A Casebase of Intelligent Buildings for E-learning Systems

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Abstract: This paper presents the conceptual description of a knowledge base for teaching and learning the programme of MSc Intelligent Buildings, which is being developed at the University of Reading and being developed into a global Master degree program. The knowledge base aims to support currently used e-learning tools such as Blackboard, and to make a knowledge engine to facilitate other relevant research into intelligent buildings. A pilot knowledge base is introduced to demonstrate the usability and acceptability of the knowledge base, which is designed according to a standard classification of intelligent buildings and a generic knowledge format to regulate case collection and reuse in teaching and learning. This paper initially covers undetermined issues such as case-based teaching and learning in intelligent buildings related programs.

Key words: intelligent buildings, case method, e-learning, knowledge management

1. INTRODUCTION

At present, there are two levels of degree programmes concentrated on intelligent buildings around the world. The first level is for bachelor's degree study, which is a three-year full-time first degree course uniquely provided at the Temasek Polytechnic in Singapore, called "Diploma in Intelligent Building Technology", which mainly focused on the technological aspect of intelligent buildings. The second level is for master's degree study, which is a one/two-year programme currently provided at three universities around the world (one in the United Kingdom and two in Hong Kong, China (see Table1)). For example, The University of Reading in UK launched established the world's first Master of Science (MSc) programme in intelligent buildings, called MSc Intelligent Buildings, in 1997, which is initially funded by the UK Engineering and Physical Sciences Research Council and co-ordinated by the School of Construction Management and Engineering at the University of Reading. This innovative programme is set up based on an interdisciplinary approach and it aims to support the holistic process towards intelligent buildings by promoting leading edge philosophy, design, construction and management using an appropriate level of technology, balanced with business and sustainability considerations; and the MSc Intelligent Buildings in UK provides a flexible schedule for students to take one-year full-time study or two-year part-time study.

The degree programme of MSc in Intelligent Buildings is unique for students to further develop their knowledge and techniques in modern architectural engineering, building services engineering and facilities management. As mentioned above, there are currently only few such MSc programmes around the world (see Table 1). At The University of Reading in UK, the MSc Intelligent Buildings has been designed in

collaboration with industry to meet the needs of practitioners within the construction sector. In order to achieve this purpose, internationally recognised professionals from over 70 leading organizations and companies actively contribute to the programme as along with leading experts from academia. For example, the programme is strongly supported by the European Intelligent Building Group and the Dytecna Ltd.; it became an accredited provider of Continuous Professional Development (CPD) course for the Royal Institute of British Architects (RIBA) in 2002, and an accredited provider of CPD course for The Chartered Institution of Building Services Engineers (CIBSE) (2005) and in 2005; moreover it became a member of the Continental Automated Buildings Association (CABA) from Canada. Besides, there are two similar programmes currently in Asia provided by the Hong Kong University of Science and Technology (MSc in Intelligent Building Technology and Management), and City University of Hong Kong (MSc in Building Engineering (Intelligent Building)). Table 1 gives a comparison of curriculum among current programmes of MSc in Intelligent Buildings. According to the comparison, current courses adopted in MSc Intelligent Buildings cover a wide range of professional subjects, including building design, building construction, building operation, management, economics, and social science, etc. Although each has some strong points to be recommended, the MSc Intelligent Buildings in Reading is masterly in the contents of courses, and it has been accredited by some famous professional bodies such as CIBSE and RIBA in the building professions.

In addition to these specially designed degree programmes of intelligent buildings, some universities around the world, who currently do not have such degree programmes, also provide short courses relating to intelligent buildings. For example, the Concordia University in Canada provides a course entitled Intelligent Buildings (Course No.: BLDG 6761), which comprises the relevant subjects (Concordia, 2005), including Issues related to the Intelligent Building; Automation, Communication and Security; Mechanical, Electrical, Electronic Subsystems and Their Integration within the Building; Configuration and Operational Characteristics; Performance Specifications; Analytical Models; Design Methods; Case Studies; and A Project. As the development of intelligent buildings requires more expertises, many universities actually have been planning to engage their new relevant programmes as well (Shou, Han and Yan, 2005). In this regards, courseware becomes more and more important for universities, who currently have or will have programmes relating to intelligent buildings, to keep strength and advantages in their programmes or short courses.

E-learning has rapidly advanced to a mission-critical component of an institution's both on-campus and distance educational environment, and has become a fixture in tertiary education (WebCT, 2004; Stanton, Chotiner, Farrar, and Pennington, 2005); there are still large spaces of innovation accompanying the fast development of information and communication technologies (Steeples, Jones, and Goodyear, 2002; Dunn, Morgan, O'Reilly, and Parry, 2003). It has also been noticed that the tight structure and fully embedded support toolkits of current WebCT or Blackboard system make it more appropriate for guided learning than independent learning (Marshall et al., 2003), while the latter one is generally recognised and emphasized in most courses in tertiary education. On the other hand, case method was pioneered by faculty at Harvard Business School in the 1920s as a way of importing slices of business reality into the classroom in order to breathe life and instill greater meaning into the lessons of management education, and it has become a major teaching method adopted at leading business schools (LBS, 2003; HBS, 2004); it is also believed that the case method can help students make the most of experience, providing a solid foundation that serves them for a lifetime, no matter what path they choose to follow. Although it is acceptable that students are required to make a defensible decision without all data they would desire due to the shortage of necessary data (Davis, 1972), the case method can

either potentially accelerate experience or knowledge transformation from on-site accumulation to practice-driven efficient the education of intelligent buildings, or effectively replenish and develop courses of intelligent buildings with a rounded knowledge coverage of various cases instead of limited fieldwork. Moreover, another potential of adopting the case method is that it provides an occasion or possibility to integrate scattered knowledge into specially designed case studies. As students might not have rounded knowledge or a developed knowledge system of intelligent buildings, it is also important to provide an appropriate knowledge network (Novak and Gowin, 1984; Clarke, Randal, and Rutherford, 1989) to facilitate e-learning processes. Although case method is currently adopted by construction MBA programmes at some universities in Europe (Reading, 2004; Oxford, 2004), it is noticed that the number of cases is much small, and there is a huge potential for both business schools and built environment schools to acquire high quality hand-on cases in their building related courses. Based on all these considerations, the authors of this paper think that an e-learning oriented case method is most adaptable for the MSc Intelligent Buildings.

In order to support courseware development to facilitate adopting case method in teaching and learning MSc Intelligent Buildings, a research project was proposed by the Intelligent Buildings Research Group at the University of Reading in 2005, which aims to develop a knowledgebase system to support teaching and learning in the programme of MSc Intelligent Buildings. There are two deliverables from this research project, i.e. two formats of the knowledgebase, including an online portal and a portable CD (Compact Disc) (see Figure 1). The knowledgebase in both formats has relevant functions to support currently used e-learning tools such as Blackboard to effectively train both on-campus and distance students. It is expected that the knowledgebase can help students to obtain essential knowledge about applied technologies of intelligent buildings, in the mean time to gain mature, active and independent learning ability. This paper aims to introduce a knowledgebase designed for the MSc Intelligent Buildings at the University of Reading. Further research and development of this knowledgebase are also discussed.

2. METHODOLOGY

The research methods adopted in this project include literature review, interview, case study and assessment, system analysis and development, etc. All research methods are adopted in sequence to achieve the final target, i.e. a practical knowledgebase system for on-campus and distance courses about intelligent buildings, which are conducted either in classrooms or via Blackboard (see Figure 1). Meanwhile, specific research methods are adopted focusing on research objectives, including the classification of educational knowledge about intelligent buildings; the prototype of the knowledgebase system; a knowledgebase shell for accessing knowledge materials; the retrieval, evaluation, collection andaccess of knowledge materials; and some theoretical work such as a multi-criteria assessment tool for knowledge materials evaluation. Questionnaire surveys and statistical analysis are complementally adopted for defining knowledge evaluation criteria for the knowledgebase. Research methods to achieve individual objectives are described below The literature review aims to obtain comprehensive understanding about current practice in case-based teaching in the building professions. Information such as educational knowledge management is extremely important for the literature review; and the review is conducted to continuously pursue professional and academic publications, reports, guidelines as well as courseware from selected resources through Internet and interviews. Teaching and assessment in intelligent buildings related courses from worldwide tertiary education are all focuses in the literature review.

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Tab.1 A comparison of curriculum among current MSc Intelligent Buildings programmes.

Items	Courses (*in alphabet*)		
	University of Reading	Hong Kong University of Science and Technology	City University of Hong Kong
Core Courses/Modules	Building Systems, Architecture & People Concepts, Strategy and Management Engineering Intelligence into Buildings Financial Analysis and Investment Appraisal Information Technology and Communication Systems	Intelligent Building Facility Management Intelligent Building System	Advanced Electronics and Information in Buildings Building Services Systems Facilities Management Green Building, Architecture and People Intelligent Building Assessment Professional Research Methods
Elective Courses/Modules	Applied Informatics Design Management and Briefing Facilities Management IT Project Management & Planning Research Methods Principles of Project Management Sustainable Design, Construction and Operation Workplace Planning and Design	Advanced HVAC Systems Advanced Energy Conversion Systems Application of Air Pollution Modeling and Control Architectural Acoustics and Audio Systems Computational Methods in Building Environment Design Conduction Heat Transfer Energy Management in Buildings Facilities and Quality Management Finite Element Methods Fluid Dynamics Impact Analysis – Physical, Economical and Social Aspects Impact Engineering Independent Study Indoor Air Quality Technology and Management Materials in Built Environment Occupational Safety and Health Issues in Buildings Risk Management and Decision-Making in Intelligent Building Special Topics in Intelligent Building Systems Special Topics in Mechanical Engineering Vibrations and Mechanical Signature Analysis	Advanced Electrical and Elevator Engineering Advanced Fire and Plumbing Engineering Advanced HVAC Engineering Advanced Project Development and Appraisal Advanced Structural Engineering Building Defects Diagnosis and Repair Built/Natural Environmental Harmony Construction Economics and Finance Contract Strategy and Cost Control Cost Planning and Building Services Measurement Legal Studies for the Built Environment Open Systems for Building Automation Strategic Operation and Maintenance

The case study and assessment aims to collect adequate cases for establishing the knowledge base. During the process of case acquisition, the classification of knowledge materials, which is a classification of intelligent buildings for managing knowledge materials inside the knowledgebase, is essential for a user-friendly system. Meanwhile, all knowledge materials need to be assessed by course directors before providing to students. To assess case materials, a multi-criteria assessment approach need to be used based on a knowledge mapping network (Novak and Gowin, 1984). Some professional specifications and relevant standard industrial classifications need to be reviewed for making the educational knowledge classification for the knowledgebase, include the MasterFormat, the North American Industry Classification System, the United Kingdom Standard Industrial Classification, the Australian and New Zealand standard industrial

Classification, and the New York City Building Classification Codes, etc.

The system analysis and development aims to make a user-friendly software environment to realize specified functions of the knowledgebase. During this process, web-based database technologies such as database programming and interface design are required. In addition, as e-learning system such as Blackboard has been adopted in many universities in many western countries, it is essential to make a smooth interlink between the new knowledgebase and the Blackboard system.

During the whole period of the research project, process loops among different research tasks at different stages are adapted in order to smooth problems or difficulties that may occur occasionally. Moreover, required data are obtained from literature review, experimental research and case studies under a holistic plan to support further research tasks as well.

3. A PILOT CASEBASE

In order to demonstrate the usability and acceptability of the knowledgebase, a pilot research has been conducted to develop a demonstration knowledgebase (see Figure 2). There are two main columns separated on the main screen of the knowledgebase interface. The left section is a structure of the knowledgebase, while the right section is used to display detailed contents of a case. In this pilot research, buildings are classified into four main kinds at the first level of intelligent buildings cases, including residential buildings, commercial buildings, industrial buildings, and public facilities. All of them are then divided to different sub-classes at the second level based on various types of buildings in different classes; and at the third level of cases, the name of countries are used to indicate the location of each buildings. For example, Figure 2 describes a case study about The German Centre of Industry and Trade in Japan. At present, case studies are conducted following a unified structure of contents, which includes Introduction, Architectural design, Structural Design, Services systems, Lifecycle cost analysis, Assessment result, and Relevant resources.

4. CONCLUSIONS

This paper provides a review on the current programmes of MSc in Intelligent Buildings in United Kingdom and Hong Kong, and makes a comparison of core and elective courses/ modules among three similar MSc programmes in Intelligent Buildings, which are being provided at three universities An e-learning oriented prototype of using knowledgebase to support case-based teaching and learning in MSc Intelligent Buildings is then illustrated..

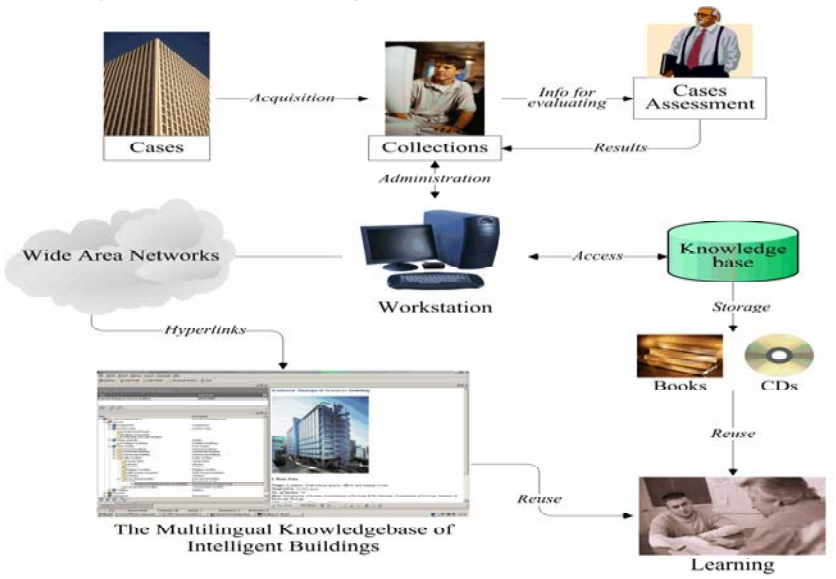

Fig. 1: The architecture of casebase development.

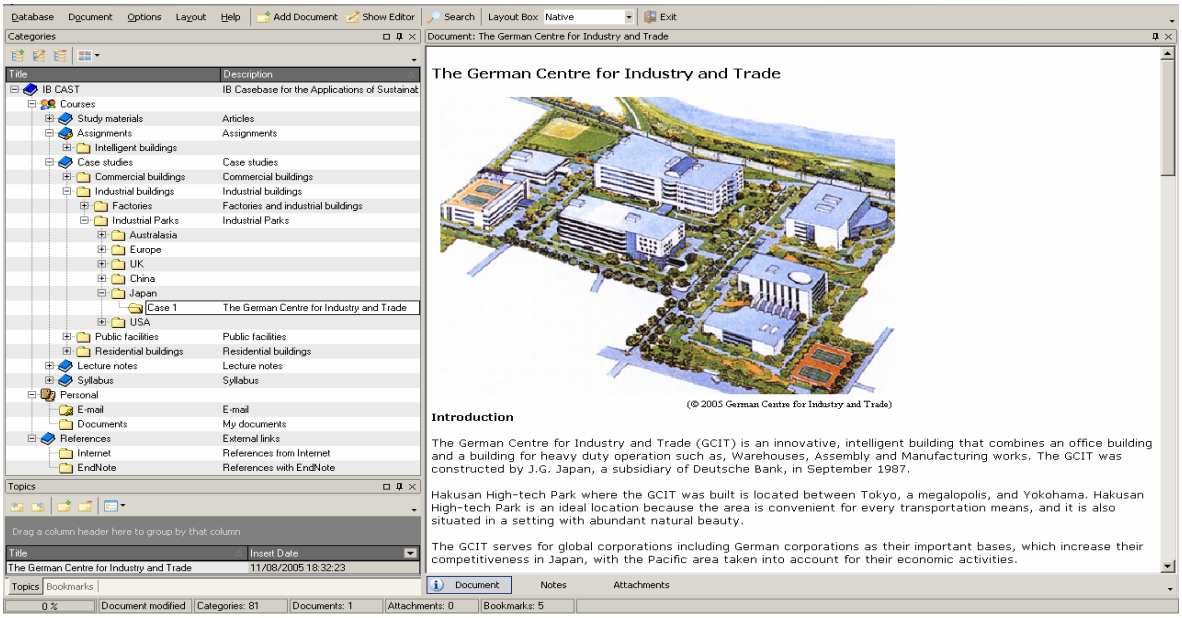

Fig. 2: A screenshot of the pilot casebase.

In order to support on-campus and off-campus study, the knowledgebase has been furnished two main kinds of formats, including web-based portal and CD. Research methodology, including literature review, case study, system analysis and development, has been discussed regarding how to achieve specific research objectives. Finally, a pilot knowledgebase is used to demonstrate the usability and acceptability of the new e-learning tool for MSc Intelligent Buildings at the University of Reading. It is expected that the knowledgebase will effectively, efficiently and economically facilitate the general deployment of case method into teaching and learning in programmes of intelligent buildings.

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