and opaque systems, burdened by excessive, temporary, bureaucratic and corrupt initiatives. In many cases, the system of support seemed ill-suited to the needs of construction SMEs, of whatever type, bearing in mind the nature of the temporary, varied and complex nature of construction projects. In particular, grants appeared to be particularly ill-suited to the needs of project-related construction SMEs. In short, although many individual construction SMEs were able to testify that the provision of support did help them to innovate, it was evident that European governments and their business support agencies had generally failed to address issues of importance to the majority of construction SMEs and to engage them in appropriate ways.

Many proposals were put forward for promoting the use of business support by construction SMEs, particularly in relation to RTD. In particular, the following proposals were made: provide case studies of successful innovation, which would illustrate the benefits of support; develop a better understanding of the RTD process; organise seminars and conferences to exchange information and knowledge about various mechanisms and the process of innovation in general; generate results quicker; increase and improve the allocation of funding; create a single-entry point mechanism, which could improve access to information about services, service providers, potential partners; and create

and develop a European network of business support organisations, dedicated to promoting innovation in construction SMEs by improving the quantity and quality of services on offer.

As a result of the issues raised concerning the promotion of innovation in construction SMEs, the project consortium undertook four pilot actions. Two partners organised brokerage events to facilitate intra- and extra-sectoral collaboration between SMEs and other stakeholders on specific subjects, namely: "concrete innovation" and "renewable energy and water". One partner led the development of a single-entry point system, which could give construction and construction-related SMEs immediate and basic access to EU and national support for RTD. Another partner worked with a network of construction SMEs, regional development centres and national bodies to establish the key elements of a regional and sectoral approach to the promotion of innovation in construction SMEs, based on the concept of an Idea Factory. Finally, the partners organised and participated in a series of seminars and workshops to explore the possibility of developing a European network of business support organisations dedicated to the delivery of more and better services to construction SMEs.[14]

4 Innovation in Construction SMEs: A General Perspective

4.1 Introduction

The objectives of WP1 were to identify the mechanisms behind successful innovation in construction SMEs and to develop strategies to transfer these into practice as a basis for pilot actions. It did this by using exploratory methods, based on fairly simple and provisional definitions of the key concepts. The results of the field study suggested that there is considerable disagreement between academics, practitioners, governments and their agencies about the correct definition of the fundamental concepts – namely, construction, construction SMEs, and innovation in construction SMEs – and, accordingly, some debate about the identity of the mechanisms behind successful innovation in construction SMEs.

This section and the next put these differences into context. The present section defines the key concepts in broad terms; describes the innovation terrain; analyses the concept of innovation in construction SMEs; and, on that basis, identifies the main mechanisms behind successful innovation in construction SMEs. The following section (Section 5) takes a closer look at business support, and explains the project's pilot actions.

4.2 Definition of Terms

4.2.1 Construction SME

[14] For further information on these pilot actions, see *WP2 D2-2 Pilot Action Case Studies* and *WP2 D2-3 A Report on Piloting Innovation Support Actions and Research/Policy/Instrument Implications*.

The definition of a construction SME (and thus innovation in construction SMEs) depends critically on both the definition of the construction industry (the set of enterprises that produce the build environment), and the definition of an SME.

The Construction Industry

According to the conventional classification of economic activities used to compile European accounts of economic activity, the construction industry comprises only those enterprises whose principal activity is the execution of building and/or civil engineering work on site.[15] These enterprises do site preparation; building of complete constructions or parts thereof, and the execution of civil engineering works; building installation; and building completion. Their principal activity does not include building design and drafting; project management; pre-fabrication and other activities typically associated with construction projects.[16] This is a narrow definition of the construction industry, and a narrow definition of construction.

A broader definition of the industry would also include enterprises whose principal activity involves some aspect of the design and control of construction works; and the supply of building materials, equipment, plant, transport and other services.[17] Some definitions also include clients, especially professional clients ('property developers'); elements of the financial services sector, including building societies; user groups; manufacturers of building materials, equipment, plant and transport; the extraction of basic materials; parts of the research and development sector; the operation and maintenance of facilities, and so on.[18] Some of these organisms and activities may be referred to as "construction-related".

However it is defined, the industry is a major component of the EU economy. On-site construction activity alone generates approximately 11% of the EU's Gross Domestic Product (5% of its Gross Value Added), and employs 7% of the EU's working population.[19] Other construction-related sectors, such as design, project management and the manufacture of building materials and components, employ another 20 million or so of the working population.

Construction SMEs

Defining an SME is not a straightforward exercise. In principle, it should take account of the enterprise's market power (e.g. share of the market, independence).[20] In practice, there have been two broad approaches: first, define SME in terms of its number of employees; and secondly, define SME in terms of multiple criteria, including turnover, balance sheet, degree of independence, and number of

[15] See Commission of the European Communities (1990) *Statistical Classification of Economic Activities in the European Community, Rev. 1 – NACE Rev. 1* (Eurostat)
[16] The main features of construction projects are conception (design), construction (planning and execution), and control – or: creativity, technology and probity.
[17] See, for example, Carassus, J. (ed.) (2004) *op. cit.* and Commission of the European Communities (1997) *The Competitiveness of the Construction Industry* (Brussels).
[18] See, for example, Osbourn, D. (1997) *Mitchell's Introduction to Building*, 2nd Edition, revised by R. Greeno (Harlow: Pearson Education).
[19] Ministry of Public Works, Transport and Housing, France (2001) *European Construction: The 2000 Figures* (Paris).
[20] Griffiths, A. & S. Wall (eds.) (2004) *Applied Economics* (Harlow: Financial Times Prentice Hall).

employees. Most schemes in the EU and its Member States adopt practical definitions. These definitions vary according to the particular objectives of the scheme. However, most adopt the same employee criterion, and define an SME as having 0-250 employees.

According to the employee criterion, Construction SMEs represent a large and important part of the construction industry, both in terms of their number and their economic activity. This is especially so in the area of on-site execution of works (*NACE Rev. 1*, 45), where they represent 99.8% of enterprises, account for 81% of construction turnover, and approximately 89% of the total construction workforce.[21] Construction SMEs are also important in other sectors of the industry, most notably design.[22]

4.2.2 Innovation in Construction SMEs

This report views innovation in construction SMEs as part of the general process of innovation in construction. The definition of innovation in construction SMEs depends on the definition of innovation, and innovation in construction (as well as the definition of construction SME).

Innovation in construction

Defining innovation is a more difficult exercise than defining an SME. Most definitions are ambiguous, in that they refer to both a process of innovation and the outcome of the process of innovation. Consideration must be given to the activities involved in the process and the forms (or outcomes) of the process.

Our research suggests that innovation is best defined as "the commercial application of existing knowledge in a new context", as proposed in the European Commission's latest Innovation Action Plan. [23] However, unlike the Commission, we suggest that the creation of knowledge through research & development, the identification of market opportunities by entrepreneurs, the reorganisation of an enterprise, project or industry, and various other "innovation activities" should be covered by this definition, where appropriate. Thus, research and development should be viewed as part of the process insofar as it is intended to or actually results in "the commercial application of existing knowledge in a new context", or is part of the collaborative process. Our concept of innovation therefore refers to a broad range of activities – including research and development, project design, and the execution of works. In effect, it encompasses the creation of knowledge, the development of knowledge, and the commercial implementation of existing knowledge. Existing knowledge can be advanced or common. The context of implementation can be broad (world; industry) or narrow (specific project; specific SME).

Innovation in construction has three main outcomes (or forms): technologically new/improved buildings and physical infrastructures, technologically new/improved construction processes; and non-

[21] See footnote 5, above.
[22] According to the market power criterion, many design firms are not small, because they exercise significant market power.
[23] Commission of the European Communities (2004) "Innovative for a Competitive Europe: A New Action Plan for Innovation", Working Paper (Brussels)

technological improvements in the organisation of construction.[24] Buildings and infrastructures made with new or improved materials and building components, such as structural steel; stress-skinned panels; desegregated concrete; flexible piping for horizontal plumbing; fuel cells; self-compacting concrete; and fibre-reinforced bars for cast-in-place concrete slabs are all examples of technological product innovation. The pre-fabrication of construction components, the use of the full-body harness for fall prevention; the zone module construction method for large coal-fired power stations; and the 'Smart Building' system to automate the erection of high-rise buildings are all examples of technological process innovation. All of these innovations increase the production (or consumption) possibilities of the user. Alternatively, strategic alliances between construction firms (e.g. architects and surveyors), partnering arrangements between members of a construction team, framework agreements between construction firms and building merchants, and private-finance initiatives are all examples of non-technological process innovation. These innovations allow a better allocation and use of resources.

As demonstrated be, innovation in construction projects is commonplace. Moreover, more attention is given to technological product innovation than process innovation. Innovations in the organisational and technological capabilities of the industry are far less frequent.

Innovation in construction SMEs

There are basically two modes of innovation in construction SMEs (see below, Section **): the project-specific mode; and the general capabilities mode. The former refers to the problem-solving activities of an SME during the process of construction. The latter refers to general improvements in the technological and/or organisational capabilities of an SME that can be applied to a range of projects.

As indicated above, project-specific innovation is commonplace. Innovation in capabilities is less frequent.[25]

4.2.3 Mechanisms behind innovation in construction SMEs

The concept of a mechanism behind innovation in construction SMEs is problematic. It can refer to activities of innovation, or to factors of innovation, such as markets and governments. In practice, Constrinnonet has focussed its activities on one type of mechanism: business support, "those measures, originating in public policy initiatives, that aim to help enterprises or entrepreneurs successfully develop their business and respond effectively to any challenges".[26] This reflects the nature of the

[24] See classification of innovation outcomes in OECD / Eurostat / Commission of the European Communities (2000) *The Measurement of Scientific and Technological Activities: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data - Oslo Manual* (Paris).

[25] Construction innovations are typically not implemented in firms, but on collaborative projects. See Winch, G. (1998) "Zephyrs of Creative Destruction: Understanding the Management of Innovation in Construction" *Building Research & Innovation, 26(4)*, 268-279.

[26] Commission of the European Communities (2001) "Creating Top-Class Business Support Services", Commission Staff Working Paper (Brussels).

project, the project consortium, and the nature of the initiative that lies behind the CONSTRINNONET project. Some attention has also been given to regulations and procurement.

4.3 Innovation Issues

4.3.1 The Innovation Terrain

Innovation in construction SMEs is part of the process of innovation in construction, and as such takes place within a specific context: the construction of the built environment. This section addresses the key features of the terrain.

Construction is different from other production systems in a number of important respects. First, the **products are fixed in space**. This means that they are produced or assembled at the point of consumption. Secondly, construction products are **generally commissioned or made to order**; each product is produced for a particular client. This means that they vary in scale, technical complexity, and expected longevity. These two features of construction have implications for the construction process. In the pre-construction phase, consideration must be given to the interaction of the project with existing facilities; urban planning systems and to client requirements. In the construction phase, consideration must be given to natural conditions, geological and climatological; the character of building components, from low-tolerance and simple components such as bricks to high-tolerance and complex components such as advanced engineering services installations; the skills required for their integration into the building product; and the general complexity of building product integration. In short, construction involves the solution of a number of unique site-related and client-related problems. Finally, the project team is a **temporary alliance between independent organisations**. This means that the degree of inter-organisational negotiation is higher than in normal manufacturing processes.[27]

Construction also takes place within a specific **socio-political context**. This means that the production possibilities and modes of inter- and intra-organisational negotiation are affected by specific codes, regulations and procedures (e.g. urban planning, professional codes of conduct, building materials regulations), which are intended to address public issues such as health, safety and the environment.

Together these features of construction help to explain the **complex organisation of construction**. Table 1 arranges the various construction actors into teams, and associates each team with the kind of activities undertaken in a medium-sized building project. It demonstrates that construction is a group activity and that success depends on good teamwork. Winch (1998) provides a simpler analysis, arranging the various actors into three groups: infrastructure of construction (trade contractors, specialist consultants, component suppliers), superstructure of construction (clients,

[27] See, for example, Winch (1996) "Contracting systems in the European construction industry: A sectoral approach to the dynamics of business systems", in: *The Changing European Firm: The Limits to Convergence*, edited by Whitley, R. and Kristensen, P.A., (London: Routledge), pp. 241–270.

regulators, researchers, professional bodies, brokers) and system-integration (principal designers, principal contractors).[28]

[28] Winch, G. (1998) *op. cit.*

Table 1: The Building Team

Team	Principal Activities	Actors
Client Team	Establish whether to build or not to build Produce building brief for advisors Establish and provide finance Agree design and construction phases, and timetabling Fulfil and manage completed project Appoint planning supervisor Nominate principal contractor	Owner of completed project
		Owner's professional advisors (financial and technical)
User Team	Supply information on user requirements	Client (or owner of completed project)
		User and User Groups
Design Team	Supply design expertise (overall design of the project, and specialist design) Cost control and financial advice Negotiate with local authority to clarify legal requirements Assess the relative performance of manufactures (assisted by the Research Team and the construction specialist). Selection and implementation of suitable construction methods. Formulate maintenance procedures. Prepare maintenance manual.	Principal designers: architects, interior designers and building surveyors
		Specialist Designers: civil engineers, structural engineers, services engineers, other
		Quantity Surveyors (Cost control and financial advice): chartered surveyors
		Other: e.g. economists; student assistants and technicians).
Research Team	Make understanding and development of current construction methods possible Discover facts by means of scientific study Provide advisory service to building team Supply in formation about use and specification of new and existing construction methods and about other aspects of the building process Education and training of skilled building workers and managers.	Advisory Bodies
		Research and Development Organisations
		Information services
		Education and Training
		Other.
Legislative Team	Control location, design and construction of a building	Planning authority
		Building Control Department
		Regulator
		Other: e.g. factory inspectors, health inspectors, water inspectors, petroleum officers, fire-fighters, police officers.
Manufacturing Team	Supply materials, components, equipment and building systems	Many organisations
Construction Team	Co-ordinate erection of and erection of building Completion of the work Design and provide specialist elements Skilled activities Semi-skilled activities Unskilled activities	Main contractor – general builders (including 'jobbing builders' and 'management organisations'), general contractors, design and construction companies, other.
		Subcontractors. These include nominated (by client) and ordinary (non-nominated or "domestic") subcontractors
		Capital works departments of large private and public organisations
Maintenance Team	Building maintenance, repairs, replacements, security, car parking attendance, catering etc. Offer advice during the investigatory phases of design, which goes towards satisfactory performance standards and running costs for intended life span of a building. Normal maintenance procedures can usually be formulated using the expertise of the Design Team without the need for special consultation.	Building's owners
		Facilities management company

Based on *Osbourn, D. (1997)*[29]

[29] Osbourn, D. (1997), *op. cit.*

Figure 1 presents a complementary perspective on construction. It shows the main processes, sub-systems and framework conditions of construction. The processes and sub-systems connect "building material and machinery" to "facility operation, management & maintenance" and represent the activities of the construction infrastructure and the systems -integrators. The construction superstructure is represented by "facility operation, management & maintenance" and aspects of "framework conditions" and "information flows".

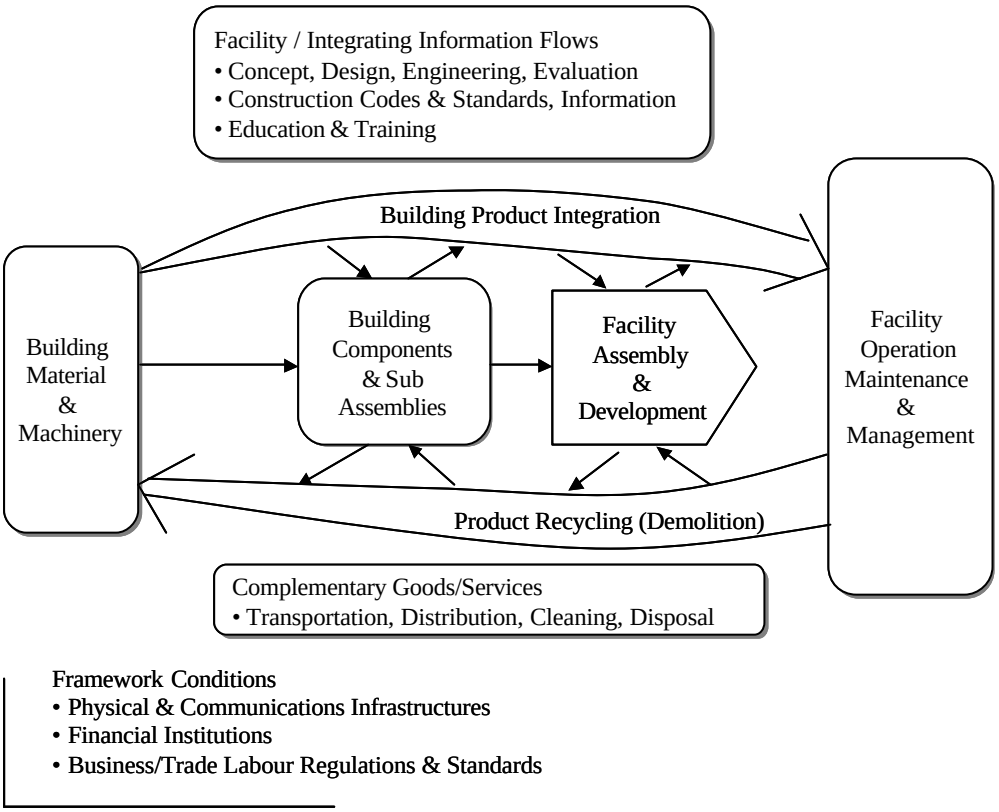

Figure 1. Key agents, major types of interactions and framework conditions in the construction industry (Manseau, 1998.)[30]

4.3.2 Innovation in Construction and Construction SMEs

The features of construction described in Section 4.3.1 affect the process of innovation in construction and its outcomes. For instance, on-site and off-site conditions limit the opportunities for controlled innovation; the scale of the product limits opportunities for the testing of prototypes; the temporary nature of construction projects limits the opportunities for learning; and building regulations constrain the choice of products and processes. They also give rise to numerous problem-solving innovations, involving the work of many different types of construction SME. The dynamic nature of the terrain also implies that construction SMEs have occasionally to improve their capabilities. However, the ability to make step changes in capabilities is constrained by the size, type and

[30] Manseau, A. (1998) "Who Cares About Overall Industry Innovativeness?", *Building Research and Information*, 26(4), pp. 241-245.

circumstances of construction SMEs. This section looks at different models of technological construction innovation, and modes of innovation in construction SMEs, and raises some issues about the willingness and ability of SMEs to innovate.

Models of Technological Construction Innovation

Slaughter (1998) describes five types of technological construction innovation: incremental, radical, modular, architectural and systemic.[31] **Incremental innovation** in construction refers to a small change in the product/process that has negligible interaction with other components of the product or parts of the construction process. The substitution of a full-body safety harness for a waist-level harness is an example of an incremental innovation. In such cases, the process of innovation is relatively simple in terms of the people and activities involved: they require little or no co-ordination within the project team and no special resources (human, physical capital). Most often the source appears within the construction industry, from suppliers and manufactures of components/tools, through designers and executors of construction works, to the owners and users of the final product. In contrast, **radical innovation** in construction refers to technological breakthroughs that radically change the character of construction products or processes: for example, the original introduction of structural steel. The changes are major and uncertain, and the process of innovation is therefore complex, in terms of the multiplicity of interactions between people and activities. These innovations require the co-ordination of many organisms and specialised technical inputs. Oftentimes, this involves interaction with organisms outside of the industry -- or the usual construction network -- such as members of the scientific and engineering research community, who may be the original source of the innovation.

Modular and architectural innovations differ in terms of the degree of interaction with other components or processes. **Modular innovation** refers to significant technological changes within the component that have little or no impact on other components and systems: for example, fibre-reinforced bars for cast-in-place concrete slabs. This means that the process of innovation is relatively simple in terms of the people involved: the development and implementation of a new/improved module can proceed with minimum negotiation. **Architectural innovation** refers to a technological change in a component that has a major impact on other components and systems: for example, self-compacting concrete. This means that the process of innovation is relatively complex; it will involve interaction between the developers and other actors regarding changes and modifications to other components and systems, and the appropriate development of the technology itself.

Finally, **system innovation** involves the integration of multiple independent innovations to provide technologically new or improved facilities: for example, the zone module construction method for large, coal-fired power stations. This means that the process of innovation must consider the interaction with new and existing components and systems, and will therefore involve major interaction between many actors. System innovation is not uncommon in construction, since its product and the process must be configured to unique site conditions and client-demands.[32]

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[31] Slaughter, E.S. (1988), "Models of Construction Innovation", *Journal of Construction Engineering and Management*.

[32] In all of these cases, innovation in construction is usually open rather than closed, the activities being distributed across a number of organisms rather than contained within one. Oftentimes the process is complex, rather than

Slaughter's analysis of technological construction innovation can be complemented by a typology of the existing construction knowledge base: namely, advanced knowledge, best practice and standard practice.[33] **Advanced knowledge** is not fully proven in any context of implementation. It offers greater production possibilities than standard practice, but the outcome is relatively uncertain. **Best practice** is proven in some contexts, but not fully proven in the context of implementation. It offers greater production possibilities than standard practice, but these are still fairly uncertain. Finally, **standard practice** satisfies minimum standards, and is generally proven in the context of implementation. It offers standard and relatively certain production possibilities. This analysis adds an extra dimension to the previous analysis, by suggesting that each type of innovation can involve the implementation of different levels of knowledge.

Innovation in construction SMEs

There are two main modes of innovation in a construction SME (and construction enterprises in general): (1) the creation of knowledge, the development of knowledge and/or the commercial implementation of existing knowledge as part of a specific construction project; and (2) the creation of knowledge, development of knowledge, and/or commercial implementation of existing knowledge with a view to enhancing the general capabilities or competencies of the SME.[34] Research and development; the manufacture of a product; the supply of building materials; the pre-fabrication of components; the design of a building; and the assembly of a building are all examples of **"project-specific innovation"**. They are essentially resource-based, and motivated by the short-term objective of completing work on time, to budget, and to brief. They can be cost-reducing or value-enhancing, depending on the project and the capabilities of the firm. On some projects there is little demand for negotiation or collaboration between firms and clients with respect to the project brief. Clients are concerned primarily with reducing costs and tend therefore to favour price-competitive procurement methods. The firms for their part are unwilling and/or unable to enhance the value of the project. This conservative approach supports incremental and modular, cost-reducing innovations. On other projects, the demand for architectural, systemic and/or radical innovation provides greater scope for negotiation and collaboration between firms and between firms and clients regarding the project brief. Clients demand value-for-money, and the firms are willing and able to provide it.

The second mode of innovation concerns the technological and organisational capabilities (or competencies) of a construction SME; that is, (i) its core ability to transform material and information inputs into outputs (final and intermediate products of construction), and (ii) its ability to organise work, including its ability to manage a portfolio of work, to procure supplies and to seek out and exploit new business opportunities. The commercial production of a new building component; the commercial implementation of Computer Aided Design (CAD) systems; the development of a new

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simple; it involves multiple interactions between different actors and activities. This reflects the nature of the construction product (novel and technically complex) and the construction process, which is itself complex.

[33] An example of this typology can be found in the proposal for the creation of A Virtual Reality Centre for the Built Environment http://www.casa.ucl.ac.uk/proposal.html

[34] A similar typology can be found in Barrett, P.B. *et al.* (2001) *op. cit.*

technique for treating Japanese knotweed in site preparation; partnering with clients (e.g. building surveyor with housing association); and strategic alliances with other SMEs (e.g. building surveyor with architect; civil engineer with landscape contractor) are all examples of **"business improvement"**, as is the creation of a new construction SME. These innovations are essentially market-focussed and involve improvements in the firm's resource base. They have various strategic motivations: 'survival' in the market of choice (due to competition, new regulations, new modes of procurement); desire for stability, in terms of workload, cash flow etc.; and growth. The former tend to be associated with the implementation of new basic standards within the market. The latter tend to be associated with the implementation of best practice and/or advanced practice. Innovation in a construction SME can be part of a general trend or simply an attempt by a specific SME to improve its own lot. All of these improvements can be driven by changes in demand or supply, including competition, new regulations, and new procurement methods. They may require training of personnel, acquisition of technology, additional finance etc., and they may require significant and systemic changes, involving further improvements in their technological and organisational capabilities.

SME Issues

In general, construction innovations are typically not implemented in firms, but on collaborative projects.[35] In the case of SMEs, this relative aversion to business improvement can be explained by their limited resources base (human capital, physical capital, financial capital), relative to larger firms. It is also apparent in collaborative projects. An aversion to innovation is particularly apparent among site-based construction firms, such as designers and contractors. Their limited resource base means that they are less able to diversify risks. This means that they tend to avoid projects that involve radical and systemic innovations, preferring instead to collaborate in incremental and modular innovations, which require less negotiation. It is worth noting that the majority (54%) of SME building firms have fewer than 10 employees, many of whom are either petty capitalist or simple commodity producers. These firms are particular reluctant and unable to innovate to a great extent, and thus particularly resistant to business improvement measures.[36]

This aversion to risky innovation has self-reinforcing and knock-on effects. It suppresses the demand for innovation and this in turn reduces the demand for RTD and other 'pre-conditions' fro advanced project-based innovation. More to the point, it affects the direction of technological and organisational innovation, moving it toward modular technology and pre-fabrication (mass production, and bespoke), and away from radical and systemic innovations. And this impacts ion the activities and capabilities of SMEs further up the supply-chain.

[35] Winch, G. (1998) *op. cit.*
[36] Ball, M. (1988) *Rebuilding Construction: Economic Change in the British Construction Industry* (London: Routledge).

4.3.3 Mechanisms Behind Successful Innovation

The analysis in Section ** implies that innovation is a common feature of construction projects, and thus a common activity of project-based construction SMEs.[37] The key innovation issue is not whether innovation takes place but rather what type of innovation takes place: is it modular or systemic; does it involve the application of basic knowledge or advanced knowledge? In short, could the industry produce better value for money for clients and users? What are the barriers? And what can the governments do to overcome them, and to produce step changes in the performance of construction? What are the mechanisms behind "successful" innovation in construction SMEs?

From the perspective of government, there are three main mechanisms behind "successful" innovation in construction SMEs: (1) the contracting system, or system of procurement; (2) building regulations; and (3) business support. As we shall see, the first mechanism can be used to determine the model of innovation in construction and thus the nature of project-specific innovation in construction SMEs; the second mechanism can be used to raise the basic standards and thus to raise the performance level of construction, whatever the model of innovation or contracting system; and the third mechanism can help to improve the general capability of both project-based and construction-related SMEs to innovate. Indeed, the latter can be used to raise the general performance of construction, by supporting a shift toward different models of innovation and the use of best practice or even advanced knowledge rather than standard (or even sub-standard) practice as part of a portfolio of innovation policies targeted at procurement and regulations, as well as business support. This section presents a critique of the first two mechanisms. The third mechanism is discussed in Section 5.

The Contracting System

Many studies of innovation in construction regard the traditional contracting system as the main barrier to "successful" innovation in construction and, thus, by implication, the main barrier to "successful" innovation in construction SMEs.[38] They suggest that the traditional contracting system should be replaced by systems that allow negotiation between members of the project team, and between members of the project team and their suppliers.

In the traditional method of contracting, the building professional, acting on behalf of the client, appoints the main contractor, who, in turn, appoints specialist contractors ('sub-contractors'). Appointments are made by competitive tender, and risk is allocated vertically, from building professional to sub-contractor. According to many studies, this method of contracting often acts as a barrier to innovations that require interaction between designers (architects and engineers) and builders. They observe that the solution of problems relies too much on architects and engineers[39]; there is poor

[37] See also Dibner, D.R. & A.C. Lemer (1992), *The Role of Public Agencies in Fostering New Technology and Innovation in Building* (Washington DC: National Academy of Sciences Press); and Slaughter, E.S. (1993), "Builders as Sources of Construction Innovation", *Journal of Construction, Engineering and* Management.
[38] See, for example, Atkin, B. (1999) *op.cit.*; Gann, D. et. al. (1992), *op. cit.*; and Miozzo, M. & C. Ivory, (1998) *op. cit.*
[39] Atkin, B. (1999) *op.cit.*

communication between design and execution,[40] and thus between execution and the manufacture and/or supply of components, materials, products, and systems[41]; that traditional procurement methods make poor use of the expertise of specialist contractors, many of whom are SMEs, and the suppliers of components, materials, products and systems.[42] In other words, the system tends to favour incremental and modular innovations, involving minimal interaction between people, and the use of knowledge that has been proven in the context of implementation. Accordingly, project-specific innovation in SMEs, tends to be cost-reducing rather than value-enhancing.

There are alternatives. The fee system (or construction management contract) separates design from construction. Under this system, the management contractor tenders out physical work and supply of materials to sub-contractors. This system can support greater interaction between the contractor and the supplier. Secondly, the project management system gives overall control to a 'project manager'. This system is regularly used on large projects. A design-and-build contract is an example of the project management system. It gives a building contractor responsibility for design and execution. In theory, this should improve the degree of interaction between design and execution. Finally, partnering is a form of organising construction that supports interaction between clients and a small number of 'partners', who work closely from the early stage of a project; it enables designers, contractors, and suppliers to combine their technological knowledge to create best value for the client. These systems of organising projects are better suited to projects that require or are expected to require architectural, systemic or radical innovation, and may facilitate the use of advanced knowledge and best practice in a way that the traditional contracting system could not be expected to do.[43]

Governments can and do support the use of alternative contracting systems. They promote the use of best practice procurement by government departments, and demonstrate the benefits to private clients.

Building Regulations

There are three main types of regulation that affect innovation in construction: technical regulations regarding products and processes; planning and environmental regulations; and labour market regulations.[44] These regulations are intended to address public issues such as health, safety and the environment.

New regulations can be used to raise the standard of construction, both in terms of its products and its processes, and thus to promote "successful" innovation in a public, if not a private (e.g. client) sense. They can be used to raise demand for "high-performance emerging technologies", such as clean technologies, as was the case in the 1990s.[45]

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[40] Gann, D. et. al. (1992) *op. cit.*
[41] Slaughter, E.S. (1993) *op. cit.*, and Atkin, B. (1999) *op. cit.*
[42] Atkin, B. (1999) *op. cit.*
[43] The choice of contracting system is partly an issue of risk management. Whereas British housing projects, for example, are governed by a risk-shedding, cost-reduction system, French housing projects are governed by risk-sharing, cost-control system. See Winch (1996) *op. cit.*.
[44] Gann, D. (2000) *op. cit.*
[45] Gann, D. (2000) *op. cit.*

The approach to regulation can also affect the model of technological innovation. Some performance-based regulations, for example, consider buildings as whole systems. This approach allows for trade-offs between component parts, which promotes systemic innovation. However, the burden of proof is on the enterprise, which can discourage innovation.[46] In France, regulations are performance-based and compliance is the responsibility of the construction enterprises. In Germany, regulations are prescriptive and compliance is the responsibility of the state.[47]

Business Support

The capabilities of construction SMEs impede their ability to adapt their practices and strategies to new challenges and to exploit new opportunities. They also act as a constraint on the widespread promotion of successful innovation in construction SMEs. Training, support for RTD and technology acquisition, and various other measures can be used to support improvements in the technological capabilities of construction SMEs. But consideration should also be given to the development of their organisational capabilities. Their limited resource base means that they may need help with risk management. Furthermore, many forms of innovation require well-functioning interactions between the members of beyond the confines of a specific project.[48] They require extra-project interaction between prospective members of the project team and the broader construction community, notably researchers, manufacturers and suppliers.

Business support has been the mechanism of choice for the CONSTRINNONET project in developing and implementing pilot actions. The next section of the report contains a qualitative analysis of business support; an assessment of its impact on construction SMEs; and identifies particular actions that could be taken to address issues of importance to construction SMEs and engage them in an appropriate way.

5 Business Support: Improvements and Successful Practice

5.1 The Availability of Innovation Support for Construction SMEs

Business support takes many forms, from "reception and referral" to "strategic measures", such as the promotion of networking. According to the Commission of the European Communities (2001), there are eight main forms of support: reception and referral; specialised types of training; information; advice and direct practical support; finance; premises and environment, and strategic measures.[49] Reception and referral includes "first-stop shops" and signposting. Information is available on such matters as legislation, markets, and standards and certification. Advice and direct support includes business planning and consultancy. Financial measures include direct grants,

[46] Gann, D. (2000) *op. cit.*
[47] Winch, G. (1996) *op. cit.*.
[48] AEGIS (1999) *Mapping the Building & Construction System in Australia* (University of Western Sydney Macarthur).
[49] *ibid.*

subsidised loans, loan guarantees and initiatives to make venture capital more readily available. Premises include incubation units, business units and technology parks. Strategic measures include conferences and seminars, promotion of networking, supply chain development and cluster promotion.

Most (if not all) of these measures can be used to promote innovation in some way, either project-specific, problem-solving innovation or innovation in the capabilities of a firm. They can support technology acquisition, research and technological development, the identification of market opportunities, and training as part of a construction project. Many measures can also be used to help construction SMEs develop their business and respond effectively to challenges. Training can be used by contractors to help them respond to changes in the technology and management of construction; financial measures can be used by engineers to develop their services; networks can be used by architects to identify business opportunities; consultancy can be used by surveyors to develop a web-site; information on legislation, markets, standards and certification can be used by the manufacturers of building materials, components, and equipment to identify opportunities for new/improved products; and premises can be used by researchers to develop new construction technologies.

Business support is supplied by a variety of business support organisations. These organisations are public, semi-public or private; some of them are government departments, while others are government agencies, with varying degrees of independence. To a large and increasing extent, business support is provided by private agents, either on a direct contract with the public authorities or within a framework established by a public programme or initiative (e.g. Innovation Relay Centres). Often the provision of business support, as defined previously, is only part of their responsibilities.

The partners of CONSTRINNONET are all business support organisations of one form or another. BBRI is a private research institute, offering R&D in the field of construction. It implements several special measures to foster the transfer of technology and promote innovation in the construction sector, including TADs (technology advisory services). VTT is the technical research centre for Finland. Its Building & Transport division aims at improving the international competitiveness of companies in the building sector, promoting better maintenance of the building stock and creating a high-quality living and working environment based on sustainable development. It offers research, RTD and testing services, consulting and training in the field of building technology, and is actively supporting national and EU technology programmes. Paragon is a private firm of specialist RTD consultants. They have participated in a number of EU RTD-projects since their inception in 1994, which have involved the transfer and dissemination of knowledge and technology from Universities and Research Institutes to Industry. CARSA is a private firm of consultants, operating in the areas of innovation, technology and internationalisation. It has managed a number of public programmes to improve the technological capacities and competitiveness of enterprises. The Research Institute for the Built and Human Environment at University of Salford undertakes theoretical and applied research for various government departments, which is used to help construction enterprises. It hosts the UK EPSRC (Engineering and Physical Sciences Research Council) Centre of Excellence for Research and Innovation in the Built Environment (SCRI) and two enterprise centres, Construct IT and Centre for Construction Innovation, all of which provide business support for construction enterprises based on a

number of EU, national and regional public policy initiatives. Vilnius Gediminas Technical University is one of the largest and most important universities in Lithuania. Its Department of Construction Economics and Property management has strong links with industry and has participated in many FP5 projects.

The public policy initiatives behind business support come (and go) thick and fast, driven by the need to realise various and evolving public policy objectives in an ever changing world. Some of these are aimed explicitly at innovation, some at construction, some at construction SMEs, and some, occasionally, at innovation in construction SMEs.[50] Some of these initiatives provide the basis for measures that can be used to support innovation in construction SMEs. For example, the EU's 6th Framework Programme for RTD can be used to support collaborative research. TEKES, the National Technology Agency in Finland, is implementing eight national technology programmes, any one of which could be used to support innovation in construction SMEs. The UK's Small Business Service comprises numerous services with applications to construction. The Belgian government has set up a construction-specific advice centre, which is being administered by BBRI. In Greece, there are programmes of support for sustainable construction.

5.2 Successful Practice and Improvements

An assessment of support for construction SMEs

Although many individual construction SMEs can testify that the provision of business support in one form or another has helped them to innovate: to create knowledge, develop knowledge and/or implement existing knowledge,[51] our research suggests that European governments and their agents have generally failed to engage with the vast majority of construction SMEs in crucial areas such as RTD and business development. For example, our research reveals that many Belgian SMEs are unaware of RTD support; that science & technology programmes have failed to engage with Lithuanian SMEs; that there is a lack of co-operation between research centres and SMEs in Belgium and Lithuania; that the cost of applying for RTD funds is prohibitive in many regions; that there is a lack of funds for business promotion in Lithuania; that UK contractors make little use of small business services; that there are too many initiatives in the UK; that there is little support for construction SMEs in Greece and Spain; and that there is a lack of information about measures and initiatives.

Our research also suggests that, to some extent, this failure to engage represents a fundamental failure to address the key innovation issues of construction SMEs: namely, their motivation, and their capabilities (technological and organisational). For example, our fieldwork reveals that many SMEs are unable and unwilling to invest in RTD; that many are unwilling or unable to "think outside the box"; that, in contrast to large firms, many small firms lack the resources to invest in RTD; that SMEs lack the technological and organisational capabilities required to implement certain forms of innovation (e.g. radical and systemic) or to make use of advanced knowledge (or practices); that many SMEs do not do research; that many do not have an "enterprise culture"; that the cost of RTD is prohibitive; that

[50] For example, CENTREX (Centre d'information sur les produits at process innovations dans la construction) was created to support construction SMEs in Aquitaine, France.
[51] See *Annex A2.0*

project-based SMEs fail to retain knowledge; and that the business strategy of many SMEs is "impulsive".

These findings are supported by our general analysis of innovation in construction SMEs, which showed that the motivation and ability of SMEs to undertake certain types of innovation is limited by their resource base, capabilities, and the circumstances of construction (e.g. contracting system; general direction of policy).

Addressing Outstanding SME and Business Support Issues

Policies to improve the performance of construction SMEs need to understand and actively manage differences between construction SMEs and large firms, differences between construction firms and non-construction firms, and differences between different types of construction firms if they are to realise a step change in the performance of construction. In other words, they need to address issues of importance to construction SMEs and engage them in an appropriate way.

Business support organis ations with a background in construction are in an ideal position to do this: to address issues of importance to construction SMEs and to engage them in an appropriate way. These organisations should be encouraged to network with each other and with other organisations, across Europe. The networks could be used by business support organisations to exchange information on appropriate business support measures, modes of delivery, and policy initiatives, which could then be fed back to policy-makers. They could also be used by business support organisations to deliver more and better services to their existing clients: for example, by identifying regulations in prospective markets, and supporting international collaboration between SMEs and research organisms.

To some extent, networking between business support organisations is already happening at a regional level. In the UK, for example, various agencies in North-West England have been working together on various matters of importance to construction SMEs. With the initial support of the Department of Trade and Industry, Chamber Business Enterprises (Manchester) and the Construction Industry Training Board have been working together as the Manchester Construction Partnership to provide appropriate business support for construction and construction-related SMEs: including training and relevant small business services. The Centre for Construction Innovation has been working together with the Construction Best Practice Programme to deliver tailor-made solutions to best practice problems in the area of technological and organisational development.

A series of conferences were organised during the pilot action phase of the project to explore the scope for creating a European network of business support organisations dedicated to improving the quality of business support for construction SMEs. They concluded by identifying the key issues: the added value of the network; the focus and scope of the network; the development of the network; and the development of a project proposal. At the time of writing, the proposal had stalled on the question of who would champion it. However, there are encouraging signs that governments may be willing to are prepared to support such initiatives. In Greece, the Ministry of Development has recently launched an initiative to develop and network the providers of technology transfer and innovation services that within Greece and beyond.

Aside from identifying the general problem with business support, our research has identified and acted upon a number of issues of importance to specific construction SMEs and specific business support organisations. Extending an SME's resource base (organisational capability); raising SMEs awareness of RTD support; and providing SMEs with a single regional entry-point to European and other science & technology measures were three issues on which the CONSTRINNONET project took action.

Extending the resource base

In contrast to large firms, SMEs tend to have a limited resource base (a tighter economic constraint). This means, for example, that many do not have enough time or funds to develop their technological and organisational capabilities, even if they have the motivation to do so. Initiatives and measures to support construction SMEs in areas such as business development should therefore help to leverage that resource base, rather than divert resources from other uses; to develop external linkages that overcome the lack of internal resources, rather than demand matched funding from industry, as in the case of many collaborative research programmes. Our fieldwork threw up numerous examples of successful networking schemes for construction SMEs: construction best practice clubs; and networking clubs intended to improve managerial capabilities of building firms. These initiatives promote learning, and therefore help SMEs to make the necessary step changes in their technological and organisational capabilities – to "think (and act) outside the box" – that their environment may demand.

The development of a particular type of networking mechanism was explored by VTT during the pilot action phase of the project. Known as the "Idea Factory", it envisages the development of specific technology projects between members of a regional network, encompassing construction SMEs and business support organisations.[52] This kind of initiative is part of an increasing trend that has seen business support organisations working with groups of enterprises, and in ways that approach those of economic development agencies.[53]

Raising awareness

Our research suggests that many government initiatives to promote innovation have simply failed to engage construction SMEs. It reveals, for example, that many construction SMEs are unaware of innovation support; research centres fail to communicate with construction SMEs; there is little co-operation between SMEs and science & technology institutions; science & technology programmes have failed to engage with construction SMEs; there is a lack of information about measures and initiatives; and there are too many initiatives. In short, it suggests that the implementation of advanced knowledge is being checked by a failure to connect construction SMEs with the research community.

Business support organisations can play an important role in developing awareness of programmes and bringing together construction SMEs with the relevant members of the research

[52] For further information, see *WP2 D2-2*.
[53] Commission of the European Communities (2001) *op. cit.*

community. The ideal broker varies, but building research institutes, professional associations, universities and standards bodies are good examples for construction. Likewise, the ideal transmission mechanism will vary, but conferences and similar brokerage events offer obvious advantages, enabling the broker to broadcast information about programmes and support, and provide an environment for collaboration.

CONSTRINNONET organised a number of brokerage events throughout Europe: notably, Belgium, Greece and Spain. The events raised awareness of the Sixth Framework Programme for RTD (FP6) and various other European, national and regional initiatives. In addition, the project produced a number of guidelines for good brokerage, taking into consideration issues of importance to SMEs.[54]

Providing a single-entry point

The limited resource base of construction SMEs and the general failure of business support organisations to engage with construction SMEs suggest that immediate and basic access to EU and national support may be helpful. This idea has been explored and developed by the project, and a technology implementation plan has been produced.[55]

6 Conclusions: Main Points and Policy Recommendations

This report is based on the output of WP1. It has outlined the research methodology of WP1; discussed issues arising from the field study; presented a general perspective on the problem of promoting innovation in construction SMEs; and identified areas for improvement in business support. The aim of this section is to summarise the main points of the report and to draw general policy implications and recommendations.

6.1 The Main Points

The main points of the report are contained in Sections 3-5. Section 3 discussed issues arising from the field study interviews with key stakeholders on three main subjects: innovation in construction SMEs; mechanisms behind successful innovation in construction SMEs; and ways to spread and support the use of those mechanisms. The issues were highly case-specific, reflecting the exploratory and action-oriented nature of the research, and revealed considerable disagreement on the correct definitions of the fundamental concepts and, accordingly, the best ways to promote innovation in construction SMEs

Sections 4 and 5 put these differences into context. They defined the key concepts in broad terms; described the innovation terrain (the construction of the built environment); analysed the concept of innovation in construction SMEs; identified the main mechanisms behind successful innovation in construction SMEs; and assessed the impact of business support on construction SMEs.

[54] See *WP2 D2-2.*
[55] See *WP2 D2-2*

Section 4.2 defined the key concepts thus:

- The construction industry is the set of enterprises that produce the built environment.
- A construction SME has 0-250 employees.
- Innovation in construction refers to "the commercial application of existing knowledge in a new context", and has three main forms: technologically new/improved buildings and infrastructures; technologically new/improved construction processes; and non-technological improvements in the organisation of construction.
- Innovation in construction SMEs refers to project-specific innovations and improvements in general capabilities.
- Business support refers to "those measures, originating in public policy initiatives, that aim to help enterprises or entrepreneurs successfully develop their business and respond effectively to any challenges"

Section 4.3.1 described the main features of the innovation terrain: products are fixed in space; products are generally commissioned or made to order; the project team is a temporary alliance between independent organisations; construction take place within a specific-socio context; and the organisation of construction is complex, involving interaction between many different organisms.

Section 4.3.2 identified models of technological innovation in construction, modes of innovation in construction SMEs, and raised issues about the willingness and ability of SMEs to innovate. Five models of technological innovation in construction were identified: incremental, radical, modular, architectural and systemic. Distinctions were made between the content of the technology, its interaction with other technologies and systems, and the process of innovation. In some cases, the process is simple, involving little negotiation with other actors, in others it is complex. A supplementary distinction was made between levels of knowledge embodied in the technology: from standard practice, through best practice, to advanced knowledge. It was observed that the type of innovation and, thus, the role of construction SMEs depend on the demand for innovation, the corresponding method of procurement, and the capabilities of construction firms.

Two modes of innovation in construction SMEs were identified: project-specific and business improvement. It was observed that business improvement is motivated by 'survival', 'stability' or 'growth', and that the motivation depends on the circumstances: in particular, a general change in building regulations and procurement methods may require SMEs in general to raise their level of performance with implications for supply of and demand for business support.

It was reported that innovation is not typical in firms, but on collaborative projects. In the case of SMEs, this relative aversion to business improvement was explained by their limited resource base, compared to larger firms. An aversion to innovation is also apparent in the area of collaborative projects. The limited resource base of construction SMEs means that they are less willing and able to undertake radical and systemic innovation than, say, incremental and modular innovation. This has self-reinforcing and knock-on effects. It suppresses the demand for innovation and this in turn reduces

the demand for RTD and other 'pre-conditions' for advanced project-based innovation. More to the point, it affects the direction of technological and organisational innovation, moving it toward modular technology and pre-fabrication (mass production, and bespoke).

In summary, the analysis in Section 4.3.2 demonstrated that innovation is a common feature, and thus a common activity of project-based construction SMEs. The key issue for policy-makers is not whether innovation takes place, but what type of innovation takes place: Will innovations in construction enable the economy to be more successful? And, What can be done to promote an appropriate step change in the performance of construction SMEs?

Section 4.3.3 examined the mechanisms behind "successful" innovation in construction SMEs. It identified three main mechanisms: the contracting system; building regulations; and business support. It showed that the contracting system can be used to determine the model of innovation in construction and thus the nature of project-specific innovation in construction SMEs; that building regulations can be used to raise basic standards; and that business support can be used to help improve the general capability of construction SMEs to innovate. It suggested that a package of measures could be developed to raise performance in construction SMEs, utilising all three mechanisms.

Section 5 contained a qualitative analysis of business support, and an assessment of its impact on construction SMEs. It was observed that government and their business support agencies have generally failed to address issues of importance to the majority of construction SMEs and to engage them in an appropriate way.

An account of the CONSTRINNONET project's pilot actions was also presented. This covered action to address the general failings of business support and actions to address specific issues: namely, the limited resource base of construction SMEs; SME awareness of RTD support; and combinations thereof.

6.2 Policy Implications

Policies and policy measures to promote innovation in construction SMEs directly through business support need to address issues of importance to construction SMEs and engage them in an appropriate way. Business support organisations with a background in construction are in an ideal position to do this: to identify issues of importance and to engage them in appropriate ways. These organisations should be encouraged to form networks with each other and with other organisations, across Europe; to exchange information on best practice; and to feed it back to policy-makers. An on-line service would support the storage and exchange of useful information on best practice and related matters.

Attention should also be given to the development of measures that address specific issues of importance to construction SMEs. SMEs have a limited resource base. Measures to support construction SMEs should help them to leverage their resource base, rather than act as a drain on resources by requiring matched funding, as in the case of many collaborative research projects. The

development of regional networks of construction SMEs and business support organisations is an appropriate mechanism for leveraging resources.

Support for brokerage activities would help to improve SMEs awareness of support and their awareness of potential collaborators. Support for a single-entry point system would help to engage construction SMEs, and overcome their resource constraint, by providing immediate and easy access to EU and national support.

There are no simple solutions to the complex problem of promoting innovation in construction SMEs. The solutions to the problem, as for similarly complex problems in the field of construction, require well-functioning interactions between stakeholders. This in turn requires joined-up thinking on the part of governments in terms of policy development, and a flexible multi-initiative, multi-agency approach in terms of policy implementation. It requires strategic and tactical innovations in the system of support.

Moreover, if the capabilities of the various stakeholders are improved, the possibilities for step changes in the performance of business support will be improved. Improved policies and measures would help in that respect: in particular, more attention should be given to improving the capabilities of site-based SMEs. Support for advances in construction knowledge is of little help in the pursuit of better buildings and better infrastructures, if the knowledge is not implemented. Innovation is a means to an end; and advances in research and technology development are only one part of that process.

Contents of Annexes (Presented on CD media - attached)

A1.0 Innovation Policy and Practice: Reports

Belgium

"Belgian Public Policy & Policy Instruments"

"Construction Research in Belgium"

"Innovation Studies in Belgium"

Finland

"Public Policy and Policy Instruments in Finland"

"Services Available to SMEs in Finland"

France

"Studies of Construction Innovation in France"

Greece

"Innovation Policies in Greece"

"Studies of Construction Innovation in Greece"

"Report on the Innovation Environment and Processes in Greece"

"Report on Programme TECHNOBROKERAGE: Development and Networking of Service Providers on Issues of Technology Transfer and Innovation"

Lithuania

"Public Policy and Policy Instruments in Lithuania"

"Support for Innovation in Construction SMEs in Lithuania"

"Short Background Information about the Innovation System in Lithuania"

"Studies of Innovation in Construction in Lithuania"

"Development of the Innovation Decision Web-based Support System"

Spain

"Support for Innovation in Construction SMEs in Spain"

United Kingdom

"Public Policy and Instruments in the UK"

"Support for Innovation in Construction SMEs in the UK"

"Studies of Innovation in the UK and Elsewhere"

A2.0 Case Studies of Innovation in Construction SMEs

Belgium

"Recycling of Stainless Steel Slags"

"The Development of an Acoustical Wall Ventilation Grid"

Finland

"LIFA AIR Ltd."

"Specifinn Oy"

"XTec Oy"

France

"Diese Telecom"

"André Mestdagh"

Greece

"DEKA"

"ISORAST"

Lithuania

"Eternit Akmene"

Spain

"Servicios y Obras Canarias S.A."

"TRAMAT"

United Kingdom

"Richards, Moorehead & Laing"

"Xetal Consultants"

"Marshall Architects"

"Contract Services".

A3.0 Additional Material

Bibliography