Berkeley-Stanford CE&M Workshop: Defining a Research Agenda for AEC Process/Product Development in 2000 and Beyond

What Impact Can IT Realistically Have on Construction?

Tim Broyd, Research & Innovation Director, WS Atkins Consultants Ltd, England

Information Technology has transformed many aspects of our daily lives, and revolutionised industries in both the manufacturing and service sectors. Within the construction industry, the changes have so far been less radical. The various different parties to construction projects are all making use of IT to one extent or another, but there is little consistency or perceived common purpose.

The supply side of the construction industry is using IT as a matter of course in many areas of its work. The industry is, as we all know, fragmented, and as a result it has been difficult so far to achieve the types of radical change seen in a number of other manufacturing and service sector industries. Construction clients are, however, beginning to try to drive their suppliers towards more integrated uses of IT.

My vision, or development target, for the use of IT within a construction project is where individual items of information are input once but used many times over for different purposes and by different people, using the concept of an Integrated Data Warehouse. This will significantly increase the efficiency and effectiveness of information handling. It will also minimise, if not eliminate, the amount of rework necessary because out of date or erroneous information has been used. A schematic is shown in Figure 1.

We have made significant progress in recent years. First and foremost, some embryonic standards have been established in construction processes (see http://www.salford.ac.uk refer to Professor Rachel Cooper) and software data formats (see http://www.helios.bre.co.uk/iai/). In a small number of cases, integrated standards have been developed allowing progression to Computer Integrated Manufacturing techniques, as with the CIMsteel initiative for structural steelwork (see http://www.nottingham.ac.uk refer to Dr Walid Tizani). We have also started to develop effective, web-based techniques for sharing project information in real-time, allowing proper "Collaborative Working" by teams of geographically disparate workers. Such systems hold the promise of:

- Controlled, managed access by different types of people
- Effective management of all types of written, verbal and electronic information
- Electronic distribution and authorisation of documents, drawings, etc
- Automatic notification of events

At WS Atkins, we are using such techniques in trials on live jobs, and first results are most encouraging.

We have also seen computer visualisation techniques develop to the point where photo-realistic images of projects can be produced at the design stage, and where virtual reality fly-throughs can help both project team members and end users of facilities communicate their needs and responses before building work commences. Of course, clash detection is an almost automatic by-product of such visualisation systems.

Elsewhere, a number of IT-assisted techniques are at the developmental stage. Examples include:

- The use of isovist analysis to help predict how given spaces will be used by people, at the concept design stage (see http://www.ucl.ac.uk refer to Dr Alan Penn);

- The development of CAD files of existing, "as built" structures, using semi-automated digital photography;

- The specification (to order schedule) of complex components such as elevator systems, directly from lap-top based computer software (see http://www.reading.ac.uk refer to Professor Norman Fisher);

- Structural analysis within a virtual environment (see http://www.birmingham.ac.uk refer to Dr Andrew Chan);

- The development of design scheduling methods analogous to critical path techniques for construction (but allowing for the iterative nature of design) (see http://www.loughborough.ac.uk refer to Professor Simon Austin);

Against all of these things, we have to acknowledge that most design is still carried out using fairly basic, 2D CAD approaches. In order to make real headway, I think we need to follow two separate lines of activity.

The first is to recognise that improvements in "the technology" are only one part of the story. There will only be a partial gain by automating our current procedures, practices and processes. This is recognised in the UK, and is the reason why public funding agencies have put money into understanding and improving the processes of construction. The real challenge, however, lies in getting project team members, from a variety of technical disciplines and organisations, to want to embrace change and to want to share information. We need to break down these separate "silos of activity", which start to be built at college and which are reinforced by company practice as well as construction contract conditions. I tend to think of this as a technology-process-culture (TPC) triangle – all too often, extending the technology is the easy bit and is only the start.

As an example, we will only really start to unlock the potential of IT in construction when we start modelling in 3D. There are a number of reasons why we don't at the

moment - 2D modelling is familiar, it needs less information and it costs less. But these reasons are beginning to look like excuses. Can we really justify not knowing the "3D design details" of interfaces between a building's systems and components for much longer? And, if we know the details, can we justify not using 3D design techniques, especially given the relatively straightforward extension of these techniques into VR visualisations and lifetime project databases? Perhaps there is a greater role here for informed construction clients, in forcing the pace by demanding greater integration.

The second line of activity is to recognise that widespread use of integrated design methods will require their incorporation in mass-market AEC software. The work of the IAI is of course valuable, but will only become truly worthwhile when the likes of AutoDesk and Bentley develop robust object-based CAD techniques. We need to find ways of persuading these software houses that 3D modelling can potentially and realistically be used far more than it is at present, and to help them develop their business cases for development. Without robust 3D techniques, extension to 4D (including time) or 5D (including cost) are problematic.

Returning to my development target shown in Figure 1, I believe that all of the necessary links have been tested to one extent or another, and shown to work. Many of the linked attributes have now been embodied in a demonstration software package by the University of Salford, called OSCON (see http://www.salford.ac.uk refer Dr Ghassan Aouad). We are also developing our own prototype software at Atkins. Use of these packages is beginning to show us how integrated data warehouse techniques might be applied in practice. There is still much to be done, not forgetting of course the different types of requirement needed to satisfy the TPC triangle, but it is all possible.

Before summing up, it is perhaps worth mentioning the work of ConstructIT (see http://www.construct-it.salford.ac.uk) in the UK. This is a network of some 60 industrial companies and universities, with a mission "to be an effective and co-ordinating force in the application of IT within the construction process as a contribution to innovation and development of best practice". Significant work has been carried out by ConstructIT in recent years in benchmarking the current use of IT throughout the construction procurement process, and using the results to develop research agendas based on proven industrial need. In addition, standard methods of setting out business cases for IT in construction have been developed, in which the benefits of a given IT investment are considered in terms of:

- Efficiency benefits – doing things right
- Effectiveness benefits – doing the right things
- Performance benefits – doing better things

To sum up, my key considerations are as follows:

1. IT is an enabler, not a solution
2. The extent of IT use in the construction process is largely determined by construction clients

3. We need to understand the significance of the TPC triangle
4. Process and IT standards will improve inter-activity knowledge and information interfaces
5. Widespread use of integrated design methods will require their incorporation in mass-market software

I believe that research agendas need to incorporate these key considerations, if the results of research are to stand a chance of making an impact on the way the construction industry works.

About the Author

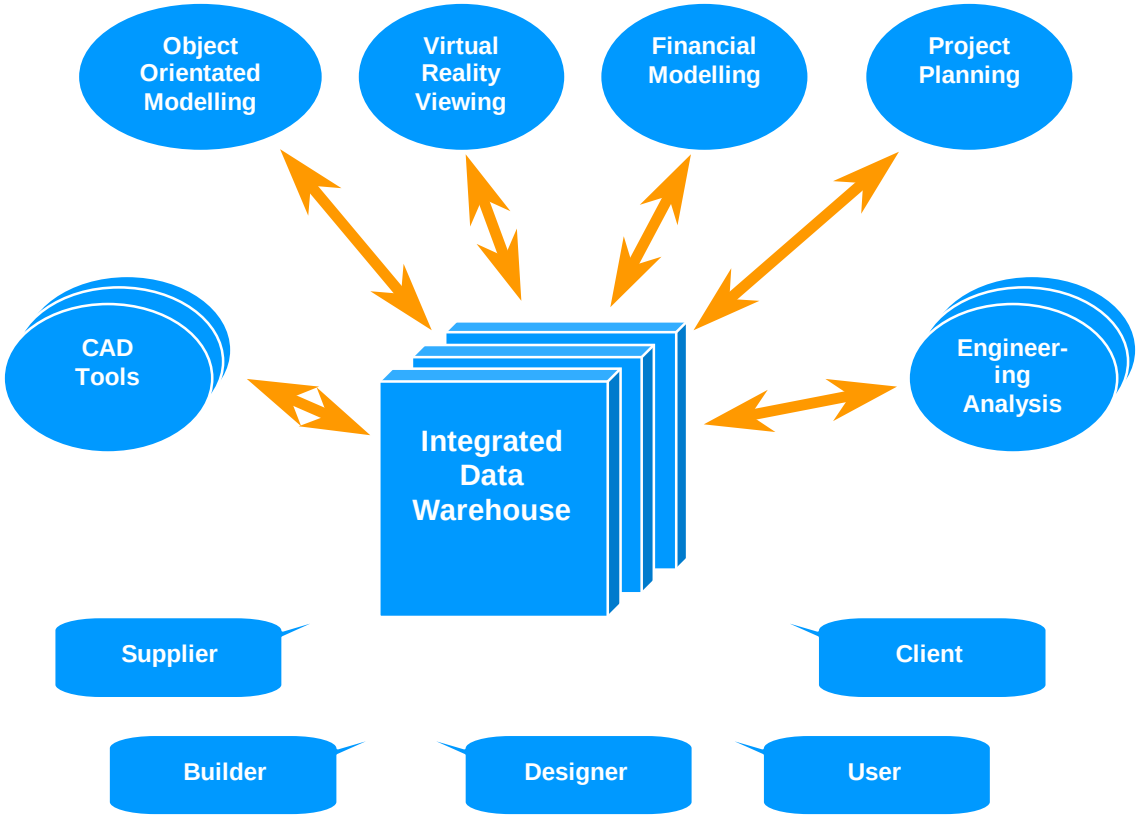
Tim Broyd holds undergraduate and doctoral degrees in Civil Engineering from the University of Birmingham, England. He has twenty years experience in the civil engineering and construction industries. His current position is as Research & Innovation Director for WS Atkins, which, with approaching 10,000 staff is the UK's largest engineering design and facilities management company. Tim's current development interests within WS Atkins include the development and widespread application of techniques for integrated design, collaborative working, novel visualisation and whole life costing. He also has a corporate responsibility for innovation as a general topic.

Beyond WS Atkins, Tim is active within a number of construction sector research forums and groups, which currently include the following involvements:

- Chairman of the Management Board of ConstructIT (see above);
- Chairman of the Management Board of the UK's National Centre for Virtual Reality in the Built Environment;
- Chairman of the Construction Associate Programme of Foresight, which is a UK Government sponsored programme aimed at identifying long-term research needs in a number of market sectors.

Tim has a reasonably good understanding of the US construction sector, having initiated and managed the secondment of an Atkins' staff member in 1997/8 to NIST to assist in the preparation of base-line cases in support of the US National Construction Goals.

In April 1999, Tim gave by invitation the 1999 James Forrest lecture of the Institution of Civil Engineers. His chosen topic was "The Impact of IT on Construction".



Development target for the use of IT within a construction project