# White Paper for Berkeley-Stanford CE&M Workshop:

# Defining a Research Agenda for AEC Process/Product Development in 2000 and Beyond

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## Vision of Future Design and Construction

In the near future design and construction will be integral parts of a bigger cluster. AEC/FM is seen as one industry. Design and construction will be closely connected to the core business of the end users and must provide not only the physical spaces for the activities, but also essential information for the use and maintenance of the buildings as well as services based on the information.

Two main views of the owners and end users of the buildings will be:
- investment (asset and property management)
- use of the building (facility management and use of the building for core business)

Most user-owners will have a combined view, where the focus point depends on the company strategy. These different views will change the traditional tasks in the design and construction from the production-orientated approach to the life cycle orientated approach with customer tailored services. Information will become as an essential part of all products and life cycle information management will be a new branch in the AEC/FM cluster. To enable this the AEC/FM industry needs real co-operation, project partnering or alliances instead of the old opposite attitude between project participants.

ICT (information and communication technology) will be the integration tool and it will provide essential added value to all AEC/FM processes. All common information will be shared in the Internet. Both financial, technical and occupancy information will be available also inside organizations using the web tools either in Intranet or Extranet. Building service systems will be connected to the common networks and will transmit the alarms and operation information directly to the maintenance database.

In the design phase the ICT tools will provide the possibility to integrate all different processes through the shared product data model. The design tasks will change from "drafting" to information management. Product data models can contain complex rules for behavior and relations between objects. This will enable partly automatic design integration and code checking. The new tools will also provide essential improvement to simulate and analyze different solutions and their impacts on life cycle performance of the building, such as:
- construction cost
- use and maintenance costs
- functionality and quality
- sustainability and environmental impacts

The contractors are between the designers and owners - also in the possibilities of the new processes: partly they can benefit from the shared information, partly they must produce the information for the use and maintenance of the buildings. The building maintenance database must be based on the as-built information, but the comprehensive information can not be in the model, unless it comes as a part of the electronic procurement and commerce. This means that the building component and material industry must provide electronic product libraries, which have direct contact to design and procurement programs and product data models, and that electronic commerce must support also product information exchange and management.

To enable the shared product data model the AEC/FM must have a standardized basis like IFC and the development of the standard is one of the key issues for the industry.

## Research Needs

### *Information of the existing buildings*

The production of new buildings is just a fraction of the total amount of buildings. To motivate an owner to invest in advanced IT systems, it is necessary that the owner can manage the whole building stock, not only the recently constructed. It is essential to find efficient tools and methods to capture the information of existing buildings. If the FM/PM processes can be based on electronic information it will also generate more demand for the advanced design and construction information. The increasing computing power has been utilized for example in automated map production from air photography and similar methods might give new possibilities in buildings too.

Possible R&D issues to capture the information of existing buildings are for example:

- video/photogrammetry and/or laser measuring combined to PDM
- translation of structured CAD files to PDM

### *ICT tools*

Main issue on the ICT area is the data sharing between all project participants and also through building life cycle. The R&D issues on this area are both the data structures/standards and technologies.

- development of data standards: IFC, STEP, XML
- sharing technologies: SDAI, repository and middleware applications
- pilot projects with new software applications

The interoperable data platform will provide new possibilities for cost efficient simulation and analyses tool development :

- LCA, LCC
- environmental impacts
- lighting and thermal simulation combined to the working ergonomics
- cleaning and maintenance costs

### *AEC process development*

New tools need also new processes, which must be developed and tested in the near future. The design and construction using shared product data models will be totally different than the traditional work with paper based documents. These traditional documents will be in the future only a view to the product data model from a specified angle at a specified moment and most probably these "documents" will be produced from the project information directly by the actor who needs the information and when he needs it, not by the one who has originally produced the information. There are several, both technical and juridical, problems, which need to be explored before this can happen in full scale.

### *Information networks*

The total effect of the information networks, mainly of course Internet will change many business concepts in all areas, also in AEC/FM. Basically information network can only accelerate and help transferring the information, but the result can and it should be a better process control. AEC/FM industry is a very information intensive branch. This means that the networks provide good possibilities to improve the processes, but the possibilities need to be tested in pilot projects for example:

- all design and engineering activities
- procurement and delivery control, development of e-commerce
- call for bids, making offers and comparing alternatives
- contract management
- control of costs and utilization degree in buildings
- maintenance planning and budgeting
- control and maintenance of technical and security systems in buildings

### *Hardware*

Product marking and identification with microchips is becoming achievable also in low cost products. This could provide several development projects also on building products:

- delivery control
- quality control of the transportation and storage conditions
- identification and maintenance control of building service equipment

The wireless communication and mobile multimedia equipment will provide for on site activities totally new possibilities for communication and "distance presence". These possibilities combined to the current CIFE research of interactive high-resolution display would be one interesting development area.

### *Education*

Before AEC/FM industry will be able to utilize IT efficiently in full scale also the education of all professionals must change, but very few universities have paid enough attention to the future IT tools. The lack of people, who will be able to use the new tools and processes efficiently, will be one of the main backlogs to improve the processes. There is an urgent need for visionary education development and international cooperation on this area.

## Background of the Authors

### *Arto Kiviniemi*

Bachelor of Architecture in the Helsinki University of Technology 1973, Master of Architecture 1982. Design activities 1972-1996. Architect Office Arto Sipinen in Helsinki 1973-1991, as a project architect 1973-1977 and as bureau chief 1977-1991, 12 first prices in architectural competitions, 36 major projects; both buildings and urban planning. Own office Studio Kivi in Helsinki 1990-1996. Main activities design, software development, design integration and FM consultancy.

Senior Research Scientist at VTT (Technical Research Center of Finland) 1996-1999, Chief Research Scientist since 1999. Main projects: Chairman in IAI Nordic Chapter 1996-1998, Chairman of IAI International Council and Executive Committee since 1998. Program Manager for the national technology program: "Vera - Information Networking in the Construction Process 1997-2002"

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MSc, University of Technology in Helsinki, Building Science 1977, BBa, School of Economics, Helsinki, Centre of Continuing Education 1987, Ph.D., Royal Institute of Technology, Stockholm 1998. Background on design and production processes and their technologies since 1975.

Development Manager of YIT Corporation in the field of IT technology, responsible in business process support and reengineering. Also wide expertise of European RTD-programmes: 1987-1994 EUREKA 130 CIMSTEEL/national leader, 1990-1993 EUREKA 520 CONCIM/international project leader, 1993-1996 EUREKA 1139 MOMIS/international project leader, 1993-1996 EUREKA 1077 COCON/international project leader, 1997-1998 Evaluation of The European Comission 4$^{th}$ Framework programmes, special knowledge of Brite-EuRam and ESPRIT

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Research Scientist at VTT 1988-1989, Research Engineer at Helsinki University of Technology 1989-1991, Research Scientist at VTT 1991-1996, Main project: 1992-1996 Globeman (Global Manufacturing towards 21 century) a global IMS project

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