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Ontology-Based Framework for Real-Time Audiovisual Art

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Abstract:

Documentation of multimedia art requires extensive analysis. To ensure contextual understanding and recognition the need for systematization is high. This work examines the use of CIDOC CRM for semantic documentation of real-time audiovisual art. Documentation of audiovisual art is a challenge due to the variety of formats and content. Standardized metadata and frameworks to describe these objects do not exist. CIDOC CRM offers a framework to describe objects of cultural heritage but is not principally designed for virtual objects. This study examines the practicability of CIDOC CRM for real-time audiovisual art and documents scopes and constraints. Sampling frame basis is the largest internet archive of computer demo artworks. With descriptive and subject analysis a method and a conceptual model for the correlation of objects is presented. This makes clear that some concepts from the CIDOC CRM can be transferred but the model needs be extended for virtual technical material.

Keywords: Ontology, Cultural Heritage, Multimedia.

1 INTRODUCTION

A standardized, granular description and representation of terms and relationships improves the usage of digital media content especially for non-human agents. The general assumption is that a properly designed Semantic Web can assist the evolution of human knowledge as a whole [1], since this gives the precondition to recombine content in new and unforeseen ways. One major problem is that there are still too few standardized data and metadata formats in the field of real-time audiovisual art. Moreover these objects are difficult to describe semantically.

2 RELATED WORK

Specification of standardized access points to media objects is possible by descriptive cataloging, for example, using the Dublin Core standard. This bibliographic practice is complemented by describing the content through subject cataloging. Using controlled vocabulary like authority files allows for a standardized description of the content. Authority files are standardized terms for key words, descriptors and classifications. These standard terms are defined in ontologies which in turn consist of the specific vocabulary (terms) and the meaning of those terms. As a collection of essential concepts with properties and relationships ontologies offer the potential to define the content and context hence achieving a semantic agreement.

Thus ontologies are the key technology for the use of relevant information and apply as a panacea for many applications [11, 15]. Therefore ontologies represent a toolbox of methods for the efficient use of bibliographic information.

2.1 Statistically Ascertainable

A standardized documentation furthermore is the basis for accessibility and usability of archived information. Standardization also is strongly associated with linking and mixing with other archives.

Composition, integration and aggregation of content are in the focus of the bibliographic practice. Smart collections are based on complex network structures modelled with ontologies. Content will be traceable by the connectivity of the objects, hence the relevance of objects gets transparent and knowledge acquisition becomes possible for a broad audience. Yet individual ontologies are different: Syntactically, terminologically, conceptually and semiotically. Overcoming this heterogeneity of ontologies is significant [9]. Therefore standardized semantic models are becoming increasingly popular for the representation of different conceptual contents for archives. The Semantic Web turns the current global file system into a global database [19].

2.2 Machine-readable Data Building Blocks

The Semantic Web provides a common framework that allows formalizing and linking of standardized data. Ontologies are building blocks of the Semantic Web. With semantic technology it is possible to manage these ontologies. Therefore creation and use of machine-readable metadata are required. Goal is to describe entities and their content to develop inter-relationships covering creation, evolution, population and documentation [7]. For this purpose it is necessary to provide metadata with unique identifiers and to typify the links between resources.

In 1999 the specification of the Resource Description Framework (RDF) and the formal ontology language (OWL) were published intended for the semantic markup of documents on the internet. In 2004 both specifications have been officially announced as recommendation of the World Wide Web Consortium (W3C). Aim is to publish and share “sets of terms” called ontologies, to support advanced search and knowledge management [2].

2.3 Linked Data for Cultural Institutions

In the 1990s the Functional Requirements for Bibliographic Records (FRBR), a scientific data model for library bibliographic metadata, has been published by the International Federation of Library Associations (IFLA) [16]. This ontology represents a concept which integrates various regulations. The framework is particularly designed to promote development of high quality information systems for cultural communities and to enable the communication between heterogeneous and semantically overlapping systems. The International Committee for Documentation of the International Council of Museums (ICOM) developed an extensible ontology for implicit and explicit concepts and relationships used in heritage documentation. The CIDOC CRM is intended to promote a shared understanding of cultural heritage information by providing a common and extensible semantic framework that any cultural heritage information can be mapped to [8]. Since 2006 CIDOC CRM is an ISO standard [17] and in 2009 the RDF ontology model (ooFRBR) was established. Both models are currently refined to eventually develop a single extensible ontology in the field of cultural heritage unifying the diverse and multi-faceted information by using formal and standardized semantics.

With linked data different documentary worlds can be merged, based on semantic concepts. The vision is to develop an open global information space allowing to access and to reuse media content. Especially in the field of real-time audiovisual media it has become necessary to analyze collections and validate the use of standardized concepts for documentation like CIDOC CRM.

3 REAL-TIME AUDIOVISUAL ART

Real-Time audiovisual art stands for computer programs and applications in which text, graphics and music are merged to a real-time generated multimedia display on a computer. It can be classified into interactive and non-interactive multimedia.

3.1 Demo Art

Real-time audiovisual computer art like demo art (interdisciplinary created digital short films) is a sub-cultural contemporary digital art form in which computer technology is used in a variety of ways to create characteristic and aesthetic presentations with special effects and programmed tricks [12]. Examples can be found at http://pouet.net, a web-based multi-platform database of news, groups and productions as well as at http://awards.scene.org, an internet archive with a selection of the best releases since 2002.

Especially in the early days of home computing plenty of demo artworks have been created. Most of them represent highest quality in terms of design and implementation while exploiting the underlying technological material [18]. In demo art obsolete platforms are still used to produce artworks. These programmed works are representatives for an innovative and creative use of technology, showing off not only programming but also artistic excellence [13]. Over the time those artists have developed a unique way to use and craft media [10]. The creation process follows strict rules. Created demo art products are presented at community events and festivals in competition with other works.

This is one reason why these digital short films, which are positioned between music videos, 3D games and abstract visions, have to be preserved and documented.

3.2 Historical Frame and Sociological Aspects

This anarchic scene has their roots in the 8-bit era and the most popular gaming platform - the Commodore C64. Until the 1990s the scene was closely associated with the cracker scene, a subcultural movement of people removing copy protections. Demo artists initially developed small introductory presentations for cracked home computer games. Cracker groups wanted to present a signature in form of a start screen in front of the cracked game. Without the popularity of games this sub-cultural art form probably would not have originated. Demo art emerged due to the distribution of cracked games. Soon these display hacks got more popular than the games themselves and evolved into discrete artistic presentations. From this background the sociological aspects of this sub-cultural scene play an important role. Together with a high degree of intrinsic motivation demo artists overcome a steep learning curve to acquire the needed craftsmanship and knowledge about the underlying technology. Technological limits are perceived as a challenge to create impressive and innovative art.

Demo artists usually join groups to bundle competencies and to develop their multimedia artwork. These artists are mostly using aliases. The most relevant roles within such a creative team are the programmer, the musician and the graphics artist. Festivals (mostly European) have existed throughout the entire history of this scene and represent the meeting places for demo artists [20]. Although they changed over time, these festivals are the most important platform where the creative protagonists of the scene present their artworks and ask for acceptance. In addition the demoscene movement is the origin of today's popular indie game developer scene (the ability to self-produce content in the era of home computing was the origin of the first homebrew game scene). It also provides an important contribution to the commercial game developer scene and delivers input to the long-term preservation of our technical culture. The demoscene is not only nucleus in the preservation and transmission of so-called "Abandonware" but also of obsolete platforms for example through emulation.

While the game developer scene and the demoscene have emerged in strong competition with each other at first, today both scenes seem to be merged on many levels and constitute a life-cycle: Since the beginnings gaming technology causes the development of the scene - nowadays demo art supplements and extends the game development with tools and expertise. This is not only reflected in the fact that demo artists are working for game companies because they have some decades worth of practical experience in the Commodore, Amiga, Atari, and PC demoscene, a good grasp of design and visuals, as well as the required expert knowledge but also because demo tools like Demopaja or Werkkzeug developed and released by demo artists are used for creating games or expanding game engines with special visual and sound effects optimizing illumination, camera movements and more [5]. Not only the experience and knowledge of the artists is passed within the scene also the existence of tools and Abandonware is continued or even advanced by the community.

3.3 Collection Analysis

Demo artworks are multifaceted data objects with diverse unique characteristics actually enabling analysis and categorization.

Borzyskowski provided a first categorization of demo artworks in 1996 [6]. It gives an impression of the diversity of demo art. Yet, it seems that the category scheme commonly used at festivals is more significant as these annual festivals influence the development of demo art categories significantly. Demo art released at festivals is documented and archived on festival websites and internet portals. Unfortunately the original source code of these artworks is rarely available. Instead various versions of the artwork are available as executable binary or video file types with different codec and compression.

Demo art presentations are based on synchronous or imperative programming languages as well as real-time systems. Besides their complex semiotic nature the tools and methods used to generate these works are mostly not documented. Up to the 1990s demo art was programmed in machine language. Nowadays usually integrated development environments are used to support the compilation of high-level languages into machine code possibly integrating additional tools used for real-time applications such as games.

In summary it can be said that demo art is representative for a characteristic aesthetic in graphics and music. In addition to classic "old-school" effects each technical platform causes a specific aesthetic in resolution, color scheme, speed, size and composition. These become apparent in visual expressions such as still images, 3D objects, ASCII and ANSI art and musical styles based on sampling, sound synthesis and chip tune [20].

4 DOCUMENTATION WITH CIDOC CRM

Media content can be analyzed from different perspectives. Besides technical and art especially historical perspectives and information-ethical points of view characterizes the overall appreciation [14]. Multimedia art exists in a large number of abundance and diversity, so the need for selection, systematization and contextualization is particularly high. Proper documentation is needed to ensure a common social contextual knowledge and a neutral, scientific reporting to enable more media-theoretical research.

4.1 Requirements for Indexing

Preservation of the tradition of real-time computer-generated demo art requires extensive documentation and cannot be done in isolation from the technological development and sociological aspects, because these aspects define the scope of artistic expression. Moreover a study of aesthetical aspects separated from the performing context and technological requirements will render a media theoretical research unsuccessful.

Hence an analysis of the sociological structures and performing context has to be conducted and its results have to be transformed into documentation formats. The granularity of documentation must be decided in each individual case. In particular the origin and the development context carry the most valuable information.

4.2 Data Selection and Methodology

Regarding the analysis, the existing population of demoscene objects with over 50,000 items is too large to make a full survey thus a partial sampling is carried out. As a complete list of all elements of the population is given, a systematic sample using the cut-off method can be applied [4].

The selection consists of especially popular demo artworks (Top Prods) which therefore are relevant for the examination target. Being 1 percent of the population a minimum of 500 Top Prods already is a characteristic selection of demo art which is particularly interesting and important. The selection contains community rated, nominated and awarded productions out of over ten different categories. Sampling frame basis is pouet.net, currently the largest internet archive of documented demo art works. Units of analysis are the relevant entities determined in illustration 1.

As necessary contextual information is distributed on countless web portals since the 1990s, an overview should be gained through exploratory analysis. By applying a descriptive and subject analysis regularities and irregularities in the properties of the entities are determined. Especially the release context i.e. the location and condition of the performance and its rating play an important role in the evaluation of the works and hence the relevance. The authorship of the works differs, in some cases considerably. Specific information can only be found in the credits at the end of the works. Each work has to be observed to determine the appropriate authorship. The semantic relation to the technological requirement and the necessity of being able to display the artwork requires a high level of specific expertise. The same applies to the analysis of content and aesthetics of the works.

The sample provides insight about whether demo art can be generally represented by the concepts of the CIDOC CRM and where the model may need to be advanced. Unlike static documentation CRM enables a comprehensible documentation of the creation process and the historical context [3]. Mapping the relevant entities to the CRM structure allows the examination of classes and relationships.

4.3 Definition of Entities

The documentation process has to be divided into distinct sets of documentation actions based on the relevant entities as suggested in illustration 1.

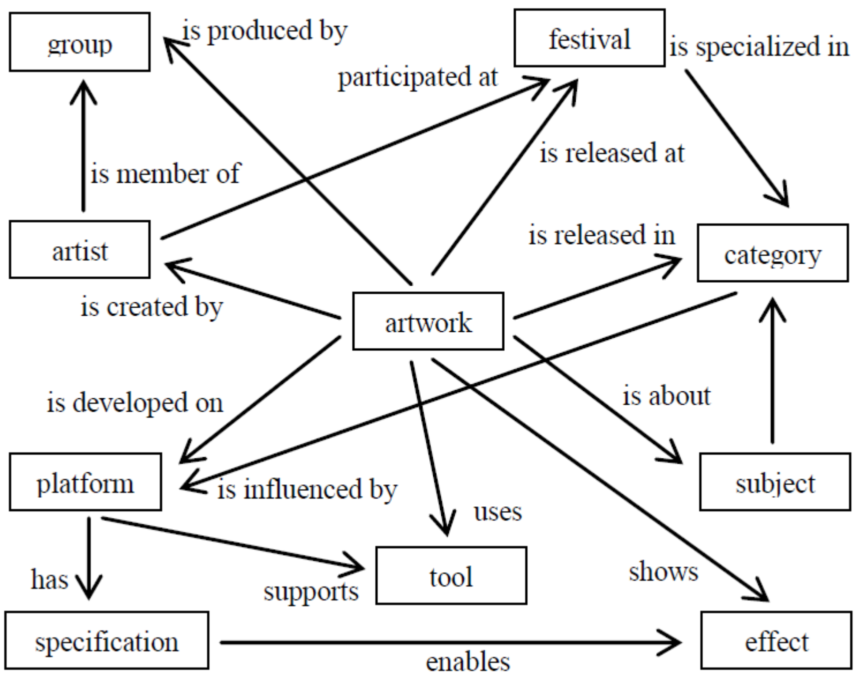

Illustration 1. Definition of Involved Entities

4.4 Exemplary Modeling in CIDOC CRM

In the following the entities “artwork”, “group”, “festival” and “platform” (as depicted in illustration 1) are discussed on the basis of CIDOC CRM version 5.1.

Illustration 2 shows a partial view of the CIDOC CRM representing the artwork and used tools.

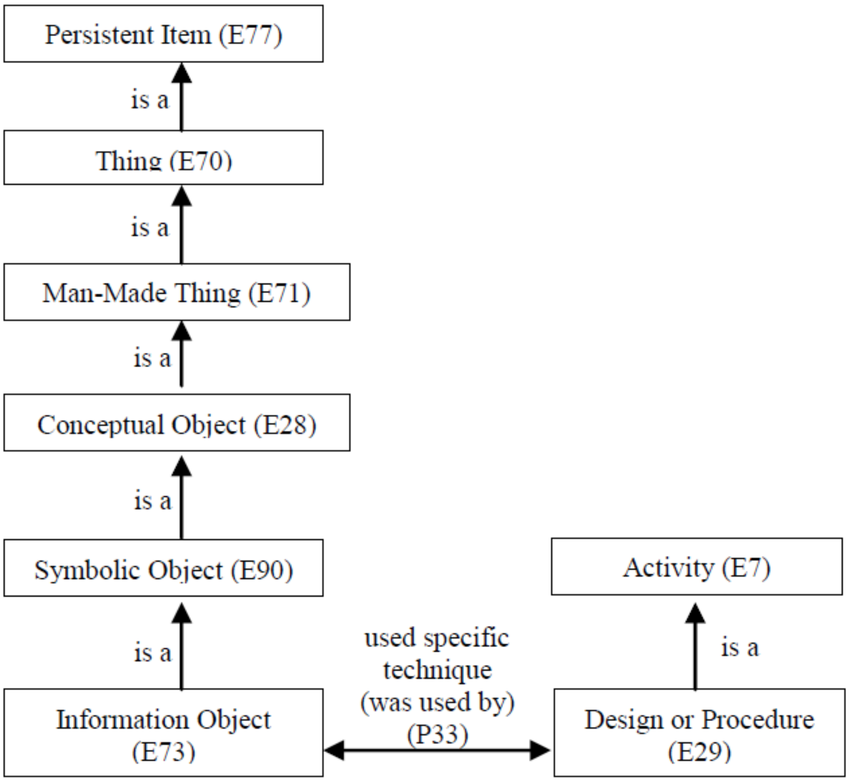

Illustration 2. Exemplary modeling of the entity "artwork"

An "artwork" is an Information Object (E73) like an identifiable immaterial item, such as multimedia object, computer program code, algorithm or procedural prescription and has to be documented as a single unit. An E73 Information Object does not depend on a specific physical carrier and can exist on more than one carrier simultaneously. The superclass of E73 is the E90 Symbolic Object which refers to identifiable symbols and any aggregation of symbols such as data sets, images, multimedia objects etc. that have an objectively recognizable structure. The E28 Conceptual Object is a superclass of E90 and refers to non-material products using technical devices such as computers. As an instance of E71 Man-Made-Thing this class comprises intellectual products like an electronic encoding. E71 Man-Made-Thing finally is a subclass of the general class E70 Thing which is an instance of E77 Persistent Item. To declare the object as a member of a particular category of items it is described as instance of Type (E55) by the CRM. Technical performance of an artwork unfortunately cannot be modeled with existing CIDOC CRM classes and relationships.

Tools used to create an artwork (E73) Information Object can be described with the property Used Specific Technique (P33). This property identifies a specific instance of Design or Procedure (E29) in order to carry out an instance of Activity (E7). A mapping with platform specific requirements cannot significant be modeled with CIDOC CRM.

Aesthetic expressions are demonstrated programmed effects and subjects with regard to content, visual and musical composition. Effects are Visual Items (E36) like recognizable images or symbols and can be described using the property Shows Visual Item (P65). Subjects can be described with Propositional Object (E89) as A Component Of (P148) an

Information Object (E73) which comprises immaterial items, including but not limited to stories, plots, procedural prescriptions, algorithms, laws of physics or images that are or represent in some sense sets of propositions about real or imaginary things and that are documented as single units or serve as topics of discourse. This class also comprises items that are “about” something in the sense of a subject. In the wider sense this class includes expressions of psychological value such as non-figural art and musical themes. Further Propositional Object (E89) has A Subject (P129) as an instance of CRM Entity (E1).

The description of a work is similar to a transcription of the documented text in a note as a String (E62) using the property Has A Note (P3).

Computing platforms can be modeled as Man-Made Objects (E22) with the property Used Specific Object (P16) which refers to physical objects created by human activity. However platform specifications cannot be modeled with CIDOC CRM because of the loss of classes to describe the technical materials like hardware architecture and software frameworks. Describing these platform specific properties as a Symbolic Object (E90) as any aggregation of an objective recognizable structure or a single unit would be too abstract and imprecise.

Modeling of the groups is defined in accordance with the CIDOC CRM class hierarchy. Demo groups correspond to Group (E74) and the artists will be assigned as an instance Actor (E39). Using the property Has Current or Former Member (P107) it is referenced from E39 to members of the parent class E74.

Festivals can be modeled as Temporal Entity (E2) which Has Type (P2) and consequently a Type (E55). Temporal Entity is also specialized into Period (E4) and Condition State (E3). As a subclass of Period (E4) an Event (E5) describes further a phenomenon within a space and a time frame. An Event (E5) Has Participants (P11) like Actors (E39).

4.5 Potentials and Limits of CIDOC CRM

Modeling the required entities in CIDOC CRM seems to be possible. However the CRM is at least not principally designed for virtual objects and technical material. Some concepts from the classical museum environment can be transferred but others seem to be rather abstract. In conclusion table 1 shows an overview of the relevant entities and attributes which can be either good or less or not represented with CIDOC CRM.

Demo art characteristics such as performance, system requirements and specifications which define both the origin and the context of use can be regarded as direct properties of artworks. Unfortunately these cannot be modeled in CRM. For mapping computing platform specific properties a new solution must be worked out. In an art-historical view platforms are considered as materials with material-specific properties. The concepts of materials in CRM refer to discrete pieces of raw-materials kept in museums such as bricks, sheets of fabric and pieces of metal which are modeled individually in the same way as other objects or parts. It is clearly pointed out that internationally or nationally agreed codes and terminology have to be used to describe materials. It gets clear that CRM must be extended with technical material descriptions. Likewise for the description of the performance categories of festivals it is necessary to specify the material properties of demo artworks as well as to establish a closer link to the technical requirements. Demo art categories must be implemented by a further classification in relation to the festivals which later complements the CRM with a standardization of types.

Table 1. Tabular overview of CIDOC CRM classes

entities	good	less	not
artwork	E73		
manifestations			no class available
performance			no class available
duration			no class available
category	E55		
tools		E29	
requirements			no class available
effect	E36		
subject		E89	
description	E62		
platform		E22	
specification			no class available
group	E74		
artist	E39		
festival	E2		
awards			no class available
period	E4		
event	E5		
participants	E39		

5 RESULTS AND OUTLOOK

The current work presents a method of analysis and a first conceptual model for the correlation of objects in real-time audiovisual art. With this sample analysis potential, opportunities and gaps of the CIDOC CRM model are illustrated. As a result of this work described it can be concluded that CIDOC CRM is still closely related to the classic field of museology but needs to be extended for virtual technical computer based material.

Basically with the CIDOC CRM the fundamental characteristics of demo art scene can be depicted. For representing specific details which closely describe the individual artwork and the specific computing hardware and software characteristics an extension needs to be developed. At this time it is not possible to describe the origin and the context of use of these individual artworks. The model must be flexibly extended so new features as part of the future development of this art scene can be integrated at a later point as well.

To close the gaps and to find a solution for modeling entities and properties which are not in the CRM a new analysis has to be done to develop a vocabulary describing virtual technical material and extending the existing model or to linking it to other ontologies.

Since demo artworks and relevant context information are widely spread over the internet and this art form is not easily accessible to non-scene-participants, memory institutions should be active and take part in the documentation of web-based art forms. While heritage institutions in the 1990s were more or less at the end of the media production chain now a paradigm shift can be observed. Today archives are at the beginning of the production process as a resource which ensures the quality and accessibility to relevant media content.

Documentation is essential for the security of tradition and transmission of relationships. It enables the reconstruction of history and tradition. Especially in the digital age, where technological development is associated with the loss of knowledge, there is an increased relevance to build diverse collections, to archive, document and to finally make public.

6 REFERENCES

[1] T.J. Berners-Lee et al., “The Semantic Web: A New Form of Web Content that is Meaningful to Computers will Unleash a Revolution of New Possibilities”, *Scientific American*, vol. 284, no. 5, pp. 34-43, 2001.

[2] T.J. Berners-Lee, “Semantic Web Road Map” [Online], 1998. Available: http://www.w3.org/DesignIssues/ Semantic.html.

[3] V. Binz, “RDA: Archiv, Museum & Bibliothek auf einem Nenner?”, *Berliner Handreichungen zur Bibliotheks- und Informationswissenschaft*, no. 302, 2010.

[4] J. Bortz, “Statistik für Sozialwissenschaftler”, Springer, 1999.

[5] Bobic of 4sceners and Ghandy of Moods Plateau (2008), „*The Demoscene and Modern Games*“ [Online], *zine behind the scene*, no. 13, 2008. Available: http://zine.bitfellas.org/articlelist.php?zine=13.Supplied as additional material zinearticle20.pdf

[6] G. Borzyskowski, “The Hacker Demo Scene and it’s Cultural Artifacts”, Study, Curtin Univ. of Technology, Perth, Australia, 1996.

[7] J. Davies et al., “Semantic Web Technologies: Trends and Research in ontology-based Systems”, Wiley, 2007.

[8] M. Doerr, „What is the CIDOC CRM“, 2011. Available: http://www.cidoc-crm.org/index.html

[9] J. Euzenat and P. Shvaiko, “Ontology Matching”, Springer, 2007.

[10] S. Felzmann, “Playing Yesterday - Mediennostalgie und Videospiele”, in A. Böhn and K. Möser (Ed.) Techniknostalgie und Retrotechnologie, *Karlsruher Studien zu Technik und Kultur*, G. Banse et al. (Ed.), vol.2, pp. 199-215, 2010.

[11] D. Fensel, “Ontologies: A Silver Bullet for Knowledge Management and Electronic Commerce”, Springer, 2004.

[12] C. Hastik and A. Steinmetz, “Demoscene Computer Artists and Community,” *CERC Collaborative European Research Conference*, Darmstadt, Germany, 2012, pp. 43-48.

[13] C. Hastik and A. Steinmetz, „Computer Technology- A Tool in the Hand of the Artist?“, *Proceedings of Euromedia'2012*, Bucharest, Romania, 2012, pp. 35-38. Supplied as additional material euromediaHS2012.pdf

[14] J. Heesen, “Was ist ein digitaler Content wert? Kriterien für die Bewahrung eines digitalen Erbes“, in C. Y. Robertson-von Trotha and R.Hauser (Ed.) *Neues Erbe*, vol.1, pp.83-93, 2011.

[15] P. Hitzler, Krötzsch M., S. Rudolph, „Foundations of Semantic Web Technologies“, CRC Press, 2009.

[16] IFLA Study Group (Ed.), “Functional Requirements for Bibliographic Records. Final Report”, De Gruyter Saur, 1998.

[17] *A Reference Ontology for the Interchange of Cultural Heritage Information*, ISO Standard 21127, 2006.

[18] N. Montfort and I. Bogost, “Racing the Beam. The Atari Video Computer System” MIT Press, 2009.

[19] M. Lowndes, “An Introduction to the Semantic Web for Museums”, J. Trant and D. Bearman (Ed.), *Museum and the Web 2006*, Albuquerque, USA, 2006. Available: http://www.archimuse.com/mw2006/papers/ lowndes/lowndes.html.

[20] M. Reunanen, “Computer Demos – What Makes Them Tick?”, Helsinki Aalto Univ., 2010. Available: http://de.scribd.com/doc/33280491/Computer-Demos-What-Makes-Them-Tick