

Competitiveness

Working Group on e-construction, Phase II

2001 - 2003

Final Report

Executive summary

The second phase of the Information and Communication Technologies Working Group (ICT WG) for the European construction industry began in Spring 2001, focusing on the development of innovative ICT applications for all stages of the construction process and between them, with a special emphasis on accessibility for SMEs. This group was given the name "Working Group on e-construction".

To evaluate the current situation in the industry and identify areas of future development, the working group undertook a review concentrating on seven thematic areas:

1. e-Collaboration and project centres
2. e-Learning
3. Business to Business (B2B)
4. Business to Administration (B2A)
5. Business to Consumer (B2C)
6. Facilities and Services Management
7. Legal aspects

As the outcome of this review exercise, five needs were identified that should be addressed by future initiatives:

1. To promote and drive forward the further development of user-friendly, cost-effective ICT solutions for the construction industry.
2. To drive forward the development of shared standards for design, materials, and business exchanges in the construction industry, as a pre-requisite for effective e-collaboration and e-Business.
3. To set up an effective e-Learning programme for the sector in order to overcome the ICT skills gap, which particularly affects SMEs.
4. To work closely with governments and administrations in setting up innovative B2A applications Europe-wide.
5. Legal, transactional and authentication aspects on information sharing, responsibilities and copyrights are all fundamental issues which must be progressed, as few will incorporate B2B, B2A, B2C, etc without the necessary legal backing. (e-legal must be defined, implemented and used).

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1. Background

The Information and Communication Technologies Working Group (ICT WG) was formed in late 1998 as a voluntary group from industry bodies and Member State representatives to support the development by the Commission of an action plan to increase the competitiveness of the European construction sector.

In its first phase the theme of the ICT Working Group was “*Information Technology as an Enabling Tool in the Construction Sector*”. The group sought to identify productivity gains that could be achieved in the construction process through ICT, whilst becoming increasingly aware that the small and medium-sized enterprise segment of the sector was lagging behind in awareness and willingness to exploit new technologies. Concrete ideas for action were developed and a four-month time scale established for work to be carried out.

The final report was published in June 1999, and the assessment of the first phase was presented to a tripartite meeting of Member States, the European Commission, and Industry in October 2000. It was subsequently decided that a second phase Working Group should be established. This would focus on ICT application throughout the construction process, with special recommendations for small and medium-sized business.

2. Terms of Reference

The first meeting of the group was held in Berlin on 7th February 2001 in the context of a major construction industry event. During this meeting the group discussed and adopted the following terms of reference for its activity.

“To evaluate the existing situation in e-Construction on the basis of e-commerce technologies, e-collaboration and knowledge technologies, including e-learning and to provide recommendations on how to develop and to exploit it”.

In order to carry out this evaluation, the group decided that they should carry out a review on the basis of selected themes. In contrast to the first phase, in which a considerable contribution was made through canvassing the views of non-specialist industry practitioners, it was decided that in Phase II, industry specialists should be invited to make presentations on developments and applications relating to the given themes. Originally, the key themes for review were defined as:

- e-Collaboration through using project centres
- e-Learning and knowledge management linked to the construction process
- e-Procurement and B2A (Business to Administration)
- B2C and B2B: customer relationship management (end user) and business to business items such as auctions (supply chain management)
- Facilities and services management
- Legal aspects related to transactions and authentication and information sharing between partners in projects, their individual and joint responsibilities and their individual and joint rights to work results.

3. Competitiveness

The construction sector is the largest industrial employer in the European Union, with a GDP contribution of around 10% and a global employment rate of 20% (including multiplier effects). Through its provision of basic infrastructure, e.g. buildings, networks of energy- and water- supply, telecommunications networks, waste management facilities and transport networks, it constitutes the backbone for many other social and economic activities.

The global economic importance of the sector, however, is largely underestimated, because of the perception of construction activities as “local”. The global competitive position of European industry and services is heavily influenced by the quality of the buildings in which they operate – the cost of the building, the efficiency of production plants, energy consumption and maintenance costs, worker productivity etc. The quality of transport-infrastructure is also essential for all industries. In other words, the construction sector represents an important overhead cost within the overall production costs of other industrial sectors.

The sector has an important social dimension and bears directly on the well-being of European citizens. For example, it can make a significant contribution to sustainable development, as it is a major consumer of primary raw materials and energy, and more than 30% of the global CO₂ output currently has its origin in the energy consumption of buildings.

On the other hand, the sector is characterised by a large degree of structural fragmentation. Different tasks within the construction process are realised by a multitude of independent partners using varying logistics. A further characteristic is the existing multitude of standards, technical specifications, labels and certification marks as well as the diversity of local, regional and national legislation and regulations. 90% of the sector is constituted by SMEs, most of them without ICT-qualified technical staff. The shortcomings in effective knowledge transfer and training are well known weak points. This structural fragmentation is the main cause for the sector’s low productivity, its low degree of innovation and relatively poor image.

Behind the scenes of today’s construction site, e.g. of a building or of a bridge, is a consortium of individual contractors that use different software applications, characterised by poorly integrated electronic information handling. In contrast to this, e-commerce technologies can significantly contribute to increased transparency, productivity and competitiveness, as already demonstrated by other sectors. Their contribution to construction is expected to be even more dramatic, due to the fact that they would act as a catalyst for integration within the sector, Such integration was already present in those other sectors before the breakthrough of the Internet.

4. Needs and challenges relating to the seven thematic areas

The working group considered needs and challenges arising in each of the seven thematic areas, in order to identify problems to which ICT could provide innovative solutions.

4.1 e-Collaboration and project centres

Problem: Co-operation and knowledge-sharing in the European construction industry is limited to date, and hampered by the scarcity of shared information standards. This contributes to cost and time overrun in construction projects due to errors and miscommunication.

ICT contribution: The establishment of project centres represents the beginning of a new way of working in the construction sector, allowing project partners to exchange information in digital form. However, effective collaboration in the construction sector ultimately depends on the development of shared industry standards such as Industry Foundation Classes (IFCs). IFCs aim to establish a 'common language' for the planning, construction and facilities management industries by providing an agreed specification of objects used in building projects. IFCs enable information sharing across software applications, and in this way have the potential to generate significant cost reductions and efficiency gains by enabling the multiple re-use of information and models for different purposes and the opportunity to collaborate in a virtual organisation. The further development of standardisation efforts in the field of IFCs and their integration in project centres or other e-collaborative software applications must therefore be considered as a major priority. In this context, particular attention must be paid to the accessibility of software interfaces for SMEs who act as subcontractors to larger companies.

It is also vital to be able to support collaboration when innovation is concerned, describing innovative concepts, designs and products, in a standard manner that can be communicated unambiguously. The use of 3D models has started. However, their use is limited to situations where a project co-ordinator is responsible for most of the construction process. The issues are related to soft and technical obstacles / barriers.

4.2 e-Learning

Problem: There currently exists a shortage of ICT skills in the construction sector, particularly among SMEs. These skills are essential for knowledge-transfer through the use of e-learning.

ICT contribution: e-Learning has the potential to make specialised education and professional and vocational training more accessible to SMEs in terms of affordability and availability. The learning process can be enhanced by the provision of interactive course material and tests that aid effective learning, and by helping individuals keep abreast of cutting-edge industry developments. To fully realise its potential, an e-Learning programme will have to be designed to the highest standards, both in terms of content and the technological platform.

4.3 Business to Business (B2B)

Problem: The construction industry fails to profit sufficiently from ICT, despite its rapid development. There is a huge untapped potential for productivity gains in the field of B2B interactions.

ICT contribution: ICTs can greatly enhance the quality and efficiency of B2B collaboration in the construction sector, e.g. by enabling quicker data transfer, advanced visualisation, and faster alterations during the planning process. Four areas of potential B2B use stand out:

- B2B exchange in the design process (digital sharing of design information),
- concurrent engineering (virtual collaboration in the engineering process),
- “Design2Procurement” (converting design requirements to object specifications and classifications to facilitate procurement),
- B2B on the supply side (contractors and suppliers engaging in e-Commerce in relation to specific products and services), and
- integrated B2B on the demand and supply side (co-ordinating project management and product supply in the building process).

On the technical side, an important factor in developing such applications is reaching agreement on object specifications and translations through a variant of XML designed specifically for the construction sector. The key to successful development and uptake of B2B is a strong commitment by industry to adopt open solutions based on simple and standard procedures that are accessible to SMEs as well as large companies.

The integration of product information from the supply side into the design process brings benefits to both parties: quality of design and construction can be improved by better information, while suppliers can have influence earlier in the project’s life cycle; manufacturers can anticipate new trends and demands.

4.4 Business to Administration (B2A)

Problem: B2A interactions in the construction sector are still in their infancy. For example, public tendering through the Internet is so far limited to regional level pilot applications despite the fact that national, regional and local public authorities are major clients of the construction sector. This increases the administrative burden on construction firms.

ICT contribution: There is a considerable need for e-Government solutions, such as digital building permissions, online tendering, online accessibility of building regulations, compliance to standards, and technical certification. Applications of this kind could make the construction process considerably more efficient, but initiatives to date are dispersed and show a lack of co-ordination. An example of the possibilities in this area is provided by the German MediaKomm project, which deals with digital building permissions in the municipality of Esslingen. This project aims at creating an entirely digital workflow between architects, engineers and local government administrators on building and construction issues, including certifications via electronic signatures.

Several documents related to public procurement are going to be replaced by electronic media. The European Commission, for example, has already stopped issuing its Official Bulletin and continued publishing the complete information through the electronic data system called SIMAP (Système Informatique du Marché Publique, <http://simap.eu.int>). Hence the EU-Service Directive (Directive 92/50/EEC of June 18th 1992) has been altered in such a way that the transfer of an offer is no longer accepted in writing only but also “by other means” - i.e. also by electronic means. However, it is not determined that a valid digital signature in the sense of the signature law is also a legally-binding signature.

If public authorities implement an e-tendering process, in addition to advantages for companies (time-saving and simplifying procedures), the introduction of B2A applications such as electronic tendering would foster the introduction of ICT in the sector. However, it is acknowledged that some intellectual and creative services, for example in architectural design, cannot be defined by electronic means alone.

4.5 Business to Consumer (B2C)

Problem: It is well known that the sector is characterised by deficiencies in matching the client’s original expectations with the final product. These have their origin in several discrepancies in the construction process - the client’s wishes and their interpretation by all those involved in the design process and their interpretation in production and delivery. These discrepancies could be reduced by a closer interaction between construction professionals and consumers throughout the building process.

ICT contribution: ICT can enhance B2C interactions in the construction sector by improving consultation and feedback between all relevant parties throughout the design and construction process. Possible applications include detailed 3/4D-animations and 4D of a construction project to enable a better “understanding” on the part of the client of the final product, and interactive client involvement to enable planners to make adjustments as the project develops. Two examples of this are:

- a) The construction of the William Gates building for the computer science department of Cambridge University tracked end-user needs through an interactive website and integrated 3D-presentations of the developing building.
- b) The property and land development company Amstell and Ontwikkeling (AO) runs an interactive housing development web site to monitor customer preferences in real time, to evaluate and adjust products, to reduce market risk, and to establish commitment: from buyers, the neighbourhood, municipal authorities, and other stakeholders.

The replacement of physical scale-models by accurate virtual models offers advantages such as interior view, effect of light and design adaptability. Those advantages are not limited to client and consumer, but offer potential benefits to all partners in the construction process.

4.6 Facilities & Services Management

Problem: Facilities and services management is a fast growing specialisation within the construction industry. Finding ways to reduce overhead costs and create value for the customer are major challenges for which information support is crucial. There is also a growing awareness that from the outset facilities management should be an integrated part of the construction process.

ICT contribution: ICT can contribute to meeting these challenges in two main ways. Firstly, by reducing the current split that exists between software tools dedicated to building design or construction (e.g. CAD tools, project management tools, etc.) and FM-focussed software tools such as CAFM (Computer-Aided Facilities Management), helpdesk applications, e-tendering for building services (via the internet), and e-benchmarking.

Secondly, by improving knowledge and know-how regarding exploitation of properties and facilities, by means of process and information modelling based on standards such as IFCs, XML, lexica. These must allow one:

- to better describe and retain the information on facilities and properties (administrative, economical, quality of usage and health dimensions, etc.)
- to trace, measure and assess maintenance and refurbishment operations resulting from design choices, and which therefore influence future technical choices for design, or selection of materials, especially in the context of sustainable development.

Those developments could stimulate a more efficient and wider implementation of facilities management in the construction sector.

4.7 Legal aspects

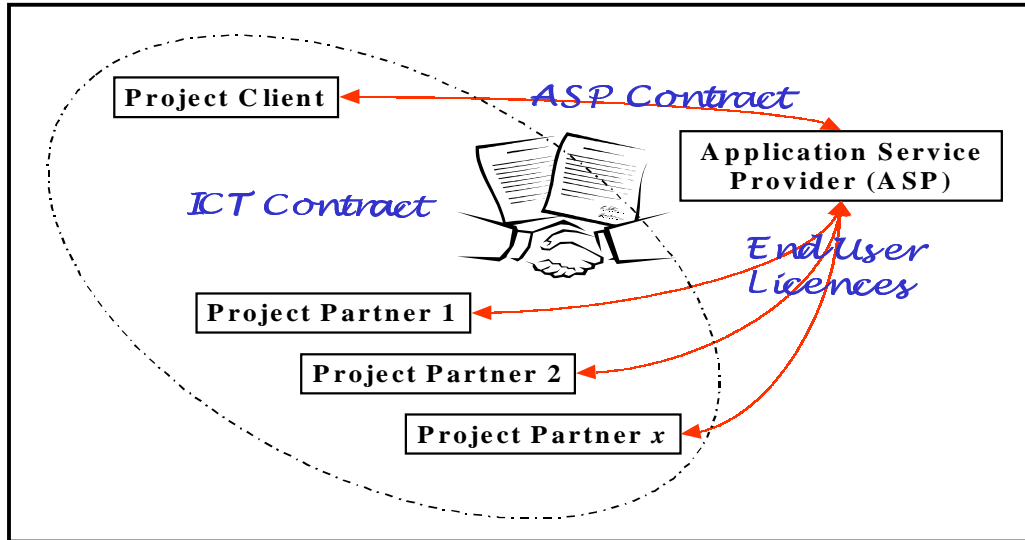
Problem: The construction industry is heavily reliant on communications, within and between inter-networked organizations, support of Internet ASPs (Application Service Providers), ownership of information, access rights, company or project information and legal status of data objects such as used in-IFCs.

ICT Contribution: As ICT led to potential legal problems, it can also offer the solution through the provision of a framework for specifying legal conditions and contracts to enable a legally admissible use of ICT in construction projects. An ICT based solution already offered by the eLEGAL IST project (IST-1999-20570) can dismantle these legal barriers. This is mainly composed of:

1. An XML based contract editor (using pre-defined contract templates) which includes a library of ICT-related clauses, covering such issues as data protection, security, agreed data formats, etc.
2. The eLEGAL Contract Wizard which uses a Meta Model and filters to offer the user an appropriate set of clauses for their ICT-related contract drafting, which can then be incorporated into a contract within the Contract Editor. This assistance is provided by predefined rules, which define the dependencies between different clauses in the library

- The Virtual Negotiation Room which is an Apache Tomcat based management system for contract information. The application provides information on contract status, potentially encouraging the idea of ASPs offering legal support for e-contracting. An interesting feature of the system is the possibility to approve or confirm separate pieces of contracts by digital signature, which also supports iterative negotiation logic in electronic meetings.

An example of a solution for overcoming legal issues of ASPs is shown below:



ICT can also contribute to avoiding legal disputes by deploying appropriate security mechanisms for electronic exchange of information and documentation. Examples of such mechanisms are: digital signatures, biometric systems, Certification Authorities and digital notaries.

ICT can also be deployed to monitor the flow of electronic information and documentation to ensure that they meet a predefined level of legal validity (e.g. within an ICT contract) security (e.g. digitally signed) and trust. This could be achieved by imposing the necessary rules on all electronic transactions in collaborative platforms.

5. Conclusions

A number of conclusions can be drawn from this thematic analysis.

5.1 Promote ICT uptake by industry, in particular small and medium sized enterprises

It is clear that ICTs have the potential to improve processes and solve specific problems in the construction sector. There are a number of innovative ICT applications currently emerging, among them virtual design and engineering, e-Commerce in the supply chain, consumer-focused construction processes, and electronic facilities management. In many cases, however, these are still at a very early stage of development. In addition, it is particularly important that new applications are taken up by SMEs, which means that the focus has to be on making them more user-friendly and cost-effective.

Recommendation 1:

The continued development of innovative ICT applications and their take-up by industry, in particular SMEs, should be promoted vigorously.

Possible actions:

- 1) The availability of innovative applications and their potential business benefits for SMEs should be vigorously communicated by industry federations and associations in order to raise awareness and stimulate demand. This could be done through demonstration projects, or by creating flagship awards for SMEs who pioneer the use of new technologies in their business.
- 2) Industry should investigate and implement measures to assure a direct and immediate tangible benefit for SMEs that use ICT.
- 3) Industry could collaborate with software vendors in setting up a basic 'ICT toolkit' for construction SMEs free of charge, with the aim of increasing familiarity with the technology and stimulating future demand.
- 4) The European Commission's eEurope 2005 initiative promotes ICT research and take-up projects for SMEs. Its approach is to stimulate secure services, applications and content based on a widely available secure broadband infrastructure, making use of multiple platforms, such as PC, digital television, mobile terminals, aiding competitiveness by encouraging benchmarking based on a few key indicators. EU candidate countries have their own action plan called eEurope+2003. Key areas within eEurope 2005 are: e-Government, e-Health, e-Learning, e-Business, Secure information Infrastructure and Broadband. eBusiness applications for SMEs is one of the priorities, and active participation of the construction sector under this initiative could be explored.

- 5) Administration, as the principal client in the construction sector (particularly in Civil Works), and large contractors should act as innovation drivers of SMEs, as major clients do for other sectors.
- 6) Raising awareness of the problem within the EU to establish workshops between planners, contractors; designers; facility managers, manufacturers; suppliers and legal professionals to define the problem and to find solutions.

5.2 The need for standards

A key factor for increasing the use of ICT in construction which has emerged very clearly is the importance of establishing shared information standards, since these form the basis of effective e-collaboration practices, B2B exchanges, and B2A/public tendering procedures. However, a range of technical problems remain to be solved (e.g. concerning the definition of IFCs, the development of 'lexica' which provide a framework for information exchange on building materials, and the creation of a uniform variant of the XML internet language for construction).

Whilst there has been considerable development in IFCs the fields they cover at present are mostly components of the building industry; but not really the tasks of the construction process. There are almost no objects linked to civil engineering works and structures, nor linear infrastructures (railways, pipelines) which often also use GIS standards. It is pertinent that IFC is not fully co-ordinated with classification systems including the ISO 12006-2 standard "Organisation of information about construction works", but it is essential that IFCs accommodate multiple classification systems.

Recommendation 2:

The development and adoption of shared standards for design, materials, and business exchanges should become a top priority for the construction industry. These standards need to be sufficiently flexible to adapt to innovation.

Possible actions:

- 1) Industry should run a concerted campaign to further develop IFCs and promote their use in design, and to ensure that the construction industry requests information-sharing capabilities from software developers in order to accelerate the technological development process. IAI should pay greater attention to the development of IFCs to take into account civil engineering works and structures and non-linear infrastructures. Federations and associations, as well as major clients, can play a useful role in this context. However, attention should be paid to ensure that IFCs continue to accommodate multiple classification systems.
- 2) Industry should continue the development of multi-lingual lexica of construction terms, to support e-business including e-commerce.

- 3) Standardisation is critical for facilities management as well. The definition of an IFC relevant to facilities management should actively be pursued, e.g. on the basis of international consensus based on existing national standards, such as the Swedish FI 2002. The Commission should take the lead in facilitating its definition by a group of industrial experts; industry federations should commit to recommending its use.
- 4) An expert group should be appointed involving key industry representatives, ICT specialists and the World-wide Web Consortium to propose a harmonised XML dialect for construction IFCs. Industry federations to take the lead in organising this.
- 5) An overview of standards currently in use (materials, information-sharing, communication, business process and execution of works) in the EU Member States should be provided by an industry working group, and recommendations for European harmonisation should be provided to this working group by the EU-supported ProDAEC project (see Annexe 2) in collaboration with national and international standardisation bodies, e.g. IAI, W3C, CEN, ETSI.
- 6) The European Commission could take a lead role in this development by linking public procurement to the use of standards-based industrial processes.
- 7) In addition there needs to be a greater awareness of the potential benefits of this technology in order to stimulate the demand side.
- 8) Referring to the experience of the eLEGAL IST project (IST-1999-20570), standards should be developed with a view to their subsequent adoption by ISO in order to validate digital communication between the parties involved in the construction process. Examples of this include authentication, ownership; responsibilities; contract agreements and legal agreements.

5.3 A concerted e-Learning initiative for the sector

If new ICTs and applications are to take hold in the construction industry, there must be a sufficient number of people skilled to use them. It is therefore vital to make new technologies more widely accessible by providing appropriate training to all potential users, especially SMEs. E-learning comprising training on ICT use and vocational training should assist in raising the skills level within the sector.

Recommendation 3:

e-Learning should become an important tool for ensuring ICT is more widely used in the construction sector, specifically with respect to SMEs.

Possible actions:

- 1) Industry associations could work together with universities and training professionals to develop an effective e-Learning concept for the construction sector. In order to be flexible enough to cater to

different needs, such a concept might be organised on two levels: a first level comprising “learning fragments” related to specific problem solving queries, and a second level integrating all these “fragments” into a complete and consistent e-Learning course eventually finishing with a recognised qualification. This qualification could become a new industry-wide training standard.

- 2) This initiative could be supported by the European Commission’s 6th Framework Programme for RTD (section: “Horizontal research activities including SMEs”). For example, an e-Learning pilot could be launched in one of the Member States (or a small group of Member States), with a view to eventually extending this across Europe.
- 3) A scheme of best practice awards could be set up by industry to encourage and promote companies that lead the way in making e-Learning programmes available to their staff.
- 4) Industry to investigate how to obtain additional political profile through initiatives such as the eEurope strategy or national SME support schemes.

5.4 e-Government pilot

B2A is an important area of development for e-Construction and can act as a catalyst for the adoption of shared information standards across the industry. As public authorities are major clients of the construction sector and as the introduction of ICT can only be successful if it is client driven, public authorities can play a major role in the introduction of those technologies in the sector.

Recommendation 4:

The European Commission to work closely with Member States governments and administrations (under the eEurope2005 initiative) to set up innovative B2A applications for construction Europe-wide.

Possible actions:

- 1) The European Commission could launch an e-Government network (DG MARKT, DG ENTR-IDA Programme & DG INFSO-IST Priority in FP6) with the aim of harmonising Member State B2A pilots, promoting best practices and supporting Europe-wide actions. Possible e-Government goals could be: a) to demonstrate a fully digital public tendering and contracting process; b) to set up all public services relevant to construction online by 2005.
- 2) Industry and the public sector should undertake appropriate steps to close the gap between generic stand-alone technological offers and end-to-end secure electronic contracts management solutions tailored to the sector’s needs.

6. Action Plan

Recommendation 1: Promote ICT uptake by industry, in particular by small and medium sized enterprises

- **Proposed action 1:** A promotional campaign could be organised & financed by the construction federations & associations. The proposed award scheme could prove a very powerful tool to encourage innovation. It should be investigated whether this action could be supported by the Innovation Programme run by D G Research within the Sixth Framework Programme.
- **Proposed action 2:** The federations should reach an agreement with all major product/service manufacturers to develop direct financial incentives for on-line procurement of products/services (e.g. 1% reduction on the price of all construction-related goods/ services sold on-line)
- **Proposed action 3:** An Action Group (see details under Chapter 7) should be set up to map the relevance of existing Free/Open Source software tools for the sector and to publish the findings on-line
- **Proposed action 4:** Investigate activities foreseen aiming to stimulate the establishment and implementation by Member States and industry of actions set out in the eEurope 2005 Action Plan. The e-Europe 2005 Plan aims to improve conditions for e-business following on from the GoDigital initiative which ended in 2002.

Recommendation 2: The need for standards

- **Proposed action 1:** The activities of the Action Group proposed above, should include work on developing further and making IFCs available to the industry. This work could be combined with XML harmonisation activities and related work that was supported by the Commission on the Eurocodes.
- **Proposed action 2:** The development of model/standards-based construction engineering approach through integration of IFCs, lexica; classification systems.
- **Proposed actions 3:** PRODAEC will provide the first input to these activities that need to be followed up and implemented by an Action Group.

Recommendation 3: A concerted e-learning initiative for the sector

The actions proposed in section 5.3 above are to be carried out by industry. However, to ensure their implementation, the Construction Contact Point, set up by DG ENTR, could serve as a monitoring group. Also, the proposed action 3 under section 5.3 could be linked with first proposed action of recommendation 1.

Recommendation 4: e-Government pilot

- **Proposed action 1:** The activities to promote e-Government processes in construction, and in particular e-procurement and e-construction, should be led by the public sector. Activities and timing should be elaborated under phase III of the WG (see section 7 below)
- **Proposed action 2:** This recommendation addresses actions that should be carried out in common by the Member States and the Commission. To take these recommendations further, it is proposed to renew the mandate of the ICT WG for phase III with a renewed composition and scope (see section 7 below).

7. E-Construction Working Group Phase III

The mandate of a renewed Working Group on ICT would be twofold:

- (1) **To analyse and recommend e-Government activities Europe-wide that will directly benefit the sector (e.g. e-Legislation, e-Procurement of public construction projects, e-Licensing, e-Learning).** This will involve electronic public/private partnerships, particularly with SMEs and will aim at fulfilling eEurope 2005 objectives, thus demonstrating the sector's competence in ICT uptake and usage to achieve tangible competitiveness gains
- (2) **To monitor progress in the implementation of activities recommended by the current ICT-WG.** This will be achieved by acting as a steering group to existing (PRODAEC, ROADCON, ICCI) projects and new projects (Action Groups) that will aim at implementing the recommendations related to the use of standards, open-source modules for model-based engineering and a basic set of free/open-source affordable applications specifically targeted at facilitating a quick uptake of ICT solutions by SMEs.

Action Group I "Affordable ICT Solutions for Construction SMEs"

The aim of the group will be to map existing free/open source solutions and their usefulness to SMEs in the construction sector. Its multi-disciplinary composition could be ICT researchers, user industry practitioners, and usability experts. The activity could be co-ordinated by a European federation, and finance could be sought via FP6-IST support actions.

Action Group II "Model/Standards-Based Construction Engineering"

Although product modelling technology is considered to be important for the future use of ICT in the construction industry, and significant research on the topic has been carried out, take-up is slow.

The development of open source models for the AEC industry should be investigated: there should be a top-down model to create the overall framework. When that is established, it should be populated from the bottom up by an open-source library of product model components which may be developed collaboratively; by any interested party; without control of a single company; freely shared, modified and upgraded and loosely integrated.

The overall structure should be based on IFCs and agreed multi-lingual lexica. Together with a single classification system, this would form a coherent approach to bring into practice model/standards-based construction engineering. Any project or software house should be able to reuse the models as well as post their own, so that their product is easily integrated with others. Under such an initiative the IAI should be encouraged to place the IFCs under an open source license and thus help promote model based CAD.

This action group will encourage developers from outside Europe to contribute.

The activity could be co-ordinated by a European federation, and finance sought via FP6-IST support actions.

Annex 1: CURRENT SUPPORTING PROJECTS

The ProDAEC thematic network (<http://www.prodaec.net>)

ProDAEC, the European Network for ICT in Architecture, Engineering and Construction, aims to create a network of European companies working in the AEC sector (mainly SMEs), with the goal of promoting business partnerships, driving forward the harmonisation of European standards in AEC-related fields, and disseminating best practice in e-work and e-Business. A standardisation road map and business best practices should be ready in 2004.

ROADCON (<http://www.roadcon.org/>)

The ROADCON project aims to develop a strategic road map for RTD projects and supporting measures in the construction industry, in order to lay the groundwork for future research and development for ICT in construction. ROADCON is concerned with identifying industry's problems, needs and requirements for ICT. The roadmap will be available in autumn 2003.

The ICCI project (<http://icci.vtt.fi>)

The overall aim of the ICCI project is to enhance the co-ordination of research and developments in IST projects targeting the construction sector, the promotion of the selected projects results, and a concerted support for the future implementation and deployment of new technologies in the industrial context. The objectives are: to synthesise industrial requirements; to publish ICT state-of-the-art in the fields of technical advances and commercial offerings; to synthesise information for the integration of human, organisational and technical elements, and to provide best practice guides; to assess the latest developments in the area of legal and contractual support for the use of ICT in construction; to disseminate information and develop future requirements, strategy and implementation plans for ICT in construction

The E-CORE project (<http://www.e-core.org/>)

The Thematic Network E-CORE '*European Construction Research Network*' funded under the FP5 Growth programme has as general objective to promote the development of European networking in order to achieve a better co-ordination of RTD efforts and a more rapid diffusion of results so as to ensure that research activity generates real innovation for construction and related industries.

By bringing together and collating results from European, national and regional RTD initiatives and following a pro-active Technology Watch approach, E-CORE seeks to become the electronic reference point in Europe for obtaining information on the state-of-the-art and the status of RTD in the construction sector. Especially the project has also the objective to increase the awareness in standardisation committees on ongoing relevant RTD work. This goal should allow the promotion of the transfer of RTD results to relevant standardisation work and practice.

E-CORE further endeavours to facilitate dissemination of cutting edge technology and its implementation, to identify knowledge gaps and to advise on RTD strategies for the construction sector at the European level.

Annex 2 : A GENERALIST'S GUIDE - GLOSSARY AND TERMINOLOGY USED IN THIS REPORT

Some of the presentations given to the Working Group, for which summaries are provided in this Report, give definitions of the technical terms used. The guide below provides a general explanation of the terminology used in the Working Group – listed by themes, internet-related terminology and the more technical terminology which is related to structuring information.

ABBREVIATION OR TERMINOLOGY	<u>Full denomination – Definitions</u> <u>(WHERE APPROPRIATE, WEBSITE ADDRESS ARE PROVIDED)</u>
3/4D-animations	3D/4D animation : is concerned with the tri dimensional electronic visualisation of models (eg. Construction details, architecture, ...) with or without (interactive) movement of the object (eg. Rotation, zooming, ...). When the image is static it is referred to as a 3D representation; Generally 4D is understood to mean the model changing with time. The Latest advanced visualisation software allows the end-user to interact actively with the object, rotating or moving it at will, through standard browsers
AEC	Architectural, Engineering and Construction (AEC) Industry The AEC market covers the design, building, operation and maintenance of infrastructure assets. Within the service providers there are many different disciplines involved: architecture; civil engineering; structural engineering; construction economists; electrical engineering; heating and ventilation engineering; etc.
aecXML	Is a type of structured text data - an eXtensible Mark-up Language. The term 'aec' refers to architecture, engineering and construction. The aecXML system is designed for all the non-graphic data involved in the construction industries. It is considered to have a place alongside the IFC system. The main idea with aecXML is not only to establish some standard ways of structuring building data but also to do it so as to enable automated processing of that data as much as is practicable. Much of the data within the scope of the aecXML system is currently stored as formatted text in word processors, or as spreadsheets or databases. The aceXML system provides a set of keywords and named data attributes, so that all users will employ the same naming logic and grouping. In addition, software will be able to make use of the data without the need for interpretation by humans or of manually re-entering the required form for each programme – which is currently often the case with e.g. costing systems.
Artificial intelligence	An explicit formal specification of how to represent the objects, concepts and other entities that are assumed to exist in some area of interest and the relationships that hold among them.
Authentication	Is the process of reliably establishing the identity of the party that is communication. Issued by a mutually trusted third party, a digital certificate is an electronic credential used to prove the identity of a server or of a user. To be effective, digital certificates must be securely transmitted between trading partners.

B2A	Business-to-Administration - the exchange of services, information and/or products between a business and a public administration
B2B	Business-to-Business – the exchange of services, information and/or products from one business to another, as opposed to between a business and a consumer.
B2C	Business-to-Consumer – the exchange of services, information and/or products between a business and a consumer.
bcXML	Building and Construction eXtensible Mark-up Language - This expression stands for Building and Construction eXtensible Mark-up Language. This XML vocabulary provides the European Building and Construction Industry with a powerful, low-cost communication infrastructure that supports communication between clients, architects and engineers, suppliers of construction products and contractors. It could be integrated with eCommerce applications. http://www.econstruct.org
Biometric systems	Biometric systems use hardware to capture specific human characteristics and software processing to authenticate the identity. Human characteristics used include fingerprints, iris and retina patterns; voice patterns and hand-written signatures.
CAFM	Computer-Aided Facilities Management
CAL	Computer-aided learning
CEN	European Committee for Standardisation - http://www.cenorm.be
Certification Authorities	Certification Authorities (CAs) are used to verify that the owners/operators of a web-site are indeed who they say they are.
Construction industry	The term “construction industry” is considered in the broad sense of the word, irrespective of the size of the organisation, and includes housing, non-residential buildings, civil engineering and industrial construction. In addition, the whole supply chain needs to be taken into account – from primary raw materials to complex products and systems. Similarly, the construction process includes all phases – from initial conception, through feasibility studies, design, execution of the works, and maintenance, to demolition (including recovery and recycling of materials, and waste disposal and incineration).
Digital notaries	A digital (or electronic) notary is the mechanism, for electronic commerce, that proves who has made an electronic interchange, with whom it was made and when it was made. Digital notaries provide a time stamping service, proving the existence of a document at a particular time.
Digital signatures	A digital signature is an asymmetric procedure involving a pair of corresponding keys. A private key is used for the creation of a digital signature. This key is kept secret. The other corresponding key (known as the public key) is publicly available. The public key is used to verify the received digital signature.
e-Benchmarking	Benchmarking is a method of improving performance in a systematic and logical way by comparing your performance against others, and then using lessons learned to introduce improvements. A benchmark is the “best in class” performance achieved for a specific

	business process performance that has been achieved in reality and can be used to establish improvements. It is incorrect to refer to it as average performance to a minimum accepted standard.
e-Business	E-business applications may be divided into three basic categories: e-procurement, e-commerce, and e-collaboration applications. All of these support supply chain integration over the internet. e-Business strategy may be considered to cover three main areas: customers (B2C); suppliers, partners and distributors and 'internal constituents', the employees of a company
ECCREDI	European Council for Construction Research, Development and Innovation - http://www.eccredi.org
EC DG ENTR-IDA	Directorate General Enterprise - Interchange of Data between Administrations - http://europa.eu.int/comm/enterprise/ida/index.htm
EC DG INFSO-IST	Directorate General Information Society - Information Society Technologies http://europa.eu.int/comm/dgs/information_society/index_en.htm
EC DG MARKT	Directorate General Market http://europa.eu.int/comm/internal_market/en/index.htm
EDI	Electronic Data Interchange - refers to the transfer of data between two different companies using networks such as the Internet. It is one form of e-commerce. It is a standard format (ANSI X12) for exchanging business data, developed by the Data Interchange Standards Association and since being merged with an international standard EDIFACT. This process arose over a period of nearly 30 years, from the need to avoid having to use different protocols to move data between different companies. Various industry groups identified sets of data that could form the basis of individual agreements. It involves direct communication between applications rather than computers.
e-Collaboration	e-collaboration comprises information sharing, collaborative planning and collaborative product development. E-collaboration technology allows for real time sharing of product sales forecasts, replenishment plans and as a result, it can closely match supply and demand across the whole chain. Ultimately collaborators can jointly reduce inventory costs and raise customer service levels. E-collaboration solutions enable real time contribution from engineers, product developers and front-end representatives to new products. E-Collaboration software allows for quick changeover to new suppliers and manufacturers to facilitate changes in products.
e-Commerce	Electronic commerce is the transmission of financial information and payment for products and services over telephone lines and computer networks. From a service perspective, it allows purchasers to realise increased quality at a reduced cost by facilitating comparative shopping and increasing competitiveness. It also reduces the time cycle (high-speed, real-time interaction and electronic payments). E-commerce may be considered to include execution of orders by customers; communication between members of the supply chain; electronic/instant order tracking; remote sensing and testing of problems in parts of the supply chain and recording of useful

	<p>performance data about the supply chain.</p> <p>Problems with e-commerce include inadequate server security, poor reliability and incompatible proprietary standards and communication protocols. Problems exist in interfacing non-standard software applications and databases over the internet. Software development tools are still evolving and changing. Government regulations and standards differ widely from one country to another, raising complex trade and taxation issues.</p> <p>A new development in this field is mCommerce (mobile commerce) - using a cell phone or other cellular device to shop or do other kinds of commerce.</p>
eConstruct project	<p>eConstruct was a European Commission funded IST research project (IST 1999-10303) that developed a new communication technology for the European Building and Construction industry, called Building and Construction eXtensible Mark-up Language (bcXML). This XML vocabulary provides the European Building and Construction industry with a powerful but low cost communication infrastructure.</p> <p>To ensure that bcXML is adopted by the Building and Construction industry it is vital that bcXML is moved towards standardisation. The first steps for this standardisation process are being done via CEN in collaboration with a number of CEN/ISSS Workshop projects called "eBES" and "eConstruction".</p> <p>In support of this, the LexiCon taxonomy needs to be extended. This work is likely to take upwards of 50 man-years and will need to be done by many parties that will include product suppliers and construction product or supplier associations. The resulting LexiCon taxonomy must then be standardised via the relevant standardisation bodies</p>
E-CORE	European Construction Research Network - http://www.e-core.org
eEurope2005	<p>The European Commission's eEurope 2005 initiative promotes ICT research and take-up projects for SMEs. Its approach is to stimulate secure services, applications and content based on a widely available secure broadband infrastructure, making use of multiple platforms, such as PC, digital television, mobile terminals, aiding competitiveness by encouraging benchmarking based on a few key indicators. EU candidate countries have their own action plan called eEurope+2003. Key areas within eEurope 2005 are: e-Government, e-Health, e-Learning, e-Business, Secure information Infrastructure and Broadband. eBusiness applications for SMEs is a priority.</p> <p>http://europa.eu.int/information_society/eeurope/index_en.htm</p>
e-Government	The use of information and communication technology in public administrations combined with organisational change and new skills in order to improve public services and democratic processes and strengthen support to public policies
e-Learning	Has been defined as "the use of new multimedia technologies and the internet to improve the quality of learning by facilitating access to resources and services as well as remote exchanges and collaboration". E-learning has come to refer to ICT-based learning seen as an integral component of education and training systems. The ability to use ICT is becoming a new form of literacy - "digital literacy".

	On 20 th December 2002 the Commission put forward a proposal for a 'Decision of the Parliament and Council adopting a multi-annual programme (2004-2006) for the effective integration of Information and Communication Technologies (ICT) in education and training systems in Europe (eLearning Programme).
Electronic payment system	In electronic commerce, payments between buyers and sellers can take place electronically online or be transacted offline.
e-Procurement	The procurement process is the process by which a manufacturer procures products from suppliers. Internet procurement solutions automate all steps of the process - acquisition to order, as well as payment transactions. Many industries which have electronic market places for buying and selling have local e-procurement software which allows for data storage, market-place management and monitoring tools etc. This means that manufacturers and suppliers have access to a competitive, global market via the internet and e-procurement applications.
ETSI	European Telecommunications Standards Institute - http://www.etsi.org
Extranet	An extranet is a computer network that links multiple companies or partners together. Generally it is a business-to-business infrastructure that aims to foster collective work groups. It can also provide business partners with access to a searchable inventory database.
Facilities	The premises and services required to accommodate and facilitate business activity'
Facilities Management'	The process by which the premises and services required to support core business activities are identified, specified, procured and delivered; it has three facets – sponsorship, intelligence and service management'
FI 2002	Förvaltningsinformation 2002 - Swedish for "Facilities Management Information 2002"
FP5	European Union's 5 th Framework Programme for research and development (1998-2002) - http://www.cordis.lu/fp5
FP6	European Union's 6 th Framework Programme for research and development (2002-2006) - http://www.cordis.lu/fp6
GDP	Gross Domestic Product
GIS	Geographic Information Systems - http://www.usgs.gov/research/gis/title.html
GoDigital	The eEurope 2002 Action Plan was endorsed by EU Member States at the Feira European Council in June 2000. The Action Plan's objective 3 was "Stimulate the use of the Internet" and included an action to encourage small and medium enterprises (SMEs) to 'go digital'. GoDigital's aim was to put together and adapt support activities to help SMEs use information and communication technologies (ICT) in the most efficient way. GoDigital's priorities were to: promote a favourable environment and framework conditions for electronic business and entrepreneurship; facilitate the take-up of electronic business and to contribute to providing information and communication technology (ICT) skills to SMEs..

HTML	Hypertext Markup Language - is the main data mechanism for the world-wide web. It is the underlying language that enables servers and browsers to communicate. HTML defines the structure and layout of a Web document by using a variety of tags and attributes.
IAI	International Alliance for Interoperability is a member based organisation which has the aim of developing standards for structuring information to enable its interoperable re-use between different software applications. The IAI has developed the IFCs described below, of which version 2x has been adopted as formal standard ISO/PAS 16739 (Nov 2002) by ISO ("International Standards Organization") – the body that controls the IGES and STEP data standards - http://www.iai-international.org/iai_international
ICCI	Innovation co-ordination, transfer and deployment through networked Co-operation in the Construction Industry – the name of a European Commission funded project in FP5 http://icci.vtt.fi
ICT	Information and Communication Technologies
IFC	Industry Foundation Classes – these are a means of representing things in a constructed facility as structured information in an electronic way. The ‘things’ may be real e.g. doors and windows, or abstract concepts e.g. space process, organisation etc. A specification represents a data structure that supports and electronic project model – thus data can be shared across applications. Each specification is called a “class”. A “class” described a range of things with common characteristics – e.g. windows can be characterised as being transparent. The IAI (International Alliance for Inter-operability) defines classes “industry foundation classes” since they both provide a foundation for a shared project model and specify classes of things in an agreed manner that allows a common language for construction to be developed. When a class is used many times, each instance of its use is called an “object”. IFC-based objects allow AEC and facilities management professionals to share a project model – yet they allow each profession to define its own view of the objects contained in that model. Although there have been moves to extend the scope of IFC to supporting data associated with estimating and project management and similar non-graphic data, the IFC system is generally considered to be essentially a graphic representation or object-modelling system (defines architectural and construction CAD graphic data as 3D real-world objects, mainly so that architectural CAD users can transfer design data to and fro between rival products with no compromises. http://www.iai.org.uk
Information Science	The hierarchical structuring of knowledge about things by subcategorising them according to their essential (or at least relevant and/or cognitive) qualities
Internet-based	The internet has a very human syntax for human communication. Work is being carried out on the “next generation internet” to make the same information structure suitable for software applications to talk to each other. (Please see Terminology Relating to Structuring Content,

	below)
Intranet	An intranet is a network of computers within an organisation which is connected through a series of Local Area Networks (or LANs). An organisation can use this to create its own private web as a low-cost channel for information sharing, electronic publishing and collaboration – also secure and reliable Online Transaction Processing.
IST	Information Society Technologies
IT	Information Technologies
IT WG	Information and Communication Technologies Working Group
KM	Knowledge Management
Lisbon strategy	In the year 2000, the European Union put together a strategy to prepare the EU economy for the challenges of the new century. Targets set were higher growth, more jobs and better social inclusion and information and communication technologies are considered to play a key role in achieving them. The strategy was launched at the meeting of Heads of State and Government in Lisbon and thus has become known as the “Lisbon Strategy”.
Metadata	Data files are those that store database information, whereas other files, such as index files and data dictionaries, store administrative information, known as ‘metadata’. Meta data is data about data. It describes how and when and by whom a particular set of data was collected, and how the data is formatted. Metadata is essential for understanding information stored in ‘data warehouses’.
Metatag	These are special HTML tags that provide information about a web page. They do not affect how the page is displayed but provide administrative information e.g. who created the page, what the page is about, which keywords represent the page’s content.
Ontology	Ontologies are the rules governing how information is structured, which in turn allows that information to be processed by computers. Ontology is in fact a taxonomy that defines and creates the objects you talk about when you communicate. The technology should make search and retrieval of data on the internet more effective and contribute to the next generation web – the semantic web. In general terms “ontology” is a branch of metaphysics that deals with the nature of being. Further information on ontologies can be found at: http://www.ontoknowledge.org/index.shtml
PLM	Product Lifecycle Management
ProDAEC	European Network for Product and Project Data Exchange - the name of a European Commission funded project in FP5 http://cic.vtt.fi/projects/prodaec
Project Centres	Is an advanced form of e-collaboration managing all relevant project data and ensuring that they are made available for the partners in the project in a constantly evolving way.
ROADCON	Strategic Roadmap towards Knowledge Driven Sustainable Construction - the name of a European Commission funded project in FP5 - http://www.roadcon.org

RTD	Research and Technology Development
Schema	<p>This is the structure of a database system, described in a formal language supported by the database management system. In a relational database, the schema defines the tables, the fields in each table, and the relationships between fields and tables.</p> <p>Schemas are generally stored in a data dictionary. Although a schema is defined in text database language, the term is often used to refer to a graphical description of the database structure.</p>
Semantic web	<p>The Semantic Web is the abstract representation of data on the World Wide Web, based on the RDF standards and other standards to be defined. It is being developed by the W3C, in collaboration with a large number of researchers and industrial partners.</p> <p>Basic Idea: "The Semantic Web brings to the Web the idea of having data defined and linked in a way that it can be used for more effective discovery, automation, integration, and reuse across various applications."</p>
SME	Small and Medium Size Enterprises
Tag	A 'tag' is a command inserted in a document that specifies how the document (or part of the document) should be formatted. Tags are used by all format specifications that stores documents as text files, including HTML.
Taxonomy	<p>A taxonomy can be used to mean a method to create a specification for representing an object and its associated properties and relationships. A dictionary definition of taxonomy is:</p> <ol style="list-style-type: none"> 1. The classification of organisms in an ordered system that indicates natural relationships 2. The science, laws or principles of classification; systematics. 3. Division into ordered groups or categories.
Tripartite Group	Member States, the European Commission and Industry
W3C	World Wide Web Consortium - http://www.w3.org
Web browser	A piece of software that allows people to browse the World Wide Web.
XML	<p>eXtensible Markup Language - an extension of HTML that separates the content of a web page from its display. It can be used to allow designers to easily create web pages to be displayed on many different devices – e.g. computers, cell phones, PDAs. XML marks up the contents of a page using 'tags' and defines what kind of content each element is. It separates the contents of a page from its display. After the content is defined, it can be displayed many different ways by applying different templates. The content on the page never needs to change – one just needs to create or change a template. The language (XML) is used only to convey information about content, not about the presentation of the content.</p> <p>A web page created in XML can be queried as if it were a database; the results being presented in a browser vary depending on the nature of the query. Without XML, there needs to be a separate data base system and rather complex web-page-to-database sub-systems.</p>

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Annex 3.2 : SCHEDULE OF MEETINGS AND THEMES PRESENTED

<i>Themes</i>	<i>Presentations</i>
E-collaboration and project centres 23.04.2001	<ul style="list-style-type: none"> - The project centre "Projectwise" – <i>Nicolas Tobbackx</i> and <i>Koos Suyker</i> (Bentley) - Check-list for the evaluation of project centres - <i>Jean Fassin</i> (BBRI) - The "As Built" project centre – <i>Geert Kiekens</i> (Switch NV, BIAC) - The EC-funded project "CONCUR" – <i>David Leonard</i> (Taylor Woodrow, ECCE)
E-learning and its significance for the sector 22.06.2001	<ul style="list-style-type: none"> - An introductory key-note presentation on e-learning – <i>Jeanne Schreurs</i>, (Research Group SMEs and Knowledge Discovery at B-LUC) - SteelCAL – <i>John Moran</i> (SCI) - Knowledge discovery server – <i>Geert Dekeyser</i> (IBM Lotus) - Demonstration of "Learning Space" and "Sametime" – <i>Peter de Loof</i> (IBM Lotus)
The role of Industry Foundation Classes (IFCs) as key elements in public tendering procedures –(B2A) 24.09.2001	<ul style="list-style-type: none"> - "IFCs: Today and Tomorrow" – <i>Jeffrey Wix</i> - Latest IAI developments towards IFC and IFCXML - <i>Thomas Liebich</i> - The role of lexica in B2A, including public procurement, standardisation, projects – <i>Maarten van Hezik</i> (STABU) - B2B and the work of the project "Building and Construction exTensible Mark-Up Language: bcXML" – <i>Michel Boehms</i>
B2B – exploiting the next generation internet and seeking to implement B2B across industry 16.01.2002	<ul style="list-style-type: none"> - "B2B: an organisational problem – <i>Dik Spekkink</i>
B2A Business to Administration 18.03.2002	<ul style="list-style-type: none"> - Project MediaKomm Esslingen - <i>Andreas Kraft</i>
B2C Business to Consumer 17.06.2002	<ul style="list-style-type: none"> - "B2C" Business to Consumer Model (Web based consultation for Cambridge University's Building programme) - <i>Simon Ruffle</i> (University of Cambridge) - "B2C" in Construction - <i>Marielle Van Dooren</i> (Amstelland Ontwikkeling)
Facilities & Services Management 17.06.2002	<ul style="list-style-type: none"> - Facility Management – <i>Kjell Svensson</i> - Facilities Management Information 2002 (FMI 2002) Project – <i>Jan Forslund</i> (Skanska, Sweden) - Facilities & Operating Services Management and the role of ICT in IT - <i>Bernard Williams</i> (BWA)
Development of virtual presentations 15.10.2002	<ul style="list-style-type: none"> - Overview 3D-4D – <i>Marcelo Blasco</i>, (BBRI)

Slide presentations from meetings have been placed on the ECCREDI web-site: <http://www.eccredi.org>. When accessing the site, please select the menu option Library. Presentations are listed by date given under the heading WG ICT

