Integration, Isolation and IT Education for an improved Architecture Engineering and Construction (AEC) Industry

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ABSTRACT:

This paper concerns the IT Education of Architecture Engineering and Construction (AEC) professionals. It reflects on the relationship between these professionals and how the AEC Industry should change for the better of all stakeholders. These changes include a greater and improved use of IT, but the implementation of such changes has been disappointingly slow. Central to the associated complications are the difficulties in integrating a variety of people, processes and technologies. The creation of separate professional groupings within the AEC Industry over the past centuries and the associated 'traditional' working processes has had some benefits, but it has hindered integration. The majority of AEC education, including that relating to IT and particularly at undergraduate level, continues to be carried out in isolation. The discussions in this paper include reference to the author's personal experience on interdisciplinary programmes and in the activities of the Construction IT Alliance (CITA). It concludes that if the AEC Industry is to make faster progress towards harnessing the true potential of IT, the education of the different professionals at all levels should be carried out in a more proactive and integrated manner.

Key words – Architecture, Engineering, Construction, professionals, integration, isolation, IT, education

IMPROVING THE AEC INDUSTRY

'We have a vision of an industry which is high in public esteem, applying the best technology to improve Europe's landscape and living environment, building beautiful buildings and creating towns in which people are happy to live in and work, providing good and affordable housing, and efficient uncongested infrastructure. People will be glad to commission construction in the knowledge that it will be normally be free of worry and conflict, and their property will be safe, healthy and easy to maintain. School leavers and graduates will be proud to enter a prestigious, rewarding, creative and secure career which contributes to improving the global environment. Designers and managers will have the computer tools to liberate creativity and to select well-tested products and construction details. Many of the more difficult site tasks will be replaced by mechanisation, factory-produced components, and easy-to-use materials, leaving craftsmen free to use their skills productively. Construction will be viewed by government as a tool for building the future society, by providing efficient infrastructure when and where it will promote useful development, and reinforcing Europe's strength of diversity of cultures, traditions and systems.' [WS Atkins, 1994]

Over the past thirty years the term Information Technology (IT) has grown in both its use and influence. The effects of IT on working and private lives in recent years have been particularly significant and these are apparently set to increase. IT is a major change influence in all industries, including the Architecture Engineering and Construction (AEC) Industry, and this is also likely to continue in the future. During the past ten years a significant number of visions of an improved AEC industry have been published. One such vision expressed in 'Strategies for the European Construction Sector – A Programme for Change' is quoted above, but other government bodies and

institutions around the world have compiled, with the help of local and international experts, similar visions in a range of reports [including Latham, 1994; DoE&LG 1997; Egan, 1998; Construction & Infrastructure Panel, 1999; Built Environment & Transport Panel, 2000]. These reports regard IT as either an important element in an improved future, or the crucial element. Increasingly such reports place greater emphasis on integration. For example in the UK the Strategic Forum for Construction [2003] stated that one of the three main drivers to '*accelerate change and secure a culture of continuous improvement*' is '*the need for integrated teams and supply chains*'.

Whatever the difficulties in generating and publishing these various visions for an improved industry, they have paled in comparison with those of implementing the associated changes. Converting visions into realities in such a fragmented and complex industry was never going to be easy. However it is suggested that a greater appreciation of the development of the professional groups within the AEC industry, including their education, is necessary. Abbott [1999] believes that '*nothing obscures one's vision of the future so much as the confusion of one's experience of the present. That is why it is so important to study history: only then do the features that presage the future stand out clearly.*' The need to incorporate the traditions, (including the evolution of the institutions, the processes, and the human element), into any consideration of the future of information generation and flow in the industry is therefore vital. Central to this consideration is the development of separate professional disciplines and how these professionals can change to bring about a more integrated IT-enabled industry.

AEC PROFESSIONS AND CHANGE

When engineers and quantity surveyors discuss aesthetics and architects study what cranes can do, we are on the right road.
[Arup O., 1970]

AEC enterprises, individual professionals and their respective institutions around the world are grappling with change. The various visions referred to above, the on-going developments in IT and increasing competition have caused a number of institutions to reflect on the future of their professions. Unfortunately the Irish AEC professional institutions have been slow to undertake this process. However the reflection on the future of AEC professionals in other countries and regions, notably the US and UK, has been underway for a number of years [e.g. Turner, 1998; Kolesar 1999; Koonce, 1999]. The relatively obvious (but difficult to answer!) questions about the definitions of the various AEC professions and the differences between them are central to the more advanced of these reflections.

In their study of the future of professionals Gold et al [2001] acknowledged the difficulty that Professional Associations have in preparing '*themselves and their members for an uncertain and dynamic future*'. However they identified the following 'essential factors' in relation to professionalism and the power of professionals to act: '*economic and social recognition; and the nature of information and knowledge processes*'. Gold et al obtained responses from seventy different Professional Associations in their study and among their key recommendations was the need for managers and leaders to '*proactively embrace the future of professional work by demonstrating behaviours of serving and trust in supportive, open and flexible environments*.' This latter proposal would obviously be difficult to implement in those professional institutions that could be classified as reactive and protectionist. Davies and Knell's [2003] more focused consideration of the future for built environment professionals concluded that in order to survive and prosper in the future '*the professions cannot turn their backs on the skills which would enable them to communicate effectively between sectors and between separate stakeholders. Ability*

to manage and exploit social networks and supply-chains will be one important determinant of whether professions are able to make high-quality building seem commercially attractive.' This conclusion would support the importance of integration and IT, particularly in the commercial context of providing better services to clients.

Among the current professionals groups within the AEC industry it could be argued that the Architects are experiencing the most difficulties in dealing with change. In their report The Constructive Change Group at RIBA [2000] identified the need for architects to understand and learn from the changes '*so that their ethics, imagination and knowledge may contribute to the new processes.*' The report referred to the marginalisation of the Architect's role in the UK during the previous fifteen years and warned that '*unless architects act as an integral part of the building industry they will cease to have a significant role in the shaping of the built environment*'. Perhaps the most telling point in relation to the topic of this paper is the statement '*to give real value to clients we need to integrate and be fully integrated into the whole process*'. In the US Richard Hobbs [2000], Resident Fellow at The American Institute of Architects (AIA), also reflected on the future role of architects and the need for greater integration. He pointed out that clients are increasingly demanding '*services that are integrated with and connected to their business strategy*' and that they will select consultation services providers accordingly.

The current discussions being facilitated by the Construction Industry Council [CIC, 2003] in the UK to create a new 'Institution for the Built Environment' which would include all the relevant professional groupings is another interesting development. Whether such an Institution is viable is unclear at this stage, but it would assist in shifting the focus from protection of individual professional disciplines to the collective improvement of the industry. Oakervee [2003] of the Institution of Civil Engineers (ICE) spoke positively about this potential development by stating '*if we can achieve a multi-disciplined, learned society that can elevate the profession, then that should surely be our goal*'. The challenge to each individual professional discipline in this scenario would be to participate in real changes for the overall benefit of the built environment without sacrificing the core strengths of their professional training and expertise.

IT AND INTEGRATION

Integration: the continuous interdisciplinary sharing of data, knowledge, and goals among project participants'.
[Fischer M.,1989]

The IT Construction Forum in the UK [2004] presents a positive view concerning IT and Integration. According to the Forum's website '*IT is enabling ever more realistic and comprehensive project models to be created, by teams that are becoming more closely integrated. These technologies help ensure that work on site is done right first time, that clients are satisfied and that better information is available to all involved.*' The Forum point out that these technologies are helping to achieve the following: '*The entire project team to share information, working on an integrated 3D project model and database; Teams operating more effectively, by linking the systems of different organisations; Provide interactive toolkits to model the benefits of modular construction; Make it easier for organisations to exchange data; Create virtual models that enable all the stakeholders to understand the proposals.*'

Whatever about the on-going difficulties with integrating people and processes in the AEC industry, a number of researchers and organisations are addressing the technical difficulties of integrating IT systems. Perhaps the most important organisation in this regard is the International Alliance for Interoperability (IAI). According to the IAI [2004] '*Alliance members are committed to promoting effective means of exchanging*

information among all software platforms and applications serving the AEC+FM community by adopting a single Building Information Model (BIM).'
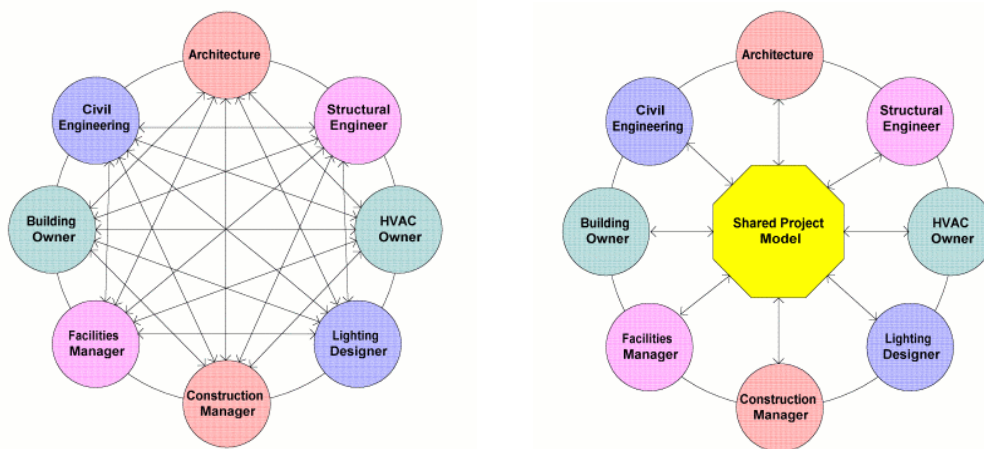

Figure 1:   Interoperability in the AEC Industry [Adapted from the IAI, 2004]

This adoption of a fully-functioning user-friendly shared object-oriented model would certainly be a tremendous asset to all participants on a construction project. However the reality is that the industry is still a long way from the widespread adoption of such models. In their survey of the UK AEC Design Community, Autodesk [2003] highlighted the concerns of the respondents about integration. There was general agreement that although IT developments were facilitating improved integration '*the industry's heritage and innate conservatism is a source of major weakness*'. They majority (56.2%) of those who responded also expressed the view that the '*recent industry/government initiatives such as Rethinking Construction have largely been ineffective*'. However a larger and more recent survey conducted by the IT Construction Forum [2004] generated some more positive results. For example almost half of the respondents said they use project extranets to collaborate online. Furthermore the participating firms indicated that their IT investments over the next three years would focus mainly on improving external and internal communications.

IT AND AEC EDUCATION

In parallel to industry practitioners, AEC Education providers around the world have been struggling to incorporate IT into their activities. Many such providers have invested significant sums of money into computing hardware and software over the past ten years. In Ireland, and presumably elsewhere, there are on-going deliberations as to the extent of computer facilities that Universities and Institutes of Technology can be expected to provide. Included in these deliberations is the recognition of the following trends:
  ➢ an increasing number of students entering AEC programmes with pre-acquired IT skills (e.g. MS-Office, Internet, e-mail, AutoCAD);
  ➢ a growing tendency for students to purchase their own computers during their time on an AEC programme;
  ➢ an increasing pressure on AEC Education budgets;
  ➢ a growing demand for part-time access to AEC education programmes, particularly at post-graduate and Continuing Professional Development (CPD) levels, which incorporate some element of E-learning.

Apart from AEC students learning about IT as part of their chosen programme, the move towards IT-facilitated or E-learning would appear to be gathering pace. Although

the author has some concerns about the extensive use of such facilities, particularly at undergraduate level, if used correctly they can offer significant advantages to both the students and education provider.

One of the concerns about E-Learning is that it could deepen the isolation of an individual student or group of students. IT tools should be used to remove the barriers to integration and it is argued that AEC students learning about IT in a more integrated manner would have a greater impact. In an industry that needs a greater degree of integration between the various participants it is important that they meet physically as well as virtually. Too et al [2002] referred to both the benefits of interdisciplinary 'Construction Information Technology Education' while acknowledging a number of difficulties. These difficulties include '*lecturers' may not themselves be ready for such a venture as they were trained in the traditional framework of construction education.*' There is certainly a possibility, but with good leadership from enlightened heads of AEC faculties and programmes 'integration' can be achieved. This will require the mixing of disciplines, students and staff, and the adjustment of programme learning outcomes.

INTERDISCIPLINARY PROGRAMMES

Two specific examples of multidisciplinary programmes that involve IT Education and which the author has personal experience of are the MSc in International Construction Management (MScICM) and the MSc in Construction Project Management (MScCPM). The former of these programmes (which was previously known as the MSc European Construction Management – MScECM) commenced in 1993. This one year postgraduate course is offered jointly by the Fachhochschule Karlsruhe in Germany (FHKA), the Nottingham Trent University in the UK (NTU) and the Waterford Institute of Technology in Ireland (WIT). To date two hundred and ten students from twenty-two different countries have completed the programme.

The purpose of this MSc programme is to educate managers for the international AEC Industry. The authors' experience of teaching 'IT for the AEC Industry' as part of the Technologies Studies module on this programme since its formation has been very positive (see topics in Figure 2).

➢ *Information & Management*   ➢ *IT Trends*

➢ *Information & Management*	➢ *IT Trends*
➢ *Information Technology*	➢ *Transmission of information*
➢ *Information Flow*	➢ *Bandwidth*
➢ *Multiple Information Systems*	➢ *IT Tools for the AEC Industry*
➢ *Impact of IT on Existing Processes & People*	➢ *IT & AEC in the future*
	➢ *IT – Design*
➢ *Factors Inhibiting & Encouraging IT use*	➢ *IT – Machines/Materials*
➢ *Strategies for improving IT use*	➢ *IT – Management/Collaboration*

Figure 2: IT Education topics on the MScICM 'Technologies Studies' module

Although the students in each year came from different countries, had gained their primary degrees in a range of AEC disciplines (mainly civil and structural engineers, construction managers, architects and quantity surveyors) and had a variety of industrial experience, they generally appreciated the increasing importance of integration and IT in the AEC Industry. Obviously the technologies and the IT skills of the students have developed significantly over the past eleven years, but the non-technical issues relating to the creation and sharing of information in the AEC industry continue to generate the most interesting class discussions. The most obvious

outcome from these discussions has been an increased appreciation of the students for the information requirements of all stakeholders in a construction project and how IT can be used to assist in the improved creation and distribution of such information. In recent years the use of project extranets has been central to the discussions, but the consensus continues to be that the use of the shared project model is still a long way away from becoming the norm on construction projects.

The fact that the MScICM has a management focus encourages the participants to think more deeply about the integration of the various disciplines rather that just the one in which they obtained their primary degree. That is also likely to be the case with the new MScCPM at WIT that is due to commence in January 2005. This has been developed to address desire for AEC professionals in Ireland (principally WIT graduates) for a dedicated Construction Project Management post-graduate programme that can be undertaken without giving up their current employment. The programme will be delivered in a blended learning format (i.e. mixture of E-learning using WebCT and traditional classroom) and will typically be completed over two years. The programme is modular in structure and one of the modules is the 'Management of Information & Communications Technology (ICT)'. Although the author has always believed that IT includes communications technology, the ICT in the title of the module is an acknowledgement of the trend in recent years to emphasize communications. It is envisaged that on completion of this module students will have

   a) reviewed the available ICT that is particularly relevant to the management of construction projects, including relevant case studies/best practice examples from Ireland and around the world;
   b) considered the future development of ICT in general and its potential impact on construction project management;
   c) reflected on the overall impact to-date of ICT on construction and the factors associated with the rate of exploitation of ICT by participants in the AEC industry;
   d) used Project Management software (e.g. Primavera) and a Project Extranet service (e.g. Buildonline).

THE CONSTRUCTION IT ALLIANCE (CITA)

The Construction IT Alliance (CITA) is an example of education providers being proactive in the move towards greater integration and use of IT in the AEC industry. The formation of CITA in 2001 and its subsequent development has taken place mainly through a unique partnership arrangement between two of the leading AEC Education providers in Ireland, the Dublin Institute of Technology (DIT) and the Waterford Institute of Technology (WIT).

The specific objectives of CITA are:
- *To inform the Irish construction sector of relevant IT developments.*
- *To establish and disseminate best practice in the use of IT in the Irish construction sector.*
- *To encourage IT related research and training collaboration between the Irish academic sector and the leading firms in the Irish construction sector.*
- *To establish and maintain links with relevant national and international organisations.*
- *To encourage the strategic use of IT by the leading firms in the Irish construction sector.*

The author is one of the two Directors of CITA and is also a member of the eleven person CITA Board of Management. CITA welcomes membership from all stakeholders who share the CITA objectives and want to help in their achievement. Part of the strategy in the formation and initial development of CITA however was to

actively target the leading participants in the Irish AEC industry. These leading participants play a very influential role and it is recognised that they are key to the improved use of IT in the industry in the short to medium term [Thomas, 1999].

In July 2004 there were one hundred and four stakeholder organisations in the Irish AEC industry who had joined CITA . Member organisations include construction firms, designers, consultants, product suppliers, specialist contractors, IT suppliers, professional institutions, legal, education and government bodies. The need for maintaining a multi-disciplinary membership to CITA is vital as it was recognised from the outset that many of the factors hindering effective IT use in the industry relate to poor integration. A strong a diverse membership should also mean that CITA will be able to help shape the successful development and implementation of future IT innovations in the industry [Thomas and Hore, 2003].

CONCLUSION

A number of reports containing visions and strategies for an improved AEC industry have been published during the past ten years. The need for greater integration, better use of IT and progress towards a single shared information model for each construction project has featured strongly in these reports. However in spite of apparent widespread agreement among AEC industry stakeholders to improve, the implementation of the necessary changes has generally been slower than desired.

AEC education providers could and should do more towards achieving an improved industry. Apart from delaying the desired improvements in the AEC industry, it is strongly argued that education providers are doing the students a disservice by educating them in isolation from other disciplines. While it is not suggested that the desirable qualities and specialist skills that distinguish one discipline from another be eliminated, greater integration and IT education at undergraduate, post-graduate and CPD levels is essential.

Mistrust, misunderstandings and unhelpful adversarial attitudes should not be allowed to develop, particularly in the formative undergraduate education programmes. Students in different disciplines should be encouraged to mix, undertake group assignments, share digital information and generally appreciate the potential contribution of other disciplines to the AEC industry. It is obviously easier for those education providers who already offer a range of undergraduate and postgraduate programmes in the various AEC disciplines to promote and encourage integration. For those that do not have such a range the possibilities for collaboration with other education providers, aided by IT, may be explored.

Regardless of the size and range of current programmes, enlightened heads of AEC faculties and programmes should be able to identify the appropriate balance of integration, isolation and IT in the future education of their students.

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