AUTHORING TOOLS FOR KOC
A Knowledge Repository to Teach Building Construction

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Abstract: Composition and authoring tools constitute fundamental instruments to facilitate the generation of new knowledge to experts in a domain, because it allows the construction of high level knowledge objects from other already existing knowledge objects. Content generators within the KOC system, a knowledge repository for construction objects based on the ArCo ontology (which covers the technical area of buildings' construction in Architecture), can benefit significantly from this kind of tools, because they allow them to generate new complex knowledge objects, by taking advantage of the structure defined by ArCo. This paper presents three composition tools for KOC: a complex objects composer issued from structured searches, a constructive processes composer and a case study composer, all of them aiming the improvement of learning quality in the building construction technical area at the architecture and engineering schools.

1 INTRODUCTION

The learning of construction in Architecture courses is a problem of high complexity and implies a great challenge to educators and researchers (Villazon, 2005). Inherent restrictions to the constructive activity prevents the students of visiting the construction sites in real time, such as physical difficulty to access the site, security and risks of the visit, the difficulty to match the academic and the construction project calendars, among others. On the other side, construction companies have to deal with these same problems when training their new employees.

The KOC project (Knowledge Objects of Construction) (Villazon & Bravo, 2007a) faces this problem by means of five great axes. The first one structures the different concepts for building construction in Architecture and their relationships in an ontology, called ArCo (Architectural Concepts) (Villazon & Bravo & Cifuentes, 2008). The second one defines a formal process to gather quality data throughout the whole construction process of real projects (Vela, 2007). The third one allows the annotation of these collected data using the ArCo ontology and to storage them into a knowledge repository. The fourth one provides a highly semantic searching and querying of content in the repository. Finally, the fifth axe, and main subject of this paper, provides several authoring tools, composers, to generate complex knowledge objects, based on existing "simple" knowledge objects in the repository. The result is a repository of high quality architectural knowledge objects, clearly described, and re-usable. In addition it provides mechanisms to high level queries, responding to architects (professional, teachers and students) requirements.

This paper first presents the main concepts of KOC and ArCo. The second part presents a brief description of three composers. Finally, some obtained results and some outcomes are presented.

2 GLOBAL VISION OF KOC

The development context of authoring tools consists

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of the ontology allowing the description of data (ArCo), the knowledge objects repository (KOC), and how they are used to annotate the data and later to improve the knowledge generation by means of authoring tools.

2.1 ArCo: The Ontology

ArCo (Architectural Concepts) is an ontology that structures a knowledge base in the technical area of the Architecture.

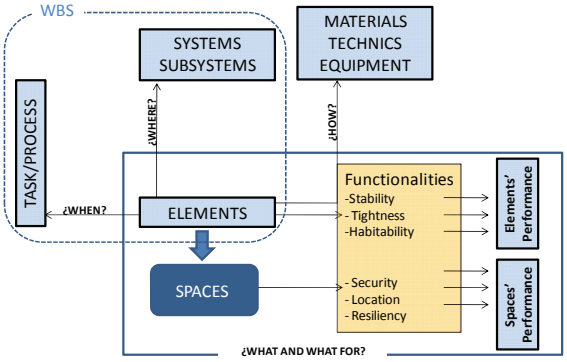

Figure 1: Main scheme of ArCo.

ArCo aims to respond several questions about the technical area of building construction.

- What can be constructed? It makes reference to the construction objects constituting the kernel of the ontology, represented by architectonic elements and spaces. Every construction object in ArCo represents an idealized instance to which real objects are related.
- Why or What For these objects are constructed? It makes reference to the intended functionalities and performance of these construction objects, in three fundamental categories: habitability, water tightness and stability.
- Where and When these objects are constructed? It makes reference to a Work Breakdown Structure (WBS) (Rodriguez, 1998), which classifies the elements in systems, subsystems and elements and also defines the chronological order of activities leading to their construction.
- How these objects are constructed? It explains the choosing of materials, techniques and equipment to construct the element correctly.

Figure 1 presents a diagram of these concepts within the ontology and their relationships. A more detailed definition can be found in (Villazon & Bravo & Cifuentes, 2008).

2.2 KOC: The Knowledge Objects of Construction Repository

KOC is a web-based knowledge repository of objects "talking about" the technical area of construction in Architecture. The main functionalities provided by KOC include the access of data and collaborative edition to students, professors and professional architects in general.

The KOC strategy consists of incrementally adding knowledge to data. The first level is the raw data represented by a file and its metadata; the second level annotates the data in terms of ArCo, turning it to a simple knowledge object. Once two or more of these simple knowledge objects are related and tied by means of any authoring tool, they conform a complex knowledge object. Finally, these knowledge objects may be enriched with learning and pedagogical metadata, allowing the definition and management of learning objects, and making possible to follow the learning process of students.

2.3 Knowledge Objects and Annotations

Knowledge objects are high level entities extending the gathered raw data with additional information and annotations, which could be considered as added knowledge. This knowledge includes the kind of data it is (e.g., a picture), the associated building lifecycle (e.g., design or construction), the granularity of knowledge that is being used to describe the object (e.g., subsystem or activity level), and a global qualitative grading indicating whether the object represents a good practice or a bad practice and finally the annotations.

The annotations make explicit the relations among the concepts defined in ArCo and the collected data coming from real projects. The annotations are the bridge joining the ideal instances defined in ArCo and real examples of construction stored in KOC. Besides these references, annotations can contain additional information enriching the knowledge object.

3 COMPOSITION AND AUTHORING TOOLS

The initial version of KOC managed knowledge

objects individually, not related to any other objects. An evident KOC evolution is to define and manage relationships among these "simple" knowledge object, in order to conform knowledge objects of greater conceptual level and finally store them into the knowledge repository.

The generation of these new complex knowledge objects could be a difficult and expensive task for knowledge generators. In order to facilitate this process, the authoring tools allow the creation and incorporation of high level content to KOC repository in a clear and simple way. These tools improve the authors' expressiveness, when supported by ArCo.

This document presents three authoring tools aiming to facilitate the work of content generators in KOC, improving then the quality of education in Architecture schools: a complex objects composer, a constructive processes composer and a case studies composer.

3.1 ArCo's Based Complex Objects Composer

The complex objects composer is an ArCo-based authoring tool, allowing the creation of new knowledge objects, using already existent knowledge objects in KOC. The knowledge generator issues a query to KOC using the concepts in ArCo, as for example "Give me the knowledge objects showing good practice techniques to build a structural column"; the composer takes the results of this query (the data and their annotations) and generates a new PowerPoint document with them, and also an initial annotation for the new knowledge object; the author may edit this document to fulfill his purpose and may edit also the annotation to reflect the changes; finally the author may include the new knowledge object into KOC repository. An immediate consequence of using this tool is the reusability of existing objects in the repository, generating networks of semantic links among them.

The main purpose of this tool is the systematic grouping of objects of simple knowledge sharing similar characteristics (by querying its annotations) in order to conform a high level object having pedagogical objectives. This new object can be presented in the class room or viewed with a WEB browser, according to the teacher's indications. Another use of this tool could be to gather answers to frequent questions that professionals have: They will not to browse the whole repository searching for the desired information.

3.2 Constructive Processes Composer

A constructive process is a sequence of chronological activities leading to a finished construction object. The constructive processes composer is a tool to generate complex objects grouping all these activities as a whole: it supports the annotators in the input of multiple simple objects, at least one for each activity, simplifying the annotation process, because common descriptions are issued only once. The individual information associated to a given data includes its order in the sequence, its duration, the involved personnel and the qualitative grading of the activity. The composer also generates a PowerPoint presentation with pedagogical purposes, showing slide by slide each activity carried out during the construction process. The current implementation allows only constructive processes for architectural elements like columns or beams; further development of the tool will include constructive processes of spaces like offices, auditoriums, etc.

The purpose of this tool is to accelerate the process of annotating constructive processes by reusing the common annotations to each activity: all of them concern a given element (a column, for instance) and it is not worth to give this information for each data. Contrary to the Complex Objects Composer, this tool does not require that all objects exists in KOC: Given n raw data representing a construction process, the composer generates (n+1) knowledge objects, n for the individual activities and one for the construction process itself.

3.3 Case Study Composer

A case study is "a description of a situation from the perspective of the protagonist" (Martinez, 1999), serving as a metaphor to teach the student to solve generic problems with the same kernel (Roberts, 2001). The case study composer allows the teachers to define and structure their own case studies by constructing a decisional graph of situations (nodes) and the transitions (arcs). The result is a directed finite deterministic and noncyclical graph. The composer generates the case study as a pdf file containing the general information about the case study and the inventory of situations. This file can be downloaded or browsed by KOC users.

The main purpose of the tool is to help the teachers to systematically structure their knowledge as case studies, taking advantage of existing contents in KOC repository to illustrate the desired situations: The author may use the queries facilities provided

by KOC in his search of situations for his case study. The case studies issued by the composer can be extended, complemented or tied to other case studies from other authors, leading to a collaborative environment. By using this composer and the vocabulary proposed by ArCo, it is possible to capture and make persistent the teachers' knowledge in a reusable pedagogical format. The case study methodology – and this composer in consequence - promotes the Socratic pedagogy: learning by doing. The composer also looks for the reuse of the knowledge produced in real construction scenes in the classroom, allowing the creation of networks of relationships among pedagogical materials and practical knowledge.

4 CONCLUSIONS

The KOC project has already shown great benefits by its application in academic contexts. Its contribution does not have to be limited by the effort that represents for the authors the elaboration and querying of high level knowledge objects. The authoring tools try to solve this problem by helping the authors to define and structure new complex objects with high level of semantics, ready to be used by student but also for software agents in the Semantic Web.

Regarding the experience of KOC and specifically the use of ArCo, it has been demonstrated the effectiveness of using ontologies for knowledge formalization and management, to ensure communications among teachers and students, and to make explicit the semantics of the technical area in Architecture. Nevertheless the potential use of ontologies can be also profited by using them as a technology for data integration, possibly among several instances of KOC or with other systems.

As a whole, KOC has a good acceptance in the academic environment; it has been presented in several national and international conferences and also has been awarded with international grants. Starting the second semester of 2009 project KOC will be used as a pedagogical tool in an undergraduate course in the Architecture school of the University.

Nevertheless, KOC could be improved in several ways, including the addition of new functionalities, the integration with other systems, its use in other contexts and the internationalization of the repository, teaching and learning tools, mobile KOC, social KOC among others.

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