https://doi.org/10.2352/issn.2168-3204.2019.1.0.12

Tools for Presenting Multimedia Performance Documentation Using 3D Visualisations

Roman Berka; CTU Prague; Czech Republic
Bohuš Získal; CESNET Prague; Czech Republic
Zdeněk Trávníček; CTU Prague; Czech Republic

Abstract

Within the project dedicated to the phenomenon of Laterna magika, tools and techniques for multimedia performances presentation and preservation were investigated, developed and applied. In order to present performances in their complexity and with respect to their historical context, a suitable data model had to be identified to build links between various documentation components with respect to existing standards and methods used by memory institutions. Being fragmented and incomplete, the existing documentation components were collected and digitized, the selected scenes were rebuilt in the form of 3D models. The actor's movement on stage was reconstructed and recorded using the motion capture system. For content management and presentation purposes, various tools were developed allowing for visualisations in VR environment and viewing/annotation of performance documentation components.

Background

The Laterna magika performance originally created for the international exhibition EXPO 58 gradually developed into a series of theatre pieces combining film projections and life stage media like dance, sound, lights, pantomime, black-theatre (Figure 1), and it is considered unique phenomenon in the context of both Czech and international art. Within the four-year project, specialists from various institutions led by the Czech National Film Archive committed to develop and apply suitable methods and tools in order to collect, catalogue, digitize and preserve selected historical Laterna magika performances, and to make them accessible to both experts in various fields and to the general public in an attractive form. Laterna magika performances provide a good illustration of complexity a multimedia performance could reach. Performance components were produced during various creative processes with participation of many acknowledged authors like film directors, where the outcomes existed in a form of physical manifestation (stage settings, film recordings, costumes), as a paper documentation (scenarios, scores or technical descriptions) and sometimes preserved only in an indirect form (like personal notes of a technical staff, letters to promoters or realisation teams, memories). Although the actual performance realisation could have been recorded, this was mostly done for promotional purposes only and these recordings provide rather a limited foundation for a performance recreation. Some of the originally created performance components, namely films used for projections, were preserved on the original medium, albeit not stored in an appropriate environment and without any administration. The remaining documentation is significantly fragmented, spread among various institutions, and some important parts, mainly related to dance performances, are missing. There were tens of thousands of physical documents with unknown relevance to the phenomenon found in various collections without any description and mostly stored in an unorganised way. The Laterna magika artistic company still exists and now it is part of the National Theatre, some historical performances were reconstructed, but without organising the content related to past shows or producing new documentation in a structured manner, mainly due to the lack of suitable methods and resources.

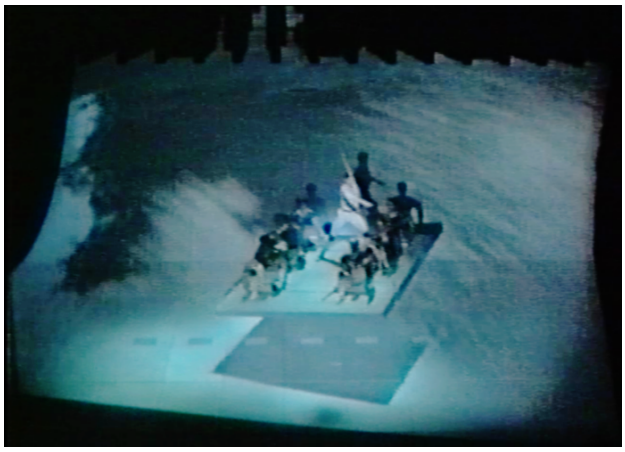

Figure 1. *Image from the performance Odysseus video recordings, originally on VHS.*

Objectives and methods used

The main parts of the Laterna magika collections are held by three institutions – the (Czech) National Archive, the National Theatre, and the National Film Archive, these institutions have different objectives and are following various cataloguing standards and rules. Also, their designated community is quite heterogeneous, therefore for setting the project goals appropriately it was necessary to evaluate the expectations expressed by a number of experts and potential users across different fields. Besides the standard requirements like the ability to effectively present the preserved content, there were requests identified related to the specific nature of the multimedia performance and to the necessity to preserve the work together with its context. Particular attention was demanded to be paid to preserving information related to versions and the way how specific documents were produced to allow for differentiating original components from their remakes or interpretations. This also includes the correct attribution of authorship together with well-defined roles. For time-based media it means that it could be beneficial to add metadata even on a segment basis, e.g. when identifying some part that was modified by different authors. Therefore, our project objectives can be seen in three main areas – a suitable metadata structure, formats for the entire performance presentations and the corresponding tools.

Laterna magika performances were created for being performed on stage and there can be two types of related artifacts

distinguished – the scripts and components that could allow for materialising author intentions using predefined tools and techniques and evidence of a performance realisation in a specific place and time. Most performance components were created by groups of authors in various roles and quite complicated relations, public presentations often varied once there were improvised parts. The performance documentation production and organisation processes were inevitably affected by their specific purpose, be it promotions, ongoing realisations or instructions for further reproduction. Once memory institutions did not participate in a performance documentation process, a necessity to identify and organise various document types emerged, while relationships among various work components and authors involved in specific roles need to be reconstructed.

For preserving Laterna magika performances in their complexity, particularly to demonstrate the relationship between film projections and dance, appropriate digital representations for all related objects had to be identified. There is only a limited number of established formats used for documenting performances (text, images, sound, video) and memory institutions have already developed adequate processes for most resource types used, however often without maintaining more complex links between different document categories. If a single type information object like text is catalogued using processes established in e.g. libraries, the specific data model used could not be suitable for preserving performance broader contexts and creating a more complex structure that allows performance documentation to be accessed and preserved as a whole. This means that for reconstructing a work from information objects spread among many collections, a significant effort is (repeatedly) needed unless all objects metadata can be shared and there is a suitable aggregation service available. Moreover, memory institutions in general have implemented various rules and standards for resource description and access with respect to their type (e.g. MARC21 for Libraries) and the introduction of a new data model to reflect more complex relations between various work components usually means that many processes have to be redefined. This problem has been discussed in the literature many times and there are convergences apparent in practices of Libraries, Archives and Museum, especially with respect to digitally engaged users [3]. Unfortunately, we are not in the position to change strategies in participating institutions, we can only propose suitable methods based on the record aggregation that allows linking objects held by our partners together with newly reconstructed content. As there are no established practices in presenting complex multimedia performances documentation, specific ways how the preserved content is supposed to be presented and eventually distributed should be also taken in account when defining a suitable metadata structure. Thus, presentation techniques and corresponding requirements for the performance documentation should be identified in parallel to ensure that some important (e.g. technical) metadata type is not omitted.

Content presentation techniques

For the purpose of all preserved content presentation, we focused on its digital representation. With the exception of restaging, the performance can be perceived only in its mediated form and all persisting objects can be digitised. To begin with, the existing physical components of historical performances were safely preserved, especially all film reels used for projections and when appropriate, digitised. In order to recreate a performance or to study its production process, digital representations of related objects can be presented using the appropriate tools – e.g. pdf reader for the text documents, and with the exception of human motion component and 3D stage model, there are no special techniques needed.

Even with quite a limited documentation available, in our case, we realised that stage settings digital reconstructions do not seem to be particularly complicated, although it has to be done using a manual process (3D modelling). On the contrary, we found a dance component as the most challenging being the least described and including a certain degree of improvisation during shows. For preserving and presenting a reconstructed movement, the already established methods for documenting dance can be applied, namely dance notations, film/video, and motion capture, see e.g. in Smigel et al [10]. Dance notations were primarily designed for a performance realisation, they are understood by relatively few professionals and there is always a significant room left for their individual interpretation. Compared to film/video, the motion capture technique provides greater flexibility in analysing and visualising data and it leaves more space for future presentation techniques. This form of motion description is also machine readable and searchable, and allows for automated segmentation that can be used for identifying specific parts in the choreography. However, it is still quite expensive to produce and requires more advanced tools. As it was already decided that some application has to be designed and developed within this project and one project partner is active in the field of VR technologies, a motion data production was seen as an obvious choice. To maintain links between information objects and to identify their relations to a specific work, there should be a solution allowing for searching within more types of objects simultaneously and presenting links to a broader work context. We have evaluated existing, both commercially available and experimental tools, most notably the work by Kipp [5], and designed our solution by adapting some already proven concepts.

For presenting the entire performance in its complexity to the general public, only two suitable formats were identified – video and 3D scene representation, both mean that all work components should be somehow reconstructed. As most authors and performers are still alive, this is better done with their help. Unfortunately, the majority was not interested in our project active participation, so it was decided to record their memories using oral history interviews and to preserve these recordings as the additional performance documentation. With respect to our goals, both formats are used, with primary focus on 3D scene and video generated as the rendered view from a virtual camera, while considering best practices in 3D objects archiving as discussed e.g. in the field of digital cultural heritage, see Chanhom et al. [2] or Koller et al [6]. As motion capture data, a 3D representation of the whole performance and rendered video include information related to time, specific metadata (annotations) can be linked to defined time segments, author credentials or any other relevant document (like an image) can be attached to a segment only.

Data model

Provided that some cataloguing concepts are applied by most memory institutions and various standards can be mapped to each other to a certain degree, the missing relations among various information objects related to performance could be described using a suitable top-level model that can incorporate and interpret existing metadata with respect to performance preservation needs. At first, key work elements and their relations should be defined, preferably by adopting FRBR concept as a starting point. Doty [4] has reviewed various ontologies suitable for live performance documentation and especially examined relations

between Work and its Performance. Based on Doty's conclusions, key work elements can be defined in the following sense (with corresponding FRBR entities indicated).

Performance-Work /work/	an abstract concept to be performed, in theatre (imprecisely) the play, there could be manifestation in a textual form (idea)
Production /instance/	what is created and rehearsed, in order that Work can be performed, this includes manifestations like scripts, costumes, light design, sounds
Performance /instance/	a particular event enacting Work in a way defined through Production

Doty discussed the ways how the relationship between Performance-Work, Production, and Performance can be defined by examining copy, kind, token/types, realisation, interpretation, performance or incorporation relations (e.g. if a specific Performance can be considered as a copy of Production). Doty has also paid attention to the problem of variations and proposed some answers, however, we found this issue to be more complex in our case (Laterna magika performances) once there could be also reconstructions and third-party interpretations of the Production/Performance made. Specific component manifestations can be linked either to Production (e.g. scenarios for films used for projections) or to Performance (e.g. performance recordings) while different authors can be involved. The question of the authorship attribution in a collaborative production has serious consequences for a work presentation with respect to the Intellectual Property Rights. Usually, a production manifestation (e.g. scripts) is created for a specific performance (and its eventual reprises) and therefore its authors can be also associated with the corresponding performance realisation(s). Nevertheless, for works that are reconstructed after a longer period based on original scripts and using some original production components, there could be a performance build on the interpretation of the original production material where new authors are involved. The resulting manifestations (like the newly interpreted performance recordings) can be then mistakenly attributed to the new authors only. Performance can even be recreated in a virtual environment, where some original production components (like digitised films) can be used together with some reconstructed objects (e.g. stage elements modeled in a 3D environment). For distinguishing objects that were not produced by any of the original work authors (participating in Production and/or Performance realisation), two more categories were introduced - Interpretation and Reconstruction. The Reconstruction attribute means that an object has been reconstructed without any active participation of the original authors and some Production components (like stage settings, choreography) had to be recreated as closely as possible to the original author intentions. A performance reconstruction could be perceived as quite similar to the original one, but as in many cases the original documentation could be quite scarce (e.g. there are no recordings of the original performance), some components can be notably different. Interpretations of various components of a performance realisation could significantly help during its reconstruction process, as well as are important for understanding a performance broader context. Especially in case of complex multimedia performances, where valuable reflections often come from theorist in a specific field like dance, an interpretation could be related specifically to one performance component. The corresponding model can be demonstrated using the following matrix with examples related to multimedia performance:

	Primary object	Interpretation	Reconstruction
Production	Choreography	Dance styles analyzed	Newly recreated dance
Performance	Performance recordings	Performance review	Performance in VR

To identify authorship properly, we have evaluated the concept of Agents as it is defined in the BIBFRAME Content Description Data Model with consequences explained by B. Lyons and K. Van Malssen [7]. In our model, Agents could represent authors or institutions associated with Work, Production or Individual Performance in various roles. For the practical application, this corresponds to the functional requirements for authority report proposal created for FIAF [8], and it was implemented in the FIAF Moving Image Cataloging Manual [11] that serves as the main guideline for the Czech National Film Archive. It can be effectively used as the underlying concept to be understood and applied by different memory institutions and could help to administer their participation in the common database of authorities. In our country, the national database of authorities is used mostly by libraries and there are relatively few active contributors from other fields. Our approach, if successfully adopted, could help to support a more interdisciplinary deployment of authorities. As our data model should allow for data sharing on the international level, existing projects were evaluated, and the concept of Annotation introduced by Bellini and Nesi for the ECLAP project [1] was found applicable. For our purpose, the Annotation element can be linked to any type of Media Object, and there are different classes of Annotations introduced that allow for identifying Interpretation and Reconstruction categories. In our application, annotations can have the Time property to associate related segments of time-based objects. Within the ECLAP project, the database of performances together with the presentation portal was designed and it is gradually populated with a huge amount of works submitted by a host of cultural institutions. Unfortunately, ECLAP presentation interface does not meet our needs for showing the multimedia performance components appropriately linked, however as a part of our data aggregation process, a partial contribution to their database (records held by our project participating memory institutions) is possible.

The entire (performance) Work descriptive structure is proposed to contain top-level entities corresponding to Work, Production, and Performance with Agents associated, specific Items (like performance recordings) are linked as a sum of related object records, most of them were already described using schemes like MARC21. Each metadata set should be mapped to a common format and accompanied with additional metadata like Annotations. It was decided to map all resource types descriptive metadata to a common structure in the Metadata Object Description Schema (MODS), where new structural relations can be created and preserved as an export of the whole structure. For the newly created objects (like 3D scenes), the corresponding descriptive structure was defined already in MODS. Together with digitised objects, additional technical and administrative metadata, the entire data structure for all object related to a specific performance can be exported in METS format for preservation purposes.

Tools developed

In order to manage the entire descriptive metadata structure, to create links between work components and to add annotations describing the relation of each component to the work, it was necessary to design a new application. The solution should allow for importing digital objects together with metadata from various sources, automatic metadata mapping to a common scheme and creating additional information and links. It should be possible to manually check and edit the mapping, to browse and view all types of digital objects including motion capture data and videos and to identify time-based media segments, optionally with the help of some automatic segmentation algorithms.

Application data and GUI design

As it was already mentioned, documenting a multimedia performance generates complex structures of data, metadata, and relations among them which often leads to a rather complicated tool design, mental models and processes. On the other hand, there is a need to have a data model understandable for various professionals which are people having a different experience with data organizing processes. Thus, the tools helping to identify, describe and define relations inside the data and metadata have to be user-friendly and, on the other hand, very flexible to allow the building of complicated structures and relations. Our design is based on the three-layer data model (see Figure 2). The basic layer contains data related to physically existing basic elements called *digital items* (video, image, audio record, motion record, VR content, text, document).

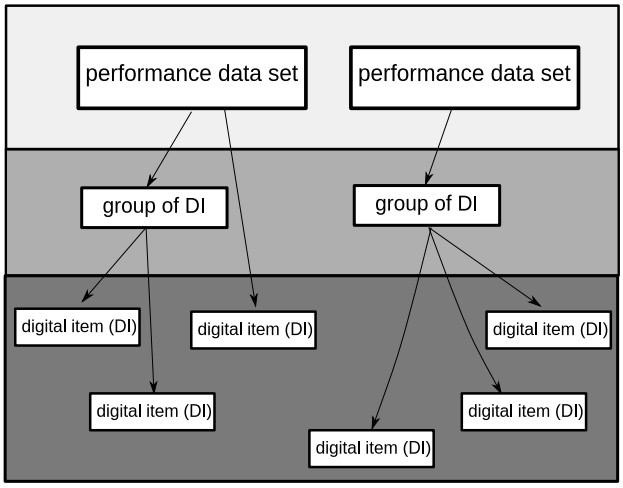

Figure 2. *The three-layer based data model of the application.*

The middle layer allows to define *groups of digital items* which helps to organize larger sets of digital items of the same type (typically images) documenting the same process. The top layer consists of components called *performance data set* which represent one performance or its part and holds all the available data, metadata and links (defined relations) documenting a given performance.

The user environment is designed with respect to three roles (general user, researcher, and editor) which have rights to browse just predefined data set presentations, see or define links and annotations and change content of the database respectively. The user environment allows to define so-called VIEWs. The VIEW is defined as a selection of *digital items* (or *groups of digital items*) which allows to arrange the selected multimedia material, define relations among selected components and present partial results of research (see Figure 3). The VIEW is presented to the user as a workspace (or canvas).

VIEWs can be stored and later presented to other researchers or to the public. The presentation of various data types inside a VIEW is solved via containers. A container is a component designed to present multimedia content (video, image, motion data, virtual scene) in a uniform way. The user can place a *digital item* or *group of DIs* to the workspace connected with the VIEW. Based on a specified data type the application will create the container specialised for the given data type and allows the user to arrange containers, browse their content and annotate it.

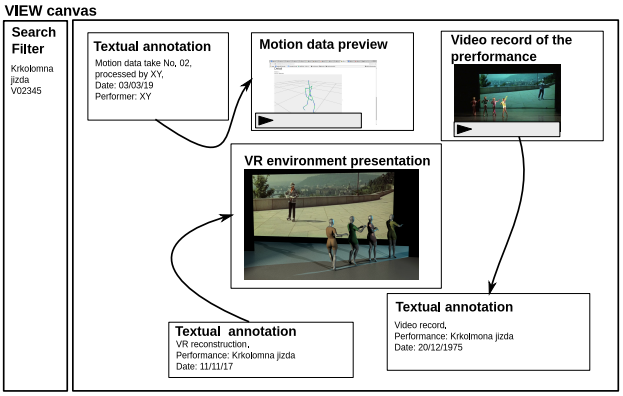

Figure 3. *A visual scheme of VIEW - the workspace to arrange and annotate all multimedia material.*

The key feature of the user environment is the possibility to define relations of a selected item to any other data component. This tool enables to create links between simple media types like images or texts and also time-based media where the user can point the link to any time stamp. Any link can be directed to other items in the current archive but also to targets at remote locations (other archives, private collections etc.) and it holds information about accessibility with respect to copyright rules or physical availability.

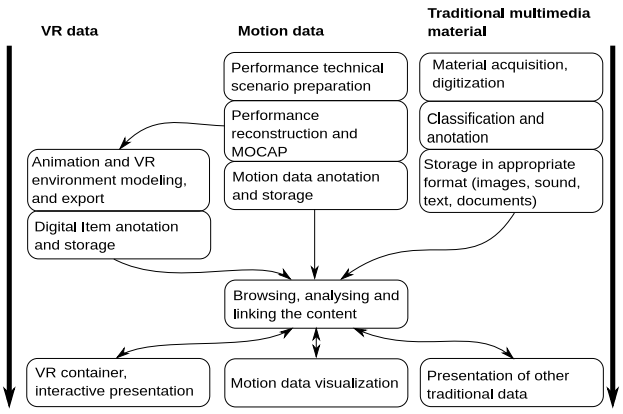

Figure 4. *The processes applied to various categories of data.*

Application module for presentation

The possibility to watch a performance from various angles and interactively move through a scene (e.g. theatre hall) is an interesting experience for professionals but also for the public in general. The form of the virtual 3D world gives the user more complex information about the spatial arrangement and relations of moving dancers during the performance with respect to video projections. Therefore, our application allows to store and work with VR content as one of the components documenting selected parts of performances. The user can place a VR presentation

using a specific container to the VIEW as any other data type. She/he can define links and annotations pointed to this content.

As the software tool is designed in style of a web application with REST API, its backend allows accessing VR content through the web-based user interface or optionally through any other kind of application or device, e.g. smart-phone (suitable for the general public user) with an appropriate application. The presentation of a performance through a virtual world using available multimedia data is a result of a very complicated production process. Thus, in order to enable presentation of virtual scene through a container placed into the VIEW, the VR data has to be packaged together with a control logic to be viewed as one digital item. To allow this, we employed *Unreal Engine 4* [12] which is used as a generally known authoring tool for game developers and, in hands of an experienced user, could be applied as a strong tool for VR data preparation (e.g.in [9]), and as a performance presentation authoring toolkit.

Figure 4 shows processes applied to three different categories of data types. It also shows the pipeline producing VR content which can be then embedded into our concept of VIEWs. In the first approach, the VR presentation is targeted to the public, but not exclusively. The VR environment (motion data, projections, sound, scene geometry, and scripts) represents a completely synchronised data package which allows additional experiments and creative work with the content. Unfortunately, our current authoring process requires too high technical skills to be used by an average internet user. Thus, to find authoring techniques supporting fast development of VR performance representation is a challenge for next research.

Results

Paper documents held by participating institutions were digitised in a preview quality that allows for reading the content and serves mainly for identifying the relevant content and presenting performances in the digital domain.

Figure 5. *Image from the performance Krkolomna jizda reconstructed in the digital domain.*

Selected film materials originally used for projections, corresponding sound reels and all available recordings of performance realisations were processed and digitised in accordance to the industrial and The National Film Archive standards, where the original carrier type and the content quality were important factors for setting the digitisation parameters. Representative excerpts from performances were reconstructed in the form of 3D models including human characters corresponding to actors and using the motion capture data previously recorded under the supervision of choreographers.

The whole process of performance reconstructions was carefully documented, the additional content related to the reconstructed performance production was created and accompanied with metadata allowing its correct interpretation within the context of the original works. Results are available in the form of rendered video and 3D scenes in VR, where an audience can observe the stage from any view-point (see Figure 5).

The performance metadata structure was proposed based on the existing standards to address requirements regarding an adequate description of performance elements and their relationships. For time-based data (video and motion capture), the newly defined time property allows that relevant metadata structures (annotations) can be linked to specific time segments, which enables to associate corresponding contributors or to attach a document to a segment only. VR presentation tools and a desktop application were designed and developed for searching and viewing performance documentation components including video and motion data visualisations. Newly introduced editing tools allow for adding new metadata and (optionally time-based) annotations for linking components together. The resulting metadata structure (MODS) can be exported in a corresponding format (XML) as a foundation for the METS package suitable for preservation purposes.

Conclusion

The tools developed for building and presenting the relationship between performance components and for viewing various content types including motion capture data and 3D scene representation together with the process of the performance reconstruction mean our project main achievement. The data model used reflects the actual situation, where the Laterna magika documentation is held by various institutions, harmonising all processes and building one common collection of all related materials was outside this project scope. We have focused on identifying, designing and testing suitable processes and techniques that could be used for better describing performance documentation and providing tools for its presentation. The data model was defined using existing concepts and ontology adapted to our performance work nature, its implementation was done in a quite pragmatic way where available metadata types, specific content manipulation, and editing needs were the main factors considered. The overall work descriptive structure in MODS is quite redundant as information is mostly retrieved from existing records, but it serves well for presentation purposes and for maintaining newly created relations. The application of the proposed data model to different types of content like general theatre performances is possible but requires a careful definition of a specific institution/collection priorities. The descriptive metadata retrieved from existing records were of mixed quality and had to be manually checked, especially for authors it means a lot of effort, this problem well demonstrates the need for a database of authorities more extensive deployment. However, the data aggregation process could help to improve the quality of original descriptive data. Although our data model and tools developed allows for creating the complex representation of the multimedia performance together with a detailed authorship attribution, it lacks some advanced conceptualisation of temporal entities as defined in CIDOC-CRM and therefore its application for preservation purposes is rather limited. There is a significant amount of manual work required to set the links between components and to add missing metadata, especially within the segments. Moreover, this work implies a collaborative effort of historians in various fields like dance, film or theatre, all accessing the same pool

of data. The tools have been designed with this demand in mind and there are mechanisms available to identify the authorship of metadata and links added, there can be also a complex approval process established if needed. The simultaneous work editing is possible, albeit the interface was not optimised for the real-time collaboration as there is a quite limited number of historians participating in our project and they are not usually editing the content at the same time. Our project results – methods and tools for reconstruction, documentation, and presentation of multimedia performances – are being verified and will be available as Open Source software and recommended methodical instructions once approved by the Czech Ministry of Culture.

Acknowledgments

The publication has been supported by the Ministry of Culture of the Czech Republic as part of the research project NAKI II Laterna magika. Past and Present, Documentation, Preservation and Presentation.

References

[1] P. Bellini and P. Nesi, "Modeling performing arts metadata and relationships in content service for institutions", *Multimedia Systems*, vol. 21, no. 5, pp. 427–449, (2015).

[2] W. Chanhom, C. Anutariya, and S. Guha, A Distributed Platform for Archiving and Viewing Cultural Artifacts in 3D. In proc. *The Emergence of Digital Libraries – Research and Practices*, ICADL 2014. Lecture Notes in Computer Science, vol. 8839. K. Tuamsuk, A. Jatowt, and E. Rasmussen, Eds. Springer International Publishing, Cham, pp. 22–29, (2014).

[3] M. Doerr, C. Bekiari, and P. LeBoeuf, FRBRoo, a Conceptual Model for Performing Arts. In proc. *2008 Annual Conference of CIDOC, Athens*, pp. 15–18, (2008).

[4] C. Doty, "The difficulty of an ontology of live performance", *InterActions: UCLA Journal of Education and Information Studies*, vol. 9, no. 1, (2013).

[5] M. Kipp, "Multimedia Annotation, Querying, and Analysis in Anvil". Chapter in *Multimedia Information Extraction: Advances in Video, Audio, and Imagery Analysis for Search, Data Mining, Surveillance, and Authoring*, M. Maybury, Ed. (John Wiley & Sons, 2012) pp. 351–367.

[6] D. Koller, B. Frischer, and G. Humphreys, "Research challenges for digital archives of 3D cultural heritage models", *Journal on Computing and Cultural Heritage (JOCCH)*, vol. 2, no. 3, p. 7, (2009).

[7] B. Lyons and K. Van Malssen, "BIBFRAME AV Assessment: Technical, Structural, and Preservation Metadata". In report, *Library of Congress, Washington, DC*, vol. 4, (2016). [Online]. Available: http://www.loc.gov/bibframe/docs/pdf/bf-avtechstudy-01-04-2016.pdf, Accessed 17 Jul. 2018.

[8] G. Patton, "IFLA Working Group on Functional Requirements and Numbering of Authority Records (FRANAR)", *Functional Requirements for Authority Data: A conceptual model*, vol. 34, p. 101, (2009).

[9] A. Racz and G. Zilizi, VR Aided Architecture and Interior Design, In proc. *2018 International Conference on Advances in Computing and Communication Engineering (ICACCE)*, pp. 11–16, (2018).

[10] L. Smigel, M. Goldstein, E. Aldrich, N. Owen, and B. Drazin, *Documenting Dance: A Practical Guide*. (Dance Heritage Coalition, Incorporated, 2006), p. 64. [Online]. Available: https://books.google.cz/books?id=xvFZXwAACAAJ, Accessed 30 Jul. 2018.

[11] L. Tadic, *The FIAF Moving Image Cataloguing Manual*. (Indiana University Press, 2016), p. 276. [Online]. Available: https://muse.jhu.edu/book/51968, Accessed Feb 8, 2019.

[12] *Unreal Engine 4 Documentation*, 4th ed., Epic Games, Inc., 2018. [Online]. Available: https://docs.unrealengine.com/en-us/, Accessed March 4, 2019.

Author Biography

Roman Berka received a PhD at Czech Technical University in Prague for the field of computer science. Over fifteen years, he has worked in the field of interdisciplinary projects on the border of technology and art. Together with colleagues from The Academy of Performing Arts in Prague he founded The Institute of Intermedia, a common workplace for students of art and students of technology, which he leads. For over twenty years, he's been teaching students in the area of programming, multimedia, and computer animation.

Bohuš Získal holds a PhD in Information Science, he spent over eight years working for TV and film productions in both a creative and technical capacity, later he worked as a project manager and a solution architect for private companies in the broadcast industry and has participated in several Czech and European research projects. He has over fifteen-years' teaching experience at Czech and English universities.

Zdeněk Trávníček received Master degree at the Czech Technical University in 2007. He is specialized in the development of algorithms for video-transmission and multimedia content presentation. He has worked on projects as a software developer in the Institute of Intermedia at the Czech Technical University in Prague since 2007.