# Recommendations for Metadata Standards for 3D Images on the Web

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## Abstract

This paper discusses issues related to the development of standardized metadata schema for 3D images. Challenges are described and a method for analyzing existing metadata schema for still images is suggested as a starting point for finding appropriate elements for 3D images. Elements from 4 metadata schema are compared and analyzed for fit with 3D images.

The use of 3D images as information bearing objects is rapidly becoming part of the next generation of web applications. The sooner we begin to build consensus on how best to describe, store, display, preserve and maintain these 3D datasets, the better able we will be to meet increasingly sophisticated user needs. This paper is a beginning attempt to put the issues of how we will do this before the research community at large.

## Background

Digital imaging professionals are constantly racing to keep their collections accessible, while planning for new technologies that will change the way their collection is accessed, stored, preserved and maintained. Three-dimensional (3D) objects on the web exemplify this type of emerging technology. 3D objects, for the purpose of this paper are defined as objects that can be navigated on the web. These objects rotate 360 degrees, have zoom functions, have degrees of navigation and can move around the screen.

The technology driving the display of 3D objects is available and being used as a web resource across many disciplines. The engineering and medical fields have been long time users of 3D objects. Scientists are realizing these tools can be used for complex modeling, as well as teaching tools. Finally, museums including the Smithsonian (http://www.si.edu) and the Canadian Museum of Nature (http://www.nature.ca), are introducing these objects on their websites, creating a new degree of interactivity between the collection and the user. It is worthwhile to look at the challenges 3D objects create in the museum environment to prevent costly errors and help with successful development.

## Growing Problem

Jon Peddie & Associates, media trend forecasters, predict by 2007, the web will be home to over 1 million websites with 3D images. (1) If technology and users' demands continue in the current direction, sites containing these objects will be the norm instead of the exception.

In the case of many new technologies, a dominant standard has not been established or adopted for these objects. This paper presents results from a study conducted at the University of North Texas, that takes an initial look at metadata standards for 3D objects. The paper analyzes existing metadata standards for images and makes recommendations for what will be needed to describe 3D objects with a standardized metadata schema.

## Adoption Process

Architects, doctors, engineers and computer scientists have used 3D objects for years. It is only recently that these objects have been accessible on the mainstream web. Museums started seeking out the complex virtual environments primarily used in the video game industry, hoping to provide a virtual visit for the web visitor. Another factor responsible for the emergence of 3D objects, are the demands of an ever more sophisticated web-user. Retail websites started to offer potential web customers the ability to see different views of their merchandise and the capabilities to zoom in for more detail. Now, web users expect to see 3D models. Finally, the decreasing cost of creating or obtaining 3D objects is another factor responsible for the increase in the demand.

## Technology Driving the Objects

Mimicking 2D digital image files, 3D metadata will have similar elements needed for preservation and access. Three dominant methods exist for creating 3D objects for museum environments. One is the "shoot and stitch" method. An object is captured from 360 degrees and software stitches the images together creating a panoramic view. Companies like VRI (http://www.vri.ca) are working with museums to create affordable images, which can be viewed with most media players. The files produced generally do not require the use

of a proprietary browser. The second type of capture technology is scanning the object. 3D scanners are still very expensive, costly to maintain and require bulky equipment to capture the image. Museums are successfully out-sourcing this part of the process. The Nature Museum of Canada displays images created by Arius 3D, Inc. a software company (http://www.arius3d.com) Third, a computer graphics artist can create an object with rendering software. This is probably the most time consuming method and again must be outsourced. An artist creates a framework of the image and then adds the texture over the initial shape of the object.

## Creation of Metadata

Similar to the evolution of capture or creation for 2D images, a single method has not been established. For example, typical hardware used in creating digital images are scanners and cameras. This information can be recorded in several metadata classes, such as *administrative* (2) or *use*. (3) Managers of digital collections realize the value of being able to retrieve a version of software or scanner settings, when facing collection migrations.

In terms of 3D metadata, we have experience on our side. The past has taught us that information regarding critical elements needed for successful data migration must be captured and preserved. Particularly when the viewer or browser needed for the 3D objects may no longer be supported or the file format is unreadable.

## File Format

It was not long ago that we were discussing which format should be used for 2D archival images Every few months, a new and improved file format seemed to be on the horizon, promising to unify the field.

The market is flooded with proprietary 3D file formats and a dominant one has yet to be established. The same situation is occurring with 3D object viewers. In 2000, the Web 3D Consortium (http://www.web3d.org) reported 40 available viewers for viewing 3D objects on the web.

Not only are we waiting for a dominant file format, we are waiting for a dominant viewer. Some images can be viewed in media players such as, Windows Media Player and Quicktime. Most of these objects are created by the "shoot and stitch" method and provide a limited view compared to some of the proprietary packages. Objects produced from scanners or created techniques usually use proprietary file formats and viewers. Each company promises more features, better image quality and longevity.

## Metadata

The nature of 3D objects makes it difficult to use the element sets from established metadata schemas. The term 3D object has yet to be defined, partly because of its attributes. For example, it is more interactive than a 2D image because the object can be navigated and moved. However, it does not fit into the category of moving images because it does not have frames, one of the defining attributes in moving images.

For this study, three metadata schemas were analyzed to see how well they handle the unique aspects of a 3D object. In addition to the technical elements about the object, it is important to acknowledge the individual(s) responsible for the creation of the digital object and file.

**DCMI (OCLC Dublin Core Metadata Initiative)**
**http://www.dublincore.org**

The Dublin Core metadata schema has been implemented in many information centers because of its cross-discipline approach to metadata. The general elements allow for customization and modification for each collection or scenario. This type of basic flexibility also makes the schema a good building block even though its primary use is for documents. Many schemas are modified versions of DCMI with additional elements added to describe unique attributes in a collection.

The fields Type, Format, and Contributor can record critical information regarding the object. For example, Contributor can record the company responsible for the scanning or the artists who contributed to the finished object. By correlating components of the 3D object into elements' DCMI Type Vocabulary, the technical side of the subject can be recorded with accuracy. Depending on how the information center defines a 3D object, the term name *image* or *interactive resource* will provide a controlled vocabulary and metadata element.

Of the three metadata standards surveyed here, the Dublin Core Metadata Initiative, shows easiest transition for capturing metadata of 3D objects on a basic level. Its general components allow for the object to be recorded, while the customization provides an opportunity for the critical technical aspects to be recorded and saved for later use.

**AMICO (Art Museum Image Consortium)**
**http://www.amico.org**

One of the most promising applications for 3D objects is in art museums. 3D objects allow the user to experience views previously not available without handling the piece. Because the object can be navigated, web-users can see the top or bottom of a sculpture, even if they are restricted by geography.

AMICO is a leader in the field, providing a repository of art images for education and research. AMICO accepts digital files from museums around the world, creating one of the most diverse and representative collections of art images. The requirements for submitting a file to the repository are quite extensive. The file must be accompanied with a text record and related image and/or multimedia files. This information is organized in records reflecting a customized metadata schema. The AMICO schema is a combination of the following metadata schemes:

- FDA/ADAG Guide to Description of Architectural Drawings data categories

- AMICO data dictionary
- CIMI Access Point
- CIDOC's International Guidelines for Museum Objects Information
- MDA's spectrum

At this time, 3D objects cannot be submitted into the AMICO repository. They require the primary file to be a TIFF, which eliminates most 3D objects. The AMICO metadata record does have a field for related multimedia files. Again, the lack of dominant viewers causes the detailed, proprietary object to be excluded because they are not currently in the data dictionary, which is understandable since only dominant file types are present.

Other submission requirements, which translate into metadata elements, will need to be revised for AMICO to accept 3D objects. The standard for high-resolution images, bit depth and file format will have to be modified into elements defining the 3D object. Metadata elements such as number of voxels or required viewers will have to be added to the current schema to handle these robust objects.

**VRA (Visual Resource Association)**
**http://www.vraweb.org**

The VRA metadata schema is an example of the DCMI being customized to suit the needs of the user. The initial DCMI elements are present but the VRA Core Categories are added to for a more descriptive set of metadata. The VRA elements primarily focus on the object, not surrogates of the work. Under the requirements, a 3D object file has different attributes compared to the schema. They will qualify as a *work* or *work type*. Typically, this element records the type of creation, painting or sculpture, for example. It is used to describe the materials in the physical objects. However, VRA's recommended authority control sources for this information do not contain acceptable terminology for this field. Similar to the previous metadata standards, the problem of lack of terminology in a thesaurus or data definition set will have to be amended before the object can fit into the schema.

VRA also emphasizes the *creator.* The schema is not restrictive when defining attributes for the *creator* element and offers one of the easiest elements to populate. Corporate names, such as architecture firms, are recorded in this field. This allows companies responsible for the scanning or creating a 3D object to be easily recorded.

**CIMI (Computer Interchange of Museum Information)**
**http://www.cimi.org/**

Sadly, CIMI no longer is in existence. Their current work has been disseminated to other organizations, which will continue to make contributions to the field. The XML project for SPECTRUM will continue through MDA.

## Recommendations

A collaborative environment involving the museums, information professionals and industry is needed to successfully bring these 3D objects to the user. Those managing these assets must stay abreast of technology trends and watch for dominant products. As the market peaks, the technologies remaining will prove to be a good choice and should be considered for implementations in information centers.

The DCMI element set will provide a general system for recording 3D metadata. The customization capabilities provide an organized place for information that may not fit into the initial element set. The VRA is built upon DCMI but not as capable of handing the technical aspects of 3D objects. AMICO will have to change its qualifications for submission before they can be submitted as a primary work for the collection.

3D objects will not require new schemas or a complete revamping of systems. With modifications to current schemas, information centers will be able to record the appropriate metadata for access and preservation. Data dictionaries and thesauri will need to be updated to handle these digital objects. The relationship between creator and object may need to be redefined to accommodate the different methods of producing 3D objects. Elements used for customization will allow for crucial information to be saved.

Table 1 is a simple representation of critical metadata elements that need to be recorded for preservation and access. The X represents basic compatibilities using current schemas.

**Table 1. Metadata Comparison**

| | DCI | VRA | AMICO |
|---|---|---|---|
| File Format | **X** | | **X** |
| Viewers | **X** | | |
| Creator | **X** | **X** | **X** |
| Resolution/Voxels | | | |

## Conclusions

Metadata schemas that accommodate the unique nature of 3D objects will prove to be a valuable component in the design of information systems. Applications and collections that include 3D images need non-proprietary standards to disseminate the richness of their collections. Adoption of new technologies is dependent on ease of use and relevant retrieval so the more we know about how users interact with 3D images, the more efficient the system. As we continue to include 3D images in our collections, our research agendas must include the development of standard descriptions and non-proprietary viewers.

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## Biographies

**Elise Lewis** is a doctoral student in information science at the University of North Texas. Her research interests are in how people interact with 3D images on the web and the development of standards for the display and manipulation of the images. She is manager of the Digital Imaging Lab at the School of Library and Information Sciences, research fellow for the Texas Center for Digital Knowledge and teaching assistant for the advanced digital imaging classes. She is a member of the American Society of Information Science & Technology.

**Dr. S.K. Hastings** joined the faculty at the UNT in 1995. She is very active in state and national professional associations and she is the current president of ASIS&T. Dr. Hastings has served as a resource person and presented a number of papers at varies professional meetings and conference programs. She was a principal investigator for a federally funded IMLS Library- Museum-University Collaboration project. Dr. Hastings continues to research problems associated with the access, retrieval, and preservation of digital images, with particular emphasis on designing information communities for the 3D environment.

**Cathy Nelson Hartman** is Head of the Digital Project Department at the University of North Texas and Associate Fellow of the Texas Center for Digital Knowledge. Hartman actively participates at the state and national level, most recently chairing an ALA committee on digitization of government information and the Depository Library Council, a federal government advisory board. She was recently elected to the Texas Records Management Interagency Coordinating Council. She publishes and speaks widely and is a successful grant recipient.