3D Digital Heritage

Exploring Virtual Research Space for Art History

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Project on East Prussian Manor Houses: Practice and Methods

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Abstracts and CVs

Erik Champion

A Scholarly Ecosystem for 3D Digital Heritage Simulations

Major impediments to the development of high-quality and effective virtual heritage projects include technological constraints and insufficient audience evaluation methods. That said, this talk proposes that a more fundamental issue has been with the design, circulation and use of the digital models themselves as components of scholarly arguments or as vehicles to communicate hypotheses to the wider public. ● In Australia, we have proposed to UNESCO that we run a project to survey, collate and develop tools for heritage sites and related built environments, focusing initially on Australia. The aim is to consolidate and disseminate 3D models and virtual environments of world heritage sites, host virtual heritage examples, tutorials, tools and technologies so heritage groups and classrooms could learn to develop and maintain 3D models and virtual environments, and act as advisor on policy formulation for the use, evaluation and application of these 3D digital environments and digital models for use in the classroom and for general visualisation projects. ● The resulting UNESCO Chair project will implement and advise on 3D models of World Heritage Sites, how 3D models can be employed in teaching and research, investigate ways to host both the digital models and related paradata and publications, and transfer formats (for desktop use, mobile computing etc.), ideally with UNESCO, and we will leverage research facilities at Curtin and at partner institutes and research facilities. ● The primary goal is to help educate the public in the area of world heritage sites via interactive collaborative digital media, with an emphasis on free and open source software, and a secondary goal is to examine virtual heritage and related digital simulations as components of scholarly arguments. The UNESCO Chair's project team will also critique, integrate and extend existing and new infrastructure to support this learning material and the overall integration of scholarly publications, publicly available media and online directories and repositories of digital 3D simulations of world heritage sites and related artefacts as a scholarly ecosystem.

Professor **Erik Champion** is UNESCO Chair of Cultural Visualisation and Heritage at Curtin University and Visualisation theme leader at the Curtin Institute of Computation (http://computation.curtin.edu.au). He researches issues in the area of virtual heritage as well as game design, interactive media, and architectural computing. Before joining Curtin University he was Project leader of DIGHUMLAB in Denmark, a consortium of four Danish universities, hosted at Aarhus University. His publications include Critical Gaming: Interactive History and Virtual Heritage (Routledge, 2015), Playing with the Past (Springer, 2011), and Game Mods: Design, Theory and Criticism (ETC Press, 2012), which he edited. His next book project (in press) is Cultural Heritage Infrastructures in Digital Humanities, (Routledge, 2017), with co-editors Agiati Benardou, Costis Dallas and Lorna Hughes.

Frédéric Kaplan

A 4D World: The Time Machine Flagship

Would it be possible to travel through time as easily as we travel in space? Could you see how your street looked 500 years ago? Could we browse the social networks of the middle ages? ● The Time Machine FET Flagship aims at building a Large Scale Historical Simulator mapping 2000 years of European History. The objective is to transform kilometres of archives and large collections from museums into a digital information system. These big datasets of the past are common resources for the future that will have a huge cultural, economic and societal impact. A consortium of 80 European institutions, coming from 20 countries and supported by 14 international programmes, is currently structuring this ambitious European cultural project (http://timemachine-project.eu/). By setting up a unique archiving and calculation infrastructure, the Time Machine project involves equipping Europe with the technology to structure, analyse and model data from the past, and realign it with the present to allow us to take a glimpse into the future. ● Time Machine aims to develop new technologies to support a scanning infrastructure able to digitise massive amounts of fragile documents from the European heritage. This would be the basis of the largest database ever created for European archival documents. High performance computing clusters are used to process this mass of documents using increasingly accurate machine vision algorithms, segmenting, indexing and transcribing their content, ultimately making them searchable like any other documents we search on the web. The information networks extracted from the documents constitute a massive semantic graph of linked data unfolding in space and time as part of an historical geographical information system. ● More than a mass of documents and a collection of models, the past will also become a new territory to build and inhabit. Simulation technologies and virtual reality will enable complete immersion in vanished places. The progress of artificial intelligence will make it possible to infer, based on historical data, the structure of undocumented places, the trajectories of actors, and the textures of these immersive simulations. The "territories of the past" will become places of intense social and economic activity. Tomorrow, we will all be time travellers.

Professor **Frédéric Kaplan** holds the Digital Humanities Chair at École Polytechnique Fédérale de Lausanne (EPFL) and directs the EPFL Digital Humanities Laboratory (DHLAB). He conducts research projects combining archive digitisation, information modelling and museographic design. He is currently directing the "Venice Time Machine", an international project in collaboration with the Ca'Foscari University in Venice and the Venice State Archives, aiming to model the evolution and history of Venice over a 1000-year period. He is also conducting projects with the Bibliothèque Nationale de France, the Bibliothèque Nationale Suisse, the Bodmer Foundation and the Musée de l'Elysée, and has participated in exhibitions at several museums including the Centre Pompidou in Paris and the Museum of Modern Art in New York. He was local co-organiser of the Digital Humanities 2014 conference in Lausanne. He created the first Digital Humanities master's course in Switzerland and is playing an active role in shaping a complete new curriculum at EPFL.

Piotr Kuroczyński, Dietmar Popp

Virtual Research Environments: The New Research Space for Art History

The amount of sourced-based digital 3D reconstructions and computer-based visualisations of cultural heritage have been increasing for almost three decades. Virtual reconstruction and 3D visualisation have opened up a new "glittering" research space for object-oriented disciplines such as archaeology, art history and architecture. Nevertheless those academics concerned with this emerging technology soon realized documentation standards were missing from many 3D projects, leading to the loss of important information or aggregated findings, along with the lost opportunity to consolidate the source knowledge and paradata that led to the creation of the digital 3D representation. ● Guidelines on computer-based visualisation and 3D documentation (e.g. metadata) have been introduced in the last decade. The recent academic commitment to the design and application of Virtual Research Environments (VRE) for 3D research projects is promising. These VREs are under construction: they require further research and the establishment of a sustainable digital research infrastructure. ● The three-year project "Virtual reconstructions in transnational research environments – the Web portal 'Palaces and Parks in former East Prussia'" addresses key issues such as the lack of documentation standards, sustainability and accessibility of digital research data and the web-based scientific visualisation of the 3D content. The focus is on introducing sustainable digital 3D reconstruction, which is approved by scholars, complaint with recognised documentation standards, and follows Linked Data requirements. ● The presentation introduces the methodological fundamentals, potential and challenges of digital 3D reconstruction, arguing that a scientific methodology and collaborative web-based research environment are crucial features for this kind of project. The groundwork for a human- and machine-readable "language of objects" and the implementation of these semantic patterns for spatial research purposes on destroyed and/or unrealised cultural heritage will also be discussed. Illustrated by practical examples and experience derived from the above research project, the presentation explains the requirements of the Semantic Web (Linked Data), the role of controlled vocabularies, the architecture of the VRE and the impact of a customised integration of interactive 3D models within WebGL technology. The aim is to showcase the state of the art at this stage in the development of a digital research infrastructure.

Piotr Kuroczyński is an architect specialising in the field of digital 3D reconstruction, documentation and dissemination of cultural heritage. Since 2005, he has been researching and teaching at the unit "Information and Communication Technology in Architecture" of Professor Manfred Koob at the Technische Universität Darmstadt (PhD in 2010). Since 2010 he has also been a lecturer at the Warsaw University of Technology. Since 2013 he has been a scientific member of staff and project coordinator at the Herder Institute for Historical Research on East Central Europe. He is co-founder and convenor of the Digital Reconstruction Working Group of the Digital Humanities in German-speaking Region (DHd) Association. His interests include VREs, semantic data modelling, CAD/BIM, 3D modelling, documentation and visualisation standards for digital 3D reconstruction of cultural heritage. Since 2017 he has been Professor for Computer Science and Visualisation in Architecture at Mainz University of Applied Sciences.

Dietmar Popp is an art historian and from 2000, head of the Scientific Collections, Photographical Archive, and Art History of East Central Europe departments at the Herder Institute, and Member of the Leibniz Association. He studied art history, archaeology and monument conservation in Bamberg and Karlsruhe. In 1994 he completed his PhD at the Technische Universität Berlin on "Duccio and Antiquity: Studies on the Image and Reception of Antiquity in Painting from Siena at the Beginning of the 14th Century". Since 2000 he has mainly focused on co-editing the project "Dehio-Handbuch der Kunstdenkmäler in Polen". He also deals with the history of the Herder Institute's collections, their tradition and the documentation of the cultural heritage of East Central Europe. Since 2006 he has been head of the Böckler Mare Balticum Foundation. The (digital) reconstruction of buildings, collections and museums in Poland and the Baltic States is one of his key interests.

Oliver Hauck, Martin Scholz

Methodology, Data Models and Implementation in the ViReBa Virtual Research Environment

This talk takes a look behind the scenes of the Virtual Research Environment (VRE) patrimonium.net, which deals with the virtual 3D reconstruction of destroyed ancient baroque manor houses, buildings and gardens. It served as the working platform for the project "Digital 3D Reconstruction in Virtual Research Environments" that ran from 2013-2016. ● A central research aspect was the development and application of documentation techniques for 3D models and the impact of this documentation on the 3D modelling process. Semantic modelling is not new to the field of architecture: Building Information Modelling (BIM) is a planning method commonly used by architects. The talk will show how BIM has been applied using common 3D modelling software in 3D reconstruction, which is the basic recommendation for using the models in the VRE, and in a virtual museum, with parts of the 3D model representing all the information behind them in the database. ● The reconstruction model is enriched by metadata describing its complex creation history, with a focus on sources used for its creation, such as visual and audio sources or measurements, with the aim of making every decision taken by the reconstructing staff transparent and revisable. This information is combined and represented as a flexible knowledge graph. ● At its core, the data model consists of an alignment of the Cultural Heritage Markup Language with the CIDOC CRM in the form of an OWL domain ontology, taking advantage of Linked Open Data and the Semantic Web. ● Handling the complexity of the CIDOC CRM and the domain ontology on the one hand, and the graph like data model on the other, however, is not an easy task for researchers that are not especially trained. Thus, patrimonium.net makes use of the WissKI system (Wissenschaftliche Kommunikations-Infrastruktur), which mediates between the data model's peculiarities and the researchers' digital abilities. By defining ontology paths, complex information in the knowledge graph can be translated to well-known tabular metadata visualisations. The data graph is further enriched by automatic annotation extraction from free text. Finally, patrimonium.net features a 3D model annotation tool, where the annotation data is stored as triples according to the ontology.

Oliver Hauck is an architect specialised in 3D reconstructions and digitising spatial environments based in Frankfurt am Main. He studied architecture and urban design at the Technische Universität Darmstadt. From 1999-2006 he worked on the DFG funded research project "Die Hagia Sophia Justinians als Schauplatz geistlicher und weltlicher Macht" at the TU Darmstadt's chair of classical archaeology (Prof. Knell, Prof. Stichel). He worked at TU Darmstadt's faculty of architecture with Professor Manfred Koob, leading the 3D reconstruction project "The Temples of Angkor" (2004-2010) followed by lectureship until 2013, from 2008-2013 also at Mainz University of Applied Sciences. In 2009 he started his PhD at TU Darmstadt's chair of classical archaeology (Prof. Lang): "Zur Methodik der dreidimensionalen computergestützten Rekonstruktion von Gebäuden am Baispiel der Hagia Sophia Justinians in Istanbul". In 2010 he founded the Institute of Space Representation in Frankfurt am Main. Since 2012 he has been a member of the board of architects of the Federal State of Hesse.

Martin Scholz is one of the principal developers of the WissKI virtual research environment. He studied Computer Science and Chinese Studies in Erlangen. After his diploma in 2008, he became a research assistant at the Digital Humanities research group of the University of Erlangen-Nürnberg and started working for the DFG-funded project "Wissenschaftliche Kommunikations-Infrastruktur" (WissKI). Since 2017 he has been involved in the digitisation of the university collections in Erlangen as part of the BMBF-funded project "Objekte im Netz". His research interests are in digital humanities, especially knowledge management, the Semantic Web, and natural language processing.

Carsten Neumann, Torsten Veit

"Königsschlösser" in the Light of Digital Art History

The East Prussian manor houses and estates and their owners shaped the region in many ways. On the one hand, they were closely linked to the royal court as "royal palaces"; on the other, they were not only an architectural expression of the rise of their builders, but also an administrative and representative centre of extensive property complexes. ● An essential basis for our work was the figurative, textual and material traditions from the archives and collections of the Dohna and Dönhoff families. In addition, the architectural history of the manor houses, their individual furnishings and art historical classification all required further research. The reconstruction and 3D modelling of our scientific work was also researched. At the end of the project, today's estates and the building histories were documented in photographs, and we continued to modify the 3D models. ● Two exemplary research results are presented here. Firstly, we share some reflections on the history of the building at Schlodien as part of its architectural history, based on a survey of the manor house ruins carried out in April 2016. The focus was on the baroque core construction, without the additions from the 19th century. Secondly, we discuss comparative examples concerning one of the most important pieces in the palace. The painting of Frederick I has been lost since 1945, but the importance of this work of art is evident from historical photographs. Creating a 3D reconstruction of such an opulent work of art raised some complications that had to be overcome. ● Thirdly, we consider the advantages and disadvantages of the digital tools used. On the one hand, this concerns the practicality and user-friendliness of the software solutions for research, and on the other, the complications resulting from interdisciplinarity and influencing parts of the daily workflow. Both are necessary sources of information to determine the value of this project and the developed tools for the future of art historical research.

Carsten Neumann is an art historian. From 1991 to 1997 he studied art history and history at the University of Greifswald, finishing with a master's thesis entitled "Das Schaffen des Architekten Johann Friedrich Künnecke in Mecklenburg" ("The Works of the Architect Johann Friedrich Künnecke in Mecklenburg"). He then studied for his doctorate at the University of Greifswald from 1998 to 2001. From 2002 to 2007 he worked on a range of projects in various roles for the Prussian Palaces and Gardens Foundation Berlin-Brandenburg. He completed his PhD thesis on "Die Kunst am Hofe Herzog Ulrichs zu Mecklenburg" ("The arts at the court of Duke Ulrich of Mecklenburg") in 2006. Since January 2014 Carsten Neumann has been a research associate in the project presented here, responsible for investigating the art and architectural history of the manor houses.

Torsten Veit is an art historian, stonemason and stone carver. After his apprenticeships in Germany and Italy he started studying art history and economics at the University of Greifswald. He achieved his BA in Art History in 2012, and his MA in 2015, with his thesis "Oberflächlich betrachtet –studies on surface treatment and effect in baroque sculpture at Bernini and Schlüter". He has been a graduate assistant in the project presented here since 2014. Currently, he is working on his PhD as a research assistant in the International Research Training Group (IRTG) "Baltic Borderlands" at the University of Greifswald. He is researching the mobility of craftsmen in Europe during the 18th century from Upper Bavaria to the Baltic Sea Region. His doctoral research seeks to combine digital and classical art historical methods and to prove the value of graphical network visualisations for art history.

Mieke Pfarr-Harfst, Krzysztof Koszewski

Dohna-Schlodien: A virtual exhibition – Digital Reconstruction of the Manor House and Garden

The project "Dohna-Schlodien – a Virtual Exhibition" was successfully completed at the Digital Design Unit, Technische Universität Darmstadt in 2016. Besides the Herder Institute, two other project partners were involved: the Computer Aided Design Unit at Warsaw University of Technology and the Department of Art History at the Adam Mickiewicz University in Poznań. The project was funded by the German Federal Government Commissioner for Culture and the Media (BKM). ● The intention was to reconstruct the manor house and park at Dohna-Schlodien, to understand and preserve the material and immaterial cultural heritage around this destroyed complex. Therefore, documenting oral history about the manor house and its park was also part of the project. Together with a contemporary, Mrs Elisabeth Dreischhoff, it was possible to document life in the manor house and paint a magnificent picture of its past in former East Prussia. Against this background, and based on other heterogeneous resources, the manor house of the 1930s was digitally reconstructed. ● Furthermore, the Polish project partners have investigated and reconstructed the main phases of park and garden (dated 1750, 1867, and 1940) and manor house with its individual buildings and vegetation. This led to a comprehensive documentation of the current tree stock and the transfer of the complete park into 3D. Collaboration between art historians and architects working on digital 3D reconstruction allowed us to draw more general conclusions about the potential of research within the realm of knowledge transfer from its tacit to explicit form. ● The collected resources, including recordings of interviews with Mrs Dreischhoff and the digital 3D reconstructed models, were all documented in the WissKi digital infrastructure project developed at the Herder Institute. ● The Dohna-Schlodien project makes a contribution to basic research to determine a suitable documentation system for digital reconstructions. The results will be integrated into further research in this field.

Mieke Pfarr-Harfst is currently working as Head of the Research Department "Digital Reconstructions" at the Digital Design Unit, Technische Universität Darmstadt. Her PhD, in which she developed a documentation system for digital reconstructions, was awarded the Kurt Ruth Prize. Drawing on this work and her experience as a manager of international research projects, she is now investigating the fundamentals and basic principles of 3D models as an innovative methodology for research and dissemination in cultural heritage. She is co-founder and convenor of the Digital Reconstruction Working Group of the Digital Humanities in German-speaking Region (DHd) Association. Mieke Pfarr-Harfst is regularly invited to give lectures at international institutes and act as a reviewer for various organisations and conferences. She was awarded two international grants at King's College London and the University of Sarajevo. Until 2017, she also held a lectureship in History of Architecture at Mainz University of Applied Sciences. Currently she is teaching master's level classes in Digital Humanities at the Johannes Gutenberg University, Mainz.

Krzysztof Koszewski, architect, PhD in architecture and urban planning, affiliated with Warsaw University of Technology (WUT), Faculty of Architecture, Chair of Architectural Design. Research interests include architectural heritage, visual communication in architecture, methodology of the design process and research by design problems. He is involved in academic research, teaching and administration. He is co-creator and director of the English-language master's programme Architecture for Society of Knowledge at the Faculty of Architecture at WUT, and is currently involved in preparing an English-language PHD programme on the same subject. He is the co-author of a visual system for a map portal presenting Polish listed architectural and archaeological monuments developed for National Heritage Board of Poland. He is a member of the Scientific Committee of the National Heritage Board of Poland and Deputy Dean of Studies at the Faculty of Architecture, WUT (2008-2012 and 2016 onwards).

Jan Lutteroth, Arthur Sarnitz

Friedrichstein: New Approaches in the Digital Reconstruction of the Manor House

This presentation exemplifies the workflow structure used for the digital 3D reconstruction of the Friedrichstein manor. It outlines the advantages of the underlying semantic database for collaborative division of tasks and modelling control within an international research team. Documenting a comprehensive workflow is an essential part of creating a scientific digital reconstruction model, as it allows for important data analysis and use after the project. The Virtual Research Environment (VRE) introduced by the project guides the modeller through three key steps to create paradata (as demanded by the London Charter) that form the basis for conscientious after-use of the 3D model. Firstly, the VRE allows the researcher to integrate, compare and comment on all sources used in the modelling process. During this viewing step, a logical building structure needs to be developed in order to precisely reference the sources relating to parts of the building. This second step of dividing the building into its essential parts also determines the level of detail that will evenly be used in the model. Finally, the VRE allows the modeller to verbally and visually describe modelling decisions in combination with the previously generated sources and building structure, hence allowing any follow-up researcher to easily retrace the information leading to the digital reconstruction model. This web-based research environment has the benefits of "de-finalising" any visualisation rendered from the 3D model, displaying modelling decisions and their critique within a collaborative work structure. Perhaps more importantly, it enables further evaluation and interpretation of the generated 3D model and its paradata. ● Arthur Sarnitz will report on SketchUp 3D software for analysing incoming data from VRE as 3D models, vector and raster drawings and maps. The presented workflow can work with many file formats, natively or by using plugins and is precise enough for historical 3D reconstruction requirements based on various sources. It is well suited to 3D modelling and photorealistic texturing for later reuse in external software for architectural visualisation, such as Lumion3D. The presentation will focus on Lumion3D to combine all the available models in one huge scene and set up real-time shaders for sky, terrain, grass, foliage, real location sun study and animation.

Jan Lutteroth studied art history and classical archaeology at the LMU Munich. He completed a master's on art crime and cultural heritage protection studies in Italy and is currently writing his PhD on visualisation strategies of digital 3D reconstructions under Professor Stephan Hoppe at the LMU Munich. He has been working as a scientific researcher for the project "Virtual Reconstructions in Transnational Research Environments", primarily on the digital 3D reconstruction of Friedrichstein manor and its surrounding buildings.

Arthur Sarnitz is an architect and general director of the architectural and design company Arthur Sarnitz – Koenigsberg (ASK), located in Kaliningrad, Russia. His company consists of architects and IT engineers. Since 2002 ASK has been engaged in projects using multipurpose 3D modelling software and the fast rendering software LUMION to create architectural visualisations. Arthur Sarnitz is well-known for sourced-based digital 3D reconstructions of over 1,000 historical buildings, mostly architecture of the former German city of Koenigsberg. Some of these are presented on the website www.altstadt.ru. Besides, ASK is known for creating suggestions for the architectural planning of the Governmental Historical and Cultural Complex on the former King's Mountain with the King's Castle – the historical heart of the city of Kaliningrad/Koenigsberg.

Daniel Dworak, Maria Pietruszka

Virtual Museum: Exploring the Past

In 2013, Łódź University of Technology prepared basic requirements and assumptions for virtual reconstructions, because these are burdened with many restrictions and unsolved problems. WebGL technology was chosen from a range of options (such as Stage 3D, Away 3D, and X3D), as it is the most promising cross-platform, plugin-free, and sufficiently stable environment in development which can be used to create a layer between the user and virtual world (Model-View-Controller). Steps have been taken to solve or minimise existing problems with 3D Web technologies. There is no single, strictly performed and consistent workflow for visualising 3D content and proposed file formats. During Daniel Dworak's 6-month supervision in Frankfurt, it was confirmed that there are many different modelling techniques and software options that produce inaccurate data during the exporting/importing process. We found that many participants have different skills and use a variety of tools (such as software, file formats, or textures). Based on this experience, we composed a short document explaining how 3D models should be created, which is ready to be shared online. ● Annotations of sources and 3D models were another important part of our task. We developed an interactive, platform-independent and Internet-accessible environment for preparing annotations, connections between them and actions, that is used by specialists in different fields (e.g. historians and modellers) to exchange their suggestions, doubts or sources of concern. ● The Virtual Museum appeared to be "the collection" of many proposed, developed and examined techniques for 3D Web. Performance, interactivity, and sufficiently realistic and authentic experience were treated as key elements throughout the workflow. As a result of the author's idea of coding and decoding 3dPNG files even up to ten times, 3D data can be downloaded more quickly. The process of decoding this data has also been improved by using general processing on graphics processing units. Techniques from computer games like portaling, hotspots, model splitting and many more proved necessary. We also considered the user's experience, proposing a user-friendly interface with carefully selected elements and mechanisms for exploring the 3D space.

Daniel Dworak specialises in 3D Web-based computer visualisation, 3D data retrieval, storage, compression and transmission improvement. Since 2013 he has been working on his doctoral thesis at the Faculty of Technical Physics, Information Technology and Applied Mathematics, Łódź University of Technology. The subject is the compression of large computer graphics data sets for interactive internet applications. From 2013 to 2016 he worked at the Centre for Media and Interactivity (ZMI) at JLU Gießen in the project "Digital 3D Reconstructions in Virtual Research Environments". He was responsible for programming, designing, improving and elaborating a 3D Web layer for displaying, retrieving and connecting a 3D interactive environment for a Virtual Museum. He had the idea of encoding, storing, transmitting and decoding of 3D data from two-dimensional PNG based format, (3dPNG), which reduces files with 3D models by a factor of twelve. Dworak also proposed a modified technique for reducing model geometry and creating new faces of geometry.

Maria Pietruszka is associate professor at the Faculty of Technical Physics, Information Technology and Applied Mathematics, Łódź University of Technology and at the Faculty of Economics and Sociology, University of Łódź. From 1994–1998 and 2009–2013 she has been Vice-Head of the Institute of Information Technology, where she has led the computer graphics and multimedia research group since 1995. Her research focuses on two domains: computer graphics (visualisation of huge data structures and real time graphic systems), multimedia and the Web. In 1995, she initiated research into virtual reality systems at the Institute of Information Technology. She is the author or co-author over 90 publications, member of the Editorial Board of the Journal of Applied Computer Science (JACS), and supervisor of 6 PhD dissertations. She has contributed to many research projects supported by industry, the Ministry of National Education, and the State Committee for Scientific Research in Poland.

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