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The Challenge of the Digital Era

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As an Introduction

To question the usefulness or adequacy of digital technology regarding teaching methods at public educational institutions is as futile and nonsensical as to question the automobile or the television. These technologies are there; they are part of our lives and they are here to stay. Whereas students have already fully embraced digital technology in all the aspects of their life, teachers, including those who are involved in construction lectures, still appear reluctant to comprehend the full spectrum of digital technology offered today, much less train themselves in order to put them to use and exploit their potential. In fact, in a rapidly changing world, teaching methods seem to have changed very little over the past 50 years.

A Review of Recent Developments in Building Technology

During the last EAAE-EHNSA meeting the team of building construction teachers of our Department endeavoured a first approach to the current situation in building construction[1]. I would like to enumerate in brief the major tendencies being in progress, as they have been postulated at the above meeting, namely

1. The shift from manual labour to ready-made industrial products
2. The assumption of building research by institutions outside the universities.
3. The new approaches to building design governed by digital technology.
4. The emergence of Information Communication Technology (ICT), which is likely to revolutionise teaching, as we know it today.
5. The establishment of resource management in buildings as a major tenet, due to recent environmental and political developments

In the following pages we are going to discuss the various ways, in which digital technology addresses building design and construction and point out the advantages but also the dangers ensuing from the adoption of this technology. Next to that we have to raise the question whether and/or to what degree Universities are prepared to deal with these new demands. At first it seems worth the while to review the types of building design technology available today and its applicability in the field of building construction.

Building Design Technologies

The Software

Geometry-based Software

This is the geometry-based CAD technology used by engineers for several decades. These applications provide drafting automation quite effectively and with little effort. However, in order to meet the demands of more complex objects, the levels of necessary effort become much higher. In addition, layer and naming standards must be introduced, when interaction and use of databases is required.

A standard 2D CAD-package requires relatively little storage capacity and hard-

ware potential and offers a number of possibilities, such as exporting drawings in a variety of formats to other applications as well as the web. In addition, these formats, e.g. DXF facilitate the interaction with databases

Object CAD Technology

Object CAD Software simulates building components in a CAD-based environment, focusing on the 3D geometry of the building. From the 3D geometry it derives 2D documentation and provides information about quantities and object properties. Object CAD technology is based on CAD and is therefore relatively easy to implement. Still, its effectiveness is contingent on user discipline and reliability and often fails to provide a high level of integrated information on the building's features.

This technology facilitates a better understanding of the building, especially to students and can be effectively applied to coordinate the various representations of the building. At this level of CAD technology, certain traditional tasks, such as the modelling of stairs and roofs become things of the past. The student can easily conceive the spatial features of a building and in addition save time and energy that can be invested in dealing with more complex tasks within the building design process.

The crucial issue however is whether a student using such software really makes use of its potential in order to fully understand the numerous aspects of the building process or merely exhausts his creativity in exploring the capacities of the software itself. Students very often tend to succumb to the 'lure' of photo-realism. Very often photo-realistic imagery is devoted to the satisfaction of the epoch's appetite for photography. It does not state much about the real building, its materials and much less how it is going to perform in the long term.

Photo-realistic representations require a lot of storage and Random Access Memory.

Parametric Building Information Modelling Technology

This is a new generation of design packages. They combine a data model consisting of geometry and data with a behavioural model (change management), which is supposed to simulate a real-world system, such as a building[2]. This technology introduces a radically new approach to building design. The basic features of this type of 'intelligent' software are:

- An integrated database with information about the entire building
- An instant feedback of any change to the relations among objects on the rest of a project.
- Availability for user definition of all relationships within the model.

The use of intelligent 3D models instead of paper drawings is likely to pervade all building design sectors. Still it calls for second thoughts.

This new approach implies a notion of building design very similar to that of mass-produced product design, e.g. cars and airplanes. Yet one must keep in mind that the above products are subject to laws of economy very different to those of building construction. We are dealing with different production scales, amortisation costs, transportability and dependence on on-site construction. Even when architects propose products involving customised mass production, they stand against a great number of conflicting laws and regulations, varying standards and different mentalities of local trades[3]. The crucial issue regarding buildings is to determine which quanti-

ties can be considered parametric (variable) and what can be taken as a standard or constant.

Innovation in building certainly entails digitally enabled manufacturing. Still, the key prerequisite to achieve and profit from such innovations is not more digital design technology. What is really needed is to establish practical strategies for the purposeful exchange of meaningful information between the many tools applied to building processes. The essential requirement, given that building design and data computability are resolved, is the so called 'interoperability', that is making the information accessible to the relevant parties involved in the building process. There are a myriad of design tools available today and moreover there are numerous applications that operate on design data and provide analytical insight. This is not a negative aspect, as it is unlikely that one CAD system alone can provide all of the means necessary to deal with the diversity and breadth of design and analysis problems in the building process. Monolithic data models and software that are meant to do everything most of the times fail in their ambition to do so. We finally come to realise that purpose-built data models and applications are more apt to meet a designer's needs. Innovation proceeds more quickly with loosely coupled, purpose-built applications than with large, interconnected, interdependent ones. A practical strategy today in order to communicate between various applications relies upon the use of commonly accessible conduits from one application to another. An example are .DXF formats, a protocol to transfer data from a CAD application to others, such as acoustic design applications or the .gbXML Format that exports model data to an energy analysis application[4].

Purpose-built Applications

Structural Engineering Software

These packages mainly address civil engineers, but are also quite useful to building designers to gain an overview of the loads, dimensions and masses involved. These applications manage loads, design beams, walls, columns, girders etc. and allow non-graphical editing using spreadsheets. They cover most of the construction materials, such as concrete, wood, hot and cold rolled steel. There are also packages managing tensile structures. Sufficient skills and knowledge are required and there has not been yet an effort to coordinate the numerous products on the market, so as to allow for better coordination among designers.

Building analysis software

As energy management in buildings has unequivocally become a dominant tenet in building design nowadays, this kind of software deserves closer attention. These products feature a more or less designer-friendly 3D modelling interface, integrated with solar, thermal, acoustic and in many cases cost functions. The value of these applications lies in the support of conceptual design, apart from a final stage validation. This means that, even before the building form is definitely considered, one can already draw vital design information using simple sketches. This information includes available solar, light and wind resources and choice of materials. In this way the designer can avoid abortive work on inappropriate design options. Building analysis packages have an interactive approach to analysis that allows for testing orienta-

tions, shapes and materials and comparing changes in a building's thermal performance, acoustic response and light levels. These applications offer the possibility to meet important decisions from the very start of a project.

Web-Based Databases

Databases originate from various sources.

Industry

Today a large variety of building components and subsystems are factory-built, using mainly digital processes: Doors and windows, fabrics and carpets, furniture systems, mechanical equipment, elevators and also entire roof and façade systems. It lies in the interest of the manufacturers, besides advertising their products, to offer information including images, CAD drawings and technical specifications. However neither professionals nor students are yet able to extract much value from them. The reason is the deliberate use of representation styles. Even drawings in DXF or DWG format are hard to handle, because of strongly varying drawing and layout standards. But the greatest danger lies in the temptation of a random, non-critical adoption of ready-made drawings. It does not take long for one to realize that no matter how perfect the product; there is no guarantee that its performance is satisfactory. Very few firms offer mounting details and even then, they do not take any responsibility about a product's adequacy for a particular project or the interoperability between different building components.

Independent Institutions

Several institutions publish information and databases on the web all over Europe and the entire world. These institutions are research centres and teams, unions of engineers, trade branches, local and national authorities, non-profit organisations, institutes etc. Their purpose is to disseminate objective and practical information on all aspects of building, construction, engineering and research. Without any intent to question their objectivity, one cannot overlook the fact that, as far as building construction is concerned, all information is based on local standards, regarding climate, construction methods and codes. This creates certain disparities between the north and the south. In southern European countries we observe a backlog on research and correspondingly a lack of analogous information pools. In these countries, any direct adoption of information originating from central and northern European sources would harbour the danger of being non-applicable or even misleading, since there are considerable differences in climate, building practices, available materials, actualities and regulations between northern and southern Europe.

Universities

In face of the deluge of information streaming in from a multitude of sources, many teachers, individually or as a team, are already attempting to compile databases consisting on articles, basic construction details and bibliography. Many pools of infor-

mation come into existence. These 'in-house' resources are useful as long as issues are concerned regarding local conditions and standards. However, no institution can claim to possess all the information or knowledge required to meet the demands of an increasingly globalised society and economy. Information cannot remain stagnant; it has to be continuously renewed, enriched and diffused. For example, guiding students to Internet resources and the use of book publishers' web-based resources could be a viable alternative to creating 'in house' resources. This brings one step closer to the next issue, namely the potentials of e - Learning.

ICT Technology

E- learning, as part of the broader spectrum called Information Communication Technology (ICT) is not really a new paradigm in education. It is a technology arriving at a crucial time to underscore the necessity of a shift in pedagogical methods and mentalities. Practically, technology is being used to re-interpret the pedagogies of traditional teaching, namely lecture, seminar discussion, testing etc. The methods do not differ substantially, only the delivery is notably different[5].

Initially the software used to convey knowledge was one for 'drill and practice'. Thanks to technological advances in informatics we have had a considerable evolution of e–Learning technologies. Artificial intelligence techniques and methods allow a personalisation of the interaction that takes place, of exercises and responses. Systems available today range from simple exercise programmes to multiple-environment systems supporting micro worlds, exercise tools, communication environments, simulation systems etc. ICT is likely to precipitate a re-engineering of familiar systems and processes. It facilitates an improved library and research environment with instantaneous access to on-line journals and resources. Universities use web-based platforms as Learner Management Systems in an attempt to support and enhance traditional methods of teaching and learning in the belief that efficiency gains and flexible modes of providing knowledge may be achieved. Another aspect underlying this method is a potentially increased transparency at a time when rigorous academic quality assurance and accountability are demanded.

At first one can mark the differences between e-Learning and face-to-face learning by considering the below basic elements:

Acquisition of information

e-Learning brings the process of information acquisition more directly under the control and responsibility of the learner. The teacher acts merely as a mediator and is either non-existent or takes up a role of counsellor.

Transformation of information into knowledge

The learner enters a world of almost infinite sources of information with little or no guidance. With no one there to judge, evaluate and elicit information, the transformation process is open and subject to individual choice and judgement.

Validation

There is only a small difference between e-Learning and other types of pedagogical methods. The issues and techniques remain more or less the same.

As e-Learning is putting an extra pressure on the institutions, once again we come face to face with the question: Can technological tools guarantee knowledge all by themselves?

In fact, learning is learning. Educationalists ought to concentrate on the learning component rather than the 'e'. Undoubtedly, e-Learning, as a methodological instrument, is by its nature highly visible, public and democratic. But, in order to enable these methodologies, educational institutions must be sure that a reliable and adequate technological infrastructure is provided, that the pedagogical and graphic design of the content is of high quality and that the level of interactivity is appropriate. Undoubtedly, a single institution cannot achieve these goals all by itself.

The Role of The Teachers

Technology keeps moving forward without pause for reflection and consideration of the outcomes for learners. As is does so the question that arises is: If everything can be done on-line, do teachers at public universities still have any function? The answer lies in comprehending the rapid changes education is subjected to by a rapidly changing world. The processes taking place slip out of both the learners' and the teachers' grasp. Information Communication Technology, the Internet, CAD applications and whatever technology besieges educational institutions may speed up evolution, but they are not the initial reasons for change.

A long drawn educational debate has evolved around problem-based learning, situated learning, process writing, differentiation, project based work etc. All these issues are part of this debate because the world is changing and learners as well, not because the Internet was invented. Most academics lack the insight and the frameworks to analyse digital technologies and apply them to their educational processes. They are only able to use the methods by which they themselves were taught. The attractiveness of the auditorium is dwindling, not at last because of teachers' traditionally acquired habits. Shrinking budgets, quality control processes, reorganisations and consequences of earlier important decisions have taken away motivation to engage in anything else but just trying to prove that one is a good teacher/researcher. Many teachers have not yet accepted the challenge of digital technology and many are not yet aware that new generations of students are totally different in this respect.

Given that the process of information acquisition is open and subject to individual choice and judgement, it becomes both challenging and dangerous. There is a serious risk that digital technologies can establish surface habits among students instead of deeper learning. This openness of information transfer may facilitate students to access information first and apply it without judgement and evaluation.

Traditional contents of construction teaching become obsolete, since software does it faster and better. CAD Software eliminates time and opens possibilities for a most global vision of the building process.

As industry research advances, technologies considered to be up-to-date a few years ago are meanwhile outdated. It is essential that teachers be prepared to constantly acquire information, evaluate new data and assist students in their effort to transform information to knowledge.

Educationalists should realise these facts and acquire sufficient competences to utilise all these tools and channel learners to the right path. If learning is considered as a mere transfer of information, it is of no value. There is a need for academics to see themselves as teachers, facilitators and mentors. Teachers need to analyse and evaluate the learners, understand their needs, requirements and preferences before they immerse themselves in technology. At the same time, they should be aware of the dramatic shift of tasks and roles taking place on an almost daily basis.

Changes in education must not be brought about by the technology, but by an interaction between teachers and students, technology and learning.

As a Conclusion

Innovation and knowledge are increasingly becoming the decisive sources of wealth. They are also the main sources of difference between nations, businesses and people. The acquisition, analysis and effective use of information will be the key to promoting and sustaining competitiveness.

The globalisation of society and the rise of a knowledge-based economy have combined in the past decade to impose drastically raised expectations upon higher education institutions. The vision of the new university emphasizes more than before the role of market forces in shaping the institution, the urge to respond to peoples' needs and the necessity to deliver knowledge continuously through lifelong learning.

Are universities prepared to take advantage of modern digital technologies, to collaborate, to exchange products and expertise, to acknowledge study programmes and credits from each other? The majority of public educational institutions are still unprepared to reorganize themselves to address these new demands.'

Notwithstanding, universities should not become supermarkets for modules and popular courses, delivering 'pure e-learning' in competition with private enterprises. They should take advantage of their solid academic basis and introduce study programmes that add something positive to the existing situation.

A way to achieve this goal is the collaboration among institutions, the exchange of courses, staff, expertise and students, thus increasing their attractiveness and variety of courses available. Collaboration among universities and with media organisations eliminates wasteful duplication and variable quality of courses, material and resources and achieves lower cost, flexibility, involvement and high quality of peer review. Combinations of on-line learning and physical meetings with students may be a preferable way of organizing study programmes. Each student then still belongs to an academic university, not an anonymous e-learning institution.

Unless the public sector educational institutions are able to offer greater openness and flexibility, they will be challenged by other alternatives, such as for-profit private universities and technology driven virtual universities. As long as the Internet and global distribution of courses and learning material keep on expanding, the old universities will lose power and status unless they enter the bandwagon.

References

1 Panagiotopoulos, N., *New Realities and Emerging New Tasks in Building Construction Teaching*, EHNSA 2004 Procedures, Thessaloniki, Greece, 2004, p. 152
2 Autodesk, White Paper. *Building Information Modelling in Practice*, www.autodesk.com/buildinginformation, July 2005, p. 5
3 Sanders, K., *Why BIM Isn't Working…Yet*, www.archrecord.construction.com/ features/digital/archives August 2005, p.3
4 Bernstein, Ph., G., Pittman, J, H., *Barriers to The Adoption of Building Information Modelling in The Building Industry*, Autodesk Building Solutions, White Paper, PDF, www.autodesk.com/buildinginformation, November 2004, p. 9.
5 O'Hagan, C., *What's e-Learning: New Paradigm or New Toy?,* www.elearningeuropa.info, Article of September 2003, p.1

Bibliography

Panagiotopoulos, N., *New Realities and Emerging New Tasks in Building Construction Teaching,* EHNSA 2004 Procedures, Thessaloniki, Greece, 2004

Jameson, F., *Postmodernism, or, The Cultural Logic of Late Capitalism*, Durham, NC: Duke University Press, 1991

Autodesk, *Building Solutions*, White Papers, www.autodesk.com/buildinginformation

Sanders, K., *Why BIM Isn't Working…Yet*, www.archrecord.construction.com/ features/digital/archives August 2005

ECOTECT, Manuals, www.squ1.com/ecotect

Brufee, K., *Collaborative Learning: Higher Education, Interdependence and the authority of Knowledge*, Baltimore, J. Hopkins University Press, 1993

Skilbeck, M., *The University Challenged – Review of International Trends and Issues with Particular reference to Ireland*, Dublin, Higher Education, Authority and Committee of Heads of Irish Universities, 2001