THE ROLE OF CASE STUDIES IN THE UPTAKE OF INNOVATION IN CONSTRUCTION IT

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ABSTRACT

The UK Department of the Environment, Transport and the Regions has initiated a Construction Best Practice programme. The primary objective is to improve management best practices. The technical performance of the industry also needs to be improved by identifying and promoting opportunities for industry to adopt new technical innovations and incorporate them into standard practices. Accordingly, a series of Technical Best Practice initiatives will be set up. One of these is likely to cover Construction IT.

It is expected that Case Study material will form an important element of the IT Best Practice programme. Concrete examples of use of technology in practice are likely to be more convincing than simple exhortations and theoretical reports. There are three major issues that need to be addressed.

1) *A Case Study is, by its nature, very specific and it can be difficult for the reader to ascertain if there is sufficient commonality between the problem described and the situation that he/she faces in order to assess whether the solutions are applicable.*
2) *It is difficult to describe the problem and solutions in sufficient detail, yet in a way that encourages the material to be read, understood and used. Ideally, a common format needs to be developed for describing the key facts.*
3) *A further aspect of importance is how to determine what applications are most in need of Case Studies. Limited resources are available and it is essential that these are targeted in such a way as to produce maximum returns for the industry as a whole.*

This paper describes a framework for addressing these three issues and will provide an update of the work of the UK Construction IT Technical Best Practice programme.

1 INTRODUCTION

The UK Department of Environment Transport and the Regions, together with the UK Construction Industry Board have initiated a Construction Best Practice Program (CBPP). This aims to provide advice and assistance to construction industry organisations to improve their performance and competitiveness and to promote actively the concept of sustainable construction (1).

The programme will focus initially on a limited number of organisations that have greatest potential to change.

The action plan will consist of:
- Marketing and impact assessment
- Signposting existing services
- Company networks and visits
- Benchmarking
- Advisory services to mentor enterprises
- Demonstration projects and case studies
- Technical best practice initiatives (TBPI), focusing on materials, components, market sectors, and probably IT

The TBPIs will concentrate on the technical performance improvements and will tackle issues such as certification, use of standardised and prefabricated components and encourage better take up of existing knowledge. Detailed plans are yet to be developed but it is expected that the services they will offer will include raising awareness, networks and advice and training. TBPIs may be set up and run by a consortium of key organisations in the sector.

A scoping study is currently being conducted into a TBPI for construction IT.

This paper reports on the results of a separate study which considers the definition of and need for Case Studies and their role in an IT TBPI.

2 WHAT ARE CASE STUDIES?

'Case Studies' (CS) are currently used to describe many different things. In the context of this work a Case Study will be taken to mean something that describes a technique or procedure that has actually been put into practice. Case Studies serve as concrete examples of use in practice and are therefore an important part of any Best Practice programme.

A CS should be well suited to convince the unconvinced. Ideally, it should present inarguable evidence that a technique/technology is useful and any deleterious side effects are outweighed by benefits. In practice, it is unlikely that this will be completely achievable. One important feature of Case Studies is that they can address both technical & non-technical issues; for example:

awareness, understanding, perception
financial, human, contractual, ...

CSs can serve as exemplars of good practice and can be used to aid in the transfer of knowledge from Tier 1 (best) to Tier 2 organisations.

In an ongoing UK project being conducted by the Building Centre Trust (BCT) it has been suggested that different types of Case Study be produced, based on:

a) a single construction project – involving various organisations
b) a single construction organisation – including a range of techniques
c) a single process – possibly using examples from several organisations/projects to cover all aspects

3 WHY DO WE NEED THEM?

Case Studies are expected, as indicated above, to be part of a larger Motivation/Dissemination Best Practice programme. One important message that comes from examination of experience gained in another UK Energy Best Practice Programme is that the messages being broadcast through the CS need to be:

- consistent with other outputs and deliverables from the overall Programme and
- credible, so as not to undermine perceived objectivity.

Case Studies could provide, inter alia:

- evidence of trouble-free implementation
- quantification of benefits
- explode common myths

CS are not intended to indicate in any detail how to set about implementing a new technique in practice. They should, however, provide references to such guidance material where available. The primary aim is to convince the target audience that they should consider adoption of new techniques.

4 WHAT ARE PRIORITY AREAS FOR CONSTRUCTION IT?

The BCT project has adopted a bottom-up approach in which a Steering group examines offers of CS and attempts to prioritise them. These proposals have been solicited from vendors and users through advertisements placed in the technical press.

An alternative approach is to devise a prioritised list of techniques for which CS are needed and then to solicit them specifically. In order to explore whether this is practical, BRE has conducted a review of 'strategic reports' dealing with the application of IT to construction, supplemented by a variety of other sources in journals etc.

This review led to the following list of priority areas:

- Teamworking – document exchange & formats (including EDI); Extranet/Intranet; distributed databases, replication & workflow; shared applications, whiteboards, video conferencing; visualisation; use of common model (including Integrated Project Database)
- Information & Intelligence - finding & re-using information & designs; support for intelligent design; managing design changes; value engineering; life cycle costing
- Site processes - site-office communications; materials management
- Performance, Control & Management – performance prediction and control in practice; facilities management; refurbishment

This review and the processes that led to the conclusions in the individual reports should be considered as somewhat subjective. They did not result from any comprehensive collection of data from sources representative of the whole industry. To produce a reliable list of priorities it would be necessary to generate a map or model of the industry, disaggregated sufficiently to allow individual sectors to be considered separately and targeted as appropriate. To date no such model has been discovered and it seems likely that much of the data necessary to construct one would not be available.

5 WHAT CURRENTLY EXISTS?

A review was conducted of CS material that has already been produced. Case Studies were found covering the following topics:

- Accounting, payroll, personnel, time management, cash flow management, new business systems
- Strategic IS planning, Document management, office applications – word processing, spreadsheet, database
- Marketing, Industrial Relations, Contract control
- Procurement, cost-benefit calculation, estimating, costing - use of expert system
- re-use of design components
- CAD, 3D, 4D, 5D, Object modelling
- CAD & structural design
- EDI, Video Conferencing, data & application sharing
- Purchasing, Refurbishment modelling
- Project planning, Construction management
- Global positioning of piling rigs
- Site processes
- Street roadworks register, transport modelling
- Health & Safety
- Plant management and control

Some of these Case Studies were based on organisations and described the use made of IT and how this arose historically. There was little attempt to quantify benefits. One (2) describes Ove Arup's role in a specific construction project for Glaxo Group Research Ltd. It deals with issues associated with teamworking. It contains some quite robust statements such as:

> 'A project of this size could not have been designed to the quality required within programme and budget without the use of CAD'.

as well as some reasons for NOT applying particular techniques:

> 'This project was no different to the norm, 3D modelling of the buildings could not be cost justified.'
> 'High quality visualisation was available but the client found low cost techniques gave acceptable results.'

Typically the CS of an organisation's use of IT cover a range of topics but at no great depth. They are best seen as promotional documents with little chance of reaching or convincing those who are not yet convinced.

An investigation into product model based data exchange (3) found difficulty in obtaining much concrete CS information and evidence of benefits, but a considerable number of references were found where industry professionals expected huge savings to result from the use of product model based information exchange. Anecdotal comments or claims of savings were made, for example:

- 10-35% design time & cost
- 5-15% facility maintenance costs
- 15% available project time

- CAD - Building Services link - 50% saving in time

In summary, a great deal of Case Study material was found, but not much that contains convincing evidence of benefits that would be likely to motivate change.

Some of the issues of interest that arose are:

a) Medium to be used – it is expected to be primarily paper in view of need to reach non-IT specialists; although note that the UK Department of Trade & Industry has successfully used videos e.g. for Knowledge Based System Case Studies; Web versions could also be considered
b) Level of detail given, impact achieved, credibility of message, practicality and balance
c) Extent to which existing CS have been used, what impact have they had? Have any surveys been done on popularity of various sections of journals? Do readers actually read CS sections? Do they use them?
d) What lessons can be learned from existing best practice programmes?
    - it is expensive,
    - it needs well-defined metrics to enable measurement of success
    - it must be credible & consistent

The requirement for clear metrics may be difficult to achieve for construction IT.

6 EXTENT OF CURRENT USAGE OF IT IN CONSTRUCTION

In order to judge the need for Case Studies, we need to know what position we are starting from. If take-up of a particular application is already high there is no urgent need for the production of motivational material.

A summary of various market research reports for BRE suggested that:

- 80-90% have computer hardware; those that do not are mainly small companies
- Half of architects have CAD
- Practical workshops and case studies are of interest to users and providers of s/w
- A national programme of workshops, exhibitions would be welcomed
- E-mail/Internet usage amongst architects is 28%

This report was based upon surveys or interviews:

1. Barbour Index, 1995
   Sample of 5000
2. RIBA IT Group, 1994
   Sample of 1675
3. RIBA J, 1995
   Sample size 300 (architects)
4. Lychgate interviews, 1996
   Questions in a regular ‘Omnibus’ survey; interviews at Building Centre and at Construct IT; in-depth discussions; sample sizes – 100; 22; 25; 23

The most popular sources of information were found to be trade journals, advice from colleagues, exhibitions/seminars.

Those interviewed about future investment plans put CAD and hardware first with Technical/Product information scoring highly in the Omnibus and Construct IT samples. It was apparent that a higher proportion of larger practices were planning to invest.

The report recommended that awareness initiatives be concentrated on Small to Medium Enterprises as larger businesses have in-house expertise and providers can target them more easily.

In addition to this review there is material from various other surveys that give similar results.

A study by Salford University (4) reported on priorities for various IT techniques as perceived by the industry. It was divided into two stages:

1. A survey was carried out of job vacancies and research posts in construction IT covering the period 1990-1994. The numbers of posts were used to indicate interest/needs for each of 16 IT topics. This showed clearly that CAD was the most frequently occurring technique over the whole period and that interest in Integration, simulation and VR increased over this 5-year period.

2. A questionnaire that defined each of the 16 techniques, gave examples of their use and asked respondents to prioritise them and indicate the extent of their usage was sent to 175 organisation. Replies were received from 18 Quantity Surveyors, 20 contractors and 17 architects. The techniques most likely to be implemented by 2005 were in order of priority – communications/networking; computer aided estimating; databases; multimedia. The rank order of the prioritisation that the respondents were asked to make was similar – communications/networking; computer aided design; computer aided planning; databases; computer aided estimating; integration etc.

Looking to experience in other countries, a paper describing results from the VERA project in Finland (5) showed e.g. that:
a) 65-90% of respondents use CAD and 50% e-mail

b) The main needs were seen as for more and better training & information, especially on:
- data sharing
- integration

A major survey is currently being carried out within Scandinavia (IT barometer) and should provide useful information on current usage and attitudes to IT. Some ongoing work on how to measure benefits of IT should also be useful.

Overall, the current review has shown that there is a need for more basic information to be gathered in order to enable a robust CS framework to be produced.

7 CONTENT REQUIRED IN CASE STUDIES

Based upon the foregoing analysis of the purpose of CS within a Best Practice programme and a review of a range of CS already produced for the construction industry, it is suggested that the following topics should be addressed:

- Situation being addressed + context
- Why is it important?
- How has it been solved?
- Costs (direct & indirect) & benefits
- Implementation issues - problems & resolutions; user acceptance
- Sufficient detail to allow judgement on relevance/replicability
- Contact/Reference details - detailed info.

8 FORMAT

Apart from the content, the format is extremely important. Some research work as well as anecdotal evidence suggests that many of the paper-based reports and information produced are not read in practice. The following suggestions are made as to format for CS:

- Audience identified clearly and named; appropriate language, length & format used
- Context setting - can I identify with situation?
- Key points summarised at start
- Short as possible - references to more detailed information
- Use of headings, illustrations, bullets, quotations
- Use of keywords, classification, standard format for consistency; this is to enable electronic systems to be used at a later stage to file and retrieve appropriate CS as part of an overall Best Practice programme

9 CRITERIA FOR SELECTION OF CS

There is a need to assess the suitability of each proposal in terms of the needs of the industry and the expected impact of the CS. The following criteria are suggested to serve as a basis for discussion:

1. Does it address an area where additional motivation is needed; is the technique already widely used; would it be adopted anyway, without CS material to promote it?
2. Can the target audience be identified & defined? If not there is little prospect of it having any significant impact. These organisations must be capable of change i.e. Tier 2 rather than cutting edge Tier 1 organisations. SMEs are probably the main target.
3. Can the benefits be clearly identified and quantified for the project/organisation in question?
4. How important is the technique i.e. can the benefits be expected to be replicated for other projects/organisations? How many are there i.e. what is the size of the audience and the total expected benefit for UK Ltd.?
5. Are the results credible? Are they consistent with other material?
6. Is it practical for others to adopt the solutions described? E.g. is the software used available commercially off the shelf or was there a significant amount of tailoring needed to address individual needs of the organisation?
7. Does it deal with a) a range of techniques applied in an individual organisation OR b) the use of technique(s) on a single construction project? Both of these seem to be valuable but the size of audience will be affected by which type it is. It might be more difficult to achieve replication with type a) if benefits are quantified for a combination of techniques

and factors, which are unlikely to exist in exactly the same combination in other organisations. However, there may be sectors where the organisations are very similar where this would be a positive advantage (perhaps housebuilders?).

If the priority topics could be more rationally devised and were to achieve consensual acceptance one could envisage applying such an analysis as a first stage in filtering (or defining) CS topics. The second stage would be to apply the criteria (suitably weighted) given above. In practice, it is not felt that the priority topics are well enough defined or firmly enough based.

10 FRAMEWORK FOR CASE STUDIES IN IT BEST PRACTICE PROGRAMME

Several strategic reports on the needs of the construction industry have been reviewed to establish needs of the industry. It has been concluded that, in the main, these identify needs for research rather than the more immediate needs for demonstrable good practice application of IT. Much of the strategic thinking is predicated upon IT being able to deliver real business benefits. The evidence for this, however, is not easy to find. There are examples from across all industry sectors of both successes and of failures of IT to deliver business benefits. The technological issues can not be divorced from the human and other issues when new methods of working are introduced. An IT TBPI must be closely co-ordinated with the overall CBPP programme.

One of the lessons learned from other Best Practice programmes is that the messages disseminated through the programme must be internally consistent and must be credible. Care must therefore be taken to ensure that only reliable information and advice is provided. The current lack of hard evidence of benefits from IT is therefore a concern.

There is much information about the use of IT for general business processes available. It may be wise for any IT CBPP initiative to concentrate initially on the promotion of basic and well-proven technologies. In parallel, more high quality Case Study material should be identified and documented to serve as exemplars of specific benefits within the construction industry.

Some possible application areas that could usefully be considered are listed below:

- Business Process Re-engineering
- CAD modelling - good use of CAD – layering, naming etc.
- Document exchange - EDI
- Document Management Systems + CAD
- Facilities Management
- Fault diagnosis; intelligent buildings
- HVAC commissioning; adaptive controls;
- Integrated design: CAD-QS; CAD-Structural, …
- Internet/Extranet
- Materials Management
- Object Models, re-use of information, standard libraries, intelligent design
- Product/Technical Information systems
- Project management – distributed database, groupware
- Site-Head Office communications;
- Video conferencing, whiteboard

Surveys suggest that a range of dissemination routes for IT Best Practice information should be employed. These could include: articles in trade journals, mentoring, visits, booklets/publications, training courses, demonstrations, exhibitions, seminars, an advice service, an Internet service and consultancy.

11 CONCLUSIONS

1. The main purpose of Case Study material in the context of construction best practice is to provide motivation for Tier 2 organisations to adopt proven good practice IT techniques
2. A set of criteria has been developed, together with thoughts on content and format for Case Studies. They could be used in developing and refining a Framework against which priority areas for Case Studies could be identified.
3. There seems to be a dearth of firmly based data on the extent of current usage, the benefits of IT techniques and the market information needed to assess potential replicability and hence overall benefits to the UK construction industry. A brief summary of such market information has been prepared. Consideration should be given to commissioning a questionnaire based survey, perhaps in conjunction with the 'IT barometer' Scandinavian one.
4. The priority applications suggested in various recent strategic reports have been reviewed, together with an examination of existing Case Study material. It is suggested that an IT Best Practice programme should concentrate initially on the proven use of existing s/w applications for improving basic business processes. A provisional list of construction IT applications for which Case Study material is needed is offered for discussion.

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