

BERKELEY-STANFORD CE&M WORKSHOP**RESEARCH ISSUES**

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Visions of some priorities for design and construction research in the future:**1. Life-cycle data**

There will be more emphasis in design on lifetime effects and transfer of data through the design and construction process into building management. More is being spent on existing buildings in developed countries e.g. Denmark spent 57% of the value of construction on repair and maintenance in 1992 and this is still growing.

2. Model development

Building modelling has now moved into the development phase through IFCs and vendor implementations, and these need to be tested, but there are big outstanding issues - parallel design, browsing of models and integration of product and process.

3. Simulating construction

Simulation of assembly of standard components will allow feedback from construction and operation to designers. The ultimate goal is to simulate the whole process before any work starts on site, and to link this with performance, cost and time data.

4. Standard v one-off buildings

There is a trend towards polarisation of building types between routine buildings, which lend themselves to prefabrication and advanced modelling, and one-off, landmark buildings for which no general object libraries are likely to be suitable.

Research issues relating to these topics

1. Investigate the proportion of buildings owned by those who commission or build them and are therefore likely to be concerned with life-cycle issues. For existing buildings and those which are sold or leased, research standards for the form and content of data required for building management.
2. Test the implementations of IFCs as they come onto the market and continue research on outstanding problems such as aspect models, combination of model data with other data for which modelling is inadequate, and techniques for browsing this.

3. Simulation techniques applied to the assembly processes of complex areas of repetitive buildings. Use 4D modellers with links to project management to provide feedback during the design phase and anticipate problems on site.
4. Development of object libraries for prefabricated methods of construction with assembly and life-cycle data. Identify the characteristics of, and future markets for, both repetitive and one-off, landmark buildings.

Criteria for status and progress of research

1. There is a need to explore existing research on building ownership, life-cycle costs and building management data standards. Check with FM organisations and standards under development. Much work is believed to be going on but in areas other than university construction departments.
2. Partial implementations of IFCs by CAD vendors are coming onto the market but the proportion of the IAI work becoming available and the degree of interoperability between vendors will need to be measured. Continue work on outstanding modelling issues such as parallel design (eg that by Jacobsen at DTU - Jacobsen K, Jeng T S, Eastman C (1997) 'Information management in creative engineering design and capabilities of database transaction' Automation in Construction 7(1)). Follow progress on integrating product and process models and model browsing facilities (Eastman C (1999) 'Information exchange architectures' CIB W78, Vancouver). Estimate what proportion of the total information exchange on different types of project can be handled by advanced modelling.
3. Study prefabricated systems on the market for simulating the assembly processes of repetitive and costly elements. Input would be required from sub-contractors and suppliers on their work and products. The 4D modelling work at Stanford could be extended to cover more building elements. (Fischer et al (1999) 'Cost-loaded production model for planning and control' CIB W78 Vancouver).
4. Assess future markets for buildings with proportions of building types suitable for prefabrication or those which will remain as one-off specials. Estimate the size of object libraries for repetitive buildings, find out who will provide and maintain the data and to which standards it will conform.

Priorities for each research area

1. While inflation rates are low, there is a high level of environmental concern and there is growing Build, Own and Operate procurement, life-cycle costs are given greater importance. If a high proportion of buildings are found to be managed by the firms which commissioned them, this area should be given high priority.
2. IFC implementations are coming onto the market and can be tested to see which problems in product modelling remain unsolved. The timescale will be driven by new versions of CAD products and progress in delivery of new IFC releases.

3. As more prefabricated systems come onto the market (for rebuilding Kosovo for example) their supply and assembly should be modelled and simulated. This could become urgent.
4. Future trends in standardised v. landmark buildings are starting to emerge, but this is not critical just a matter of recognising this polarisation of two extremes in construction and the suitability of each for integrated modelling.

Potential impact on practice

1. Where clients have a life-cycle interest and their thinking is long-term, there will be growing demands on designers to estimate life-cycle effects and hand over good data for building management.
2. IFCs are being pushed at practitioners and, while there is some resistance to this (eg lack of awareness in Denmark shown in IT Barometer survey - Howard R (1998) 'The use of information technology in building' DTU rapport 5), when vendors deliver their versions there will be pressure on CAD users to adopt them.
3. There is a long-term aim to simulate the whole construction process but product suppliers will take time to move on from their CDs and Web sites into dynamic simulations of their products, but will eventually push these at designers, and they are likely to be in non-standard formats.
4. Modelling is presented as the solution to all types of building production but recognition that common object libraries will never cope with Frank Gehry's buildings will introduce some realism. (Akbas R & Fischer M A (1999) 'Examples of product model transformations in construction' CIB W78 Vancouver) For repetitive construction much more can be achieved with modelling (eg Macdonalds restaurants), technically if not aesthetically.

Personal background, motivation and work

Trained and practised as an architect. Started in computing with the first graphics systems in 1971, setting up a technology transfer organisation for construction in the UK. Worked in national and international standards particularly in CAD layers and models. Managed multimedia projects on presenting experts' views on future use of IT in construction (Construction IT Forum (1995) 'Building IT 2005' CRC London). Author of a book 'Computers in construction - pioneers and the future'

Professor of IT in Building at the leading engineering university in Denmark since 1997, setting up the IT byg research group spanning modelling and multimedia, and construction management. Currently studying the means and efficiency of communications on partnering projects in housing and methods of measuring benefits of IT in construction firms. Putting together proposals to the EU for European distance learning, studies of the future use of IT, etc. Web www.ifp.dtu.dk/~it/itprh.html