Approaches to Construction Information Technology Education

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ABSTRACT: This paper evaluates three current approaches adopted by construction educators to address the need for future IT knowledge and skills for construction professional. The three approaches are (1) Continuing Professional Development, (2) Incorporating IT modules into existing construction courses, and (3) Interdisciplinary courses with IT as the main integrating theme. This paper concludes that the Interdisciplinary approach with IT as the main integrating theme is the best way forward to equip future construction graduates with IT knowledge and skills that are critical for the development of the construction industry.

1 INTRODUCTION

Information Technology (IT) is central to most visions of the future. A recent review by Edkins of University College London (2000) found that:

“IT underpins so many of the scenarios that it can be considered as a foundation of the next twenty years. Its influence will be highly pervasive...our lives may be increasingly dominated by this new way of functioning.”

Construction will be no exception. The next 20 years is likely to be exceptionally challenging for the construction industry. IT will be the main technical driver for globalisation, and the technical basis for many of the steps the industry needs to take (e.g., greatly increased use of knowledge and communications technologies, and progress towards the “virtual building factory”) if it is to prosper in a globalised world (Bartholomew, 2000).

This scenario warrants an immediate response from construction education since more and more organisations in the construction industry have increased their adoption of IT in their business processes to enhance their competitive advantage. The rate of adopting these technologies is expected to increase significantly in the very near future. Thus, the urgent need for construction educators to review and re-vamp their current curricula in order to provide its graduates with the knowledge and skills needed to operate professionally in a knowledge-based economy cannot be over-emphasised. Thus, this paper aims to review some approaches that can be adopted by construction educators in their attempt to equip their students with the right IT knowledge and skills.

2 THE APPROACHES

Three main responses are envisaged as possible answers to bridge the gap in education between construction business and management and that of computer and technology. They are:

- Lifelong Learning: Continuing Professional Development
- Incorporating IT modules to Existing Construction Courses
- Interdisciplinary Courses with IT as the Integrating Theme

2.1 Lifelong Learning: Continuing Professional Development

Construction professionals today acquire most of their knowledge as undergraduates and through personal, practical experience, and the pattern is broadly the same for everyone else in the industry (Bartholomew, 2000). This is no longer good enough in a rapidly changing and diverse world. In the decade ahead, lifelong learning will see significant growth. UNESCO, OECD and other organisations have documented that mature adults will become an increasing presence in many systems of higher education (Ehrman, 1996; UNESCO, 1996). Everyone needs to continue to learn throughout their career, both to keep up with external developments and to cope with changing roles within the organisa-
tion. As the construction industry makes increasing use of Information Technology it will have to continuously develop the skills of its members (Construct-IT, 1995).

For many countries, lifelong learning for professional, work related purposes is already at a substantial level. A recent study in the United States, for example, estimated that one-third of employed adults are currently engaged in some form of employment related training, and more than half of managerial and professional employees are engaged in such employment related training (Kopka and Peng, 1994). Thus far, a large proportion of the activity directed to lifelong learning involves vocational training and skill development. Another large proportion focuses on executive and management development, and still another large segment is directed to the updating of technical and professional skills (OECD, 1993a).

However, for many people, lifelong learning will remain a pipe dream unless it can happen anytime, anywhere. It has long been recognised that adult learners, in order to combine learning with other ongoing responsibilities in their lives, are interested in flexible time schedules, easily reached locations and other convenience factors as they choose among various educational options. This is summed up by El-Khawas (1999) as follows:

Many adults especially prefer programmes that are linked to their present workplaces and jobs, and subsidised by their employer. Others, seeking career changes, place great importance on programmes that can be completed without a significant disruption in their current work schedules.

Many traditional higher education institutions have long ago established various initiatives (e.g. centres for continuing education, distance education programmes, time-compressed degrees) that offer such convenience factors for the adult learners. Convenience factors are likely to take greater importance in the emerging era of electronic, virtual learning. Adult learners no longer need to search for convenient locations or course schedules that fit around their work hours; they can instead, work at their own computers, at home or at the office, at whatever hours they wish, and still receive full access to electronic lectures, multimedia presentations, or electronic interaction opportunities with tutors and other students. It should be noted that ‘convenience’ in this context does not mean ‘easier’. The maintenance of existing standards of academic rigour is a key requirement of these programmes.

In the new, more competitive environment, a new direction is emerging. Niche-focused programs have emerged in eastern and central Europe in the last decade (Farnes, 1997), typically limited to courses in business management and computer technology. The explosive growth of “niche” programmes are directly linked to expanding employment sectors. With the increasing use of IT in the construction industry, this “niche” market can be capitalised. For example, postgraduate courses have been introduced to provide a more comprehensive and integrated approach to construction IT. The MSc in Construction IT offered by University of Salford is one such example. This course can be studied in three different modes i.e. full-time, part time and Internet based distance-learning modes. Individual modules can also be studied as short training course. Despite its flexibility in meeting the learning needs and learning styles of busy construction executives, the student population has remained small. There are many reasons for this situation. Some of the reasons could be attributed to:

- Work commitments: Workloads are unevenly distributed and variation in the amplitude of cycles of work pressure such as dealing with rush works, urgent reports, etc.
- Domestic commitments: The majority of lifelong learners are married. Of these, a majority have children and a spouse in full time employment. It is inevitably that domestic pressures will sometimes become severe and impact on their studies.
- Companies are reluctant to grant study leave for their staff to attend such training.
- Failure to see the importance of such courses which lead to ignorance of the availability of such courses.
- The unwillingness of individuals and companies to invest in such education, which is similarly reflected in their unwillingness to invest in information technology (Price Warehouse, 1994).

Due to the amount of time available to professionals to attend a prolonged and comprehensive course of construction IT, any attempt to develop relevant IT courses for such professionals will need to consider only those IT skills most relevant to their jobs. This would mean many discrete short courses of specific IT applications to suit different needs. These short courses are the preferred method as it can develop new skills quickly and lay the foundation for future learning. This is compounded by the fact that employers are primarily concerned with improving their existing employees to perform a reasonably well-defined set of activities. Therefore, organisations are only willing to invest in training, which is specific to their needs, rather than general education for improvement. This approach, however, will not solve the industry problems of fragmentation because such short courses, usually conducted over many discreet short time periods, will at best address the shortages of specific IT skills in the short term.
In summary, it appears that such avenues of addressing construction IT skills deficiency remain ineffective in building a substantial pool of knowledge workers in the industry. Hence, such courses alone will not solve the need for construction IT knowledge and skills and consequently prevent its success in creating significant and long term improvements in the performance and efficiency of the industry.

2.2 Incorporating IT modules into existing construction courses

As mentioned in the previous section, most construction professionals acquire their knowledge through diploma and undergraduate courses before embarking on their career in the construction industry. It is generally agreed among educationalists that young people’s minds are formed by their time in higher education. Therefore, perhaps the best way to build up a substantial pool of knowledge workers; well equipped with relevant IT knowledge, skills and the right attitude, is through formal construction courses.

A review of the curriculum of construction courses offered by the 20 top universities in the UK (See Appendix A) and the 1 university and 2 polytechnics in Singapore, through their web pages, reveals that most Universities and Polytechnics have incorporated a diverse range of IT related modules into their courses. Hence, this has so far been the most popular approach amongst higher education institutions to prepare their students with the relevant IT knowledge and skills for the industry.

This in itself demonstrates that higher education institutions recognise their role to provide students with the relevant IT knowledge and skills for the industry. However, it is also noted that, due to the amount of time available to each course in covering a whole range of syllabi, which include aspects such as construction technology, construction management and law, environment and health, etc., IT modules only cover the very basic and fundamental applications such as CAD, estimating and planning software, spreadsheets, the Internet, etc. This phenomenon is supported by research conducted by Barnard (1996) on the teaching of IT skills in higher education. The research found that higher education institutions tend to adopt a laissez faire approach, which limit their delivery to basic low-level hardware skills and industry specific software tools such as estimating, CAD and project planning together with the more general word processing and spreadsheet packages.

This is not dissimilar to the various discreet short courses offered as continuing education for adults discussed in the earlier section i.e. specific IT applications modules to suit specific functions for graduates trained for the industry. For example, architectural courses would focus on CAD whereas Quantity Surveying courses would concentrate more on Excel and Estimating software.

This approach of incorporating IT modules in existing courses mirrors current construction practices whereby the project process is seen as a series of sequential and largely separate operations undertaken by individual designers, constructors and suppliers who have no long-term interest in the success of the product nor a commitment to it. This view is shared by Sarshar (2000): In the last two centuries, the construction industry has approached its work from a functional point of view. In turn, this has meant functional project structures. In this type of structure, each discipline involved in a project carries out its own activities without much thought for how it fits into the activities of other disciplines...The aim is to move towards a focus on the process, or ‘process thinking’, and process-based organisations. In other words, managers in construction need to stop thinking about organizational structure, and start focusing on the processes and how these processes interface with the client. In this new structure, the communication barriers between the various disciplines (and life cycle stages) are reduced, and there is strong focus on the project and the customer.

This is very different from the much-needed integrated approach advocated by Egan and other reports for industry improvement. In fact, this traditional model came under severe attack from both within and outside the higher education system. From an internal point of view, the model does not acknowledge theoretical developments, which break through traditional knowledge boundaries. The increasing proliferation of academic disciplines and their fragmentation into smaller distinctive units is a matter of concern to those who believe that such autonomous units hinder the pursuit of promising interdisciplinary perspectives. Externally, there is a need for higher education to become a more appropriate preparation for occupation fields outside the teaching and research sectors.

Thus, the advocated culture of teamwork and multidisciplinary collaboration cannot be fostered through such courses nor prepare construction professionals with the right IT knowledge and skills in the long run. The central question remains whether this model based on disciplinary views and standards is adequate to meet the demands of an increasingly changing society.
2.3 Interdisciplinary Approach with IT as an Integrating Theme

Many graduates today have been educated and trained within the tramlines of a narrow specialisation. The majority of today’s construction courses are typified by study in depth, lack of breadth, little attempt at integration between topics and lack of industrial and business context. Increasingly, the construction professionals that will be sought are those able to combine their technical skill and competence with business understanding and abilities to manage both people and projects. The requirement for personal skills has been strongly stated, although the need for a wide, but firm technical foundation remains. Courses embodying personal, technical and business education will thus provide a base for a varied career.

An interdisciplinary approach to construction education is not a new phenomenon. A number of reports in the late 1980s highlighted the relative divisive nature of the construction industry in the UK and other Commonwealth countries compared to Japan, USA and other European countries (Collier et al., 1991). A recurring conclusion was the need for greater collaboration amongst professionals and attempts to encourage an interdisciplinary approach have since been gathering momentum through further reports (Burton, 1992; Andrews and Derbyshire 1993; Latham, 1994; Egan, 1998 and Construction 21, 1998) and Conferences (University of Cambridge, 1991; UCE, 1995).

The essence of such reports and conferences appears to be consistent. Many of their recommendations are compatible in terms of desirability of greater cooperation amongst key built environment disciplines, and all recognise that construction education plays an important role; for example: Collier et al. (1991) identified the following objective for future developments:

To encourage the view that students of related disciplines benefit from working and learning together and that collaborative working is a positive and important component in an education programme.

Andrews and Derbyshire (1993) also concluded that:

There is considerable scope for greater commonality in the education, training and continuing professional development of the construction professions.

Wood (1999) summarises the whole scenario as follows:

In the rapidly changing world of business and the built environment, there is an ever increasing blurring of the boundaries between the professions... The interdisciplinary nature of design: people who do not usually see themselves as designers are nevertheless very heavily involved in design at some level... The process and traditional roles are changing: contractors are not just involved in constructing, but designing, financing, managing the whole process through mechanisms such as the Private Finance Initiative... We must acknowledge the reality of overlapping design practice and seek opportunities to reflect this change in the education process.

Consequently a “new breed of people” are required who would only emerge from a completely different approach to the nature of Built Environment education. IT will be the technical key to all of this. IT can provide everyone, from client and designer to site manager and component supplier, continuous online access to a common project database. IT can track all transactions from contract variations to the delivery of bricks and thus address the main problems of the industry such as poor cross-disciplinary communication, lack of process transparency and poor management of industry knowledge (Egan, 1998).

Construction data management is one example of the contribution by IT to support the construction process. The flow of information can be tracked, monitored and constantly updated. This provides avenues for secure storage of design documents and control of the distribution of information. Monitoring of project processes, tasks and deliverables will be much easier. In addition, construction planning can utilise IT to simulate the sequence of construction and analysis by adding a fourth dimension – time, to the design model (Construct IT, 1995). As construction work progresses, staff can update the programming information. Any problems or changes are recorded on the model. This will allow virtual progress monitoring. This reduces ad-hoc decisions on-site and in haste. If the design is changed, due to last minute consideration, as-built information can be captured and handed over to the client. This effectively means that through IT, all the various disciplines from Architects to construction planners and constructors are integrated together via the information model. Hence all parties will understand each party’s problems better and thus enhance communication and ultimately improve the whole construction supply chain.

IT as the integrating theme would result in a future that does not require lines of professional demarcation and construction education must therefore prepare students for this future. Curriculum review should begin by considering the basic functions and operations involved in construction processes, rather than deriving the functions from existing professional disciplines. This does not necessarily equate to the demise of professional construction disciplines, what it will do is foster greater understanding
and collaboration between them, surely a very desirable outcome?

The preceding discussion had argued that an interdisciplinary approach to education could provide graduates with the capability to deal with the challenging employment world in the future as a result of IT penetration. These interdisciplinary graduates can then propel the construction industry forward towards improvement.

3 SUMMARY

This paper largely focuses on the three main responses for construction education providers in the light of changes in the industry, in particular, the need for incorporating construction IT. Lifelong learning is recognised as an important avenue for providing updated knowledge to the working population as a result of constant changes to the skills required. However, it can only solve the short term and specific skills needed by their immediate tasks. Incorporating IT modules into existing construction courses has proven to be the preferred method by many higher education institutions. This approach aims to provide the student with some basic IT skills to help them for their future employment. Due to the limited hours allocated for IT modules to existing construction courses, it can only cover the very fundamental office automation and process support. This again may not be able to provide a group of graduates who can apply IT strategically into construction processes. The interdisciplinary approach is envisaged to be the way that can solve the industry problems of fragmentation and poor communication. By adopting this approach using IT as a main integrating theme, this could possibly be the best response to produce a sufficient pool of knowledge workers for the future.

The discussion from this paper has presented a challenge to construction education providers. Whilst acknowledging that an interdisciplinary approach is the best way forward, it is not easy to adopt such an approach for several reasons. Firstly, the industry itself may not be ready to absorb any of such graduates trained in an interdisciplinary approach as most of them are still practicing based on their own functional discipline. Secondly, the adoption of IT in the construction industry has been slow compared to other industries. As such many of the graduates trained via an IT based interdisciplinary approach may find limited avenues to put their IT skills and knowledge into practice thus creating frustration and doubt on the usefulness of such a course. Thirdly, the lecturers’ may not themselves be ready for such a venture as they were trained in the traditional framework of construction education, i.e., according to the professional disciplines.

In conclusion, further research on the effective implementation of an interdisciplinary approach needs to be done to find an optimum way to prepare graduates in response to the future needs of the industry.

REFERENCES:

Barnard, S. (1996), The IT Skills versus Training Gap in the Construction Industry, Unpublished MSc Dissertation, School of Construction and Property Management, University of Salford
Constrct IT report (1995), Bridging the Gap, Department of Environment
Edkins, A. (2000), Key Considerations for Building Scenarios, Scenario Planning in Foresight, CRISP Consultancy Commission (00/05).
Egan J. (1988), Rethinking Construction, Department of Environment, Transport and Regions (DETR), UK.
Latham M. (1994), Construction the Team, Joint Review of the procurement and contractual arrangements in the UK construction industry, Final Report
University of Cambridge (1991), Education for the Built Environment, University of Cambridge.
### Appendix A

Information Technology Modules Coverage for Courses Offered by Higher Education Institutions in CONSTRUCTION in UK & Singapore

<table>
<thead>
<tr>
<th>Institutions and Courses</th>
<th>IT Modules</th>
<th>Estimated % of IT Coverage***</th>
</tr>
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<tbody>
<tr>
<td>University College London Construction Management</td>
<td>Computing for the Built Environment</td>
<td>4</td>
</tr>
<tr>
<td>University of Reading Building Construction &amp; Management Quantity Surveying</td>
<td>Information &amp; Communication Information Technology</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Information &amp; Communication Information Technology</td>
<td>8</td>
</tr>
<tr>
<td>Loughborough University Commercial Management &amp; Quantity Surveying</td>
<td>Information Technology</td>
<td>4</td>
</tr>
<tr>
<td>Construction Engineering &amp; Management</td>
<td>Construction Management System</td>
<td>4</td>
</tr>
<tr>
<td>UMIST Construction Management</td>
<td>No information available*</td>
<td></td>
</tr>
<tr>
<td>University of Ulster Construction Engineering Management Quantity Surveying</td>
<td>Computer Aided Design IT &amp; Communication</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>IT &amp; Communication</td>
<td>4</td>
</tr>
<tr>
<td>Kingston University Quantity Surveying</td>
<td>No specific modules**</td>
<td>0</td>
</tr>
<tr>
<td>Building Surveying</td>
<td>CAD &amp; IT Management</td>
<td>4</td>
</tr>
<tr>
<td>Oxford Brookes University Building Construction Management</td>
<td>Microcomputer Applications Production Information Systems</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Microcomputer Applications Production Information Systems</td>
<td>8</td>
</tr>
<tr>
<td>Nottingham Trent University Construction Management Quantity Surveying &amp; Construction Cost Management</td>
<td>Information Technology</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Information Technology</td>
<td>4</td>
</tr>
<tr>
<td>University of Plymouth Construction Management &amp; Environment Quantity Surveying &amp; Environment</td>
<td>Information Technology &amp; Management</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Information Technology</td>
<td>4</td>
</tr>
<tr>
<td>Coventry University Architectural Design Technology Construction Management</td>
<td>Information Resource &amp; Technology Architectural &amp; 3D Visualisation</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Information Resource Research &amp; Technology</td>
<td>8</td>
</tr>
<tr>
<td>Institution</td>
<td>Course</td>
<td>Modules</td>
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<tr>
<td>-------------------------------------------------</td>
<td>---------------------------------------------</td>
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</tr>
<tr>
<td>Herriot-Watt University</td>
<td>Construction Management</td>
<td>No specific modules**</td>
</tr>
<tr>
<td></td>
<td>Building Economics &amp; Quantity Surveying</td>
<td>No specific modules**</td>
</tr>
<tr>
<td>University of Salford</td>
<td>Construction Management</td>
<td>IT Applications I &amp; II</td>
</tr>
<tr>
<td></td>
<td>Quantity Surveying</td>
<td>IT Applications I &amp; II</td>
</tr>
<tr>
<td>National University of Singapore</td>
<td>Building</td>
<td>Information Processing, Land Information System, Information technology in Construction</td>
</tr>
<tr>
<td>Singapore Polytechnic</td>
<td>Building &amp; Property Management</td>
<td>Statistics &amp; Computing, CAD &amp; Spreadsheet, Information Technology I &amp; II</td>
</tr>
<tr>
<td>Ngee Ann Polytechnic</td>
<td>Building</td>
<td>CAD, Information Technology, Internet &amp; E-Business, Computer Programming, Construction IT (Electives)</td>
</tr>
</tbody>
</table>

*No information available: Website of the institutions does not provide information on the modules taught

**No specific modules: No specific modules related to IT incorporated into the syllabi.

***Estimated IT coverage is calculated based on the modules related to IT over the total modules taught in the course.

(Note: Most courses cover an average of 24 modules over a three-year duration)