ABSTRACT

Most advantage construction and real estate libraries select, organize, retrieve, and transmit tacit and explicit information/knowledge. Different reports contained an explicit criticism of the libraries’ focus on their specific collections and a recommendation to focus more on user needs. There is a need to overpass the key limitations in the development of traditional libraries, which have been developed for a particular content and a specific group of learners. We suppose that the future libraries will become a practical knowledge storehouse and will offer intelligent opportunities for people. In order to increase the efficiency and quality of EURASIA project activities, an Intelligent Library and Tutoring System for EURASIA project (ILTS-EAP) was developed. ILTS-EAP have the ability to personalize, maximum-reuse, index, analyze and integrate valuable information and knowledge from a wide selection of existing sources in all building life cycle. ILTS-EAP is briefly analyzed in the paper.

Keywords: Construction and Real Estate, e-Libraries, e-Learning, EURASIA project, Intelligent Systems.

1 INTRODUCTION

As digital libraries become more popular, information and knowledge overload has become a pressing required literature searching problem. Problems with search on digital libraries will worsen as the amount of information and knowledge increases. Traditional digital libraries often
index words and documents when learners think in terms of topics and subjects. As a result, learners cannot without problems determine how well a particular topic and subject is covered, or what types of searching will provide required information and knowledge.

Search engine rankings have been adopted in the most advanced intelligent libraries (Alexandrov et al., 2003, Gutwin et al., 1999, Hsinchun et al., 1998, Kaklauskas et al., 2006, Ruch et al., 2007, Trnkoczy et al., 2006, J. Wang, 2003) and tutoring systems (Armani et al., 2000, Brusilovsky, 2000, Day et al., 2007, Lucence, 2005, Pouliquen et al., 2005) recently. As part of the ongoing Illinois Digital Library Initiative project, the research proposes an intelligent personal spider (agent) approach to Internet searching, which is grounded on automatic textual analysis, general-purpose search and genetic algorithms (Hsinchun et al., 1998). Pouliquen et al. (2005) use parsing techniques to extract information from the text, and provide a proper semantic indexation which is used by a medical-specific search engine. Day et al. (2007) use the Jakarta Lucene full text indexer to index the full text of the textbook. Jakarta Lucene is a high-performance, full-featured text search engine library written entirely in Java. The technology is suitable for nearly all applications that require full-text search. It is also readily available and has a good API for our needs. ITA (Pouliquen et al., 2005) index the chapters, sections, and subsections of the textbook. Highlighter is used to highlight the index context. Finally, the ITA provides reading recommendations for students via the chapter similarity function.

However, intelligent libraries (Alexandrov et al., 2003, Gutwin et al., 1999, Hsinchun et al., 1998, Kaklauskas et al., 2006, Ruch et al., 2007, Trnkoczy et al., 2006, J. Wang, 2003) and intelligent tutoring systems (Armani et al., 2000, Brusilovsky, 2000, Day et al., 2007, Lucence, 2005, Pouliquen et al., 2005) with search engine rankings cannot select chapters (sections, paragraphs) of a specific text which are the most relevant to a student, cannot integrate them into learner-specific alternatives of teaching material and cannot select the most rational alternative, i.e. cannot develop alternatives of training materials, perform multiple criteria analysis and select the most effective variant automatically. However, an Intelligent Library and Tutoring System for EURASIA project (ILTS-EAP) can perform the aforementioned functions. No one thought of above function before, so this attempt is the first (rare). The approach helps students to obtain suitably tailored material for an e-learning course. Above and other improvements are possible by using the ILTS-EAP.

The EURASIA (EUROPean and ASIan Infrastructure Advantage) project is being carried out with the financial assistance of the European Union under the Asia-Link Programme. EURASIA aims to enhance the capacity of the partner institutions for training, teaching and research activities required for the creation and long-term management of public and commercial facilities and infrastructure. One of the main activities includes development of a professionally accredited postgraduate curriculum,
design and delivery of training courses. In order to increase the efficiency and quality of delivery of above training, teaching and research activities, an Intelligent Library and Tutoring System for EURASIA project (ILTS-EAP) was developed.

The e-learning Master Degree studies Construction Economics, Real Estate Management and Internet Technologies and Real Estate Business were introduced at Vilnius Gediminas Technical University in 1999. There are currently 225 master students from all over Lithuania studying in the e-learning Master’s Degree programs. ILTS-EAP also is used for these e-learning Master’s Degree programs.

This paper is structured as follows: following this introduction, Section 2 describes the application of ILTS-EAP for e-learning. Section 3 depicts the possible use of the ILTS-EAP at all stages of a building life cycle. Finally, some concluding remarks and future works are provided in Section 4.

2 INTELLIGENT LIBRARY AND TUTORING SYSTEM FOR EURASIA PROJECT

The intelligent library (library of e-learning modules) in construction and real estate sector should have the following functions:

- Customisation and personalization function. Learners are central to the library of e-learning modules and all efforts to develop e-learning modules should be based on the need to provide interesting, practical and innovative knowledge to learners. Customisation and personalization function serves students with various goals and characteristics: to access a steadily expanding amount of digital information and knowledge with the minimum efforts according to explicit and implicit learner requirements; to personalize information access to digital content at the levels of content selection, content presentation, services and content volume.

- Cooperation function. The library of e-learning modules must provide easy communication between students, tutors, researchers, construction and real estate industry professionals, etc. on topics that are of mutual interest.

- Maximum-reuse efforts, economy of scale and extensibility function. Within the EURASIA Project, the library of e-learning modules should be created by broad variety of participating universities and institutions, which would interconnect modules across Europe and Asia and support for easy sharing and reuse of materials and integrate their contents.

- Integral multimedia function. The library of e-learning modules should manage all multimedia forms (electronic format of textbooks, video, audio as well as computer-software, computer learning systems) integrally.
• Notification function. Notification when new multimedia of importance to the learner is added to a e-learning modules library.
• Function of support of cooperation within communities of best practice.
Some above functions are briefly analyzed as follows.

2.1 Indexing and Multi-variant Design as a Core Component of Module Large-scale Content Integration

Indexing often is used to refer to the automatic selection and compilation of ‘meaningful’ keywords from e-textbooks into a list that can be used by a search system to retrieve texts. This list is more properly called a concordance. As this procedure involves no intellectual effort indexers distinguish their own work by calling it intellectual indexing, manual indexing, human indexing or back-of-book-style indexing. Indexing also means the intellectual analysis of the e-textbooks to identify the concepts represented in the document and the allocation of descriptors to allow these concepts to be retrieved. During indexing the Indexing Sub-system visit definite EURASIA Project modules and collects information/keywords about it. Intelligent copy and paste from many modules with retention of a link/reference to the module can be performed. Development of new module is performed by using a combination of knowledge found with the possibility of easy editing and integrating. Learners can use Indexing Sub-system for computer-assisted extraction of data from text for their own purposes, making their work more efficient. As importantly, these data can then be reused and made useful for a large learners community: they can be incorporated (connected, interlinked) into a large distributed knowledge base.

Table 1 shows the frequency of each specific keyword in the analysed text. Keyword ranking in modules seeks to determine the level of relevance of chapters and sections for student’s needs. The level of relevance to student’s needs can be defined by the term “Keyword density and significance” as described by indicators provided in the table: weight (shows the significance of one keyword over another from a student’s perspective in a search for specific learning material), difficulty of a text (the level of difficulty is determined on the basis of previous examination results related to a specific topic) and other indicators (number of pages, words and sentences in the analysed text) which help to determine the keyword’s density. Then, information describing the usefulness of the analysed text for a learner’s needs is summarised in a Table 1. Also, the relevance of a text to a student’s learning needs is described by the presence of different keywords in one sentence (see Table 2). The occurrence of several different keywords that are specified by a student in the same sentence shows higher relevance of the text to the learner’s needs.
The significance/efficiency ($Q_j$) of alternatives of the teaching material is determined on the basis of keyword density characteristics (i.e. frequency of each specific keyword, weight, difficulty of a text, number of pages, words and sentences in the analysed text). Significance $Q_j$ of the learning material $a_j$ indicates the satisfaction degree of requirements and goals pursued by the students, e.g. the greater the $Q_j$ the higher the efficiency of the learning material.

Table 1 Density of specific keywords in the analysed text

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Weight</th>
<th>Minimising Value</th>
<th>Paragraphs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human rights assessment 1</td>
<td>6</td>
<td>1</td>
<td>29</td>
</tr>
<tr>
<td>Human rights assessment 2</td>
<td>12</td>
<td>2</td>
<td>21</td>
</tr>
<tr>
<td>Human rights assessment 3</td>
<td>9</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Human rights assessment 4</td>
<td>28</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Human rights assessment 5</td>
<td>29</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Human rights assessment 6</td>
<td>21</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>

Legend - The first column of the table provides the keywords under evaluation; the second column provides the weight of the keywords. The table’s third column specifies whether the minimising or maximising value is the best. From the fourth column onwards, numbers of paragraphs are provided with references to full texts and the frequency of iterated keywords.

Table 2 Combinations of analysed keywords in sentences

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<td>1</td>
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<td>4*</td>
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<tr>
<td>8*</td>
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<td>0</td>
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The degree of utility $N_j$ of the teaching material $a_j$ indicates the level of satisfying the needs of the actual student. The more learning goals that are achieved and the more important they are, the higher the degree of the teaching material’s utility. The degree of the teaching material’s utility reflects the extent to which the goals pursued by the student are attained. The greater the $Q_j$ the higher the priority of the teaching material (see Table 3).

Table 3 Results of Multiple Criteria Evaluation

ILTS-EAP can display previously covered keywords that might be used for search required knowledge. The tutor can add additional keywords to this list. Also the search is possible by any combination of keywords. Using the keywords provided by a student and some criteria delivered by a Tutor and Testing Model, the system formulates a number of alternatives for an optional module. These alternatives are composed from sections or
components of many different modules matched in a certain way. The selection of keywords and determination of their importance is not as simple as it seems. Numbers of feasible alternatives can be as large as 100,000. The received information is used for action plans, i.e. mini curricula that are used to lead the learner/student to rationally accomplish the learning process. The Mini Curricula are adapted to individual learner's needs, depending on their knowledge level, age, study and learning styles and difficulties.

2.2 Customisation and Personalization in Student model

As constantly increasing amounts of information and knowledge in the library of e-learning modules become available to a growing number of learners, it becomes very difficult for students to find the information and knowledge they need. Moreover, different students with different education, objectives, requirements and priorities may expect particular and individualized ILTS-EAP behaviour. What distinguishes the personalized ILTS-EAP from a traditional construction and real estate e-libraries systems is the existence of Student Model that stores data that is specific to each individual learner. These learner profiles let the ILTS-EAP adapt its behaviour to the education, objectives, requirements and priorities of learners.

In general, ILTS-EAP performance may be adapted, i.e., personalized, at different levels: at the content selection, content presentation (electronic format of textbooks, video, audio, computer-software, computer learning systems), services (life long learning, master degree studies, PhD degree studies, etc.), content volume (i.e. 50, 100 or 250 pages of textbook) or interaction level, taking into account the education, objectives, requirements and priorities of learners. For example, various learners are provided with diverse content according to their requirements and priorities. The same content can be offered to different learners in a summarized or an extended form or in different multimedia. Various learners may have access to different services, which may be customized according to learner requirements and priorities.

The Student Model stores data that is specific to each individual student. The Student Model is used to accumulate information about the education of a student, his or her study needs, training schedule, results of previous tests and study results.

2.3 Decision Support Sub-system and the Database of Computer Learning Systems

The Decision Support Sub-system is used in mostly all components of the ILTS-EAP (Intelligent Library, Student Model, Tutor and Testing Model, and Database of Computer Learning Systems) by giving different levels of
intelligence to these components. The Decision Support Sub-system was developed by applying multiple criteria decision making methods that were created by the author, i.e. a method of complex determination of the weight of the criteria taking into account their quantitative and qualitative characteristics; a method of multiple criteria complex proportional evaluation of the alternatives; a method of defining the utility and market value of an alternative; and a method of multiple criteria multivariate design of an alternative. The Decision Support Sub-system assists and strengthens some kinds of decision processes.

The database of computer learning systems enables the use of the following Web-based computer learning systems for students: construction, Real Estate (see Fig. 1), facilities management, international trade, ethics, innovation, sustainable development and building refurbishment, etc.

Fig. 1. Real Estate’s Knowledge and Device-based Decision Support System

2.4 Statistical Information Streams and the Tutor and Testing Model

Permanent streams of statistical information (information based on voice analysis of student answers, information on correct and incorrect answer, time distribution on every question, the number of times a student changed an answer to each question of a test, history on interaction between students and tutors) is integrated into the Tutor and Testing Model. The
Tutor and Testing Model provides the function to process and integrate permanent data streams and provides access to this data to different stakeholders. ILTS-EAP provides appropriate mechanisms for online processing of these aggregated stream data. Statistical aggregated stream data are particularly important in the library of e-learning modules for all stakeholders for later improvement and development of e-library. For example, on the basis of available statistical information, it is possible to determine which topics are the most relevant to learners and what their presentation form should be (e-books, audio, video, etc.). Besides, weaknesses and strengths of existing modules could be determined, and this information could be used as a basis to provide specific recommendations how to improve these modules.

The Intelligent Library presents learning frames to the student. The Tutor and Testing Model provide a model of the teaching process and supports transition to a new knowledge state. For example, information about when to test, when to present a new topic, and which topic to present is controlled by the Tutor and Testing Model model. The Tutor and Testing Model reflect teaching experiences of associate professors and/or professors. The Student Model is used as input to the Tutor and Testing Model so that the Tutor and Testing Model's decisions reflect the differing needs of each student in the optional modules. The Tutor and Testing Model formulates questions at various difficulty levels, specifies sources for additional studies and helps to select literature and multimedia for further studies and a computer learning system to be use during studies.

A student can select the level of difficulty at which the teaching will take place. The Tutor and Testing Model compares the knowledge possessed by a student (test before studies) and knowledge obtained by a student during studies (test after studies) and then it performs a diagnosis based on the differences. By collecting information on the history of a student's responses, the Tutor and Testing Model provides feedback and helps to determine strengths and weaknesses of a student's knowledge, and his/her new knowledge obtained during studies is summarized and then various recommendations and suggestions are provided.

The system provides information on the testing process in a matrix and a graphical form: information on correct and incorrect answer, time distribution on every question, and the number of times a student changed an answer to each question of a test, etc.

3 THE USE OF THE ILTS-EAP AT ALL STAGES OF A BUILDING LIFE CYCLE

A building life cycle consists of seven closely interrelated stages: brief, design, construction, maintenance, facilities management, demolition and utilisation. A building life cycle may have a lot of alternative versions. These variants are based on the alternative brief, design, construction,
ILTS-EAP have the ability to personalize, maximum-reuse, index, analyze and integrate valuable information and knowledge from a wide selection of existing sources in all building life cycle stages. A number of tightly integrated search components (text search, audio search and video search) can be used. Such search possibilities ensures that stakeholders from construction and real estate industry can take advantage of quickly retrieve the most relevant information from the available content that has already been developed and approved for different manuals, handbooks, directives, research, normative documents, databases of best practice and other sources. Although ILTS-EAP allows users to type queries in all languages, word meaning, words frequency and combination when the developed search engine’s only purpose is to retrieve documents or their parts based on keyword search.

Searching, finding, indexing, selecting and integrating of required construction and real estate information and knowledge (lessons learned, training, analogies (best practices, law and directives, reports, industry practices, case studies, just in time training, market analyses), models, regulations/policies/guidance (historical baseline, communication, policies and guidance), new initiatives, estimating tools and techniques, etc.) is providing sizeable supplementary value. Many organizations function in the infinite information universe, incapable to access and analyse all valuable information that already exists.

Tacit Construction and Real Estate Knowledge Base of Best Practice (TCREKBBP) consists of informal and unrecorded procedures, practices and skills. This “how-to” knowledge is essential because it defines the competencies of employees. TCREKBBP is of value to organizations to the extent that it can codify these “best practices”, store them, search and find them upon demand according to set of keywords. It shapes tacit knowledge for concrete project. Because of the orientation toward unique projects, much knowledge in the construction and real estate industry is experience-based and tacit. The knowledge needs are dynamic, depending on the task or the problem. Nevertheless, the typical strategy for knowledge management is to make knowledge explicit and store it as databases. Organizations have been successful at collecting and storing explicit information in enterprise databases but they are poor at searching, finding and integrating of useful information and knowledge. Consequently, organizations professionals find it difficult to reuse core experts’ knowledge for highly knowledge-intensive construction and real estate activities. This situation calls for better collecting and disseminating tacit knowledge from experts’ brains to achieve higher quality construction and real estate projects. An enormous volume of construction innovation knowledge is generated during the phases of brief, design, planning, construction, maintenance, facilities management, demolition and utilisation of a facility. Throughout the whole life cycle of a project, organizations rely on their
experiences, professional intuition and/or other forms of tacit knowledge to accomplish satisfactory work. In order to develop a tacit knowledge base of best practice, its economic, technical, qualitative, technological, social, legal, infrastructure and other aspects must be analysed. The diversity of aspects being assessed should follow the diversity of ways of presenting data needed for decision-making. Therefore, ILTS-EAP can be used for the searching, finding, indexing, selecting and integrating of above most relevant information and knowledge for building’s life cycle stakeholders.

4 CONCLUSIONS AND FUTURE WORKS

We suppose that the Intelligent Library (library of e-learning modules) will become a practical knowledge storehouse and will offer intelligent opportunities for learners in construction and real estate industry. The library of e-learning modules is individualized, can operate in Europe and Asia distributed EURASIA project universities and institutions and can provide to learners different forms of content.

In order to improve the developed ITS-CE the future plans are to develop a Tacit Knowledge Base of Construction Experts. The searching, finding, indexing, selecting and integrating of required information and knowledge in a Tacit Knowledge Base of Construction Experts is useful too. In organizations, it is more likely that employees will work on similar projects, although there is no explicit link between them. Top managers generally assume the professionals in enterprises already possess tacit knowledge and experience for specific types of projects. This allows experienced workers to place their knowledge and experiences in the Tacit Knowledge Base of Construction Experts. Specifically, sophisticated construction methods are successfully applied by highly educated, experienced professionals on job sites. This knowledge is extremely important to organizations because, once a project is completed, professionals tend to forget it and start something new. Therefore, knowledge multifold utilization is a key factor in productively executing a construction project. One of the more successful initiatives for sharing tacit knowledge is Communities of Practice. These communities are designed to build a network of knowledgeable experts who work together to learn and solve complex problems when the solutions are needed. In general, they operate informally through virtual meetings, videoconferences or e-mail communications to exchange knowledge and work practices on topics of interest to the members. By using the Knowledge Base of Experts and intelligent library it is possible to search for experts and facilitates communication with those experts by using internet technology. Logging into the Knowledge Base of Experts and intelligent library, a professional in organization can search for an expert with the relevant knowledge and will communicate with him in real time by using virtual meetings, videoconferences or e-mail communications. As a result, the professional
in organization could receive direct tacit help from an expert who had recently experienced a similar problem. At the time of communication, experts' tacit knowledge will be transferred in the most appropriate forms and applied in business processes. Their dialogue would be audited and stored in enterprise database systems to be searched by others. In this way, the organizations extract valuable tacit knowledge from employees' brains and apply those assets to the work process. In this way, higher performance levels can be achieved theoretically by accelerating the knowledge transfer processes.

For most organizations, potentially valuable information exists in multiple locations in multiple file formats, both within and outside the enterprise. Without access to this information, different stakeholders are faced with the daunting task of creating and continuously updating a body of knowledge to solve customer problems quickly, efficiently and accurately. Therefore, in future is intended that ILTS-EAP will help to exchange of construction and building knowledge by using global databases and support the management and integration of design contributions from globally distributed partners.

5. REFERENCES


