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Vertical metadata in learning objects to recovery the industrial historical heritage

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Abstract

Every day, new methods and techniques to represent the past are investigated. Frequently, those innovations are incorporated in other knowledge areas where graphics engineering has previous experience in this important subject. As current examples can be cited the reconstruction of Virtual Reality (VR) with realism character covering the resource and to study the interaction with their environment, anthropological or otherwise, or Augmented Reality (AR) techniques with applications in museums or interpretive centres, among others.

In particular, these techniques are mainly based on two-dimensional (2D) and three-dimensional (3D) models, which in its development stage, Computer-Aided Design (CAD) techniques produce a lot of educational materials, likely to be used for training of future researchers in cultural heritage subject.

Setting this idea as starting point, this article is based on the work of recovery in industrial heritage, such as windmills, to identify key learning points. Once detected these, it is possible to create Learning Objects (LO). Later, may be used in any educational system, for example, at Learning Management System (LMS).

The proper functioning of the system depends on the existence of a standard vocabulary as SCORM, trying to be a reference to the creation of LOs using CAD techniques in the field of cultural heritage.

1 Introduction

Over time, archaeology has felt the need to incorporate into their research others scientific disciplines. The aim is to achieve a complete analysis of reality through including the perspectives of experts in several areas of knowledge. It is the way to attain a fully defined reality.

Also, it is possible to consider that archaeology is a science that covers various fields of work, such as historical archaeology, industrial archaeology and ethnoarchaeology, among others.

In particular, industrial archaeology has gained a greater presence as discipline over the years. The first person to use this term was Michael Rix in 1955, arguing that it was necessary to inventory and preserve the origins of industrialization. Later, Kenneth Hudson in 1963 defined the industrial archaeology as *'the discovery, documentation and study of the physical remains of the industrial past, to meet them through the production process*'. Later there were other milestones such as launching of the Journal of Industrial Archaeology in 1968 and the establishment of The International Committee for the Conservation of Industrial Heritage (TICCIH) in 1973.

In the other hand, graphics engineering is one science discipline most widely used for documentation and representation of industrial heritage. For the geometric description are employed graphics techniques like Computer-Aided Design (CAD). The subsequent analysis is performed using Computer-Aided Engineering (CAE). The processes and results achieved in situ tasks and the subsequent analysis will create the ideal resources for incorporation into educational tasks. Further, research is based on experience that "Engineering Graphics & Industrial Archaeology" group directed by Professor José Ignacio Rojas Sola, has in this field of science.

The main objective of this paper is to create a specific vocabulary of LOs' metadata, in order to be searched in repositories dedicated to graphics engineering applied to archaeology. Thus, it is possible to train new researchers and professionals in the discipline.

2 LOs of Graphics Engineering applied to Industrial Heritage

The Industrial Archaeology uses graphic engineering to describe geometrically a resource or other remains type to analyze them through the virtual models. Moreover, it may include information relating to the future, as LOs at different stages of archaeological works. In this way, educational resources will be better structured and can be classified in more obvious way with the metadata vocabulary design. These resources will be inserted in repositories of different educational platforms, such as the

Learning Management Systems (LMS) or Learning Content Management Systems (LCMS). In particular, this software type is used for administration, documentation, monitoring and reporting of any educational activity. There are several experiences in different branches of knowledge which have been successfully implanted [1-2].

The LOs can be classified according to the main features of engineering graphics related to the representation in archaeology. So, there are three major sets of objects representation: Projection Systems, Modelling and Rendering Techniques.

2.1 Projection systems

The representation is based on the type of projection used to define a certain reality. This feature is chosen to allow discriminate LOs depending of the work system. The most relevant Representation Systems are:

- Orthographic projection: it is a parallel and orthogonal projection system. The projection is done on two planes perpendicular among themselves. This way allows to measure directly. It is used in 2D representations.
- Contour Map: it is based on parallel projection, being orthogonal to one of the main planes. It is the reason why we can measure directly in one of them. It is used in 2D representations.
- Axonometric system: is a parallel projection and orthogonal over a tri-rectangle trihedral. It can be an orthogonal or oblique projection. It is employed in 3D representations.

2.2 Modelling techniques

Several archaeological research tasks require a geometric description which results in the generation of a virtual model. This process can be carried out mainly through three techniques.

The first technique is the solid modelling. It consists in modelling Constructive Solid Geometry (CGS), both implicitly or solids processing. It can hold information on physical properties, aspect very important for further analysis.

The surface modelling consists to obtain the model shape through using meshes of different nature, such as polygonal meshes, NURBS or T-Spline, among others. This modelling type is highly recommended if you use methods of analysis that are based on use of meshes, such as the Finite Element Method (FEM) or curvature analysis.

Finally, the generative model is based on use of geometric design coming from nature shapes. It is composed of L-System (known as Lidenmayer), particles and fractals. These techniques are able to better fit the shapes of certain elements.

2.3 Rendering

Today, the graphical representations are possible by obtaining a 3D image by using models of ray tracing. Choosing the ray tracing model to obtain the virtual image, it is possible divided the rendering process into four main groups:

- Radiosity: the first method used to simulate the interaction of light ray with a specific surface. It allows create realistic scenes because it displays the properties of colour and type of reflection from the nearest object.
- Scanline rendering: it is based on an algorithm to determine the visible surfaces. The working principle is known as ‘row by row basis’. It can submit improvements such as the inclusion of Z-buffer, improving performance and benefits.
- Ray Casting: it uses an algorithm with the same name, it was presented by Arthur Appel in 1968 [3]. It is based on ray tracing from the point of view of the observer. Initially it had the problem about the impossibility of occurrence of rebounds and, at the same time, reflections and refractions that it may affect the level of realism final.
- Ray Tracing: it is the most complete technique. During the calculation process takes into account the incident ray that causes a refraction, reflection and shadow, to a greater or lesser extent.

3 E-Learning Data

Developing E-Learning tools has generated the need to create standards for the exchange of LOs. Thus, it seeks the same educational database for be used by the international community through different learning software. Furthermore, it is necessary employ a widely accepted standard with the aim of facilitate communication between different databases of several areas of knowledge. Also another important point to be considered is that standards in E-Learning institutions should be independent of country, language or any other regional circumstances in the process of creation the LOs.

Today, institutions involved in standardization in the field of E-Learning tools are the Interoperable Learning Technology (IMS), The Aviation Industry CBT (AICC), Alliance of Remote Authoring and Distribution Networks (ARIADNE) and Advanced Distributed Learning (ADL). In addition, there are organizations with more integrative perspective such as International Organization for Standardization (ISO), Institute of Electrical and Electronics Engineers (IEEE) or Comité Européen de Normalisation/Information Society Standardization System (CEN/ISSS).

3.1 SCORM 2004 4th Edition

The specifications followed in this document correspond to the Sharable Content Object Reference Model (SCORM) [4], included in version SCORM 2004 4th Edition. As a goal, SCORM claims to be the standard in E-Learning environments, meeting the following requirements:

- Reusability.
- Accessibility.
- Durability.
- Interoperability.

In the other hand, LOs are organized into the following levels: assets, Sharable Content Objects (SCOs), activities, content organization and content aggregations.

Assets is the most basic building block of an educational resource. These are digital resources such as images, audio, objects, functions or documents, among others. These resources are described by metadata that can be searched in repositories. It is considered ideal for reuse and easy maintenance.

A SCO is a set of one or more assets. The main feature is the ability to communicate with an LMS and LMCS using ECMAScript Application Programming

Interface for Content to Runtime Services Communication standard proposed by IEEE.

Activities is a schema generated by the responsible educator of creating an educational environment, such as it is the case for the creation of a self-study or practice. The hierarchy is vertical and can be composed of sub-activities. At the same time, it is related with educational resources such as SCO and Assets.

Content Organization is a conceptual map that defines the design of instructional units, for example, the Activities. This sequencing can only be applied to Activities or Groups Activities where the educational intention will be reflected in the content organization.

Finally, Content Aggregation describes the action of a set of Content Objects, as it shown in Figure 1.

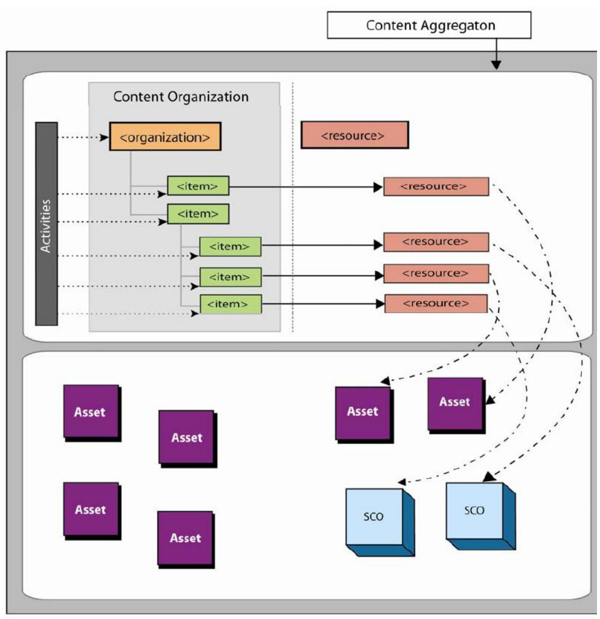

Fig. 1 Conceptual sketch of a content aggregation. Fuente: 'SCORM® 2004 4th Edition Content Aggregation Model (CAM) Version 1.1.'.

4 Metadata Structure

Within the SCORM Content Model Components structure, it is necessary that the educator can find and use resources. This process is achieved through the analysis of the metadata associated to LOs, based on the IEEE 1484.12.1-2002 Learning Object Metadata (LOM) [3]. In addition, SCORM encourages to follow the guidelines for the creation of IEEE LOM metadata. LOM XML offers 64 metadata definitions elements which are classified into three groups. Those they are necessary appear as 'Mandatory', the rest belong to 'Optional' or 'Not Permitted'. The parent is <lom> instance of which depends on other mandatory: <General>, <lifeCycle>, <metaMetadata>, <technical>, <educational>, <rights>, <relation>, <annotation> and <classification >.

Each child has specific relationships with the rest [5] and it may have a vocabulary that is internationally accepted. In the vocabulary created in this research about the field of archaeology, including the industrial, we have been taking in account the details contained in LOM XML Binding [6].

4.1 <purpose>

It gives an overview about the SCORM CAM. As sub-elements are <source> and <value>.

4.2 <taxonPath>

Its aim is to create a classification system through a specific taxonomic path properly prepared. This element depends on two child: <source> and <taxon>. The first refers to the classification system selected and the second is using to refer to a field of general knowledge. Its structure is alphanumeric and has two sub-child: <id> and <entry>. They can appear simultaneously together or not, but the vocabulary chosen for this research requires the presence of <id>. The Figures 2, 3 and 4 shows the <id> of educational resources set out in the second section.

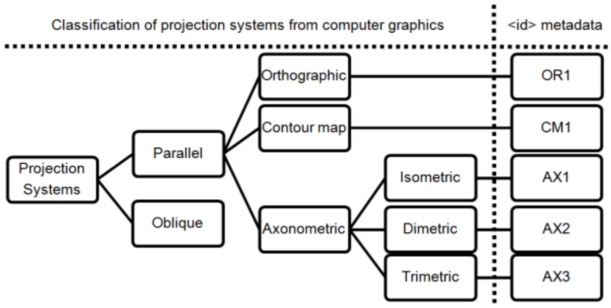

Fig. 2 Sketch of classification of projection systems from computer graphics.

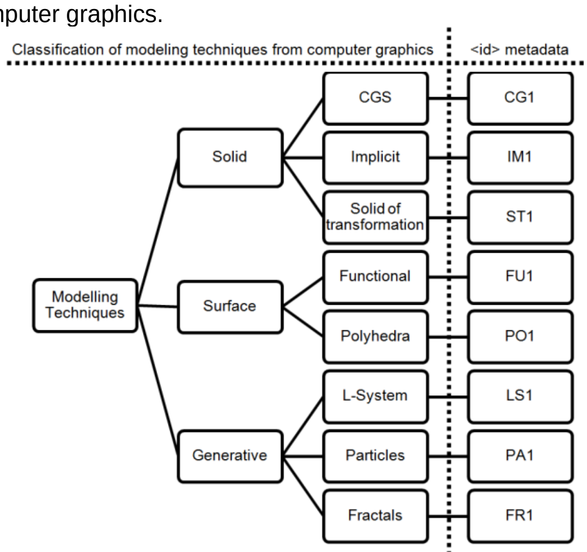

Fig. 3 Sketch of classification of modelling techniques from computer graphics.

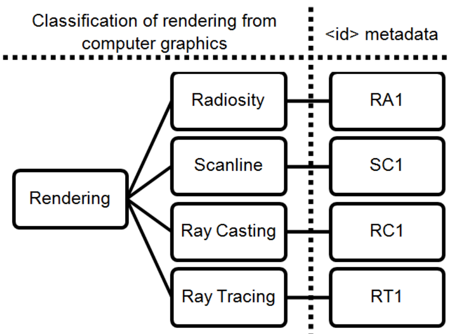

Fig. 4 Sketch of classification of rendering from computer graphics.

4.3 <description>

It aims to create a sense of purpose through a structured explanation with LangString data format. In the proposed vocabulary is considered like an optional description. It is employed to developing the idea when it is not fully reflected in <keyword> element.

4.4 <keyword>

Keyword contains the words to summarize the purpose. It is important to correctly select the keyword, trying to make the search as easy and intuitive as possible.

5 Results

As noted above, engineering graphics is used as support for multiple targets in the field of industrial archaeology. In fact, some final results in the industrial heritage is expressed through 2D or 3D representation of the realities under study and sometimes the creation of models are the starting point for further analysis.

As a result, it has created a repository of engineering educational resources to learning graphics for use in the field of industrial heritage. The main classification learning this deposit was made on the basis of previously proposed metadata vocabulary, where the metadata element <taxonPath> plays an important role in the reuse and classification of the LOs, being employed as a planner of the subject at the same time.

The chosen platform for E-Learning process is a widely distributed LMS called Moodle. This is a free software that is used in large schools like the University of Cordoba, among other 38 institutions in Spain as well as internationally. However, any other LMS that includes the LOM standard will be able to use the SCORM content packages generated.

In addition, for the creation of SCORM content packages is used Reload © Editor that is based on Eclipse Rich Client Platform Supports IMS and MD (versions 1.1, 1.2.1 and 1.2.4), IEEE LOM, IMS CP (versions 1.1.1, 1.1.2 and 1.1.4) as well as SCORM 1.2 and SCORM 2004 (3rd edition) Specifications. In Figure 5 shows the creation of one of the modules for a course called Moodle active in Graphic Representation in Industrial Heritage through the SCORM package editor.

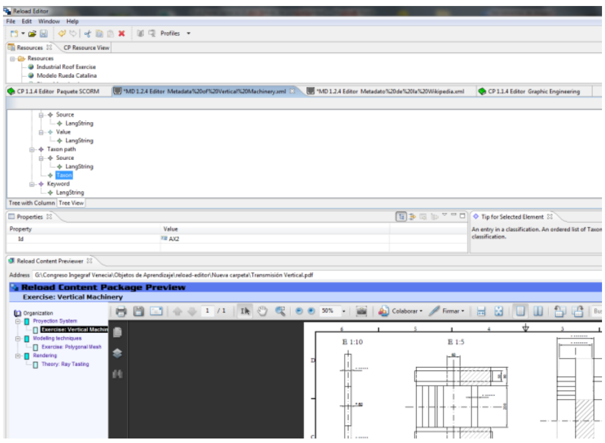

Fig. 5 Reload Editor (Eclipse RCP Version) to creating a Moodle course.

Once created the educational resources are integrated into the Moodle platform as shown in Figure 6.

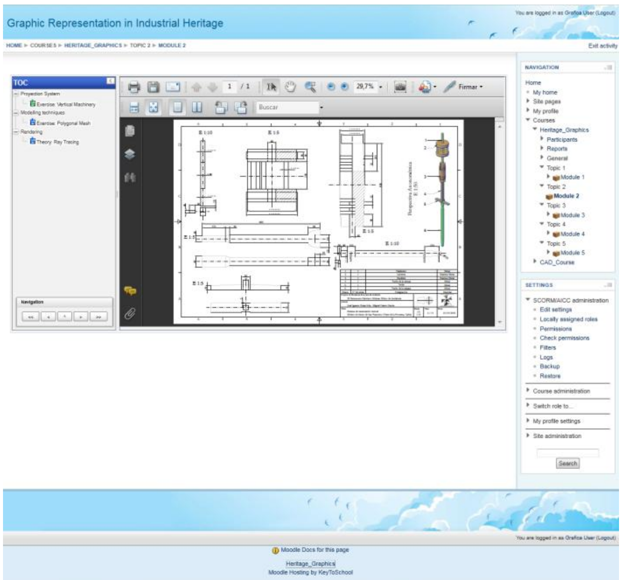

Fig. 6 Module 1 into Graphic Representation in Industrial Heritage course on Moodle platform.

We conclude in this way the transfer of research results to the field of education where new professionals can rely on the experience of the most current in the industrial archaeology.

6 Conclusion

Although the recommendations of metadata standards for indicators that the line of action should be to homogenize the structure of the instances to the search engines, however, this paper shows the need to standardize the vocabulary of the disciplines involved in individual research.

In this case, has resulted in a vocabulary designed to classifying graphics engineering applied to industrial archaeology. Thus, the strategy of creating the most obvious is to be well structured related metadata, as well as search and reuse of resources in other repositories e-Learning platforms such as LMS and LCMS.

It was tested on the LMS called Moodle, where the repository for the creation, reuse resources has enabled a specific search through its contents described to the precise language, particularly by <taxonPath>.

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