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Marleen DE KRAMER
Born on 11 February 1984 in Starnberg, Germany

DECISION-MAKING PROCESSES AND CERTAINTIES IN HERITAGE RECONSTRUCTIONS USING THE EXAMPLE OF LAROCHETTE CASTLE, LUXEMBOURG

Dissertation defence committee

Dr Michel Margue, Dissertation Supervisor
Professor, Université du Luxembourg

Dr Thomas Cauvin, Chairman
Professor, Université du Luxembourg

Dr Pedro Cardoso Leite, Vice Chairman
Professor, Université du Luxembourg

Dr Sander Münster
Professor, Friedrich-Wilhelm-Universität Jena

Dr Reinhard Friedrich
Head of European Castles Institute

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A note on page numbers:

This thesis was written by compendium, through the inclusion of conference papers, book chapters and journal articles. These are presented as published, with self-contained bibliographies in each publication venue's style and with the page numbers of their respective publications still included. The page numbers of this manuscript are continuous in the footer and are marked "Thesis Page x/n" to help the reader distinguish these published or submitted works' internal pagination from the overall numbering. Footnotes are numbered by section.

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Introduction

Architecture depends. “Architecture, at every stage of its existence – from design through construction through occupation – is buffeted by external forces”[1]. Architecture depends on the laws of physics. On the building materials available. On the climate from which it is a shelter. On the social and cultural norms of its occupants. On the aesthetics of its time. On the budget and the expertise and the wishes and the quirks and the law and the changes and the landscape and the *context* in which it is placed. And the lives of the people depend on the architecture.

This dependency is what allows us to reconstruct forgotten architecture, because even when the substance is gone, it leaves behind a network of dependencies. We can investigate how it shaped those who used it. How it functioned, and how they talked about it. How other buildings were shaped by the same forces.

For this reason, architectural history is social history. It is engineering and law and geography and art and cartography and linguistics. It is interdisciplinary. Not all digital cultural heritage is architecture, but built heritage is a particularly rewarding field for digital exploration.

“Digital” is not a discipline. It is a tool. A tool to be wielded where appropriate, not an end in itself to be applied to every investigation like a blunt instrument. When the only tool you have is a hammer, everything looks like a nail.

It is, however, a very powerful tool, especially for architecture, because it removes many of the dependencies that make architecture slow and expensive and cumbersome, even the constraint that only one volume may occupy a given space at any one time, and allows us to create a building without a physical manifestation. Digital building reconstructions map the space left by the network of dependencies and give it form. Sometimes, this form coalesces

[1] Till, Jeremy. Architecture Depends. MIT Press, 2009.

into a clear and specific shape. Sometimes, it is more amorphous, containing many potential shapes. Many theories.

While describing "how to paint what doesn't exist", James Gurney explains that "history isn't a collection of facts. It's a collection of stories"[2]. A theory is formed from the narrative told by a collection of facts – from their dependencies. And this is why to understand a reconstruction, we must be able to follow its narrative path, the series of decisions that led to one form out of many possibilities being chosen above the others. We must understand the context of its creation and of its presentation.

Because a reconstruction depends.

[2] Gurney, James. Imaginative Realism: How to Paint What Doesn't Exist. Andrews McMeel Publishing, 2009.

Reconstructions As Scholarly Resources

Of course, it is possible to tell stories without depending on any facts at all. Works of fiction. But a cultural heritage reconstruction is the presentation of a scientific theory, a thought experiment[3] that must be reproducible to be validated. This means that the reasoning behind it, the dependencies between the facts and the conjecture, must be recorded and communicated to the intended audience. As scholars, we are well used to undertaking this communication of our theories in text form – we have established conventions on what makes a text a scholarly resource, on how and when to cite our sources and explain our reasoning.

No such conventions are yet conclusively established for reconstructions and models, virtual or otherwise. The discussion around documenting 3D reconstructions has lagged behind the technical possibilities, with models being evaluated for visual impact and technical finesse before scientific accuracy, leading to a general distrust among archaeologists, historians, and other heritage professionals[4]: "The lack of transparency had been identified, along with the epistemological problems posed by hyperrealism, as a burning issue by scholars from the mid 1990s."[5] In other words, "*our [engineers] were so preoccupied with whether or not they could that they didn't stop to think if they should."*[6]

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[3] "A thought experiment is a device with which one performs an intentional, structured process of intellectual deliberation in order to speculate, within a specifiable problem domain, about potential consequents (or antecedents) for a designated antecedent (or consequent)". Lindsay Bertram Yeates, *Thought Experimentation: A Cognitive Approach*, 2004, http://archive.org/details/TECA2004.

[4] D'Andrea and de Francesco. 'Standards and Guidelines for Quality Digital Cultural Three-Dimensional Content Creation'. 2008, Digital Heritage. p. 229-233, , ISBN/ISSN: 978-963-9911-00-0. P. 231

[5] Denard, Hugh. 'A New Introduction to the London Charter'. Edited by A. Bentkowska-Kafel and D. Baker. Paradata and Transparency in Virtual Heritage, Digital Research in the Arts and Humanities Series, 2012, 57–71. p. 57

[6] Paraphrased from the film *Jurassic Park* (1993) http://www.imdb.com/title/tt0107290/characters/nm0000156.

The word “reconstruction” itself has several common definitions, some of which appear mutually contradictory, from “the work of building something again after it has been damaged or destroyed” or “an attempt to get a complete description of an event using the information available” to “a set of changes made to the basic structure of a business or economy”[7]. Within digital cultural heritage, there are two common uses; as an engineering term, the “reconstruction” of a three-dimensional object is the calculation of depth through an algorithm to turn a laser scan into a point cloud, while as used by archaeologists and historians, it means re-creating the missing pieces manually. This reflects the two types of models identified by De Francesco and D'Andrea:

> *“• semi-automatic digitization, or 3D scanning, of real objects (at the small, medium or large scale);*
>
> *• human-driven modeling of digital 3D representations of real or hypothetical structures.*
>
> *In the first case, we have accurate instruments to encode reality in digital formats, while in the second case we produce representations which are mediated by the experience and culture of the human operator.”*[8]

The latter is the type on which this work will focus; in this form, digitisation of existing structures through the use of laser scanners, photogrammetry or other semi-automatic methods is used for data acquisition as a basis for hybrid models in which the focus is still on that which has been added through interpreting other sources. Combining text, images, and “logical sources”[9] and transforming them into three-dimensional data is not yet a feat that algorithms or artificial intelligences can perform; it is where we require human-aided design.

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[7] ‘Reconstruction’. In Cambridge Dictionary. Cambridge University Press. Accessed 2 September 2021. https://dictionary.cambridge.org/dictionary/english/reconstruction.

[8] D’Andrea and de Francesco 2008, p. 231

[9] Sander Münster uses this very fitting term while presenting his thesis to describe things like architectural knowledge or the internal logic of building systems.

Best Practice Guidelines

Unfortunately, humans, unlike computer algorithms, do not have the innate ability to log their thought processes and generate automatic reports in codes immediately understandable to others. For us, documenting our work is an additional step that, lacking conventions, researchers undertake individually or at an institutional level.

However, the cultural heritage community as a whole recognises the importance of this documentation, which takes reconstructions and models beyond illustration to become scholarly resources in their own right. This has led to collective efforts to define best practice guidelines for the whole digital heritage community.

The most prominent of these is perhaps the London Charter for the Computer-based Visualisation of Cultural Heritage (2009), which seeks to "ensure that digital heritage visualisation is, and is seen to be, at least as intellectually and technically rigorous as longer established cultural heritage research and communication methods."[10] This will be discussed in somewhat more detail as applicable in most of the papers that make up this work; so, to avoid repetition, suffice it to say that it does not dictate an exact methodology but rather establishes five key principles[11]:

- intellectual integrity
- reliability
- documentation
- sustainability
- access

[10] Denard, Hugh. 'The London Charter for the Computer-Based Visualisation of Cultural Heritage', 2009. http://www.londoncharter.org/fileadmin/templates/main/docs/london_charter_2_1_en.pdf. p. 2

[11] Denard 2009, p. 2

These are closely related to the Ename Charter of 2008, in which ICOMOS[12] establishes best practices for "the Interpretation and Presentation of Cultural Heritage Sites".[13]

- Principle 1: Access and Understanding
- Principle 2: Information Sources
- Principle 3: Attention to Setting and Context
- Principle 4: Preservation of Authenticity
- Principle 5: Planning for Sustainability
- Principle 6: Concern for Inclusiveness
- Principle 7: Importance of Research, Training, and Evaluation

This in turn builds on the pre-digital Venice Charter of 1964, which deals with the conservation and restoration of monuments and sites, and in fact seems to mandate the use of digital technology in today's heritage research, as they specify that "the conservation and restoration of monuments must have recourse to all the sciences and techniques which can contribute to the study and safeguarding of the architectural heritage."[14]

All three require rigorous documentation and the implementation of project policies that consider the needs of all stakeholders, including the eventual audience. The Seville Principles for Virtual Archaeology (2017), finally, are ICOMOS' proposal for the practical implementation of the London Charter. They define virtual reconstruction as follows:

[12] The International Council on Museums and Sites

[13] ICOMOS. 'The Ename Charter – The ICOMOS Charter for the Interpretation and Presentation of Cultural Heritage Sites'. Ename, 2007. https://www.icomos.org/charters/venice_e.pdf.

[14] ICOMOS. 'The Venice Charter of 1964'. 2nd International Congress of Architects and Technicians of Historic Monuments, Venice., 1964. https://www.icomos.org/charters/venice_e.pdf. p. 1

> *"Virtual reconstruction: this involves using a virtual model to visually recover a building or object made by humans at a given moment in the past from available physical evidence of these buildings or objects, scientifically reasonable comparative inferences and in general all studies carried out by archaeologists and other experts in relation to archaeology and history."*[15]

This is differentiated from virtual restoration, virtual anastylosis and virtual recreation.

Documenting Knowledge Provenance

Documenting data and knowledge provenance in virtual models is especially challenging because of its multidimensionality and the fact that many related data are not text-based and therefore more difficult to annotate, browse, and catalogue, requiring semantic enrichment to be searchable or machine-readable. This necessitates an interface, defined as something that "[provides] a way to mediate between humans and machines and between culture and data, affecting the way we perceive cultural activities and perform them in public and private."[16] The interoperability of data, therefore, is only one aspect of interfacing in cultural heritage research, the other being the interface between the data and the user.

Two significant initiatives, CIDOC-CRM[17] and Arches[18], were created specifically to address the challenge of documenting knowledge provenance in digital heritage. They go beyond

[15] ICOMOS. 'Seville Principles'. e 19th ICOMOS General Assembly in New Delhi, December, December 2017. http://sevilleprinciples.com/. p. 2

[16] Andersen, Christian Ulrik, and Søren Pold. Interface Criticism: Aesthetics beyond Buttons, 2011. http://site.ebrary.com/id/10607724.

[17] Doerr, Martin, 'The CIDOC CRM – an Ontological Approach to Semantic Interoperability of Metadata', Ai Magazine – AIM, 24 (2003)

[18] https://www.archesproject.org

recording sources to show the connections between historic events, objects, people, and places.

CIDOC is the international documentation standards committee of ICOM, the international council of museums, and its CRM is an “object-oriented conceptual reference model” that “represents an 'ontology' for cultural heritage information i.e. it describes in a formal language the explicit and implicit concepts and relations relevant to the documentation of cultural heritage”. This framework allows disparate data and sources to be mapped to a common frame of reference.

Arches is a practical implementation of CIDOC-CRM, an open-source software platform for cultural heritage data management, aimed at helping cultural heritage institutions and organizations collect and manage their data in a common format. It was developed jointly by the Getty Conservation Institute and World Monuments Fund and includes an app to make it easy for end users to gather data.

Unfortunately, it is not suitable for individual projects unless it is supported at the host institution. As the project’s information sheet cautions, “Arches is a powerful enterprise-level platform designed to be used at an organization or project level and not as an individual desktop application. As a result, adopters will need to identify a server to host the Arches platform and as with any enterprise-level system, should expect to engage the services of an appropriate IT professional to set up and maintain it.”[19]

Of course, while Arches is designed to work with Geographic Information Systems (GIS) or maps, it does not include a way to view and browse 3D models. This is a task more appropriate to Building Information Modelling systems, such as H-BIM for cultural heritage.

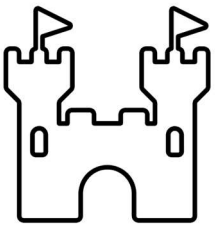
Heritage BIM is an interesting and challenging field because it inverts the typical BIM process. In modern construction planning, architects and engineers can draft structures using BIM systems such as ArchiCAD, which break the building down into discrete

[19] ‘What Is Arches Software for Cultural Heritage Inventory and Management?’, *Arches Project*, 2015 <https://www.archesproject.org/what-is-arches/> [accessed 10 June 2020]

parametric objects and feed their qualitative and quantitative metadata directly into a database, allowing their costs, structure, building time, etc. to be quickly computed and analysed.

A heritage building, however, is "the result of modification and stratification processes carried out over time"[20], meaning that its existing or past elements must be surveyed, analysed, and then reproduced as-built in a BIM environment in order to enrich the resulting model with data, and that the intangible history of the building must be taken into account.

While they are specific to cultural heritage and are helping to address the specific intricacies of modelling existing historic buildings, even an H-BIM system combined with a heritage ontology such as CIDOC-CRM is insufficient for documenting 3D reconstructions. While sources and relationships between data points are tracked, their *dependencies* are not. It is not possible to specify that a conclusion is true or an element exists only *if* a previous assumption is true, to compare different theories or assign probabilities or degrees of accuracy to those theories. Furthermore, they are not designed to allow for conflicting theories or multiple versions of an element to be contrasted. This means that while they are a good choice for tracking metadata, they do not yet extend to paradata.[21]



[*citation needed*]

[20] Introduction to Special Issue "Heritage Building Information Modeling (HBIM)", *Heritage,* 2020, https://www.mdpi.com/journal/heritage/special_issues/heritage_BIM#info [accessed 10 June 2020]

[21] The above summary of documentation best practice is largely reproduced from my own paper, which is not included in this thesis but rather documents its creation process. It is to be published by DeGruyter under the title "3D Models Are Easy. Good 3D Models Are Not." as part of a special volume about C²DH's Doctoral Training Unit. The relevant section there is entitled "The State of the Art – Documentation".

Purposes of Documentation

The problem of documenting the reconstruction process, therefore, is clearly far from trivial, especially at the level of an individual researcher, which may be one reason it is often forgotten. The human brain is well suited to making connections between concepts; these insights are inherently rewarding to us. However, they are also accompanied by *certainty* that our solution is correct[22], meaning that we do not prioritise recording them for reproducibility.

Sander Münster's meta-analysis of virtual reconstruction projects reveals that very few have a documentation strategy in place that is designed for more than internal documentation, let alone communication with the public. It is therefore often a bit of an afterthought, and must be supplemented with personal notes to even attempt a reconstruction of the reasoning behind the model.[23] This makes it difficult to share data even with other interested scholars, and almost impossible to systematically annotate a model for public consumption. Rather, such documentation serves for internal version control and as a basis for writing papers and other publications. These, not the reconstructions themselves, often appear to be the goal of undertaking virtual reconstructions, as demonstrated by Champion & Rahaman, whose analysis of virtual reconstruction publications reveals that not one of the 1483 projects analysed actually contained a working link or another way to access the virtual reconstruction in question.[24]

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[22] Tik, Martin, Ronald Sladky, Caroline Di Bernardi Luft, David Willinger, André Hoffmann, Michael J. Banissy, Joydeep Bhattacharya, and Christian Windischberger. 'Ultra-High-Field FMRI Insights on Insight: Neural Correlates of the Aha!-Moment'. Human Brain Mapping 39, no. 8 (2018): 3241–52. https://doi.org/10.1002/hbm.24073.

[23] Münster, Sander. 'Interdisziplinäre Kooperation Bei Der Erstellung Virtueller Geschichtswissenschaftlicher 3D-Rekonstruktionen'. PhD, Technische Universität Dresden, 2014. pp. 261

[24] Champion, Erik, and Hafizur Rahaman. '3D Digital Heritage Models as Sustainable Scholarly Resources'. Sustainability 11, no. 8 (January 2019): 2425. https://doi.org/10.3390/su11082425.

A promising newer project that seeks to address this lack of documentation is Jonas Bruschke's "Dokuvis"[25], a new documentation system for digital 3D reconstruction and visualisation projects, which was specifically conceived to simplify documentation so that it could be implemented by individual researchers without further institutional support. It seeks to address the fact that

> *"such projects usually lack a proper, traceable, rigorously applied – therefore valuable – documentation practice. In the final reconstruction of the object the references to its sources may only be known to the experts involved in the project. Those not involved in the reconstruction project may not be able to understand this relationship. Research into documentation practice has until now typically concentrated on theoretical approaches; effective tools are still missing."*[26]

It is specifically intended to support documentation from data collection to presentation of the results to third parties, including, crucially, museum visitors and other lay users, and features for version control and CIDOC-CRM compliancy.[27] This tool has not been tested here because it was not yet available for use[28] when this work was conceived and structured, but shows great promise for future use.

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[25] http://dokuvis.org/

[26] Bruschke, Jonas, and Markus Wacker. 'Simplifying Documentation of Digital Reconstruction Processes'. Edited by Sander Münster, Mieke Pfarr-Harfst, Piotr Kuroczyński, and Marinos Ioannides. 3D Research Challenges in Cultural Heritage II: How to Manage Data and Knowledge Related to Interpretative Digital 3D Reconstructions of Cultural Heritage. Cham: Springer International Publishing, 2016. https://doi.org/10.1007/978-3-319-47647-6_12. p. 1

[27] Bruschke, Jonas, and Markus Wacker. 'A New Digital Documentation Tool for the 3D-Reconstruction Process', 2014, 6.

[28] It also proved quite difficult to find even now, as the initial papers in which it is described never mentioned it by name, stating that it "is not available for use or even testing purposes yet and lacks of [sic] a proper and recognizable name" (Bruschke & Wacker 2014) and the project website does not include a description or keywords for non-registered users – another aspect of accessibility that we as cultural heritage researchers need to be aware of.

Communication

While the above efforts have established best-practice guidelines on which types of data should be collected, there is not yet a common convention on how to communicate them. This means that most 3D reconstructions are reduced to illustrations for scientific texts, or displayed in contexts where the inherent trust[29] in the author or institution stands in for an assumption of documentation. The metadata generally include, at most, the author and date of the model and what is being modelled, but they lack paradata such as sources or knowledge provenance.

Digital 3D models displayed in interactive viewers can allow creators to define different data types to be included in the same model and revealed through changing parameters, such as the use of different textures or degrees of transparency, interactive elements that trigger text or audio descriptions and so on; the interfaces for this draw largely on established conventions of computer gaming.

One notable example of a well-annotated and accessible model is the Maya Arch 3D[30] initiative, which documents historic Copán, Honduras, in a 3D Web GIS. Unfortunately, like many such initiatives, it has not kept pace with changes in web browsing technology, so some elements are no longer active – thereby illustrating the "sustainability" issue in virtual heritage.

As communication with the general public, site visitors, school pupils, etc. has so far often been neglected, it will be a particular focus of this work.

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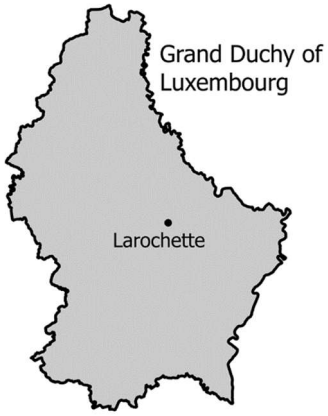
[29] Trust as a stand-in for documentation extends beyond cultural heritage – see for example: Huang, Jingwei. 'Knowledge Provenance: An Approach to Modeling and Maintaining The Evolution and Validity of Knowledge', 2008. https://tspace.library.utoronto.ca/handle/1807/11112. p. 111 ff for a discussion of knowledge provenance and trust in mechanical engineering.

[30] 'MayaArch3D | 3D Visualisation and Analysis of Maya Archaeology'. Accessed 10 September 2021. https://mayaarch3d.org/en/.

Introducing the Case Study Site

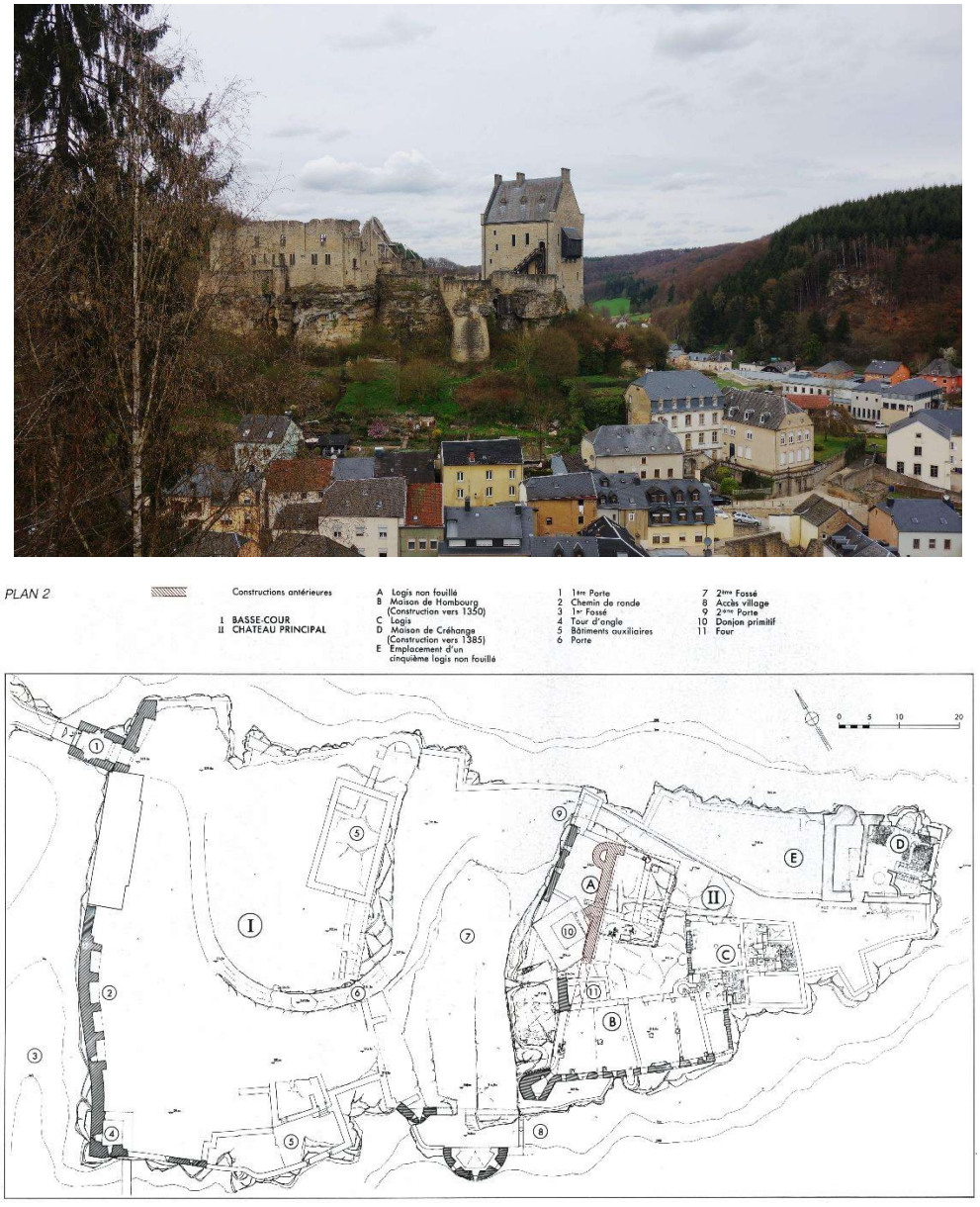
The case study used to demonstrate various principles in the following work was chosen to be at the intersection of my interests and research and those of my supervisor, Michel Margue – it was quickly determined that it should be a medieval castle within Luxembourg. The obvious choice, Vianden, had recently been re-constructed by a commercial archaeology consultant, and was perhaps too well documented for new research to contribute to the overall knowledge. Instead, we chose Larochette Castle in the town of the same name, because it is partially rebuilt and accessible, reasonably well documented in secondary sources and by local historians, and has primary sources available in the form of written documents and the castle ruins themselves. As the castle and its town and surrounding landscape function as a unit, the study area was extended to include them as well.



Larochette castle dates to the 12th century CE, and was inhabited until approximately 1565, when it was destroyed by a fire. The state of Luxembourg bought it, and numerous other castles, in 1979 and carried out a survey and archaeological excavations before partially restoring the site in the 1980s.

This castle is not particularly significant, not having belonged to any particularly powerful nobility or secured any major borders, nor is it the best-preserved of the available sites. Instead, the interest lies in the fact that it was a so-called “Ganerbenburg”, a castle co-owned, in this case, by as many as 13 families at once. This is due in part to local inheritance law, which saw the castle split up between multiple heirs rather than defaulting to the oldest son; as the lesser nobility grew impoverished due to inflation and economic recession, these inherited parts were bought, sold, bartered, or pawned, leading to an ever-increasing number of co-owners. Furthermore, local custom allowed the owners to rent out their shares of the castle to other knights in need of a nearby safe base, complicating matters even more.

Inevitably, this arrangement led to numerous squabbles between owners and necessitated detailed contracts, the so-called *Burgfrieden,* which recorded the names of their owners, their rights and responsibilities, established which parts of the castle were held in common and how it should be maintained, supplied and protected. These and other legal documents, and the castle ruins themselves, are the only primary sources available, as no contemporary depictions of the castle are known to exist.



Map of Castle Ruins by John Zimmer[31]

[31] In *Le Château de Larochette – L'Histoire de son Architecture*. Edited by Les amis du château de Larochette. Luxembourg: Saint-Paul, 1990, p. 21

Challenges

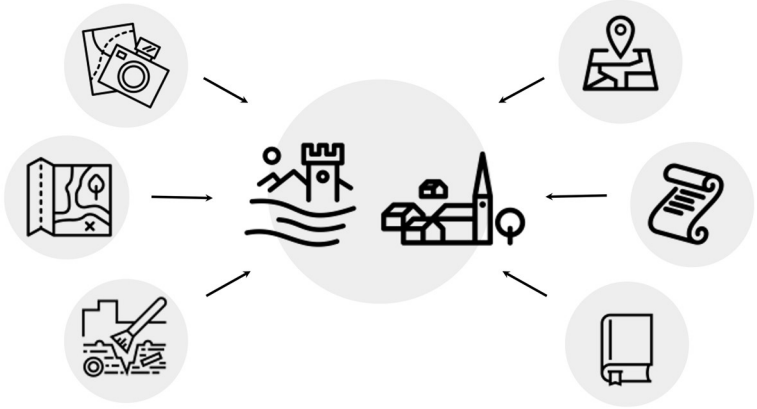
The lack of visual primary sources was a challenge deliberately introduced through the choice of the case study. Other challenges included the lack of access to certain documents contained in archives, and the multilingual nature of Luxembourg, which necessitated searching for key words across languages – for example, searching for "Larochette" was not enough; the castle and town are also referred to in German and Luxembourgish as "Fels" and "Fiels" respectively, and also have historic variants such as "Veltz" or even "de la Rupe". Third, the name "Larochette", meaning "the rock", is far from unique.

Finally, the search also had to include images. Most of the relevant texts are now machine readable and can be found via the usual search tools, or contained in books available through the library catalogues. Images, however, are much more difficult to find, analyse, and even cite. Texts may lose some metadata when digitised, like the texture of the paper they are printed on, but this loss increases greatly in images, which are very sensitive to scanning and reproduction methods, losing resolution, skewing, shifting colours or simply being displayed with the wrong aspect ratio. Excerpts are particularly difficult to trace to their original contexts, and there is no one established way to cite them[32]. Which brings us back to the difficulties inherent to annotating virtual reconstructions…

[32] All images except castle map in this introduction are author's own.

Interdisciplinary Exploration

The case study of Larochette was chosen for its paucity of primary sources, specifically so that I could demonstrate how various other sources could be investigated to fill in the gaps in the data and form a more complete picture of the place in question. Therefore, the first step was to get an overview of the castle, town, and landscape by attempting a reconstruction of its state in the 16th century based on the various data available, which would also give an overview of the current state of knowledge and sources.



To this end, I collaborated with two colleagues: Christopher Morse, who was completing his PhD in Human Computer Interaction for virtual museums, and Sam Mersch, whose topic was the microtoponyms of Luxembourg. As the project related to aspects of each of our work, it served as a mental warm-up exercise for our investigations as well as an opportunity to collaborate across disciplines, a stated aim of the C²DH Doctoral Training Unit.

This process comprised both a desk-based study and a site visit, during which each researcher explained to their colleagues how they looked at a landscape, which elements they found particularly interesting and why, and which types of information could be gleaned from them.

The desk-based portion focused on finding primary and secondary literature – documents detailing the history of Larochette until the 16th century – and historical maps. The maps were imported into GIS, geo-rectified over the modern ordnance survey, and microtoponyms, the historical river course, the town walls and other elements were added to show their geospatial context. Finally, I created a photorealistic terrain model in TerraGen. This used the Luxembourg Ordnance Survey's 5m resolution digital terrain

model[33] as a base, which was then modified to reproduce the historical landscape: the riverbed was altered to an approximation of its course before it was straightened, the underlying stone and clay were adapted to match the geological survey, and the vegetation was made to reflect the historical water meadow and mixed deciduous forests. This three-dimensional terrain was also used to investigate sight lines.

The site visit consisted of a visit to the castle and a walk through the town to investigate specific points of interest we had noted during the mapping process, documented with photographs and a written log, and mainly focusing on the relationship between specific microtoponyms and what was currently in those locations. This helped establish which toponyms were older and which came after the 16th century.

Left: interesting microtoponyms mapped to the modern town. Right: the photorealistic terrain.

[33] Administration du cadastre et de la topographie Luxembourg, *Modèle Numérique de Terrain Avec Un Maillage de 5x5m*, Datum – Projection : LUREF EPSG2169 (Luxembourg, n.d.), https://data.public.lu/en/datasets/bd-l-mnt5/.

We then selected specific questions to answer together, like the locations of specific landmarks, the extent of the *bannum*, the types of crops and industry found in and around the town and the connections between the castle, the town, and the surrounding countryside. Not all questions could be fully answered, but for some, our disciplines revealed complementary information that combined to create a more complete picture than any of us could have achieved on our own. This research was then to form the basis of a learning game for site visitors designed to promote engagement with the historical landscape and make its intangible heritage explicit.

Though the photorealistic topographical map was created to provide a landscape in which to embed the volumetric reconstruction of the town and castle, the primary goal of this stage of the research was not a visual reconstruction but an ideational model to serve as a framework for understanding the castle and its context. Therefore, the reconstruction is largely textual rather than geometric, though maps and charts are used to show the spatial relationships between elements.

This poster and the following paper show our results as presented at the Euromed conference on digital cultural heritage. Besides laying the groundwork for future investigations and demonstrating the power of interdisciplinary collaboration, it already references several key themes in my work: the poster includes both metadata and paradata and shows how different forms of data combine for a reconstruction, and the reconstruction itself makes use of the four distinct confidence intervals "*relict – interpolated – extrapolated – speculative"* to show how certain we are of our interpretation.

RECONSTRUCTING THE HISTORIC LANDSCAPE OF LAROCHETTE, LUXEMBOURG

EUROMED 2018 INTERNATIONAL CONFERENCE ON DIGITAL HERITAGE

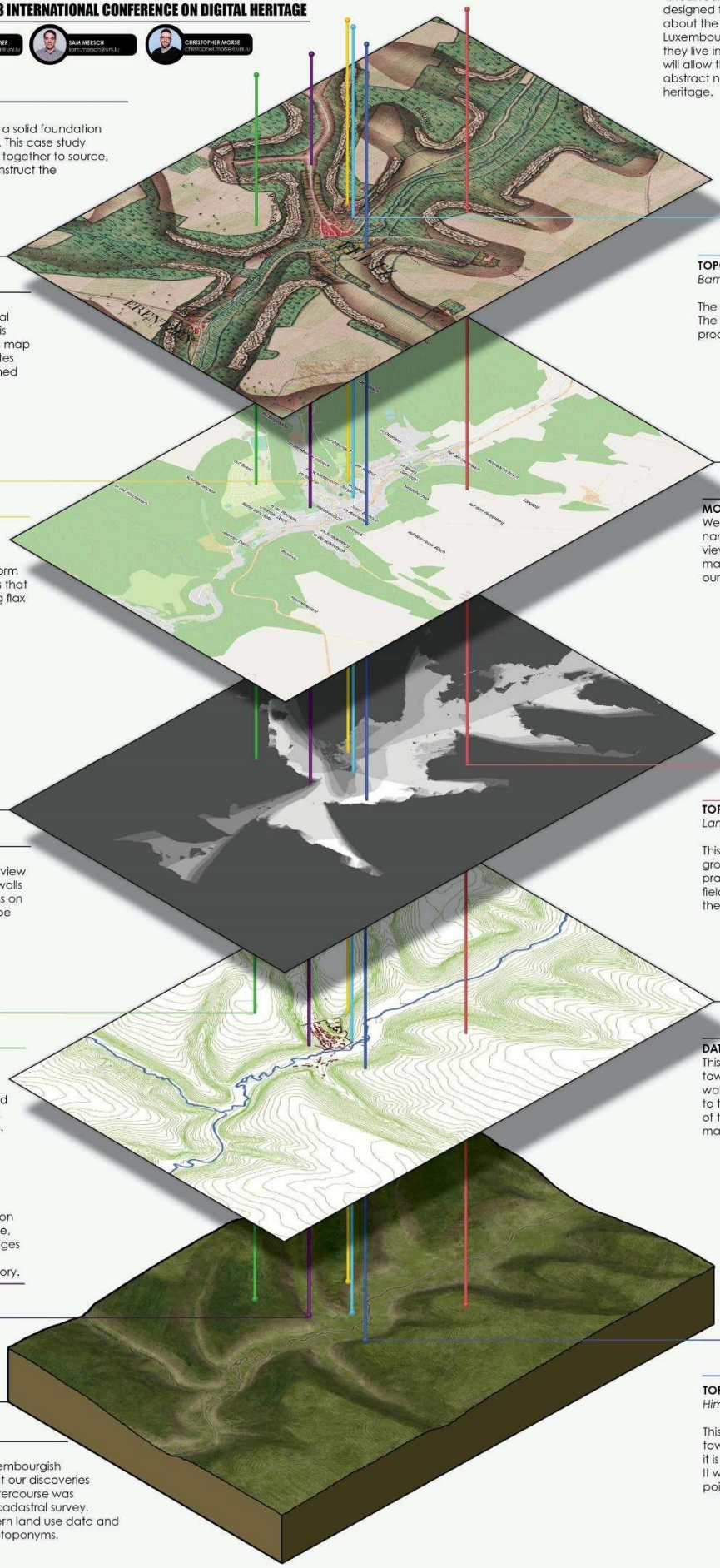
MARLEEN DE KRAMER
SAM MERSCH
CHRISTOPHER MORSE

INTRODUCTION

Cultural Heritage education relies on a solid foundation of scientifically validated knowledge. This case study shows how different disciplines come together to source, combine, and interpret data to reconstruct the cultural landscape of Larochette, Luxembourg from the 16th century.

VIRTUAL REALITY APPLICATION

Historic Larochette will serve as the backdrop for an educational virtual reality application designed to teach visitors about the connection between Luxembourgish names and the landscapes they live in. The intuitive, gamified interface will allow them to make connections between abstract names, physical locations, and their heritage.



FERRARIS MAP (1778)

This is the oldest existing topographical map of Larochette, part of the Ferraris Atlas of the Austrian Netherlands. This map was published in 1778 and incorporates landscape elements that were deemed important for military strategists.

TOPONYM: BONGERT

Bam · Gaard (tree garden)

The toponym alludes to a former orchard. The proximity to the walls suggests that it produced fruit for the castle and town.

TOPONYM: BEI DER OLIGSMÜHLE

Olig · Mühle (oil mill)

Larochette had early industry in the form of mills. The name of this one suggests that it was an oil mill, most likely processing flax seed.

MODERN MAP WITH PLACE NAMES

We overlaid the documentable place names on a modern Open Street Map view to show them in their context and make their locations easier to find during our site visit.

CUMULATIVE VIEWSHED

This diagram gives a cumulative overview of the areas visible from the castle's walls and towers. It helped inform decisions on the study area and place names to be included in the toponym game.

TOPONYM: LANGFELD

Lang · Feld (long field)

This place name shows where crops were grown. The name suggests ploughing practices, as it is much easier to plough fields in long, narrow sections than to turn the plough frequently.

TOPONYM: AUF BIRKELT

Biirken · Feld (birch field)

This place name alludes to a managed birch woodland. Birch wood and bark were harvested for many applications.

DATA FROM OTHER SOURCES

This map shows John Zimmer's proposed town structure, including the castle, town walls, and peripheral buildings in relation to the shape of the land and the course of the river before it was straightened to make way for the railroad.

TOPONYM: VERLUEREKASCHT

Verluer · Kascht (lost castle)

This watchtower is the probable location of the town's Roman fortress. The name, meaning "lost castle", shows that vestiges of past Roman occupation remain in Larcochette's collective cultural memory.

TOPONYM: IM HIMMELBERG

Himmel · Berg (heaven mountain)

This hill offers a panoramic view of the town, and got its name from the idea that it is an ideal lookout (i.e. heavenly view). It was favoured by artists as a vantage point.

DIGITAL TERRAIN RECONSTRUCTION

This terrain model is based on the Luxembourgish elevation data and modified to reflect our discoveries about the historic landscape. The watercourse was reconstructed from the 19th-century cadastral survey. Vegetation zones are based on modern land use data and orthophotos, historic maps, and microtoponyms.

UNIVERSITÉ DU LUXEMBOURG
C²DH LUXEMBOURG CENTRE FOR CONTEMPORARY AND DIGITAL HISTORY

Conference Paper: Reconstructing the Historic Landscape of Larochette, Luxembourg

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Reconstructing the Historic Landscape of Larochette, Luxembourg

Marleen de Kramer, Sam Mersch, and Christopher Morse(✉)

Luxembourg Centre for Contemporary and Digital History,
University of Luxembourg,
2 avenue de l'Université, 4365 Esch-sur-Alzette, Luxembourg
{marleen.dekramer,sam.mersch,christopher.morse}@uni.lu

Abstract. Cultural Heritage education relies on a solid foundation of scientifically validated knowledge. This case study shows how different disciplines come together to source, combine, and interpret data for a landscape reconstruction of Larochette, Luxembourg. It is the initial stage of a larger interdisciplinary project to create an educational game that highlights the tangible and intangible heritage that can be traced in the town's structures even today.

Keywords: Cultural heritage · Interdisciplinary · History
Reconstruction · Larochette · GIS · 3D modelling · Landscape
Tangible vs. intangible CH

1 Introduction

The reconstruction of the town and castle of Larochette, Luxembourg is a case study that shows how our expertise combines to create and validate a scientifically accurate model of a historical cultural landscape. This is the initial stage of a larger endeavour: to design an educational game that reveals the connection between a town's past and the names of its squares, streets, and even car parks—a visualisation of its intangible heritage. Our interdisciplinary approach, which draws on history, heritage science, linguistics, architecture, and interaction design, reveals the town to be a palimpsest, with traces of its history preserved within its structure.

It highlights the importance of context in heritage. Our changing perspective on history acknowledges that the castle did not exist in isolation; rather, it is part of the cultural and socioeconomic construct that is a fortified medieval/early modern town. Our analysis will attempt a snapshot of the landscape ca. 1550 in order to provide a backdrop for a reconstruction of the castle at the peak of its development, before it fell into ruin, and the town continued to develop independently [1].

This chapter was funded by the Luxembourg Fonds National de la Recherche.

The original version of this chapter was revised: Inadvertently the funding institution was not mentioned in the original chapter. A footnote for the explanation was added on the first page of the chapter. The correction to this chapter is available at https://doi.org/10.1007/978-3-030-01765-1_34

M. Ioannides et al. (Eds.): EuroMed 2018, LNCS 11197, pp. 30–37, 2018.
https://doi.org/10.1007/978-3-030-01765-1_4

The town of Larochette is located in the centre east of the Grand Duchy of Luxembourg and was already settled during the Roman era. The castle and the House of Larochette later rose to prominence during the High Middle Ages, but became less significant in early modern times. [2] Due to many divisions of the estate and internal squabbles, the castle fell into ruin. [3] Until the 20th century, the town was well renowned for its cloth manufacture, but today, its main industry is tourism, the picturesque ruins of the castle attracting visitors with outdoor pursuits like hiking and camping [4] (Fig. 1).

Fig. 1. Larochette castle and town, seen from the watchtower.

The Grand Duchy of Luxembourg is known for its linguistic diversity, as French, German, and the native Luxembourgish are all national languages. Luxembourgish is usually a spoken language, while French and German are primarily administrative. As a result, French and German have a lingering influence on the naming practices of places. Major place names have up to three official names[1], and minor place names were often transliterated into German rather than rendered in Luxembourgish when they were initially recorded[2] [5].

2 Data Overview

Our landscape—cultural or natural—is a *dramatype*,[3] an emergent pattern that evolves and adapts to its changing environment without ever being completely

[1] Such as the three official names for Larochette; *Larochette, Fels, Fiels.*

[2] We use the term *minor place names* or *micro-toponyms* for anything smaller than towns (e.g. fields). Their meanings are provided in idiomatic English for purposes of this article.

[3] In biology, a "dramatype" is an organism that adapts to changes in its environment directly, within the lifespan of a particular individual, as opposed to the phenotype, the expression of the genotype of a particular population that has developed within a particular environment. (See"The Principles of Humane Experimental Technique", W.M.S. Russell and R.L. Burch, 1958).

destroyed and rebuilt, so that the structure of the original can be read in the traces that remain. While some elements can change drastically in centuries, decades, or even years—buildings, land use, and, historically, the courses of rivers, and others remain fairly constant. Of course, the most persistent feature is the underlying geomorphology, but major roads, property boundaries and landmark structures are also often remarkably slow to evolve—as a consequence, the landscape itself is our main primary source (Fig. 2).

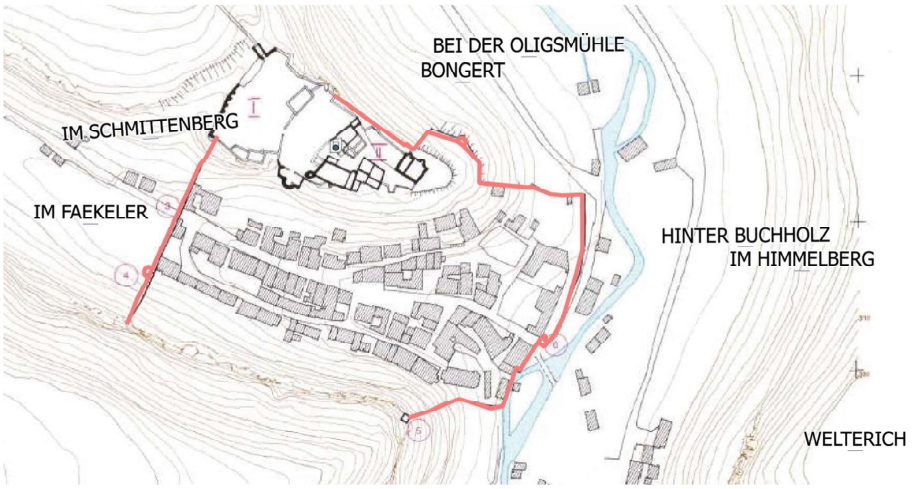


Fig. 2. Location of former town walls and place names.

Little scientific research pertaining to our case study has been published, so we amended our initial survey using other sources relating to historic landscapes. These include archaeology, place names, aerial and historic images, maps, local history and other related fields. As no official archaeological documentation was ever produced, we relied on the archaeological data on Larochette Castle provided in Zimmer (1996), a book that includes surveys of the castle ruins, but also overview maps of the town walls and other landscape features. Primary sources on the castle, the town, or the House of Larochette are found in the form of legal treaties. The open data portal of the Luxembourgish state (data.public.lu) and the website of the land registry office (http://geoportail.lu) gave us access to orthophotos, modern and historic maps, including the 1777 Ferraris map and historic cadastral maps, land use, toponymic and other geographic data. The two-volume special issue on Larochette of the journal *Cahiers Luxembourgeois* (1938), which includes articles on regional and local history and the toponomastic landscape, is a concise overview of secondary sources [6].

While much of this material dates from well after the period we are reconstructing, and although many descriptions are rather romanticising, rather than showing a contemporaneous reality, they were still useful in assessing the situ-

ation in Larochette, which has changed more significantly since the 1950s than in all the preceding centuries.

3 Methodology

3.1 Desk-Based Study

Our initial overview was a desk-based comparative study, combining data from our individual disciplines.This yielded enough material for a rudimentary assessment of the castle of Larochette and its immediate surroundings.

To give our data a spatial context, we conducted a GIS analysis. This allowed us to define our study area. A pragmatic decision was made to limit it to what can be seen from the castle itself. A viewshed analysis of the official 5 m resolution digital terrain model using observation points on all of the castle's towers[4] revealed that, due to the hilly terrain, nothing outside a 5 km radius was visible from the castle, and all man-made structures shown on historic maps fell within 2.5 km. Since the study focuses on the cultural landscape, the smaller circle was the obvious choice. Our work mainly focused on the area that is both visible from the castle and within the bounds of the town as shown in the original cadastral map [7].

To help identify features, the first cadastral maps of Larochette (1824) were georectified and layered over modern maps and orthophotos. Finally, we added the local minor place names, land use data, and drew in J. Zimmer's hypothesised town wall as a linear feature.

3.2 Fieldwork

Although terrain maps and satellite images provide an overview, the importance of comparing data from primary and secondary sources to the modern terrain was immediately apparent when we visited the site. We acquired new data in the form of details not considered important by cartographers or impossible to reproduce in a map—the names of car parks, a GPS-tracked walk along the postulated town wall supplemented by photographs of turning points, a feeling for the steepness of the climb to the castle, details of watercourses, soil and vegetation.

3.3 Cross-Validation

Our analysis shows a striking contrast between the areas inside and outside the town walls—while the building footprints, streets, and property boundaries within the walled town remain remarkably constant, the area just outside the original town gate on the eastern wall on the other side of the river is quite volatile. Two roads are combined into one, property boundaries disappear as

[4] The observer's height above the ground was roughly estimated from the number of stories in each part of the building.

fields become houses, the river is straightened and partially paved over, a new square is created, the town gate gives way to a wider bridge and a new road leading through the town, and a larger church is built along the eastern edge of the valley.

But how can we draw conclusions about the 16th-century town based on its 19th-century state? Industrialisation had a much larger and much more sudden impact on the landscape than previous developments. The town's population, reasonably steady throughout the preceding centuries [8], suddenly grew, farming gave way to industry, and a railway connected the town to the rest of the Grand Duchy. The landscape before the industrial revolution, which arrived in Luxembourg in the 1840s, is more similar to the 16th-century landscape than it is to the present day [9].

In fact, even the modern place names may not necessarily be historically correct. For cross-validation of our theories, we can refer to other data points. Minor place names are a good indicator of the previous use of a particular piece of land. The medieval town wall has angles built to accommodate an existing building. Surviving medieval documents refer to the town, its landscape, and its early industry.

The importance of cross-validation of sources to eliminate false conclusions can be demonstrated using the example of the place name *Schmittenberg* (i.e. smith's mountain) in Larochette town, near the western gate close to the castle, which at first glance implies a smithy. Its absence in the first map does not necessarily suggest that there was no such place, just that it might not have been important enough to be put on the map. However, the value of a field survey soon became apparent, as we found an inscription above the door of a nearby house that identified the owner as one *Johannes Schmitz*, who presumably lent his name to the street.

4 Historic Land Use

As in any medieval town, the majority of Larochette's landscape was dedicated to agriculture, primarily subsistence farming. Our knowledge of this comes primarily from minor place names designating fields, streams, hills, etc. Many of these indicate crops and the demarcation of certain fields set aside for planting. These include *auf dem fischten Stück* (i.e. on the forward-most plot), *in den Theilen* (i.e. in the section of fields). Others evoking the elongated shape of a plot—such as *Langfeld* (i.e. long field)—evidence crops like wheat, as they suggest ploughed fields [10]. The valley and river have names relating to wetlands, such as *auf dem Wasser* (i.e. on the wetland) or *im Weiher* (i.e. in the pond) [10].

Situated close to the city walls, *Bongert* and *Oligsmuehle*, also relate to agricultural production, the former referring to an orchard, the latter to an oil mill. The earliest evidence of these names is the first cadastral map that dates to the early 1800s, but the names themselves and their locations suggest an earlier usage.

Livestock farming is evidenced by names such as *auf dem grossen Driesch* (i.e. on the big common), *Platzwies* (i.e. a meadow) or *Bourenpesch* (i.e. pasture close to water, from lat. *pascua*, pasture), while others relate to woods, like *Weltrich* (i.e. rich in forest) or special trees, such as *Biirkelt* (i.e. birch field). Beyond such toponyms as *hinter Buchholz* (i.e. behind the cleared land), the oil mill that was formerly a sawmill evidences the production of timber [12].

Numerous mills in Larochette attest to early industry, but the most important by far is also the oldest, the *Bannmühle* (i.e. bound mill). The name attests to a mill soke (*banalité du moulin* in French), meaning that locals were required to use only that mill to grind grain. This law gave the House of Larochette economic control over the villages under its dominion. A 16th-century edict dictates a hierarchy for use of the mill, which was broken down by social status and rank, and gave first use to the town providing the millstones [11].

Larochette was known even in the 20th century for its textile industry, whose roots date at least as far back as the 14th century. King John the Blind of Bohemia (*1296-†1346) granted the right to erect four looms with frames suitable for cloth with a length of 25 ells (a Parisian fleece ell was about 0.61 m). Four looms were a significant asset at this time, with most towns being granted only one [13]. Among the town's many mills were a fulling mill (Luxembourgish *Follmillen*) for the production of good woolen cloth or fine leather, dating at least into the 15th century [11].

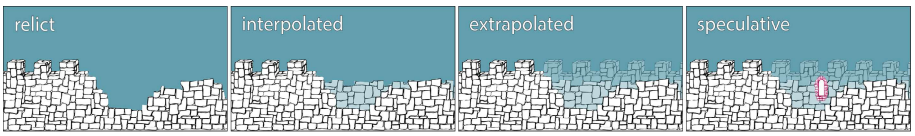
Medieval town life centred around the market and the church. Today's church is located well outside the walls, along the eastern slope of the valley. However, older maps and depictions of the town show a small church and adjoining graveyard in the southeastern corner of the old town. A further clue is, once again, in the name: the street leading through it is the *Rue St. Nicolas*, and the car park itself is named *Kierfecht* (i.e. graveyard) [14].

There is no room for a market within the bounds of the former city wall, the only open space being a walled garden on the northeastern corner, nor is one shown on the 19th-century maps and engravings. Instead, most commercial buildings cluster around the road leading to the bridge across the *Ernz blanche* (White Ernz) river and into the main gates of the town, suggesting that the wide meadow in the east was in use as a market. One engraving shows a high-ceilinged non-residential building in the middle of a square, which could well have been a covered market.

4.1 Certainty of Results

We apply a four-tier hierarchy of certainty to our reconstruction work:

relict-interpolated-extrapolated-speculative



"Relict" covers elements for which evidence survives from the time of their creation. "Interpolated" refers to consulting several nearby data points, e.g. filling a gap in a wall along an existing foundation. Where this "interpolated" result is a line between two points, an "extrapolated" one is a vector, using a solid point of reference augmented with secondary and tertiary sources. "Speculative" results are obtained using only secondary and tertiary sources, e.g. comparing with similar sites or drawing on expertise from other fields, like estimating heights of walls using engineering knowledge.

Our conclusions fall into the third to fourth tier; we are using existing data points to draw conclusions about former states, and presenting the results as our working hypothesis. Comprehensive documentation is a critical element in the development of our reconstruction. It summarises research decisions, tracks sources, and affords the opportunity to re-examine our conclusions if new, contradictory information comes to light. Grounding the reconstruction within the scientific method guarantees a duplicable process and an adaptable model.

5 Prospects for Virtual Reconstruction

Moving beyond the traditional "artist's impression" toward a reconstruction that is researched, validated, and documented, we support a broader movement that integrates emerging technologies into heritage science, providing tools for the outreach and dissemination of knowledge to the public.

We are developing the Larochette learning game using A-Frame[5], a web framework for virtual reality applications. Players will be positioned inside a reconstruction of one of the rooms in the Criechinger Haus on the eastern side of the castle, overlooking the valley below. They will be tasked with combining graphic representations of the name elements of local minor place names in Luxembourgish (e.g. Bann + Mühle) and locating them on a map of the valley. Correctly combining and placing the names will reward players with a three-dimensional symbol in the virtual landscape. Suitable names were chosen based on visibility, variety, and natural separation into distinct elements.

Drawing on learning models designed for cultural heritage, such as the *Sandbox Serious Games* (SBSG) model described by Bellotti et al. (2012), the Larochette game will engage users while simultaneously encouraging the creation of "well-connected knowledge structures representing relationships among facts and concepts" [15]. This approach, based originally in cognitive science and reconceptualised for use in cultural heritage contexts, extends the project's reach to general audiences and brings the cultural landscape and its tangible and intangible heritage to life.

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[5] https://aframe.io/.

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Showing the Intangible

In 2003, UNESCO published its Convention for the Safeguarding of the Intangible Cultural Heritage, which defines intangible cultural heritage as follows:

> *Intangible Cultural Heritage means the practices, representations, expressions, knowledge, skills – as well as the instruments, objects, artifacts and cultural spaces associated therewith – that communities, groups and, in some cases, individuals recognize as part of their cultural heritage. This intangible cultural heritage, transmitted from generation to generation, is constantly recreated by communities and groups in response to their environment, their interaction with nature and their history, and provides them with a sense of identity and continuity, thus promoting respect for cultural diversity and human creativity.*[34]

Alongside built heritage, visual art, literature and other, easier-to-grasp elements, intangible heritage is an integral part of our cultural identity, which can be difficult to express, preserve, or impart due to its ephemeral nature. Therefore, UNESCO and other heritage conservation organisations are particularly concerned with its documentation and preservation.

Larochette Castle, which dominates the view of the town, is a symbol that is easy to grasp, which communicates the bygone era's power structures, architecture, and forces that helped shape the town's history. But what about the view from the castle into the surrounding valley and hills? The historical cultural landscape was just as much a part of life in the past as the castle was – farmed, hunted, fought over, home to houses and mills and roads that no longer exist. The visual connection has largely been severed; the river has been straightened, the fields and farms replaced by houses spilling out from the original town boundaries, the forests cut down and replaced with monocultures of pine. This isolates the castle and makes it a tourist attraction rather than an integral part of the

[34] UNESCO, 'The Convention for the Safeguarding of the Intangible Cultural Heritage' (UNESCO, 2003), https://ich.unesco.org/en/convention.

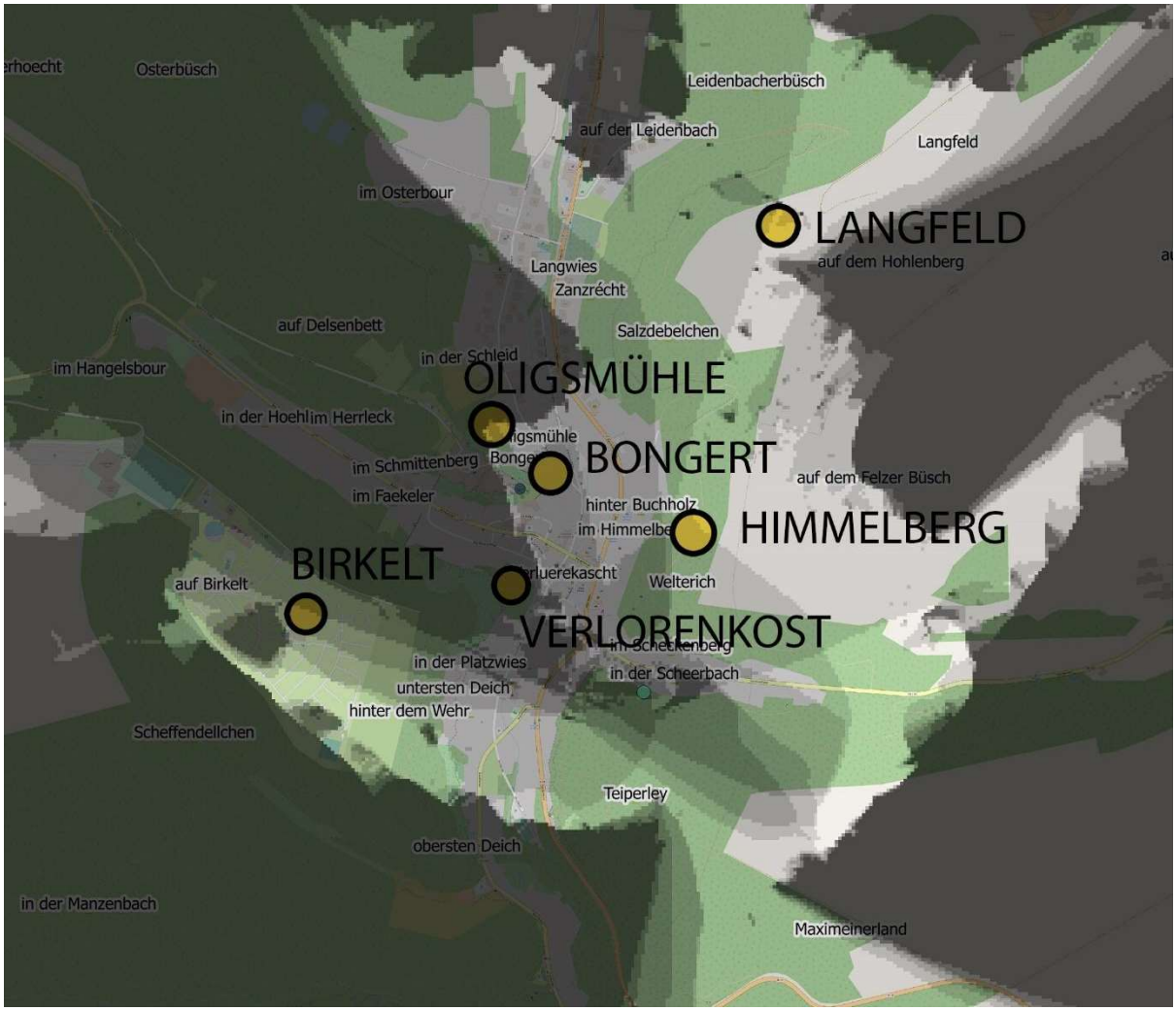
function of its historical landscape. This change is entirely natural, a testament to the many intervening years of history and development.

However, like all change, it is a loss in terms of heritage conservation. For the preceding paper, we had investigated what we could learn about the historical landscape based on numerous sources, including the area's microtoponyms, which often linger long after the eponymous landscape elements have evolved. Fields and forests and farms and crosses and crops are not intangible – but the knowledge that they once stood in what is now a car park or a holiday camp certainly is.

Therefore, we decided to use the microtoponyms as a bridge to connect the modern and historical landscapes in a way that would be both informative and engaging to site visitors, gamifying the experience to pique their interest.

Of course, this meant selecting some names according to strictly-defined parameters and neglecting others – they had to be composed of multiple elements that could be represented by symbols, and describe different types of landscape elements that could be easily defined and explained. Finally, they had to be visible from a defined point within the castle – the wooden oriel projecting from the eastern façade of Créchange Manor.

We had calculated a viewshed from the castle originally as a way to see which areas it could guard and whether the visible area corresponded to the area covered by the Burgfrieden – it did not – but this made it easy to see where we should focus our search for suitable toponyms.



Viewshed analysis with toponyms

Originally, this was to produce a self-contained virtual reality mini-game, which we hoped to deploy in-situ at the castle; however, we could not divert the time and resources from other aspects of our research, so it was only deployed twice as an alpha version: at a conference, and at the public-facing Forum Z. Therefore, it must remain a proof-of-concept, demonstrating tangible-intangible connections in a three-dimensional model.

More importantly, however, it served as an entry point to exploring a larger theme of this work: enriching a reconstruction with metadata in a way that could be intuitively understood by the average user, showing how the data are used to reach conclusions about the past appearance of a heritage site, and presenting them in an engaging way.

Conference Paper: What's in a Name: Gamifying the Intangible History of Larochette, Luxembourg

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What's in a Name: Gamifying the Intangible History of Larochette, Luxembourg

CHRISTOPHER M. MORSE and MARLEEN DE KRAMER, University of Luxembourg, Luxembourg

The Larochette app is part of a larger interdisciplinary project to create a digital reconstruction of the town and castle of Larochette, Luxembourg. The paper discusses the creation of an app that serves to pique interest in linguistics and historical geography, traditionally dry subjects with little intrinsic appeal to children and the general public. This project harnesses this effect, presenting the results of the preceding landscape study in an interactive educational environment that rewards the user for engaging with the content. As the app allows natural movement and intuitive interaction, exploration and learning are prompted by curiosity. The goal of connecting place names to heritage is not explicitly stated, nor is it presented as an educational game. In short, this is the second phase of a collaborative case study in the digital experience of history, which is grounded in user experience design and informed by the historical and architectural expertise of the collaborators.

Key words:
Digital cultural heritage, gamification, toponyms.

CHNT Reference:
Christopher M. Morse and Marleen de Kramer. 2018. What's in a Name: Gamifying the Intangible History of Larochette, Luxembourg.

INTRODUCTION

Much as people learn to read a book, they must learn to read a landscape – its individual elements, its hidden connections, and its historical context. This project aims to make historic cultural landscapes – notably their structure, land use, relation of town and countryside, and key buildings – accessible to the public while also showing the variety of data that can help inform our knowledge. Its approach integrates the expertise of researchers in heritage science, linguistics, and information visualization to create and validate a scientifically accurate model of a historical and cultural landscape. It embeds the castle in its sociocultural context and highlights the tangible and intangible heritage that can be traced in the town's structures even today.

The digital reconstruction of Larochette castle and its historic environment supports a broader movement that integrates emerging technologies with heritage science and considers methods of evaluation and documentation that take into account the specific priorities of cultural institutions [de Kramer et al. 2018]. In this phase, the focus is on gamification, a powerful tool for outreach and dissemination. The final goal is the design of an educational game that reveals the connection between a town's past and the names of its squares, streets, and even car parks – a visualization of its intangible heritage.

Further development of the Larochette game builds upon experience fellow researchers have gained in a number of published case studies that explore the adoption of novel mixed reality and other 3D applications of heritage, such as a virtual reality exhibition featuring Cypriot engravings and Byzantine iconography [Loizides et al 2014], a gamified reconstruction of the Palazzo Fruscione-San Pietro a Corte archaeological site in Salerno [Andreoli et al. 2017], and an interactive installation to explore color in medieval illuminations [Correia et al. 2014]. These case studies, in addition to a recent survey [Papagiannakis et al. 2018], emphasize the strength of interdisciplinary collaboration and reinforce the need for iterative user testing and comprehensive assessment methodologies in the creation of serious games.

RELATED WORK

Gaming in cultural heritage has become an increasingly popular method to connect the public with historical places, objects, and ideas. These types of games are generally referred to as *serious games*, that is to say, games designed in tandem with pedagogical models that provide an educational experience alongside general entertainment [Zyda 2005]. A number of studies have shown the benefits of serious games and their effect on learning outcomes and retention [Wouters et al. 2013] and better attitudes toward learning [Vogel et al. 2006].

A recent study on interactive systems in cultural heritage [Koutsabasis 2017] revealed that almost one-third of reviewed systems (15 out of 53) consisted of varying types of educational or historical games. Moreover, 22.6 % of reviewed systems (12 out of 53) made use of 3D game engines, either as standalone PC-based applications or as immersive VR installations.

The present research draws on learning models designed for cultural heritage, notably the "Sandbox Serious Games" (SBSG) model [Bellotti et al. 2012], which immerses users within virtual environments and produces a series of localized tasks to encourage learning. This approach, derived in part from work on task-based learning [Willis 1996], has been re-conceptualized for use in cultural heritage contexts. It extends the project's reach beyond the academic realm to general audiences and brings the cultural landscape, with its tangible and intangible heritage, to life.

Mortara et al. [2014] differentiate between *cultural awareness* games, which attempt to educate users on intangible heritage, such as customs or beliefs, *historical reconstruction* games, which focus on faithful reconstructions of historical periods or places, and *heritage awareness* games which introduce virtual tourists to the tangible heritage (architecture, natural features, etc.) of a location. The Larochette app attempts to combine some of these approaches by creating opportunities for virtual tourism within a historical time period, while simultaneously presenting both the intangible and tangible heritage of a place based on empirical research.

PROJECT DESCRIPTION

GAME

In the app, the user appears inside a small room high on the side of the castle, its windows shuttered. Directly in front of the user, a small table holds two blocks with symbols for "castle" and "rock," which can be picked up with the "Virtual Reality" (VR) controllers and combined. On the far wall, a second table holds a map, with the single name "Buerg Fiels" in its center. When the combined symbols are placed on this name, the shutters fly open to reveal enticing glimpses of a winding river flowing through the green, empty valley below. This simple interaction teaches the user the purpose of the game without an explicit, potentially intrusive tutorial, but rather through experimentation and exploration.

When this initial problem is solved, further blocks with symbols will appear on the shelves in the niche and the map populates with more place names, chosen for their multiple clear elements. Combining these and moving them to the appropriate places on the map causes 3D graphical representations of the places attached to the names to appear in the landscape.

To the primary target user group of children and adolescents, the interface will be intuitive, and progress will be easy to measure; learning how place names connect to history is implicit, but not presented as the major goal.

ENVIRONMENT

The game is located inside an enclosed wooden porch or oriel projecting from the eastern facade of the Great Hall in the Criechinger Haus, the private apartments of one of the noble families that co-owned the castle, rather than on top of one of the towers.This decision was made for multiple practical reasons: this oriel offers a broad view over the valley and all place names of interest. It has been physically reconstructed and can be visited today. Its dimensions – roughly 2.5 m x 5 m – are approximately the same as those of a typical Virtual Reality play area, meaning the user can move naturally and not need to learn a counterintuitive "teleport" control. An enclosed space with windows to look out of is less likely to cause vertigo in users. Finally, but perhaps most importantly: a scientifically accurate

educational game would require a complete, validated reconstruction of the castle if using one of the towers; in this case, only one room needs to be reconstructed.

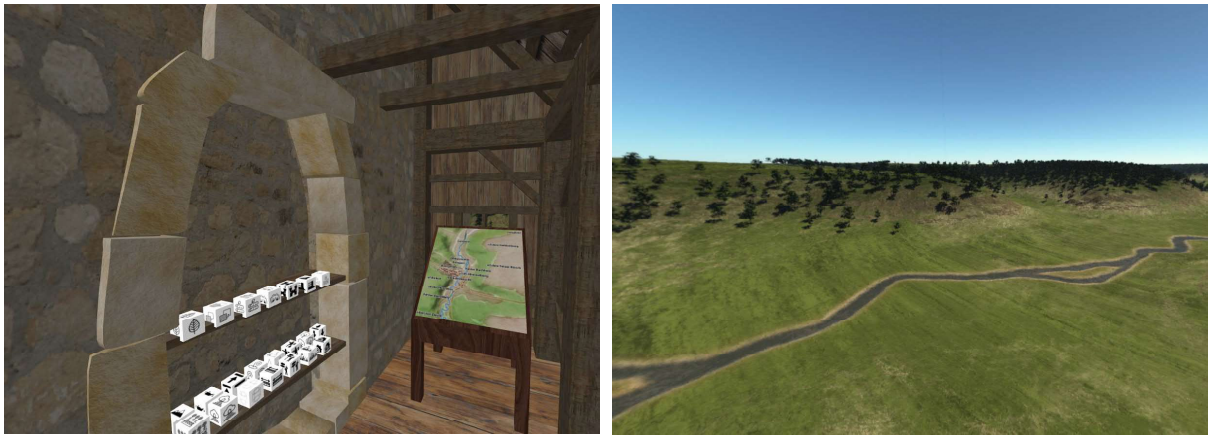

Fig. 1. Views of gameplay: room within the castle with map and symbol blocks (left), historical landscape (right)

Although a physically reconstructed room exists today, no record is available of the decision-making process for the reconstruction, so we cross-validated it using surveys of the ruins conducted in 1977, before the castle was partially rebuilt [Zimmer 1996]. The mostly-intact gable wall has a door leading out, a fireplace on the outside, and a window that looks across to the altar of the chapel in the tower on the northern side. The presence of the oriel is indicated by holes suggesting joists and rafters (their position makes them unlikely to be putlogs for temporary scaffolding) and four stone corbels to hold a lightweight floor. The original purpose of the room is unclear; Zimmer postulates that it was a latrine, though its size and placement above the path leading up from the town make that unlikely. The current interpretation given by the information boards in the castle declare it to have held the bath. A defensive structure such as a hoarding or brattice is also possible, though the provision or a fireplace is puzzling. The virtual reconstruction largely aligns with the physical reconstruction in situ, though some changes were made to the roof based on the location of the holes for the wooden beams.

The virtual room was given somewhat anachronistic paned glass windows (similar to the windows in the physical reconstruction) to allow users to see out, and a wooden door closing off the doorway to visually constrain the user to the space. The fireplace was repurposed as a niche to hold shelves for game objects.

The room was modelled in *Autodesk 3ds Max*[1], using architectural drawings based on those from the 1977 survey as a reference. To keep the polygon count low and allow the finished app to run smoothly on a number of devices, the geometry is simple and detail is mostly provided through textures with bump maps, though individual, existing stones were reproduced around the wall openings for added realism. Wood and stone textures were chosen based on the local landscape; some even taken from photographs of the castle itself.

The landscape was modelled in *Terragen*[2], based on the results of the preceding study [de Kramer et al. 2018]. It was rendered at high resolution using a spherical camera at the point where the viewer would be standing – with a 5 km radius, the 5 m movement allowed is negligible – and the rendering applied to a spherical skybox. This again significantly reduces the polygon count while presenting a photorealistic perspective of the landscape. As the landscape was represented in summer, with lush vegetation and ripening crops, the position of the sun was calculated for high noon at midsummer solstice in 1550, which minimizes shadows.

All symbols come from the *Noun Project*[3] and are used under license. They were chosen to correspond to name elements accurately – for example, they include a water mill rather than a windmill for the "mill" symbol.

[1] https://www.autodesk.com/products/3ds-max/overview
[2] https://planetside.co.uk/
[3] thenounproject.com

CONTENT

As the game is intended to show the connection between toponyms and landscape features, it highlights those features alluded to by names that can be found today – in street names, on maps, on signposts and in the local collective memory [de Kramer et al. 2018].

In its simplest form, the game would consist only of players matching symbols to names. Instead, names composed of multiple elements were chosen. This adds a layer of challenge by making users combine symbols to create full names. However, it also expands the learning effect – users are shown common elements and can infer their meaning. This helps with contractions, like "Birkelt" for "birch field", but also allows them to extrapolate meanings of common elements and apply them to other toponyms they encounter. This is enforced through repetition of certain symbols.

The 3D symbols for the map will be abstract models rather than photorealistic accurate reconstructions of each part, so they will have a relatively low level of detail.

PLATFORM

The app will showcase historical research, but also serves to demonstrate how modern technology can be used as a teaching tool at open days, lab tours, and conference visits. It is designed to provide a realistic experience in virtual reality, especially the astonishing sensation of depth when viewing the landscape from high above. As it is designed for the HTC Vive, interactivity is made possible using two controllers.

The virtual reality experience can easily be set up and run with two people and a power source; an internet connection is not necessary, as the app is stored locally. However, this presents a barrier to dissemination, as it relies on specialized equipment and operators. Consequently, a web-based version that can be viewed on computers or mobile devices will also be developed, which will use touch or mouse controls for navigation and interactivity.

The first version of the app used *A-Frame*, a web framework that allows fast and simple implementation of virtual reality project, and which supports the import of objects and textures, and uses native elements for movement and behaviors. Due to technical issues, this will need to be changed to another, more complex platform as the game is developed.

PROTOTYPING & DEVELOPMENT

CHALLENGES

A-Frame[4] was useful for the initial proof of concept insofar as it provided a portable, web-accessible, immersive environment for initial user testing. Nevertheless, it is not suitable for the envisioned game. Initial testing encountered a series of problems with the physics system, which is currently a separate plugin, and revealed that the system was designed for native objects and is not compatible with the more complex geometries generated in other programs. It will not, in its present form, allow the interactivity needed.

Instead, the content will be ported to a gaming engine such as Unity, which has support for complex geometries and prefab scripts for interaction and movement. It can be exported as *WebGL* for online display, and as a local app for use with common VR hardware.

INITIAL USER TESTING

The project has undergone two phases of early user testing: first in Cyprus during the EuroMed 2018 conference, and again in February 2019 at the *Forum Z: Who's Afraid of the Digital?* event in Luxembourg City.

At EuroMed, conference participants tried an early version of the immersive VR experience where they were able to walk around the castle room and view the landscape through the windows. This initial test revealed that the controllers provided necessary visual orientation even without interaction, and users felt safer holding them. Since interactivity was extremely limited in this version, it was difficult to gauge the interest of people in the app versus in the novelty of the VR experience itself.

[4] https://aframe.io/

During the *Forum Z* event in Luxembourg City, researchers and industry professionals had the opportunity to play an analogue version of the Larochette game, followed by full immersion in the VR prototype. The analogue Larochette game consisted of a paper prototype featuring a printed map from the game and all of the associated symbols. Participants were instructed to match the symbols with the location on the map as they would in the real game. During the event, fifteen people who tested both the analogue and the virtual reality game were asked to provide feedback. This consisted of written comments/suggestions about the VR prototype and an additional form for participants to draw symbols that they felt best represented the names of places.

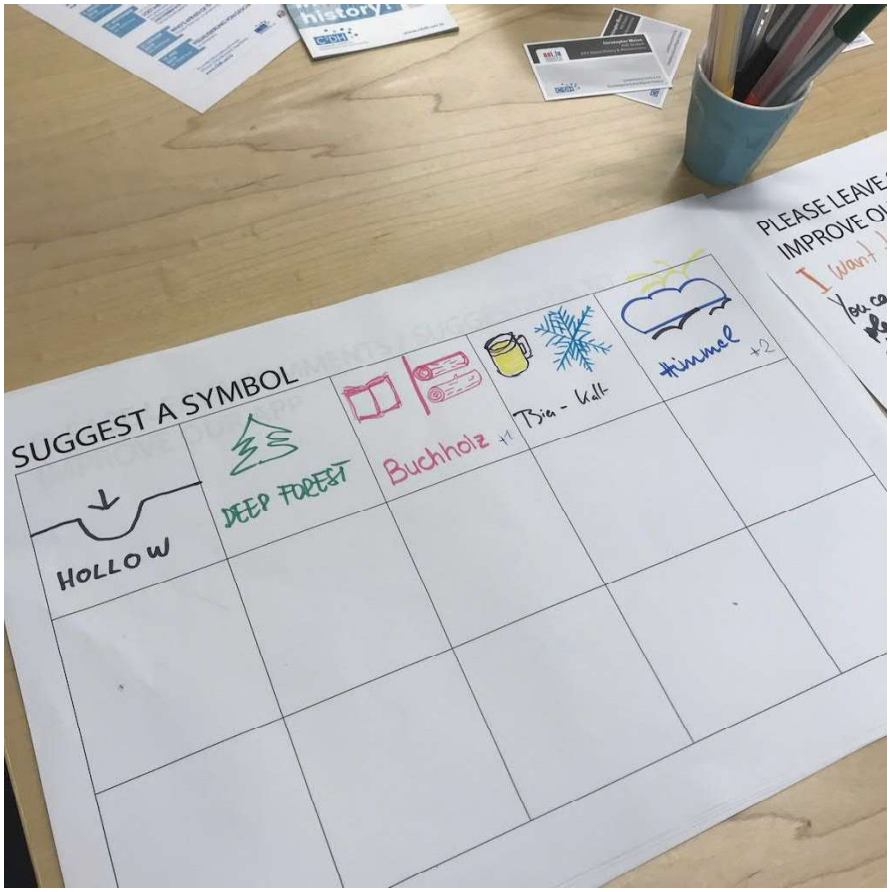

Fig. 2. User provided suggestions for symbols to represent different toponyms in the game

This test revealed that the difficulty level of the game needs to be adjusted for the average user. Useful changes include: clearly separating the names into elements, marking irrelevant prepositions, optimizing symbols, and providing feedback when elements have been combined correctly. Providing a list of names alongside the symbols so they can be matched while all are visible is also potentially a useful improvement. Alternatively, symbols could be matched to elements and then combined automatically, rather than combinations matched to full names – as some elements repeat – this would decrease the difficulty, like a crossword providing some letters through answers to other clues.

CONCLUSIONS

While virtual reality remains an emerging technology, users are often drawn to try it for the novelty alone. The app seeks to capture that interest and transform it into interest in local heritage without explicit teaching. This requires a subtle approach, a *meaningful environment* and a *suited and intuitive interaction paradigm* [Mortara et al. 2014] that harnesses the user's curiosity and subtly guides them to explore the setting and discover rewards for completing tasks without ever stating them outright. To keep the user's attention, the app will require careful balancing to be

challenging but not frustrating. The premise is, at present, easily understood, but requires fine-tuning of the user interface and interactivity and level of guidance to meet this ideal.

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Communicating Certainty

The preceding learning game was used to demonstrate how metadata and intangibles can be communicated to users beyond the classical text, in a more immediately accessible format – the problem of finding an interface between the data and the user. The next step was finding a way to communicate the paradata, the decision-making processes, data density and other indicators of how certain or accurate a reconstruction is, because reconstructions are not binary. They are not right or wrong, true or false, correct or incorrect; they represent a hypothesis that relies on partial data which might be supplemented or disproven in future.

At present, there is no convention for communicating the data behind a model to equal the established validation of a text through citations and references. Usually, the reconstruction is used to illustrate a text, captioned like an image, with basic metadata such as its creator and what it represents, but not its creation process.

Inventing a fully-fledged new documentation system without technical support or outside expertise for its implementation was clearly outside the scope of a PhD thesis, but a part of the problem could be addressed: classifying uncertainty in architectural reconstructions, using the existing tools of text and tables to document them.

A first test of how well an audience could understand and would want to engage with this principle was my TEDx talk "History and Other Lies – Why I Don't Tell the Truth About Castles"[35], given on the 25th of October 2019 at the University of Luxembourg's TEDx event "Rewiring our Future".

[35] TEDx Talks, *History and Other Lies | Marleen de Kramer | TEDxUniversityofLuxembourg*, 2020, https://www.youtube.com/watch?v=zclubTunwd0.

This test can be considered successful in that it was well-received and led to discussions with researchers from other disciplines as remote as chemistry and psychology about their approaches to communicating not only what we know, but how well we know it. As the goal was a system that could be implemented easily by a solo researcher and retroactively applied to older reconstructions, what I developed was a simple, adaptable system with discrete levels, presented in the following paper.

Book Chapter: Relict – Interpolated – Extrapolated – Speculative: An Approach to Degrees of Accuracy in Virtual Heritage Reconstruction

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Chapter 21
Relict–Interpolated–Extrapolated–Speculative: An Approach to Degrees of Accuracy in Virtual Heritage Reconstruction

Marleen de Kramer

Abstract The London Charter for the Computer-Based Visualisation of Cultural Heritage (2009) lays out best-practice guidelines for producing reconstructions of ruined buildings but does not mandate specific tools, workflows, or data formats, acknowledging that technology will change over time. Their implementation is left up to the individual researcher. The approach described here is designed to produce a virtual 3D model for public consumption within the scope of a small, individual research project. It allows the user to query metadata and understand degrees of accuracy without sacrificing a photorealistic, immersive experience. Recognising that accuracy is dependent on the level of detail at which the reconstruction is to be made and viewed, it is presented as a matrix rather than a linear scale. This allows elements of the reconstruction to be sorted into 12 discrete categories of accuracy. The goal is a scientifically validated virtual reconstruction that can be used to teach a non-professional audience about the metadata that goes into such work.

21.1 Introduction

In 1964, the Venice Charter for the Conservation and Restoration of Monuments and Sites specified that ruined monuments are not to be reconstructed, and any parts added or rebuilt must be clearly recognisable as such and not be built in the style of the original. That risks faking history—as the new material weathers, future generations will be unable to tell what is authentic and what has been reproduced, thereby eroding its value as an historic document. However, attempting to preserve a monument in a perpetual state of ruin not only presents technical challenges, but precludes many uses, including, presumably, that for which it was built, so most are restored to a degree, then supplemented with new architecture.

According to these foundational standards for international heritage conservation, it is also not acceptable to peel away later additions to restore a previous state, except

M. de Kramer (✉)
C2DH - Luxembourg Centre for Contemporary and Digital History and Institute for History University of Luxembourg, Esch-sur-Alzette, Luxembourg
e-mail: marleen.dekramer@uni.lu

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in very specific circumstances where the historical and artistic value of the old far outweigh the new—buildings change over time. Their structure, their use, and their decoration changes.

As medievalist Dr. Sara Uckelman wrote in response to the fire in Notre Dame Cathedral in April 2019:

> […]churches live. They are not static monuments to the past. They are built, they get burned, they are rebuilt, they are extended, they get ransacked, they get rebuilt, they collapse because they were not built well, they get rebuilt, they get extended, they get renovated, they get bombed, they get rebuilt. It is the continuous presence, not the original structure, that matters. (Uckelman 2019)

So how do we reconcile this with our desire to know what structures looked like at different points in their history? How they were used, and how they related to their environment? How do we communicate this knowledge with different disciplines, and with the general public, that might not have the skills to imagine a complete three-dimensional structure from ruins and old drawings?

Historically, communicating these theories has relied on drawings and architectural scale models. Now, we can use digital tools to create models not reliant on physical constraints, which can be presented as films, as still images, but also on interactive screens and in immersive virtual environments, which give a realistic impression of a space, complete with authentic-looking materials, sounds, and lighting.

This hyper-realism can make it hard for the viewer to separate fact from fiction or archaeological evidence from speculation, which is reinforced by the "museum effect" (Putnam 2001, p. 34)—something being exhibited in a museum or displayed in relation to a heritage site gives it an aura of importance and authenticity, independently of its actual provenance. This effect, described by Lawrence Weschler as the "Voice of Institutional Authority" (Weschler 1996, p. 101) comes with a responsibility to ensure that the viewer understands the meaning and the limits behind visualisations. All too often, such concerns are dismissed with the addition of the qualifier "artist's impression" in the description of the image or model.

21.2 Scientific Reconstructions

What's the difference between a reconstruction and an artist's impression? Merely that the latter doesn't imply scientific accuracy. This phrase is often used in an attempt to bypass the issue of explaining how a reconstruction was validated, how and by whom design decisions were made, and how conflicting theories were reconciled. This process is time-consuming to document—but very necessary if the finished model is to be a scientific document in its own right, in which "the foundations of evidence for the reconstructed elements, and the reasoning around them, are made not only explicit and interrogable but also can be updated, extended and reused by other researchers in future work" (Bruseker et al. 2015).

As any good science, a virtual model shows a hypothesis, but gives the viewer the data needed to make the experiment reproducible—meaning that by following

the same steps, the researcher will arrive at similar conclusions—and provides for new data to be introduced, potentially changing the results. This is also an important step towards providing sustainability for a virtual model. Often, this word is used to describe issues with data storage, file interoperability, project responsibilities and other practical concerns, but it must extend beyond them to include an output whose underlying structure is available to other researchers and which they can update independently of the original author (Champion and Rahaman 2019).

The ICOMOS Charter for the Interpretation and Presentation of Cultural Heritage Sites specifies that "*visual reconstructions […]should be based upon detailed and systematic analysis of environmental, archaeological, architectural, and historical data, including analysis of written, oral and iconographic sources, and photography. The information sources on which such visual renderings are based should be clearly documented and alternative reconstructions based on the same evidence, when available, should be provided for comparison*" (ICOMOS 2007). Best-practice guidelines for producing such models are laid out in the London Charter for the Computer-Based Visualisation of Cultural Heritage. They encompass the key areas of "intellectual integrity, reliability, documentation, sustainability and access" (Denard 2009), but do not mandate specific tools, workflows, or data formats, acknowledging that technology will change over time.

Putting these guidelines into practice is, therefore, left to the individual researcher. Many current scholarly proposals rely on a dedicated database in a suitable format to be in place, so the data can be mapped to CIDOC-CRM, a cultural-heritage-specific ontology (Doerr 2003), and published as Linked (Open) Data. However, from a standpoint of finances, expertise, and time, this is outside the scope of many individual projects. At best, reconstructions are given a brief text description or labelled using percentages of accuracy—which look scientific, but include no explanation of how they were calculated or indeed what an accuracy of "50%" means.

21.3 Case Study: Larochette Castle

My own work is a proposal toward addressing this problem in practice, seeking to fulfil the demands of the aforementioned Charters. As these documents represent a consensus reached through long debate between interdisciplinary groups seeking to establish digital cultural heritage as a recognised science, they are a good basis on which to build this type of scholarly work.

The case study for this approach is a virtual reconstruction of the castle in Larochette, Luxembourg, at its fullest extent in the 16th century, shortly before it was largely destroyed by fire in 1565 (Zimmer 1990, p. 14). This model is to serve as a vehicle to demonstrate to the viewer how such reconstructions are made, the nature of the metadata, paradata, and decision-making processes behind them, and that they represent a hypothesis rather than absolute fact. This requires a system that is, in its

Fig. 21.1 This model at Larochette lacks all useful metadata—it does not indicate which building or year it depicts, the scale, its creator or its year of creation

display, simple and intuitive, and which can be used to document knowledge provenance and visualise the problems of uncertainty and lack of data in architectural reconstructions (compare Fig. 21.1).

In essence, the creation of the virtual model follows the standard series of steps laid out by Bruseker, Guillem, and Carboni: commissioning, documentation research, proposition identification, function hypothesis assumption, global geometric volume reasoning, in situ element reconstruction, ex situ element reconstruction, and visual representation production (Bruseker et al. 2015), following a similar looped reasoning process. As the model is constructed, the decisions behind the drawing are entered into a table that records the decision made, the reasoning behind the decision, which part of the building and which aspect it concerns, its estimated accuracy, the data sources and their types, experts involved, and whether this decision conflicts with any other data. As a simple CSV file, this table is a sustainable way to document the project's metadata and paradata as it is machine readable by a variety of software. By attaching unique identifiers to each part of the model and entering them in the table, it serves as a simple relational database that can later be queried to display the metadata alongside the model based on parameters chosen by the user.

21.4 Accuracy

To make "accuracy" a useful metric, it must be defined in relation to the project. In its simplest form, it is binary: something is either accurate, or it is not, it is "factual" or "hypothetical". This oversimplifies the matter, making it unclear how much data is needed to count as "factual". Moreover, the level of accuracy can fluctuate simply by level of detail—it is easy to say that the existence of Larochette castle is "factual",

since its ruins are clearly visible, but the paint colour on an individual wall that's no longer standing is entirely a matter of conjecture and therefore "hypothetical". To this end, I have designed an accuracy matrix rather than a linear scale. The first axis has four categories, in decreasing order of estimated accuracy, which are intentionally broad and chosen to be reasonably self-explanatory:

Relict–Interpolated–Extrapolated–Speculative

"Relict" covers elements for which evidence survives from the time of their creation—this could be archaeological evidence, but also covers contemporary drawings or descriptions. "Interpolated" refers to elements reconstructed by consulting several "relict" data points, e.g. filling a gap in a wall along an existing foundation. Where this "interpolated" result is a line between two points, an "extrapolated" one is a vector, using a solid point of reference augmented with secondary and tertiary sources—for example, continuing the battlements along a wall at the level of the remaining ones, because a wall such as this would have been embattled. "Speculative" results are obtained using only secondary and tertiary sources, e.g. placing a window in a wall because an inventory mentions a curtain there, but not knowing where exactly in the room it was located (Fig. 21.2).

The second dimension in the matrix is level of detail (LoD). This concept is widely used in architecture and building information modelling (BIM), with many computer aided design suites offering adaptive display depending on the architectural scale selected. Different architectural scales are associated with different levels of detail because they are normally used to display different types of information, a convention derived from the days of manual drafting when drawings were constrained by the physical size of the paper (ArchDaily 2018).

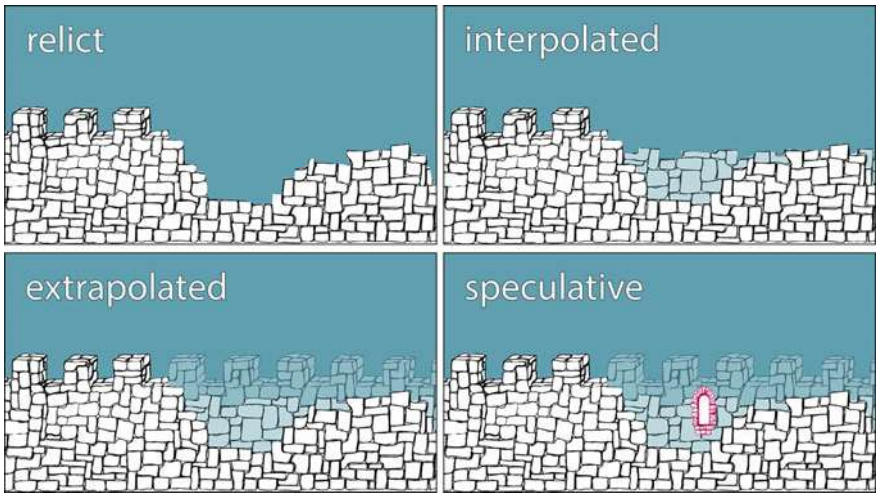

Fig. 21.2 The four degrees of accuracy

Fig. 21.3 Accuracy versus level of detail

Low, medium, and high levels of detail, as used here, correspond to the conventions of site, building, and detail scales. At a site scale of approximately 1:200, architectural plans deal with a building's general shape and volume, roof lines, access points, and relationships between different elements. At a building scale of about 1:100, doors, windows, and relative wall thicknesses are shown, and the overall flow and composition of the floor plan and facade are drawn. At a detailed scale of around 1:50 or less, the focus is on materials, surface treatments, furniture, and the internal structures of walls, roofs, and other components.

At a low LoD, the degree of accuracy may be very high, with the location and dimensions of a building known based historic maps, etc., while at a very high LoD, such as individual rooms, all conclusions may be speculative, with no trace remaining of the original furnishings (Fig. 21.3).

21.5 Segmentation

This system relies on a segmented model whose granularity increases with its LoD, controlled by attribute tables attached to the segments. This means that while at a low level of detail, a space may simply be filled with a single monolithic block named "keep", the same space could be occupied by dozens of individual stones, beams, and furnishings at a detail scale.

The display of these elements can then be adapted dynamically, e.g. showing anything with an accuracy of "interpolated" or better at a medium level of detail, along with the metadata linked to individual elements. As new data are found or

new conclusions reached, individual segments can be updated or their classification changed without invalidating the model entirely, though the changes may perpetuate through higher levels of detail.

This approach requires re-modelling the same building up to three times to provide geometries for all levels, which can be a very time-consuming process. Therefore, a maximum level of detail for each element can be selected depending on its function in the finished model. This does not necessarily have to correlate to the level of data available for each section—it is entirely possible to build a detailed speculative model of an important area, while only roughly sketching in a background that could be researched in depth.

Furthermore, geometry is not the only way to convey more detailed information. When modelling geometries, a balance must be struck between an accurate representation and a low polygon count—the more detailed the geometry, the larger the load on the graphics processor, meaning that better computer hardware is needed to display the model. Instead, as often seen in computer gaming, a detailed texture can be overlaid on a reduced geometry to give it the appearance of more detail. Especially in architectural applications, many elements have simple basic geometries—flat walls, beams, doors, etc.—that can easily be made more complex with a simple swap of texture, e.g. showing individual roof tiles instead of flat colour. The higher polygon counts can then be reserved for areas where geometric detail is important, i.e. showing "relict"-level architectural stonework or making areas that the viewer will see close up more realistic.

21.6 Maximum Levels of Detail by Area

The castle of Larochette and its surrounding town were closely linked—especially after the castle's owners decided to remove parts of the castle wall to allow more living space, relying on the city walls for defence (legal contract 1415, in Hardt 1849). Meanwhile, the location of the castle and the shape of the town are determined by the landscape around it, contained by steep cliffs and a meandering river. Therefore, the castle cannot be understood without its geographic context, and those areas need to be included in the model. A preliminary landscape study was carried out, cross-validating historic maps with microtoponyms and historic representations (de Kramer et al. 2018).

The focus remains on the castle, so the level of detail of its surroundings can be much lower than that of the castle itself. Consequently, the town was modelled at a low level of detail (Fig. 21.4) corresponding to a "site" scale, showing building heights, footprints, and roof lines, but not doors, windows, chimneys, or other "building" scale details. The landscape, taken from official LiDAR scan data, has had its geometric level of detail reduced outside the immediate area of the castle. Still, in order to support the realistic aesthetic of the model, they have been given photographic textures that give an impression of the colour and material of their original facades.

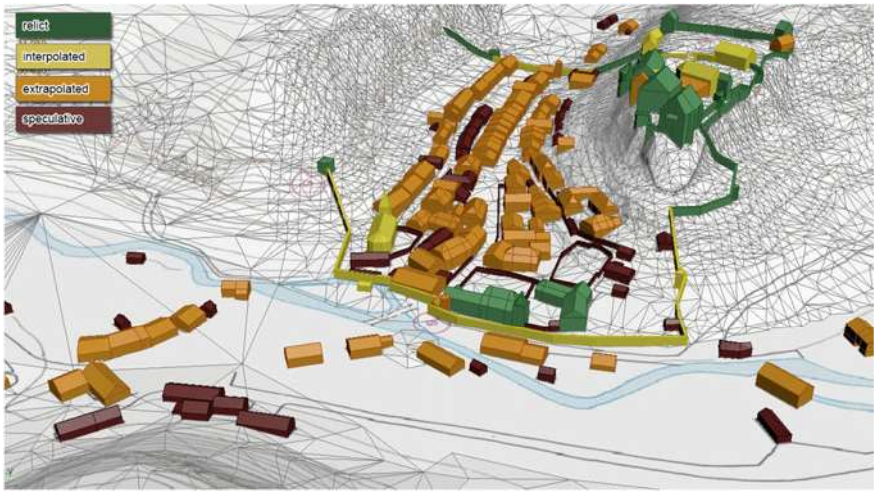

Fig. 21.4 A volumetric reconstruction of the town, castle and landscape at a low level of detail, with accuracies segmented by building

Within the castle itself, the focus will be on the Criechinger Haus, a building situated at the north-eastern corner of the castle (Fig. 21.5). As this is the only part of the castle to have been physically reconstructed, it is the only one that visitors

Fig. 21.5 The Criechinger Haus, partially reconstructed

can enter and walk around at the appropriate floor levels, and it contains interesting details in the stonework and chapel. However, it has not had its furnishings, wall coverings, etc. restored. Therefore, I decided to reproduce this building at a detailed, if speculative scale to allow users a direct comparison—and, entirely pragmatically, for ease of access in making photogrammetric models of the architectural details.

The rest of the castle—its walls, gate house, keep, living quarters and outbuildings—will be represented at a medium Level of Detail, a building scale. While no more or less accurate than the Criechinger Haus, they will only be viewed from the exterior, and are not intended for closer inspection.

21.7 Examples

With three levels of detail and four degrees of accuracy, 12 different combinations are possible, the more interesting of which are explained below.

High LoD, relict: in essence, the rest of the model can be seen as a frame to showcase these parts, which combine good detail with high accuracy. These are elements that still survive, and which can be closely measured and modelled, like photogrammetric scans of architectural details in lintels and columns (Fig. 21.6).

High LoD, speculative: The living quarters are filled with reproduction furniture of the period to showcase its use, though no actual furniture, nor depictions of furniture or inventories survive.

Medium LoD, interpolated or extrapolated: This category makes up the bulk of the model, containing wooden floors evidenced by beam holes, gaps filled in sections of wall, missing stairs replaced, etc.

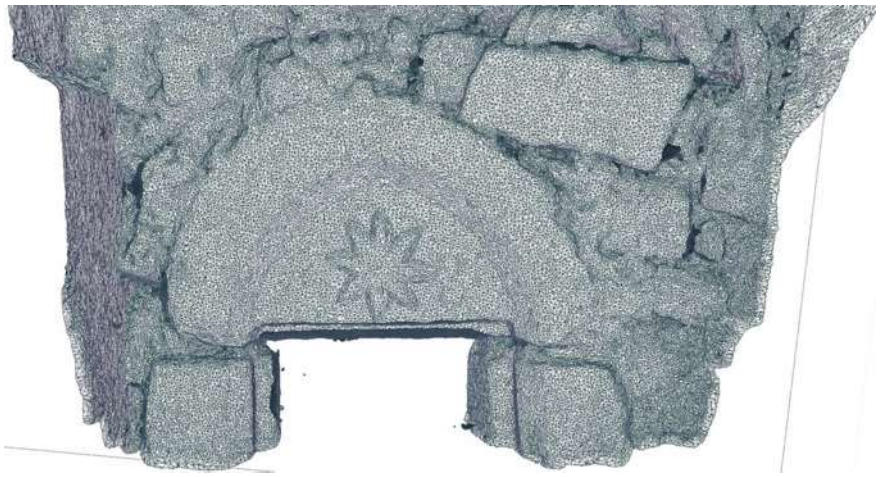

Fig. 21.6 An example of a high-LoD relict element, a photogrammetric model of a surviving door in the Criechinger Haus

Low LoD, relict: This category is perhaps the most fruitful for future researchers to develop, as it contains many elements that still exist, but have not been studied in greater detail because they are not the focus of the model, such as the Roman watchtower on the hill to the south.

Low LoD, speculative: This category contains the "infill" needed to complete the insignificant areas of the model—for example, the outbuildings behind the houses in the town, which add to the complete picture but whose location, dimensions and density are not known.

21.8 Conflicting Data

A good example of a place where data conflicts and a decision has to be made is the eastern gate of the city walls. In his seminal work on the castles of Luxembourg, *Die Burgen des Luxemburger Landes*, John Zimmer includes a map of the historic town and castle (Zimmer 1996), which he asserts is based on archaeological evidence[1] and old maps. It shows a small, *rectangular* building on the *northern* side of the bridge, where the road crosses the river and runs into the town.

In contrast, the Ferraris map (de Ferraris 1778), one of the oldest maps of the region, shows a protrusion on the *southern* side of the bridge—coloured in red to indicate that it was surveyed, rather than estimated. The first cadastral map of the region, produced in 1824, shows a small building of somewhat *ambiguous shape* on the *northern* side of the bridge, attached to the larger municipal building behind it.

This disparity can perhaps be explained by the fact that the river meanders and may change its course from time to time, necessitating a new wooden bridge, but matters are further complicated by the introduction of a third data point. In 1845, the Dutch artist Barend Cornelis Koekkoek sketched the town as a preliminary study for a series of landscape paintings. His view of the eastern gate shows a remnant of city wall, several recognisable buildings still present in both the maps and the modern town, a wooden bridge—and on its *northern* side, the stump of a *round* tower. Koekkoek was, in his own words, prone to "assembling real elements into an artistic whole that does not exist in this form in reality" for his landscape paintings, which he called "pretty lies" (Pelgrom 2012). However, his sketches are generally considered to be meticulous studies, and his Luxembourgish paintings are closer to the truth than his usual style.

All these points combine to make an interesting conundrum—which source should we believe? John Zimmer, who sees things with a modern engineer's eye and includes scholarly citations in his work? One or the other of the historic maps, whose makers surveyed the structures when they were still standing? The sketch by an artist who is carefully studying shapes in preparation for his work?

[1] Unfortunately, official reports on the findings of the rescue excavations are not available, so all data on archaeological evidence is second hand.

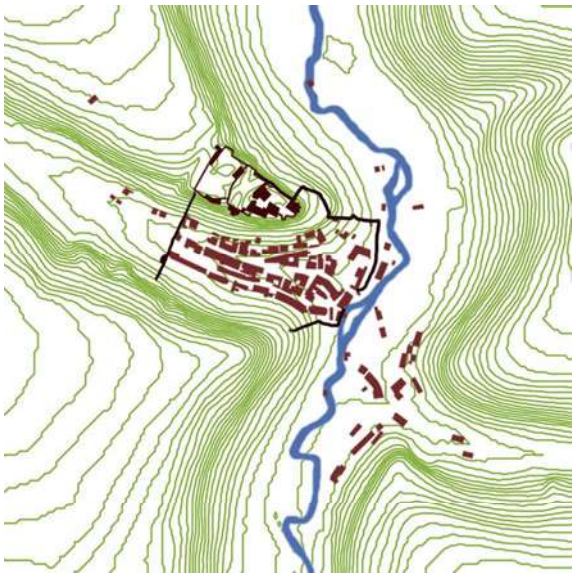

Fig. 21.7 A map combining different data sources

Unless new evidence comes to light, it is not possibly to conclusively reconcile these different sources (Fig. 21.7). Instead, they can be used as an example of how to deal with dependencies.

21.9 Dependencies

Making a decision about the shape and the location of the gatehouse will affect other decisions, from the rendering of the building itself to the precise location of the bridge, the path the road takes once it passes through the wall, and even how reliable the sources that gave the conflicting data are considered to be in relation to other decisions. Therefore, the decisions themselves, the reasons one solution was chosen over alternatives, the data supporting each one and how this decision relates to the overall process must be recorded.

This issue is far from trivial, and requires detailed mapping, preferably using an ontology like CIDOC-CRM—which would be far too complex to present to the public. Instead, users should be made aware of this type of issues and the changes they can perpetuate across the model without naming them all explicitly. Meanwhile, not all possible variants must be fully mapped out; instead, documenting where they would branch, and which branch was pursued allows future researchers to add their own data.

21.10 Interactivity

The model will be presented in an interactive, immersive app that allows the user to control their environment, either in virtual reality or on a screen. It offers a choice of a bird's-eye or an interior view in which to explore the model. On load, the model will be presented at a maximum level of detail and with photorealistic textures to provide an impression of its state ca. 1550.

Using simple sliders, the user can choose to dynamically adapt the display to reveal which parts have which levels of accuracy at different levels of detail. All parts below the chosen combination are faded out, turning semi-transparent and removing their textures to highlight the higher-quality parts, but still offer a context for them.

Selecting individual building elements will let users view the associated metadata stored in the underlying table. Similar elements can be grouped for this purpose to avoid excessive repetition—for example, it can be given all at once for the beams in a certain floor.

Since an explorable model will not, by itself, be enough to give the user a deeper understanding of the connections between data and metadata and how decisions in reconstructions affect other parts of the model, mini-games can be introduced to demonstrate particular aspects.

The first of these is based on our initial landscape study and serves to pique interest in linguistics and historical geography alongside the architectural reconstruction. It places the user in an interactive educational environment that rewards them for engaging with the content, and allows natural movement and intuitive interaction prompted by curiosity (Fig. 21.8).

Fig. 21.8 A screenshot from the microtoponym learning game

By combining building blocks with symbols for place name elements and placing them on the map, the user progressively makes representations of those place names appear in the landscape below, connecting microtoponyms, their meanings, their place in the landscape and the history of the town. Learning how place names connect to history is implicit, but not presented as the major goal (Morse and de Kramer 2019).

Dependencies can be demonstrated in a "choose your own adventure" storytelling format, allowing the user to make decisions about which sources to trust; this influences which options are available later in the story and can be compared to the outcomes of choosing different options.

21.11 Conclusion

Though it does not have the resources that can be devoted to a larger team effort, this project seeks to fulfil the key points of "intellectual integrity, reliability, documentation, sustainability and access" in a way that is manageable alongside its other requirements. Documentation cannot overshadow the reconstruction process itself, but neither can it be ignored—it is an integral part of any scientific endeavour. Communicating this to the public is as important as communicating the results themselves.

The Charter of Venice demands that "[restoration] must stop at the point where conjecture begins" (ICOMOS 1964), but virtual reconstruction allows us to speculate freely without affecting the original structure. Still, as researchers, we have a responsibility to document our knowledge and conjecture, to allow and encourage criticism of our results, and not to sell our hypotheses as the absolute truth.

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Exploring User Understanding and Critical Reflection in Virtual Reconstructions

The Study That Wasn't

Initially, this next paper was to be about an entirely different study, of which the survey was meant to be only a small aspect. However, the global pandemic prevented it from being carried out within the time allotted and it had to be replaced by an online-only project. Perhaps something similar can be carried out in future, by myself or others, to build on the study presented in the paper.

Still, the aim and design of the study is worth describing, as it addressed several major themes in my work. The first of these is public outreach and education – ensuring that my work is useable not only by fellow academics but by everyone. Rather than pitching it to general museum visitors, tourists or university students, this specific project was designed for another key stakeholder in museums and heritage sites: school groups. A visit to a castle is often a highlight of school pupils' introduction to the Middle Ages. And with curricula evolving to incorporate more diverse skills and cross-disciplinary work, it would be an excellent opportunity to address issues like source criticism and the scientific method.

Another theme is accessibility, as demanded by the London Charter. Often, this is taken to mean that the reconstruction should be hosted on a website available to the general public, that an effort should be made to provide functionality for disabled users, or that it provides an intuitive user experience that does not require learning a new interface.

However, there is another form of accessibility that is often neglected: intellectual access.[36] This means that it must be ensured that the intended users have the skills and knowledge to understand what they are being shown. If intellectual access can be provided for school pupils, who are still learning reading comprehension and critical thinking skills and often lack the general knowledge of adults, it also encompasses those with better-developed skills.

[36] http://www.kulttuuriakaikille.fi/accessibility_what_is_accessibility_intellectual_access

Language must also be carefully calibrated to their reading level. As museums and heritage sites are common tourist destinations, this will also help those who are accessing content in a second language or don't have the country-specific or regional knowledge that can be assumed for local visitors.

Finally, targeting school groups rather than casual museum visitors helps ensure social accessibility – that is, ensuring that issues of class, income or education do not prevent potential users from accessing the reconstruction. As school attendance is compulsory in both countries that were to take part in the study, and pupils come from a wide range of backgrounds, a project that takes place in a school helps to reach more of those for whom visiting museums or heritage sites is not a regular occurrence otherwise.

For a researcher, this choice of a user group also has certain advantages when designing a study. It is fairly homogeneous, by definition comprising people of a similar age and educational background who speak the same language. Their background knowledge and general comprehension skills are continuously assessed by their teachers, they have sufficient end-user devices and know how to handle them to access websites and use them for research. Also, organisational concerns like finding a time, place, and venue and recruiting sufficient participants with parental permission are made easier.

Methodology

This study was comprised of two elements: a 3D model to be accessed through a web viewer, and a "choose your own adventure"-style exercise to be built using Twine and run in a standard web browser.

This questionnaire was to be completed independently, and guided the user through a reconstruction process. A gap in a 3D reconstruction was displayed, and users would fill it in by making choices about the building that had stood there. This meant making a series of choices by examining sources – mostly visual – which sometimes agreed and were sometimes in contradiction, to arrive at an individual solution.

The 3D model, on the other hand, was to be explored and interrogated as a group exercise. It consists of a virtual reconstruction of the castle and town, at a relatively low resolution that is segmented by individual buildings. These can be viewed in three modes: one with a realistic surface texture, one that groups them by type, and one that shows their relative certainty. Selecting individual buildings reveals different data in each view: in the “type” view, this is metadata describing the building and its function, in “certainty” view it is paradata describing how it was reconstructed, and giving sources.

After exploring the model, pupils would be assigned to one of several “blank” buildings with no data attached, provided with selected sources, and asked to research it, then write a snippet of text for each view and agree which colour it should be, that is to say, which category it was assigned to in the different views.

These texts would then be evaluated not on the basis of whether they were “correct”, but whether the pupils had understood the different types of information being conveyed and written their texts accordingly, and whether they had documented the decisions they had made.

To see how explicitly demonstrating the process of comparing sources and making choices influenced this understanding, half of the participating groups would do the group exercise first, and the other half would complete the questionnaire first.

The Questionnaire

The questionnaire in its original form, as intended to be used with this project, is quite simple. The basic concept is to demonstrate how the reconstruction process works, as a series of questions to be answered by often incomplete or contradictory data. The goal is to demonstrate that while one result may be more likely, there is not usually an absolutely “correct” answer.

There are three sets of choices to be made – positioning, shape, and direction. As the survey progresses, these become slightly more complex because they are more abstracted. The

first question is a simple binary choice where respondents are told exactly what they are looking at and what it means, the second provides multiple sources from which to draw information, and the third clearly describes the two options but does not explain how to find an answer.

The example used was the southern gate of the town. This originally caught my interest because one of the maps used for the town reconstruction during our previous papers showed an odd gatehouse that forced anyone entering the town to take a circuitous, roundabout way. Closer investigation of available sources indicated that it was most likely an erroneous transcription of an older map at a low resolution, but a third map was somewhat ambiguous. Fortunately, the most commonly depicted view of the town from the south included the location of the old gatehouse, as drawn several hundred years later after the removal of the wall.

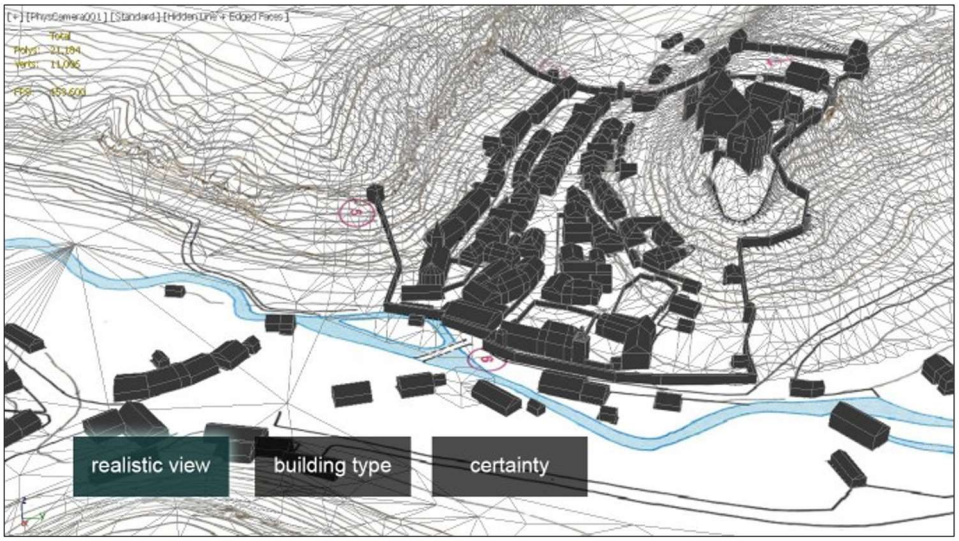
This predestined it for this exercise for several reasons:

- The building in question is discrete and self-contained, small enough to be shown in its entire extent on the depictions in question.
- Various sources available are clearly drawn, but ambiguous. None are contemporary, and the building no longer exists today.
- The building has a clear function that can be used to justify different configurations.
- There are several simple, binary choices to make that yield different results, but are all plausible in their own right.

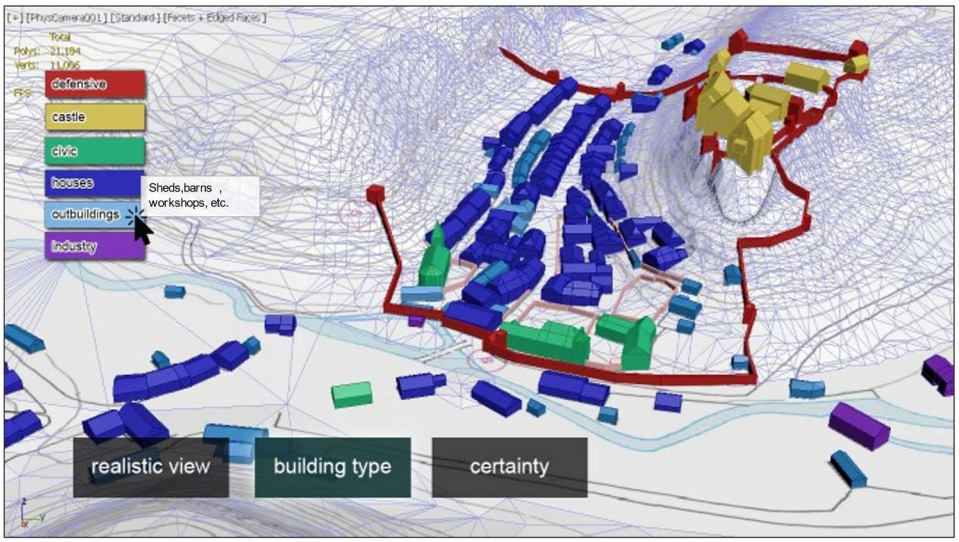
The 3D Model

This mockup shows the intended functionality of the 3D model of Larochette castle and the surrounding town and its landscape, which can be interrogated by the user in different ways.

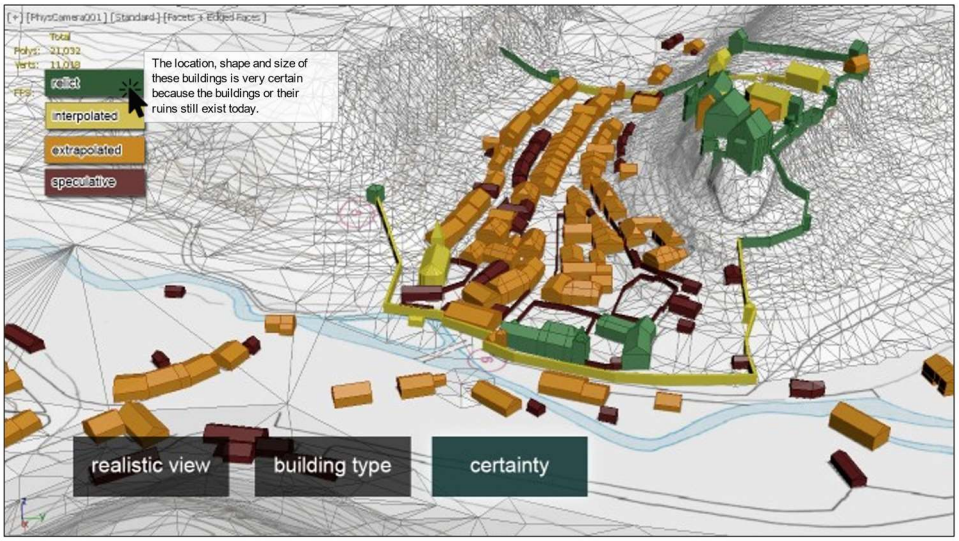
The starting screen shows a textured model that gives a photorealistic impression, and allows the user to explore by panning and zooming.



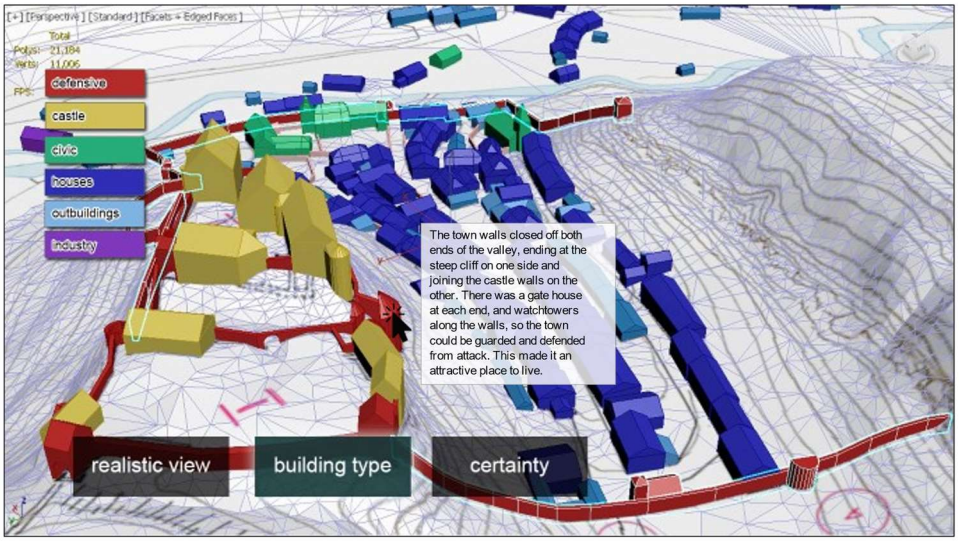
The “building type” view removes the textures in favour of colour coding. Clicking on the key gives a definition for that category.



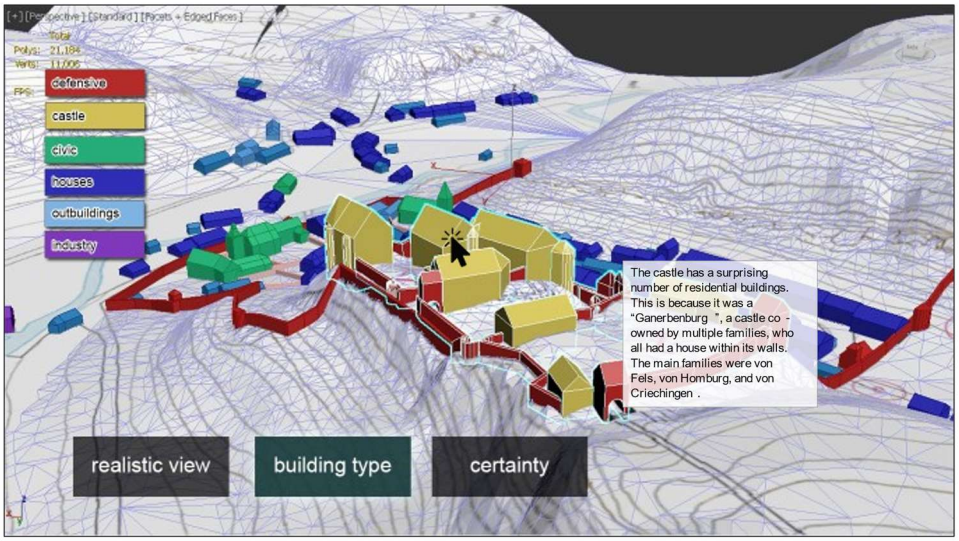
The “certainty” view shows the reconstruction certainty, using an intuitive “traffic light”-style colour ramp.



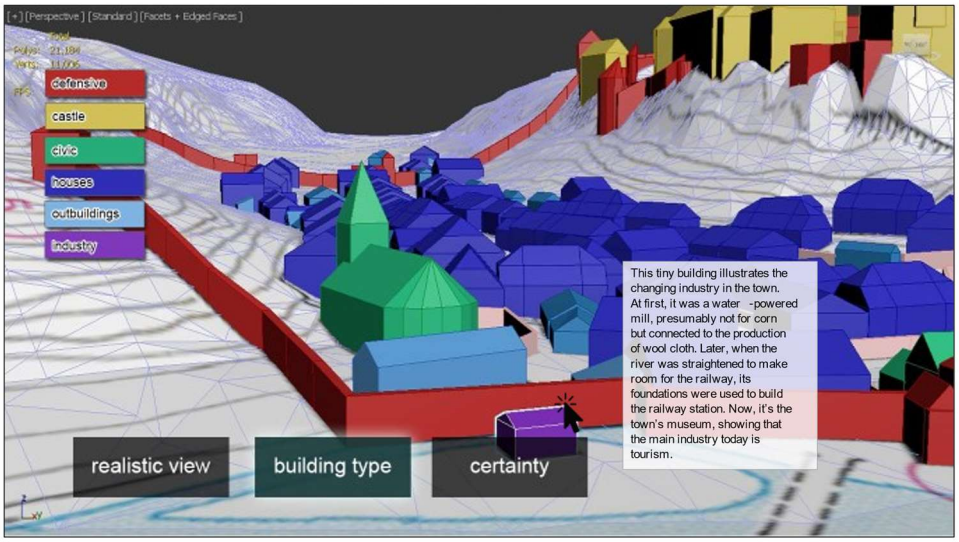
Clicking on individual objects gives different types of information depending on the current mode.



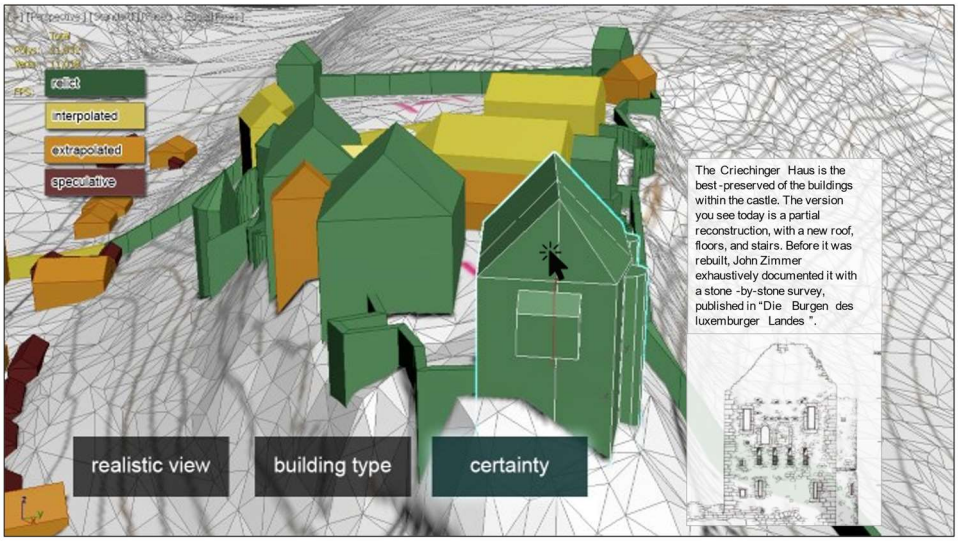
At this scale, the castle is not yet segmented into different elements, but functions as a whole.



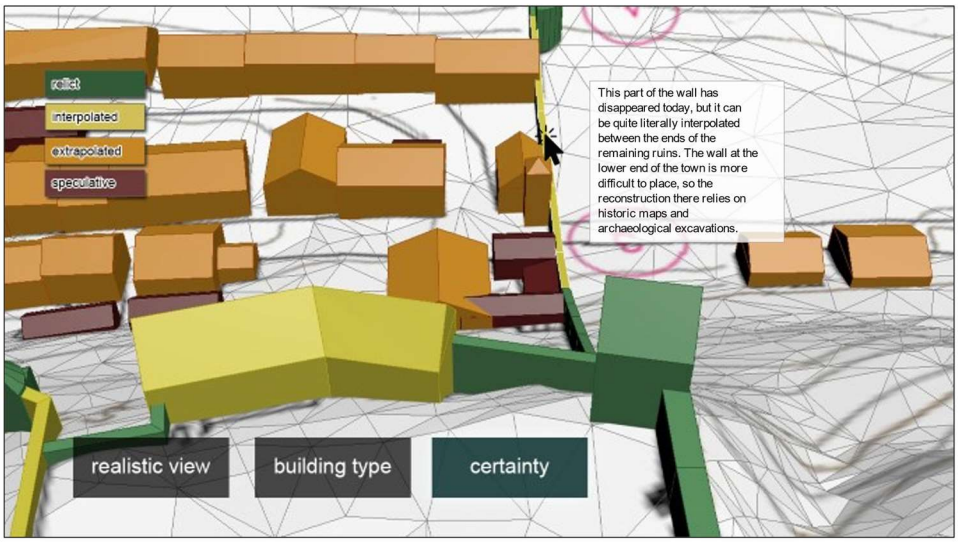
Specific interactive elements are selected for inclusion to represent different aspects of the town and give a more general idea of its history when selected in building type view.



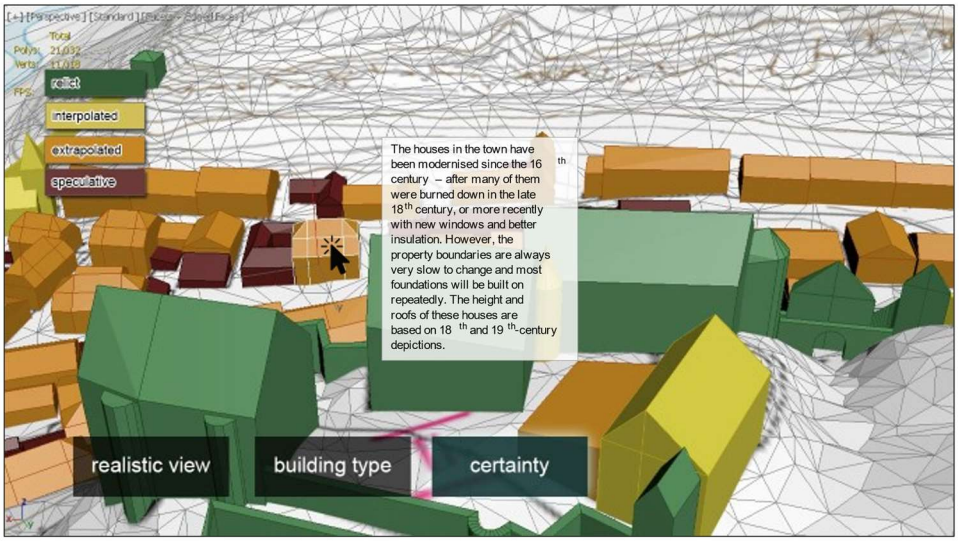
The certainty view explains why each element is in that category and provides sources and other metadata.



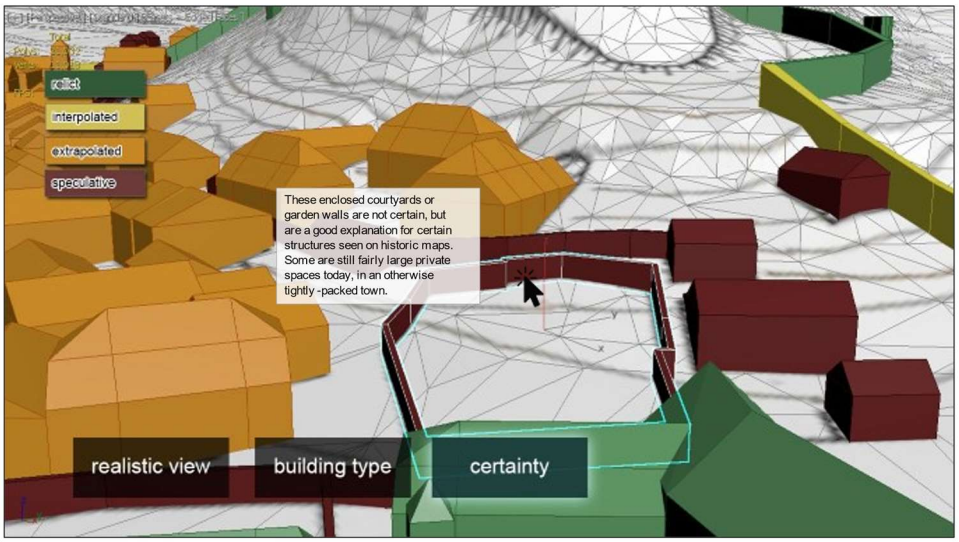
In certainty view, some elements have been further segmented to show their relative accuracy.



Since many elements are very similar, they have been grouped so that clicking on one will bring up the information for all.



Speculative elements are clearly marked, but are included – leaving these areas empty is not neutral, but gives false information, implying that there was nothing there.



The castle reconstruction largely follows John Zimmer's proposal, while the town is based on current and historical maps and the research for the preceding papers. This app was never fully implemented as priorities shifted for reasons detailed below, though the content was prepared for deployment using either A-Frame or Babylon.js, both of which are designed to display 3D content in a web browser and provide pre-configured features such as physics and navigation. A-Frame uses HTML, while Babylon.js is JavaScript-based.

The Setup

A total of three schools in Luxembourg and Germany had already expressed interest in participating, with contacts at two more potentially interested schools established. All had pupils aged 12-14 who were studying the Middle Ages, could complete the exercise in German, and were familiar with the use of tablets for schoolwork.

The university ethics committee had already approved the following study setup:

The primary investigation in this project will be done with volunteer school groups whose teachers are interested in using it to enrich their lesson plans. It will consist of a two-hour project in which the groups are introduced to the principles of reconstruction, asked to examine a 3D model with annotated data on a website using their own devices, and then work in groups to augment some deliberately empty buildings with their own data. They will also go through a guided reconstruction process using an online form, in which they must choose between different options based on sometimes conflicting sources.

The data they provide for their chosen elements will be analysed to see whether they are able to produce the same type of results, rather than for content/correctness, though the latter may be discussed with the group as part of the lesson.

The research questions to be answered in this study are:

- Can adolescent users distinguish between the two different data types attached to a 3D reconstruction, and how they influence its estimated degrees of accuracy?
- Does going through a guided reconstruction process influence this understanding?

Parents will be given information in advance and can choose not to allow their child to participate.

No audio or video recordings will be made; users will submit their responses in writing and any points brought up in discussion will be documented in the researcher's written notes.

The Change of Plan

Unfortunately, the global pandemic led to in-person education, especially with guest lecturers or group trips, to be suspended indefinitely. I considered adapting the study to an online group experience – after all, one of the strengths of a digital project should be the ability to carry it out remotely. After speaking to the teachers, however, we came to the conclusion that it was not feasible for several reasons. On my end, the primary barrier was that the app would need to be rigorously tested, absolutely reliable and multi-platform compatible so that pupils could use it with no extra guidance. On the side of the pupils, availability of devices (which were being shared with siblings, for example) and a reliable internet connection with sufficient bandwidth was an issue for some. And perhaps most importantly, the teachers felt that they were behind in their curricula and had to focus on the absolute essentials, so they could not spare any of their class hours for extracurricular, supplemental activities.

Instead, the focus of the study was changed to allow for some of the original research questions to be explored. The brief "choose your own adventure" guided reconstruction was used as the starting point for a longer survey. To ensure adequate participation, it was made to be self-contained, not requiring it to be taken before or after another exercise, and the audience was expanded to include adults and possibly younger children.

The 3D model/app was not developed further at this stage, as it was difficult to gather data on user interaction without observing them, for which I did not have the technical infrastructure. Instead, the survey was augmented with questions to explore not only which decisions users made, but to ask them to explain why they had made them – answers that would later be analysed to discover common themes.

This shifted the focus from “do the users understand metadata and paradata better after having the reconstruction process explained?” to questions such as “do the users understand how the decision-making process behind a reconstruction works well enough to apply it independently?”, “does their confidence grow after they learn how a reconstruction is made?” and “which types of arguments do they find compelling when it comes to evaluating reconstructions?”.

The following paper seeks to answer these questions by evaluating the responses from 360 adult participants.

Journal Article: Understanding by Doing – Guided Decision-Making as a Tool for User Engagement with Reconstructions

In the process of submission to the *Journal of Interpretation Research*

Understanding by Doing – Guided Decision-Making as a Tool for User Engagement with Reconstructions

Marleen de Kramer, C²DH and IHIST, University of Luxembourg

Introduction

The London Charter for the Computer-Based Visualisation of Cultural Heritage (2009) lays out best-practice guidelines for producing virtual reconstructions of historical buildings. This study seeks to further objective 3: “[To] ensure that computer-based visualisation processes and outcomes can be properly understood and evaluated by users”, meaning that “the outcomes of research that include computer-based visualisation should accurately convey to users the status of the knowledge that they represent, such as distinctions between evidence and hypothesis, and between different levels of probability.” (Denard 2009, p 4)

While users are often fellow cultural heritage professionals or other academics who are well versed in source criticism, knowledgeable about the limitations inherent in researching history, and know how scientific theories are formed and tested, we must also consider a potentially much larger group of users: the non-expert consumers of cultural heritage, such as museum visitors, the audience of televised documentaries or the readers of popular history books.

It is especially important for us as professionals to maintain the principles of “intellectual integrity, reliability, documentation, sustainability and access” (Denard 2009, p 2) in relation to these groups, as they rarely have access to the tools and training required to separate fact from fiction or archaeological evidence from speculation, or even know that they should. This is further reinforced by the “museum effect” (Putnam 2001, p34) – how something being displayed in a venue that carries the “Voice of Institutional Authority” (Weschler 1996, p 101) gives the impression of truth and authenticity, regardless of its actual proof and provenance.

To this end, it is important to understand how users think about historical reconstructions, so they can be presented accordingly. This study seeks to address the following questions:

- Do users gain confidence in their decision after being guided through the reconstruction process?
- Can they apply the process independently?
- How do they handle ambiguity or conflicting sources?
- Which arguments do they use to support their decisions, and which type of arguments influence them?
- How do they evaluate existing reconstructions?

Study Design

Originally, this questionnaire was intended as part of a project at a heritage site, in which school groups explore a 3D model semantically enriched with metadata about the buildings and paradata about the reconstruction process, discuss it, research some of the buildings and annotate it with further information of their own. Some users were to complete a version of this questionnaire before viewing this model, others after. This way, the groups could be compared to investigate how being guided through reconstruction decisions influenced their comprehension. It has been adapted and expanded to stand alone due to the pandemic-related impossibility of working directly with large groups, and youth and adult versions were provided in English and German.

Questionnaire Description

The core of this study is an online survey that demonstrates how the reconstruction process works, presented as a series of questions to be answered by often incomplete or contradictory data. The goal was to show that while one result may be more likely, there is not usually an absolutely “right” answer – though after the intense frustration of not knowing whether they are correct expressed by the testers, a most likely solution is presented after each set of decisions.

The questionnaire utilises the author’s ongoing work into reconstructing historical Larochette, Luxembourg. It is divided into two main phases – the introductory phase dealing with the city’s lower gate, and the more complex, abstract phase dealing with one of the buildings in the castle proper.

In the first phase, there are three sets of choices to be made about the building – positioning, shape, and direction. As the survey progresses, these become slightly more complex because they are more abstracted. The first question is a simple binary choice where respondents are told exactly what they are looking at and what it means, the second provides multiple sources from which to draw information, and the third clearly describes the two options but does not explain how to find an answer.

The images themselves contain no text to make it easier to translate the survey into multiple languages; as the responses remain the same, they can be combined into one master analysis or looked at separately to gain insights into differences between German and English speakers.

For purposes of this study, the real interest lies not in making users choose a version of the gate, but in the questions about their confidence in their answers – whether they felt more or less confident after making their decisions based on data, and what would make them change their minds again. These are asked at the end of the first section to ensure that users still remember their choices.

The second section asks users to make decisions about a specific building in the castle itself by comparing multiple sources. While there is guidance given on what to look for, the answers are no longer binary but involve several choices. They are then asked to analyse several existing reconstructions based on their mental image or decisions. These did not include the digital reconstruction, to ensure that the results were not skewed by users knowing it to have been made by the author of the study and choosing it to please them. The optional introductory text included an image showing a volumetric model of the castle and town, with an incorrect gatehouse based on an erroneous map drawn by an earlier scholar, but refuted by the historical images. Several users cited it in their reply, assuming it must be correct as it was chosen for inclusion, thereby indirectly validating this approach.

The demographic questions help group similar users for the analysis. Among common demographic survey questions, gender, nationality, and especially ethnicity were not deemed relevant, so they were not included – after all, best practice is to collect only necessary personal data, not as much data as possible. Age and educational background help gauge a respondent's experience in source criticism and reasoning processes, while users working in cultural heritage and related fields will tend to be better at analysing maps and historic images and have more exposure to reconstruction methodology in general.

Test Phase

The questionnaire was tested and refined as part of the User Experience Design course taught through the psychology department. Unfortunately, due to the social distancing situation, it was not possible to invite users to test it in the lab and observe them directly. Instead, a meta-survey was incorporated into the questionnaire, with questions about the reconstruction questions, how they made users feel and whether they understood the tasks. It was tested by 19 users, either participants in the course or recruited through social media.

All testers enjoyed the exercise and the general concept, but most complained about the lack of a "correct" solution, so a de-briefing was added after each section. To

balance the risk of information overload and need for metadata, a brief history was added to the website as a pdf, so that reading it was optional. As they felt there was too much time-consuming free-form writing involved, several questions were updated to multiple choice. Over ¼ of users struggled to interpret some content, so images were adapted to make it clearer where the focus lay, and architectural terms were better explained for lay people. Some survey respondents still struggled, especially with the word “gable”, but these respondents often commented that they were not native speakers. Others had trouble distinguishing between the town walls or gate and the castle itself, conflating the two.

Evaluation

In total, the English adult version had 264 responses, of which 259 were valid, the English youth version had three responses, all valid, the German adult version had 105 responses, of which 101 were valid, and the German youth version had two responses, both valid.

The low participation rate for the youth versions meant that they could not be evaluated; this was most likely due to issues around getting parental consent outside a school setting where formal systems are in place.

Of the 9 invalid responses, 6 were accidental double submissions, 2 failed the screening question whether they had been answered seriously, and one was deemed invalid as most responses were non-answer. This left 360 responses for evaluation.

How frequently the survey page was accessed was not monitored, so it is not known how often it was started but not completed.

The responses were encoded for quantitative analysis, but also considered individually for qualitative analysis. Results of both will be shown below.

Qualitative Analysis

In this step, specific individual responses were analysed and grouped by theme to show the broad range of responses and their sometimes contradictory nature. These have been anonymised and are attributed using a code made up of the respondent language and number. They have also been lightly edited for spelling and grammar to aid in comprehension and to make them more uniform. German quotes were translated into English by the author.

Historical Understanding

The responses indicating historical knowledge – or lack thereof – are of particular interest for future iterations of this survey or its application at heritage sites, as they show where there is potential for confusion or bias.

Some respondents were entirely aware of their limitations when it came to historical understanding, and clearly able to identify where those ideas had been formed. Computer games and movies were a common theme – a field of research among medievalists in its own right. (Jiménez 2010, Spring 2015)

> *"Most of my 'knowledge' in this regard stems from video games (like 'Kingdom Come Deliverance' as a current example)." – EN 200*
>
> *"Maybe I just have a Disney idea of castles. (US citizen)" – EN 186*
>
> *"I am so biased by former knight's tales (e.g. public history ;-)) to guess that it might be used partly as a toilet – EN 132*

Others clearly had misconceptions – whether lacking understanding of the sequence of events, not realising that our modern landscapes are largely man-made, or failing to understand that basic architecture transcends epochs.

> *"Round towers are Roman." – EN 27*

> *"A panzerfaust would probably light the [wooden parts of the castle] on fire, though at the time inexperienced kids operated them, so..." – EN 195*

> *"Landscapes like rivers don't get up and move." – EN 120*

Finally, some respondents used the comments to demonstrate or report their detailed historical knowledge, while being aware of their own limitations:

> *"It's an aesthetic response. It looks like the early figurative work of Kandinsky. A mix of National Romantic (called Arts and Crafts in Britain) sensibility with a bit of antiquarian knowledge of the building. As an architect myself, I would not be able to trust the reconstruction because I know (and enjoy) the temptation to make things up for completeness when the evidence is not quite there." – EN 190*

> *"I am active in Living History at a museum level, and while I haven't occupied myself specifically with castle construction, I believe that I have above-average knowledge of the subject. Which does not preclude misinterpretations, as became clear over the course of this survey." – DE 6*

Bias and Self-Confidence

Their self-perception of their previous knowledge may have influenced respondents' confidence in their own answers, which varied across a very wide spectrum, from "none" to "absolute conviction that their personal theory is correct".

> *"I need to say here I'm not comfortable in claiming any certainty about anything! (…) Given my level of uncertainty, a sudden noise in the street [could make me change my mind]". – EN 37*

> *"Pretty close to what it actually looked like." – EN 29*

Some users assumed ulterior motives on the part of the author and made their choices accordingly. This may be due to the "quiz" title under which the survey was distributed, which was chosen to encourage participation. Perhaps this made them want to "win", despite having been told in the introduction that all replies were valid.

> *"You got me on the first quiz, the round was so obvious I thought it had to be rectangular." – EN 212*

> *"I did not change my opinion because it clearly depends on which map you saw last". – DE 57 EN 204 "*

> *"This could be a trick question, because the old structure could have been torn down between 1778 and 1824." – EN 195*

A large number of respondents argued from personal conviction, often ignoring the new data presented if it did not match their initial guess. Some simply stated that they were unwilling to deviate from their initial choices.

> *"[I chose this source because] its opinion is identical to my decision." – DE 3*
>
> *"Because I'm stubborn." – EN 86*
>
> *"The reasoning I made up makes sense." – EN 92*
>
> *"That's what I think – I might be wrong, but that is my opinion." – EN 82*
>
> *"I'm sticking to my choice because I like it." – EN 8*

Some cited a pre-conception, without explaining how it was formed.

> *"Left is best." – EN 248*
>
> *"Round towers are better..." – EN 243*
>
> *"With the French name for the town, I felt that a soft, round turret would be used." – EN 202*

Some had a picture of what a medieval building "should" look like.

> *"It's suitable to my opinion of what a castle from that time and place should look like but I would add round features." – EN 123*
>
> *"Robust, functional buildings, that's how I imagine the medieval mentality." – DE 28*
>
> *"Corresponds with my internal model of how a castle looks." – EN 147*

Others were aware of their own biases, but consciously maintained their previous theories.

> *"It appears from the photos to be round. But I am sticking with my first guess. Wrong or not." – EN 175*
>
> *"I am biased by the idea that it's on the left, to be honest." – EN 132*
>
> *"My answer is mostly linked to a feeling rather than a real justification." – EN 88*

Finally, many respondents reported that they gradually changed their minds while aware that they were doing so – as this was the aim of the exercise, these responses were particularly gratifying.

> *"I found it interesting that my functional reasoning was apparently contradicted by reality." – DE 65*
>
> *"Very interesting how the gradual presentation of extra material in the first part made me change my opinion of the tower design." – EN 112*
>
> *"I want to believe that my earlier guess was right but it looks round on these images."- EN 190*
>
> *"I'm afraid that my initial enthusiasm for the positioning on the left is being weakened by this very clear image. Presumably, the gate also did not go through the tower. I was wrong about that, too." – DE 30*
>
> *"I tried to lose my pre-conception that I wanted to be 'right' on the previous one. Then I looked at both maps and tried to see what seemed more 'logical' to me." – EN 46*

Certainty vs. Ambiguity

Another kind of certainty to be considered is not users' confidence in their own choices or in the work of experts, but how certain one can even be about various aspects of a reconstruction. Due to the sparse and varied nature of sources available to document the historical state of a building, there will always be parts of a reconstruction that are speculative or otherwise ambiguous. The only way to achieve absolute certainty would be to have the building fully preserved and unaltered – which would render a reconstruction unnecessary, and still be lacking data for some aspects, such as its day-to-day use.

This ambiguity, and how to manage it, is a bone of contention in the digital reconstruction community. For physical reconstruction and restoration, the rules are more clear – do nothing that can't be undone, preserve the original, and clearly mark what is new for posterity (ICOMOS 1964) – but because digital representations don't interfere with the original substance and can co-exist, the freedom and temptation to speculate are much larger. Attitudes range from "everyone will know it's only a theory" to "show nothing you can't prove". However, such representations establish seeing habits – there is no way to not make a statement. Many reconstructions borrow from architects' volumetric models and show all-white, abstracted shapes – but as can be seen from depictions of classical Greek and Roman architecture, this leads to the assumption that the buildings were white. Showing raw stone, on the other hand, because we do not know exactly what was painted on the render leads to the impression that castles were plain and grey. Some artists' impressions are designed to be evocative rather than purely factual, prioritising emotion and a sense of presence over proven fact; other representations err so far on the side of caution that they are nothing more than a sober stock-take of the ruins.

How to balance these conflicting needs is a question that has not yet been answered conclusively, with many researchers working in parallel toward a satisfactory solution. This study is, in itself, a contribution to this collective effort.

Interestingly, the comments from survey respondents mirror this wide range of possible responses, from rejecting ambiguity to celebrating it, from valuing certainty over completeness to fully embracing speculation.

> *"For a layman like myself it's all about impressions rather than knowledge". – EN 249*

> *"For a virtual reconstruction, don't fall into the 'horror vacui' trap and attempt to reproduce everything photorealistically; instead, use our 500-year-old seeing and interpretation habits of abstracted graphics for virtual reconstructions as well. Clearly show what we know and what we don't, using transparency, for example." – DE 95*

> *"[The physical reconstruction is best] because you can imagine the rest yourself – like the difference between a book and a film. The other three constructs don't allow for any alternative interpretations." – DE 62*

> *"Considering the sources available, this reconstruction is the most pragmatic. However, it is missing the colour scheme of the model, if it is attestable. Minimalism, especially in castle reconstructions, tends to generate an incorrect impression – like missing render on the exterior walls." – DE 33*

The sources shown in the survey were specifically chosen for their differences, forcing respondents to choose between two options. Some respondents attempted to reconcile the ambiguity caused by conflicting sources by finding explanations for the conflict.

> *"It looks rectangular with a round end, but you didn't offer that as a choice."- EN 185*

> *"The first two pictures, especially the first one, give a strong impression of a round tower. Are we sure that the ruins were still standing in 1883? Could it have been replaced with a foundation of another building, perhaps built from the tower stones? This is really a baffling one." – EN 73*

“The previous question is hard to answer the way it is worded. Because the maps are from different times, they could both be correct. The layout of that area could have changed.”– EN 6

“The views are from different locations, elevations, and times of day as well as years. (…) The different perspectives also show that the artists had slightly different intent, one is a street scene emphasising the near buildings, one from a rocky outcrop with a view across the river valley to the castle. (…) So I see different artist’s intent, locations, time of day and town development. I wouldn't rule out eyesight either.” – EN 64

Others rejected having to make a decision at all, uncomfortable with having to commit without feeling that they were fully informed. Eliciting this discomfort was a specific aim of the study, to recreate the position in which those making scientific reconstructions found themselves and to demonstrate that certainty is not possible with the limited data available.

“The question of good, better, best is qualitative. The alternatives offered for comparison are too different to be subjected to a uniform qualitative verdict.” – DE 79

“So far, the illustrations are too vague to make a decision.” – DE 33

“Normally I would trust a more recent cadastral map more than a more ancient map. The sketches in which the roadway seems to go through other features makes me confused, though. If I would really have to decide I would want to reference both maps to the existing situation and see what seems to fit best. Though that might even further complicate things.” – EN 91

“I had to make a decision, and the red marking saying this was a required question was right underneath this answer, so I picked it. I did not have enough information to base a real decision on.“ – DE 80

"I liked this exercise, but I would have liked a few more 'I don't know' options! (but I realise that too many people would probably have picked it, so forcing an answer at least forces one to rationalise to some degree.)" – EN 168

Purpose

An important part of source criticism is considering the *purpose* for which a depiction was created. The respondents' very different views on this became especially clear in the question of which reconstruction is "best", ranging from outright rejection of the principle to embracing all possibilities.

"I am against reconstructions." – DE 8

"We don't know what was there, so the reconstruction can be chosen aesthetically. (…) I think it is better to be honest about it being a 21st century reconstruction." – EN 19

"I have chosen every one of the above models and rejected each to finally settle on the physical reconstruction. Each poses problems. Each proposes possibilities, and I'm not convinced by any, but the physical one is doing the least alteration." – EN 214

"A drawing can be used to communicate one's ideas and dispute them with others without interfering with the original object. Mistakes are easier to rectify, and to admit to, than if you are standing in front of a completed project. Today, the castle is a tourist attraction, whether authentic or not, that is useful to the community. The reconstruction drawing can be augmented with a 3D model to show all perspectives. The drawing still serves better for drawing attention to scientific findings and expounding on them." – DE 36

Another point of contention was whether speculation was to be welcomed or avoided.

> *"Do we even need a visual reconstruction? Aren't the preserved ruins and one's own imagination enough?" – DE 80*
>
> *"Good balance between information from actual ruins and speculation." – EN 31*
>
> *"It is best because it leaves the least room for speculation." – DE 98*

Many respondents believed that the physical reconstruction had a purpose beyond built heritage conservation, from tourism to education. They conceded that this might come at the cost of scientific accuracy if it captured the imagination; this mirrors the approach used by some documentary film-makers and their "the creative treatment of actuality", which can introduce artistry, plot and dramatic tension. (Kerrigan & Mcintyre, 2010)

> *"'Best' is not the same as 'most accurate' for me. The best one is the one that is in the physical location, and engages with the town and the environment, preserving the structure (or a reasonable approximation of it) for posterity." – EN 34*
>
> *"It's history you can touch. It's one thing only to read about it and have to imagine it yourself, and quite another to really be able to go there and see it with your own eyes". – DE 15*
>
> *"A material reconstruction must be examined very critically, because often, modern materials are used to cover the original remains. This aspect alone is in no way related to the original! But at least the attempt is made to preserve the building and continue using it, which I would gladly see done all over the country! Interested parties can learn what is original and what is fantasy by taking part in guided tours of the site or by reading." – DE 36*

However, proponents of other reconstructions also had compelling arguments for their purpose, often incorporating an element of documenting metadata, which they felt drawings and models were better able to accomplish than the in-situ reconstruction. This is reflected in the fact that it was not the physical reconstruction, but John Zimmer's perspective drawing that proved the most popular among respondents.

> *"[This drawing] gives the easiest to understand perspective on the entire site. The model might be better if you can see it in person, but a 2D photo of a 3D model is not as good as the drawing." – EN 252*

> *"[John Zimmer's drawing], because it's the simplest. The reconstruction also has a high value. However, it's hard to show on site what we know and what we don't, so the impression remains that 'THIS is what the castle was like'." – DE 103*

> *"A drawing is a reproduction of an idea, and can be adapted to new findings. Any physical reconstruction, whether a model or 1:1, pretends to be authentic to the original." – DE 28*

Metadata & Source Criticism

The intentionally leading question “what could make you change your mind” about the respondents’ chosen final reconstruction offered several options that corresponded to the codes consensus, authority, and metadata, but also allowed users to add their own response. The overwhelming majority of the “other” responses called for more metadata. However, this was often mediated through an authority who communicated the data, rather than through direct access to data. This is an interesting insight into the wants of users – someone they can trust giving a substantiated explanation, rather than users interpreting data themselves.

> *“A time-traveller who explains exactly how it looked back then.” – EN 43*
>
> *“A friend who is a history nerd picking something else based on the maps and drawings and explaining it.“ – EN 62*
>
> *“Both 3D model and drawing + explanation if they were created by a historian. In this list we don't know who created them – could be a games designer for all I know.“ – EN 71*

In general, users seemed to trust those in authority to have made the correct choices, even without being given metadata to corroborate those choices.

> *“The source is known, and therefore I trust it more than the anonymous scale model.” – EN 205*
>
> *“The reconstruction will have been preceded by all the drawings we have seen, and probably much more. And historians, archaeologists, people who knew what they were talking about. So while the drawings are fine, the physical reconstruction goes one step further and will be the most right. Otherwise, they would not have transferred their findings into stone and into reality!” – DE 37*

Others, however, worried about the availability, reliability and use of metadata, showing an awareness of the need for source criticism and documentation.

> *“My original degree was classical archaeology. It seems even harder to clarify later architecture because there are maybe too many sources?” – EN 148*

> *“I would view most of these options critically: does the historian have proper evidence to back their claim up? How well grounded is the explanation with the drawing? How natural is the style of the medieval painting? But if the arguments are backed up convincingly, then yes.” – EN 37*

> *“I like it, but they created something without a body of evidence that it’s the same as the original.” – DE 28*

Finally, the replies included a comment from a respondent who had clearly watched the TEDx talk linked to from the “more information” section of the survey website.

> *“I vaguely remember you complaining about this scale model before, though I don't recall the details.“ – EN 97*

Considering that the complaint in question was about the lack of metadata and paradata and the importance of including the reasoning for decisions in a reconstruction, the irony here perfectly encapsulates the issue that this study is designed to help solve.

Feedback

Respondents also left feedback about the design and usefulness of the questionnaire itself.

Some made it clear that the purpose of the questionnaire had not been explained well enough. While the description was kept deliberately vague to avoid bias, it was made clear that there were no “wrong” answers, and that it was not meant to crowd-source the “correct” answer. However, some users clearly did not understand this, and were bewildered as to the purpose behind it.

> *“This is so bizarre – I have no archaeological evidence to work from, and I am not an expert in French castles to make even a slightly educated guess. What are we gaining here?” – EN 191*

> *“This questionnaire is confusing. I don't understand how and why you are asking the opinion of a layman.” – EN 15*

> *“I did my best to make it useful for your research, but as I saw, I made a lot of mistakes.” – EN 259*

However, this experience was not common to all respondents.

> *“I very much enjoyed this. It was presented in a way that allowed me to feel that my ideas and opinions mattered even though I am not very learned in history or architecture.” – EN 202*

Others were frustrated by the inherent ambiguity and being forced to make choices – this was intentional, to demonstrate the impossibility of giving absolute answers, but left some users feeling unsatisfied with the process.

“You should allow for 'can't say' answers in the Likert scale items. I answered all of them seriously except the last two Likert scales. I picked a number that 'felt right' because I had nothing to go on.” – EN 98

“Nice questionnaire, but it ends with a cliffhanger. What do you think is the best representation based on your research?” – EN 235

On the other hand, several respondents, both professional and non-professional, explicitly stated that this questionnaire helped them understand reconstruction processes better, the stated aim of the exercise.

“I found it fascinating to be able to be able to comprehend a reconstruction by re-tracing it.” – DE 64

“It’s very interesting to think about what goes into recreating structures for which we have limited information.” – EN 105

“This really makes you examine your reasoning based on evolving evidence and review of facts.” – EN 138

[responding to the question “which of these could make you change your mind?] “The process of this questionnaire!” – EN 87

Several respondents also agreed on its general applicability and usefulness as a teaching tool for use with reconstructions.

“This is an excellent way to encourage people to think about old buildings and will make a visit to the site much more meaningful for them.” – EN 54

“Nice survey. Lots of fun to take. I wish other students of history would take this approach to surveys and research as it was both educational and challenging at the same time.” – EN 79

“Keep it up! Intriguing questions concerning authenticity and perception of reconstructions.” – DE 92

Professionals vs. non-professionals

Of the demographic information collected – age, education and professional background – the latter was the most interesting for the analysis, with age and education primarily being used to ensure diversity among the respondents.

The provided choices of relevant professions – architecture, history, cultural heritage and archaeology – were supplemented by those deemed relevant during the encoding process, and included professional costume reconstruction, civil engineering and stonemasonry, among others. Their common denominator was familiarity with skills such as reading maps and technical drawings, constructing buildings, or evaluating historical data. Both the responses from German and English-speaking professionals were combined for evaluation, as were those of non-professionals.

In some cases, the results hardly varied between groups, in others, there were significant differences. Some were to be expected: professionals were more likely to value metadata, more sceptical of choices made without them but more confident in their choices after they had viewed the sources provided, less likely to make unsubstantiated guesses and more likely to see the significance of context and historical artefacts or base their decisions on specific details. Unsurprisingly, they also relied on their previous knowledge more often and provided more specific sources or direct comparisons, being more familiar with the subject matter.

However, some differences were unexpected. Professionals were, on the whole, less likely to indicate that they had changed their minds, and were more likely to accept authority as a valid argument, though the latter may be due to their confidence in their colleagues' good research than in their lack of a need to see data for themselves. They were also significantly less likely to argue for what makes a good reconstruction by citing realism or authenticity.

While they were much less likely to use aesthetics as a basis for their reasoning, professionals were also significantly more likely to employ emotional arguments for what makes the "best" reconstruction– perhaps demonstrating their passion for the

subject matter at hand. Some also showed a willingness to ignore data, accuracy, or certainty in favour of subjective taste:

> *"If I was working on the building, [the Zimmer reconstruction] would be useful but I would rather put the Koenig drawing on my wall." – EN 190, an architect*

> *"I chose the physical reconstruction because I see it as more impressive, more tangible, more immersive even. To be honest, it might be the inner child speaking more than the historian (re the accuracy of the reconstruction), the emotional / impressionable side taking over the reasonable one." – EN 44, a historian*

> *"It's the prettiest. I know it's probably the least accurate, but 'best' to me means 'I like it the best'. – EN 204, a civil engineer*

> *"In my opinion, no reconstruction is 'the best', each is a product of its time and of particular desires and visions. Zimmer's drawing is presumably the most 'accurate' reconstruction drawing, but the works of Koenig and the model builders express an equally interesting, and therefore 'good' desire for idealised embellishment." – DE 100, a historian*

Quantitative Analysis

Encoding

To make it possible to perform a quantitative analysis on free-text answers, show general trends and correlations, and visibly represent changes in attitude, the responses were encoded with key words. To reduce the influence of the author's own bias, the first 10% of responses were encoded by multiple researchers, then compared and a final code set generated from their combined lists.

In total, this list comprises 36 codes in six categories:

- Knowledge – which type of information informs the user's decision
- Reasoning – how the user reaches a decision
- Decision – the type of decision made
- Argument – which type of argument they present for a decision
- Reflection – user demonstrates that they are thinking about the process
- Issues – any problems that arise during the survey

These each convey a different type of information for analysis, from whether the user was able to complete the survey without difficulty to which type of arguments they employ to whether they are thinking about the reconstruction process or the survey on a meta-level. "Frustration" was not counted among the issues but rather as a type of reflection, as it is a reaction to ambiguity or their own perceived lack of information or knowledge. Several respondents used emoji in their comments; these were encoded as "emotion".

The code "evolution" was later added to avoid mis-using the codes "time" and "change" when "change over time" was given as an argument, or to dilute "context" by using it for temporal context as well. The term "detail" was also challenging to apply consistently to refer to users arguing by referencing a specific detail, rather than when terms like "more detailed" was used, which falls under the code "medium". To ensure quality and consistency, all codes were double-checked on completion.

Full Code List

Knowledge	prior	References their own perceived prior knowledge
	source	Cites a specific example
	authority	Appeals to an expert or official
	consensus	Agreement of multiple indicators or sources
	emotion	Shows emotional response
Reasoning	context	Physical context, surroundings, geometry
	function	Fulfils a specific requirement, logistics, purpose
	inference	Attempt at logical deduction from own prior knowledge
	intuition	Feeling or guess with no reason given
	interpretation	Deduction from data provided
	artefact	Specifies historical thing that still exists
	comparison	Weighs relative merits of two possible solutions
	evolution	suggests change over time
Decision	rejection	Rejects one of author's theories or facts presented
	approval	Confirms theory offered
	sceptical	Questions theory offered
	confirmation	Repeats own previous answer, doubles down
	change	Changes mind about previous answer
	bias	Refuses to examine new data and repeats previous theory
Argument	detail	Specific artistic detail as indicator of accuracy
	time	Later or earlier time as indicator of accuracy
	aesthetics	Appearance, artistic interpretation, or cultural implications
	realism	Classified as realistic/not realistic or accurate/inaccurate
	personal	Reasons particular to the user (bias but not rejecting data)
	medium	How something is made or shown
	purpose	Specific intent by creator of a representation
	physicality	Material properties
Reflection	self-awareness	Identifies own personal bias or limitations
	contradiction	Contradicts own statements
	ambiguity	Points out or comments on ambiguity or lack of certainty
	metadata	Wants more, specific information
	frustration	Expresses annoyance or frustration with survey or self
Issues	non-answer	Response not a valid answer
	comprehension	Problems with understanding, something is unclear
	invalid	Responses not useable – remove this respondent
	technical	Technical issues experienced

Reasoning and Arguments

Which types of arguments respondents use to justify their choices, or the reasoning used to make them, is especially important for understanding how to communicate with users – which type of arguments are they especially receptive to, and how do those arguments map to the types of data available?

The first point of interest was whether respondents would agree with general consensus, defer to a perceived authority, or require knowledge of the metadata behind the information they were given – though of course, this type of survey only yields their own perceptions and not an objective analysis of whom they believe.

Besides the codes assigned to comments, this was also explicitly asked in one multiple-choice question:

Which of these could make you change your mind?	**Corresponding code**
Most people getting a different result.	consensus
A 3D model that looks very real.	authority
A historian writing something different in a book.	authority
A reconstruction in a museum that shows a different gate.	authority
A drawing that shows a different gate, with an explanation of why they drew it that way.	metadata
Seeing a medieval painting where the gate looks different.	metadata
An archaeological excavation that found remains of something different.	metadata
Other [free text]	[individual]

The second subset of codes to be investigated more closely is those corresponding to the degrees of certainty assigned to different parts of the reconstruction (unbeknownst to the respondents) in the virtual model. These degrees, from highest to lowest certainty, are

Relict – Interpolated – Extrapolated – Speculative

“Relict” covers elements for which evidence survives from the time of their creation. “Interpolated” refers to consulting several nearby data points, e.g., filling a gap in a wall along an existing foundation. Where this “interpolated” result is a line between two points, an “extrapolated” one is a vector, using a solid point of reference augmented with secondary and tertiary sources. “Speculative” results are obtained using only secondary and tertiary sources, e.g., comparing with similar sites or using engineering knowledge to estimate heights of walls. (de Kramer 2020)

They are associated with the following codes, denoting different types of reasoning commonly used by respondents to explain their choices.

Code	Certainty
artefact	relict
interpretation	interpolated
context	extrapolated
function	speculative
inference	speculative
intuition	guess (outside certainty chart)

Finally, the key to assessing respondents’ understanding of how reconstructions were made was to analyse which arguments they would use to choose the “best” out of four reconstructions. These had minimal metadata – a year, an author, and the author’s profession – and users were asked to give their impression of each and gauge its accuracy before choosing one, then explaining that choice.

Once the responses were encoded, the codes could be analysed to show general trends. As there were clear differences between the versions, they were investigated as a combined total, but also as professional[1] vs. non-professional. Some interesting differences between German and English speakers have also been noted, though the cause of these differences is unclear. 33.6% of German respondents and 19.7% of English respondents indicated that they worked in a relevant field, for a combined total of 23.6%, or 85 vs. 275 users.

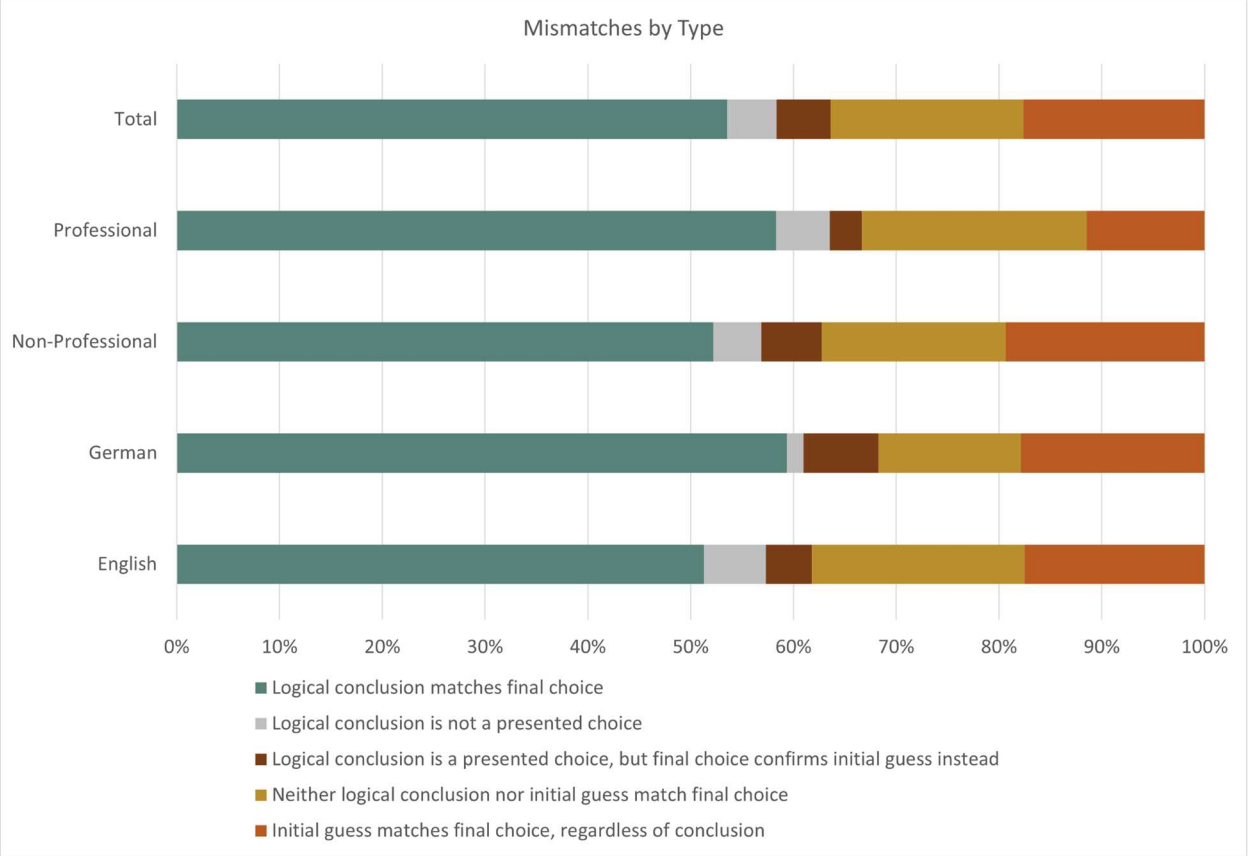
[1] Respondents who worked in architecture, history, cultural heritage, or archaeology were assumed to have a different understanding of the issues involved and be better at interpreting the visual sources.

Mistakes and Mismatches

The survey makes no claim to be unbiased, but instead subtly steers participants toward one “correct” solution, i.e. the conclusion its designer reached through analysis of the same data, which were then chosen to develop this viewpoint – after all, the purpose is guiding users through the process, not crowd-sourcing a solution. Examples of such consciously designed bias toward one solution include not even offering one possible solution pair as a choice (round or rectangular tower with gate on the left), requesting confirmation of the placement on the left with new, contradictory data, but not for placement on the right, and showing historical images with a tower on the right side of the bridge even after the user has chosen “left” for other steps.

Therefore, it is surprising that only a little over half of users chose the “correct” combination in the end. Furthermore, many respondents chose a final version of the gate that did not correspond to the sum of their choices, meaning they had either forgotten which decisions they had made or decided to ignore them in the final step. These decisions were further investigated to explore whether the respondents simply confirmed their original choice despite their data-driven decisions (showing bias) or had made an entirely new decision. 65% of users made a final choice that matched their decisions, 6.4% confirmed their initial choice, 5.8% had to choose something different because their logical conclusion did not match any of the versions offered, and 22.8% chose something that matched neither their initial guess nor was a logical result of the decisions they had made – which may mean that these users did not properly understand the task they were assigned.

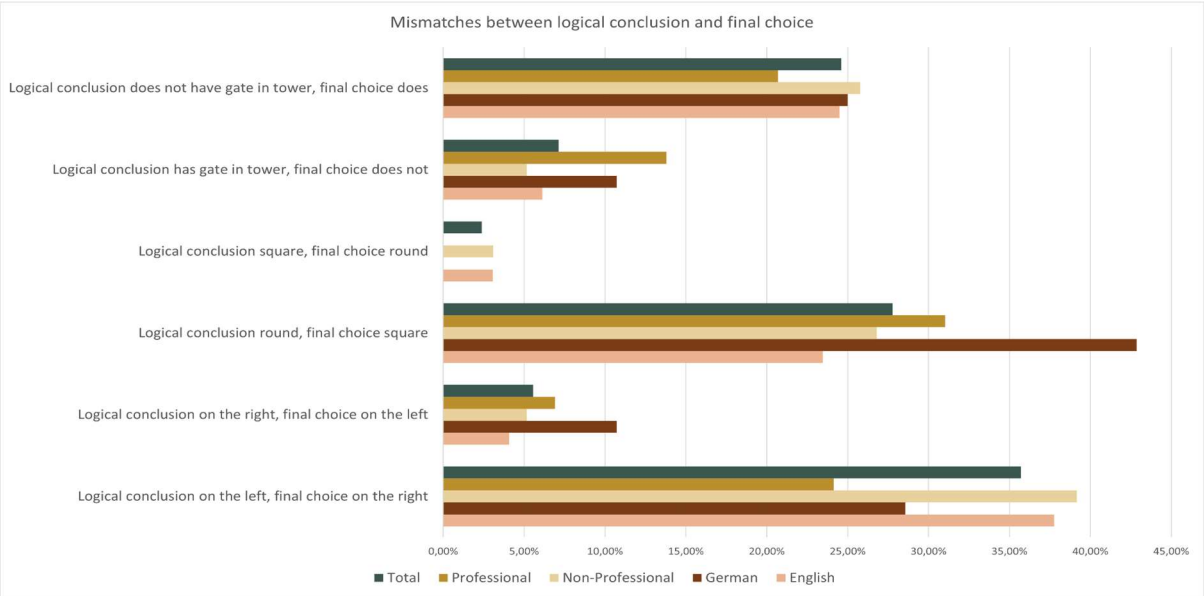
While the overall rate of mismatches varied little between professionals and non-professionals, it was significantly lower among German speakers (27.7%) than English speakers (37.8%). The reason for this difference is unclear – if it were caused by a poor translation, the higher error rate would be expected in the target language rather than the original English.



In just over 35% of cases, the issue was that left and right had been swapped – and in the vast majority of these, the “correct” final choice of the tower on the right was made, despite their conclusions that the tower was placed on the left, which suggests they were influenced by depictions in later choices.

This phenomenon was much more prevalent among non-professionals than professionals (39.2% vs 24.1%). Professionals were also more likely to make the “mistake” of choosing a rectangular tower when they had concluded it was round, at a rate of 31.0% of professionals vs. 26.8% of non-professionals.

For all groups, the third most common error at 24.6% was coming to the logical conclusion that the gate was not in the tower but the wall, then choosing a final option that had the gate in the tower. Notably, the error of choosing a round tower when their conclusions should have led them to a square one was the least common overall, and was not made by professionals.



There was little difference between non-professionals and professionals in making decisions not adding up to any of the variants offered, at 5.9% and 5.9% respectively. Non-professionals were 41% more likely to show bias than non-professionals (31.6% vs. 22.4%).

Among those whose final choice matched their initial guess (regardless of whether it matched their decisions), 40% had shown bias elsewhere – many more than the 6.4% who confirmed their guess despite their logical conclusions. This might mean that they made choices that confirmed their guess, consciously or subconsciously, then argued for them. Professionals had the lowest overall rate (18.2%) of confirming their initial theory in their final choice while also displaying at least one instance of bias – an expected result, due to their training. Interestingly, they did not exceed the total average when it came to making a final choice that was a logical conclusion of their decisions.

Bias, Metadata, and Self-Awareness

At the opposite end of the spectrum, 35% of respondents showed awareness of their own limitations or biases at least once, and 29.2% expressed that they wanted more metadata to make a decision. Interestingly, these two phenomena did not show a strong correlation, with only 13.9% of respondents displaying both.

Despite less than 1/3 of total respondents explicitly wanting more metadata, in answer to the question what would make them change their minds, 98% indicated that they would be convinced by metadata, with 42.8% saying they would believe an authority and only 5.6% being swayed by consensus.

However, among all 8834 codes analysed, the argument of “consensus” was used 56% more often than “authority” (253 vs. 162). 256 responses indicated prior knowledge[2], though only a further 55 cited specific sources. 163 codes showed emotional arguments, 338 were for personal reasons, and 136 instances of clear bias were recorded.

[2] Excluding those who indicated sources; “knowledge” is taken to mean their own perceived general knowledge of the matter.

Summary of All Responses

Across all responses, the most frequently encoded were realism (601 or 6.8%) and function (593 or 6.71%) followed by interpretation of data shown (540 or 6.11%). The arguments most consistently applied across all categories were (geometrical) context, scepticism at theories presented, inference from their (perceived) previous knowledge and intuition or guesses. A sceptical response to the theories presented was the most similar across all categories, making up 2.4% of total codes in all cases. The largest difference between the groups was found in their use of function as an argument, which accounted for 7% of non-professional, but only 5.8% of professional codes. Conversely, professionals (3.7%) were significantly more likely to argue using the purpose for which a reconstruction was made than non-professionals (2.5%). Professionals (3.1%) and non-professionals (3.1%) did not differ in their use of physicality as an argument, but professionals (2.0%) were somewhat more likely to cite artefacts than non-professionals (1.7%).

Analysis All Codes	Code	EN %	DE %	PRO%	NO %	Total %
Knowledge	prior	2,84%	3,04%	3,51%	2,70%	2,90%
	source	0,60%	0,68%	1,05%	0,48%	0,62%
	authority	1,78%	1,96%	2,60%	1,58%	1,83%
	consensus	3,32%	1,72%	2,33%	3,05%	2,86%
	emotion	2,16%	1,04%	1,78%	1,87%	1,85%
Reasoning	context	4,52%	4,67%	4,38%	4,63%	4,56%
	function	7,85%	3,84%	5,84%	7,01%	6,71%
	inference	4,69%	4,51%	4,84%	4,58%	4,64%
	intuition	4,82%	5,07%	3,93%	5,22%	4,89%
	interpretation	5,67%	7,23%	6,21%	6,09%	6,11%
	artefact	1,80%	1,72%	2,01%	1,70%	1,78%
	comparison	2,72%	3,28%	2,65%	2,95%	2,88%
	evolution	2,16%	2,28%	1,92%	2,29%	2,20%
Decision	rejection	2,37%	3,72%	2,92%	2,70%	2,75%
	approval	8,37%	5,03%	6,16%	7,85%	7,43%
	sceptical	2,40%	2,40%	2,60%	2,34%	2,40%
	confirmation	1,47%	0,84%	0,64%	1,51%	1,29%
	change	0,57%	0,68%	0,50%	0,63%	0,60%
	bias	1,78%	0,92%	1,10%	1,69%	1,54%
Type of argument	detail	2,51%	2,92%	3,24%	2,43%	2,63%
	time	1,47%	0,84%	1,37%	1,27%	1,29%
	aesthetics	4,71%	6,63%	4,88%	5,38%	5,25%
	realism	6,14%	8,47%	6,75%	6,83%	6,80%
	personal	3,79%	3,92%	4,20%	3,71%	3,83%
	medium	5,32%	7,19%	6,30%	5,71%	5,85%
	purpose	2,42%	3,72%	3,65%	2,50%	2,79%
	physicality	3,30%	2,56%	3,06%	3,11%	3,09%
Reflection	self-awareness	2,61%	1,68%	2,19%	2,40%	2,34%
	contradiction	0,00%	0,04%	0,05%	0,00%	0,01%
	ambiguity	2,15%	2,24%	2,92%	1,93%	2,17%
	metadata	1,63%	2,68%	2,74%	1,66%	1,92%
	frustration	0,38%	0,36%	0,55%	0,32%	0,37%
Issues	non-answer	0,79%	1,12%	0,50%	1,01%	0,88%
	comprehension	0,69%	0,60%	0,59%	0,69%	0,67%
	invalid	0,05%	0,16%	0,00%	0,02%	0,08%
	technical	0,14%	0,28%	0,05%	0,17%	0,18%

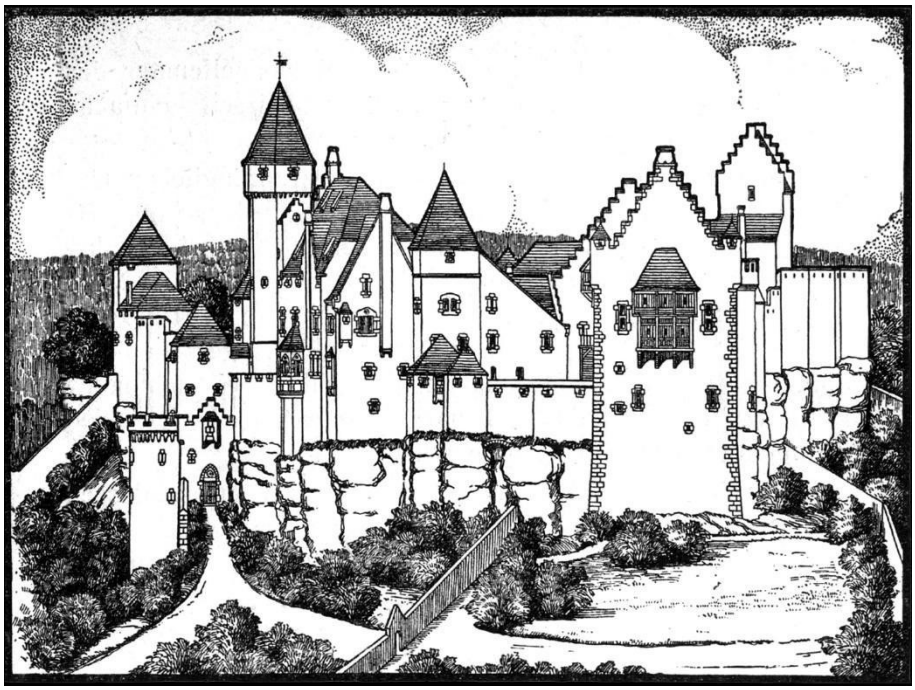
Independent Application

The second section of the survey was designed to analyse whether respondents were capable of independently applying the reconstruction process they had been guided through in the first section. They were provided with a total of six historical images with a view of one of the castle's buildings, which shows the traces of another element that had been attached to its façade. Some guidance was provided in the form of highlights on the images to help respondents see the part under discussion, and leading questions to establish that details varied in each view and there were a number of possibilities for the reconstruction. However, they were no longer given a binary choice, but could choose from among several pre-defined options or provide their own answers. They were tasked with deciding what, if anything, had been attached to the wall in question, and which material it was made from.

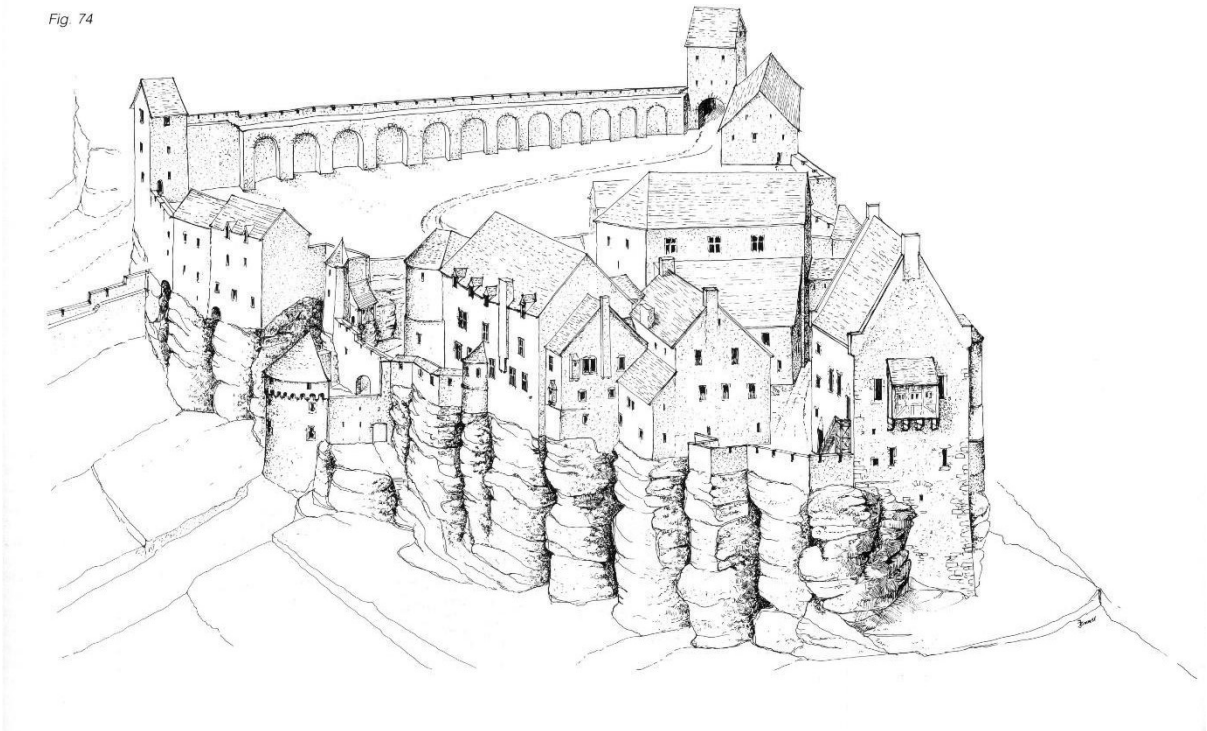
The main analysis was performed not on their choices, but on the reasons they gave for those choices. Only eight out of all 360 respondents declined to engage by giving non-answers. 40.8% of replies showed that users had made their decision based on an interpretation of the data provided, while 38.9% argued using the physical properties of the materials in question, 19.2% used functional arguments, 24.7% showed reasoning relying on change over time, and 15.6% mentioned the remaining ruins.

Since only 15% indicated that they were relying on previous knowledge and only 14.2% admitted that they guessed at the answer, these responses indicate significant engagement with the sources presented and a willingness to analyse and interpret them to arrive at an answer. Only one user expressed frustration and only three said they would need more metadata, showing that on the whole, they felt empowered to answer the question using the sources provided.

What is the “best” reconstruction?



1 – JP Koenig's reconstruction

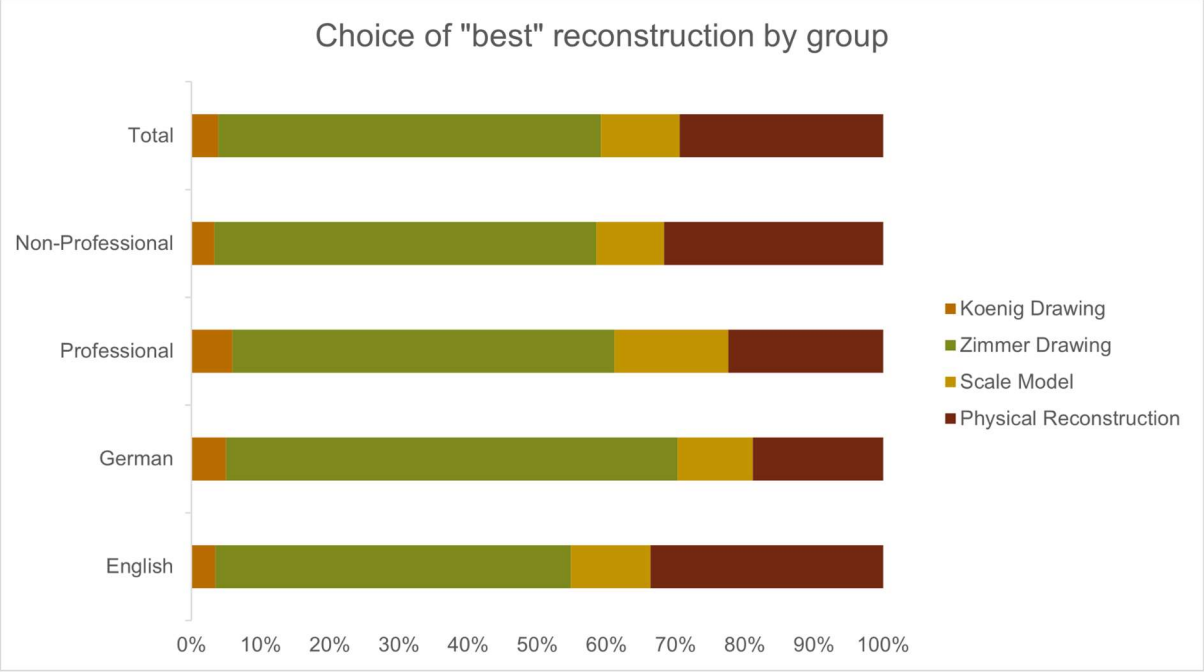


2 – John Zimmer's reconstruction

3 – The anonymous scale model

4- The physical reconstruction

The final set of questions in the analysis sought to determine how respondents applied the preceding guided reconstruction process to the analysis of four existing reconstructions. First, they were tasked with giving their first impressions and rating the perceived accuracy of each on a scale of 1-5, then asked to decide which reconstruction was “best”– a term left deliberately vague to see what respondents prioritised.



Across all groups, users clearly favoured John Zimmer’s illustration, which a combined total of 55.3% of users considered “best”. Second was the physical reconstruction at 29.4%, third the scale model at 11.4%, and the least favourite was JP Koenig’s reconstruction drawing at only 3.9%. This reconstruction has the least “scientific” aesthetic, drawn in a flat, illustrative style and embellished with fanciful details like stepped gables and numerous narrow spires. Close observers will also note that it fails to comply with the primary defensive function of a castle, as the hinges of the main gate are placed on the outside.

Therefore, it is astonishing that it was much more popular among professionals than non-professionals. While only 3.3% of non-professionals chose this representation, it was favoured by 5.9% of professional users, an increase of 69%.

While their enthusiasm for the Zimmer reconstruction corresponded to the total average, professionals were also much more sceptical of the physical reconstruction, which only 22.4% thought was “best”, as opposed to 31.6% of non-professionals.

For the analysis, the responses were encoded to compare the type of arguments used for which of the four reconstructions presented was the “best”. Percentages total over 100%, as multiple codes could be assigned to each response.

The analysis showed clear favourites in each category of responses. For knowledge, this was authority at 10.8% total. Surprisingly, professionals also favoured emotional arguments, at 10.6%, compared to 6.9% for non-professionals.

In the reasoning category, first place was tied between artefact and context, at 11.4% each, though German speakers also favoured intuition at 8.7%, while it only accounted for 2.7% of English responses.

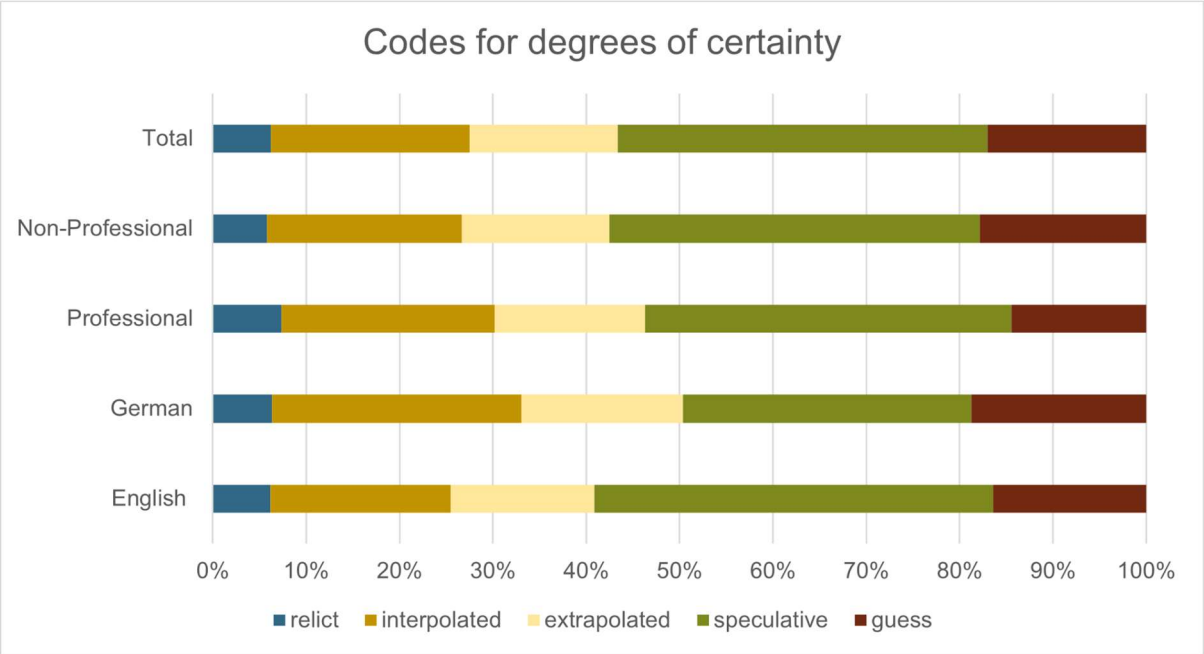
Decision codes were rare for this question, but leaned toward bias, at 2.32% of English and a surprising 0% of German responses. Argument types were the most common codes for this question, with 1.5 codes assigned per response on average. These clearly favoured medium – how something was made – with 41.7% of respondents using this type of argument followed by realism at 30.6% and purpose at 24.2%. All three were especially favoured by professionals. Surprisingly, the argument of time – how old the reconstruction is – only accounted for 1.9% of responses and was not used at all by German speakers.

In the reflection category, 5.6% of responses pointed out the inherent ambiguity, with professionals (8.24%) 75% more likely to do so than non-professionals (4.7%). Almost as many (5%) wanted more metadata or showed self-awareness (4.7%), meaning they showed that they considered what influenced their decision-making process.

Explanation for best	Code	EN %	DE %	PRO %	NO %	Total %
Knowledge	prior	3,09%	3,96%	2,35%	3,64%	3,33%
	source	0,00%	0,00%	0,00%	0,00%	0,00%
	authority	10,42%	11,88%	16,47%	9,09%	10,83%
	consensus	2,70%	0,00%	0,00%	2,55%	1,94%
	emotion	7,34%	8,91%	10,59%	6,91%	7,78%
Reasoning	context	13,13%	6,93%	18,82%	9,09%	11,39%
	function	1,93%	2,97%	2,35%	2,18%	2,22%
	inference	0,00%	0,00%	0,00%	0,00%	0,00%
	intuition	2,70%	8,91%	4,71%	4,36%	4,44%
	interpretation	1,16%	1,98%	2,35%	1,09%	1,39%
	artefact	11,97%	9,90%	9,41%	12,00%	11,39%
	comparison	6,56%	4,95%	8,24%	5,45%	6,11%
	evolution	2,70%	2,97%	3,53%	2,55%	2,78%
Decision	rejection	0,39%	0,99%	1,18%	0,36%	0,56%
	approval	1,93%	0,00%	1,18%	1,45%	1,39%
	sceptical	1,16%	0,99%	0,00%	1,45%	1,11%
	confirmation	0,39%	0,00%	0,00%	0,36%	0,28%
	change	0,00%	0,00%	0,00%	0,00%	0,00%
	bias	2,32%	0,00%	1,18%	1,82%	1,67%
Type of argument	detail	6,95%	4,95%	7,06%	6,18%	6,39%
	time	2,70%	0,00%	1,18%	2,18%	1,94%
	aesthetics	9,27%	8,91%	5,88%	10,18%	9,17%
	realism	28,96%	34,65%	28,24%	31,27%	30,56%
	personal	14,29%	25,74%	24,71%	15,27%	17,50%
	medium	39,00%	48,51%	50,59%	38,91%	41,67%
	purpose	18,53%	38,61%	28,24%	22,91%	24,17%
	physicality	19,69%	8,91%	14,12%	17,45%	16,67%
Reflection	self-awareness	5,79%	1,98%	3,53%	5,09%	4,72%
	contradiction	0,00%	0,00%	0,00%	0,00%	0,00%
	ambiguity	5,02%	6,93%	8,24%	4,73%	5,56%
	metadata	3,86%	7,92%	4,71%	5,09%	5,00%
	frustration	0,77%	0,99%	1,18%	0,73%	0,83%
Issues	non-answer	1,54%	3,96%	0,00%	2,91%	2,22%
	comprehension	0,00%	0,99%	0,00%	0,36%	0,28%
	invalid	0,00%	0,00%	0,00%	0,00%	0,00%
	technical	0,39%	0,99%	0,00%	0,73%	0,56%

Relict Interpolated Extrapolated Speculative

As described above, one goal of this study was to investigate the type of arguments respondents used in relation to the four categories of certainty: *relict* – *interpolated* – *extrapolated* – *speculative*, as this could indicate how receptive they might be to each type of argument or how salient those arguments seem to them. Percentages below are given out of the total of these six codes, not out of all codes assigned.



The most popular form of argument across all groups is clearly speculation – encoded as “function” or “inference”, this class covers deductions from the respondents’ own prior knowledge or understanding of the purpose, structure and logistics of a building. In part, this shows that users are attempting to fill in the obvious gaps in the sources with tertiary data; however, it could also indicate that they rely more on their own perception of history and architecture or urban planning than on the data itself.

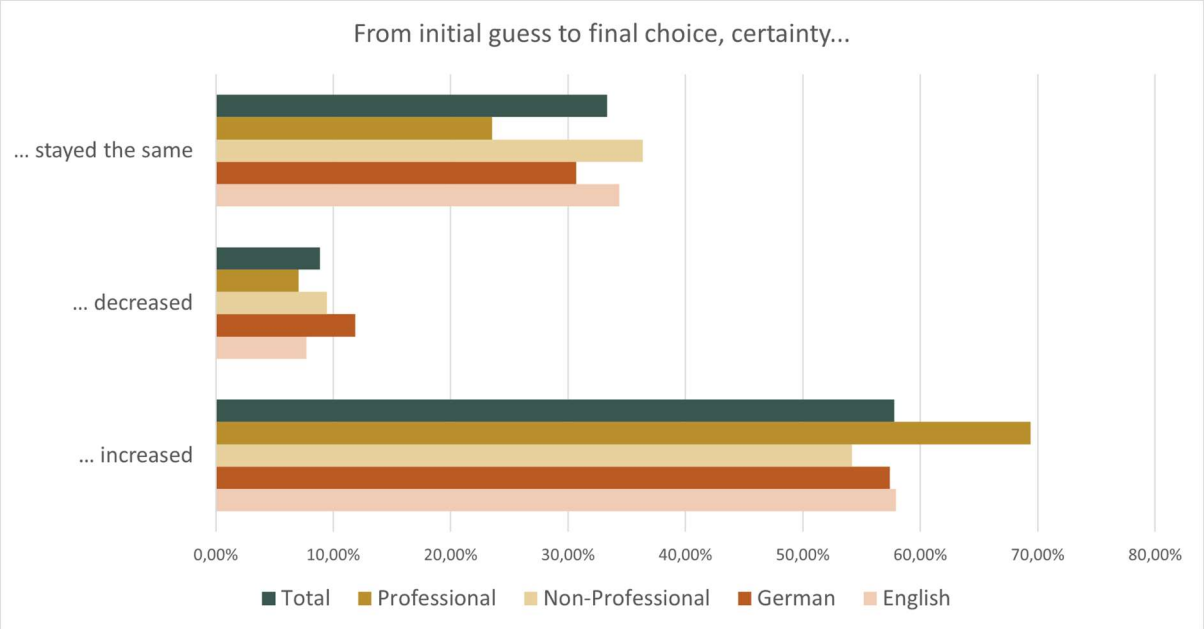
This is underlined by the fact that the second most frequent were not arguments using the spatial or geometric context to fill in gaps in the data (extrapolation) but interpretation of the sources themselves (interpolation) – which indicates that the data themselves were not so meagre that no more information could be gleaned

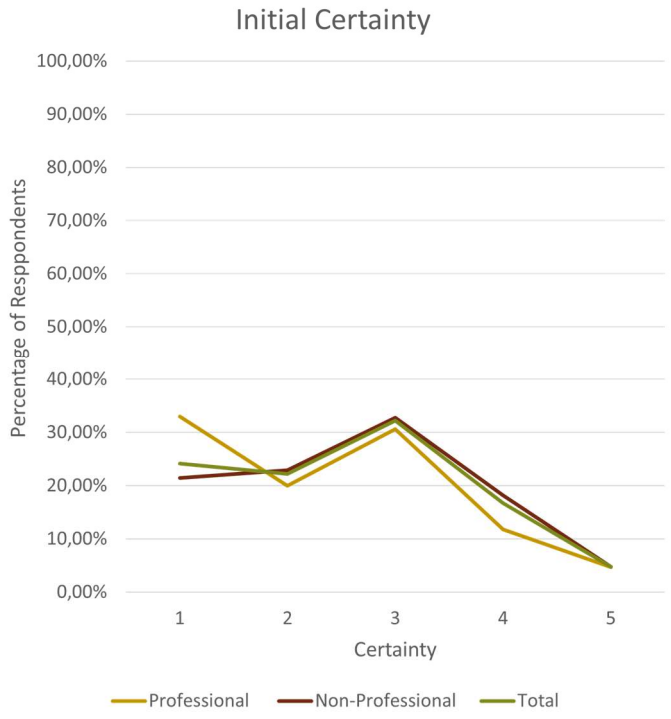
from them, but that users preferred to fall back on their own knowledge entirely rather than extrapolate from the data provided.

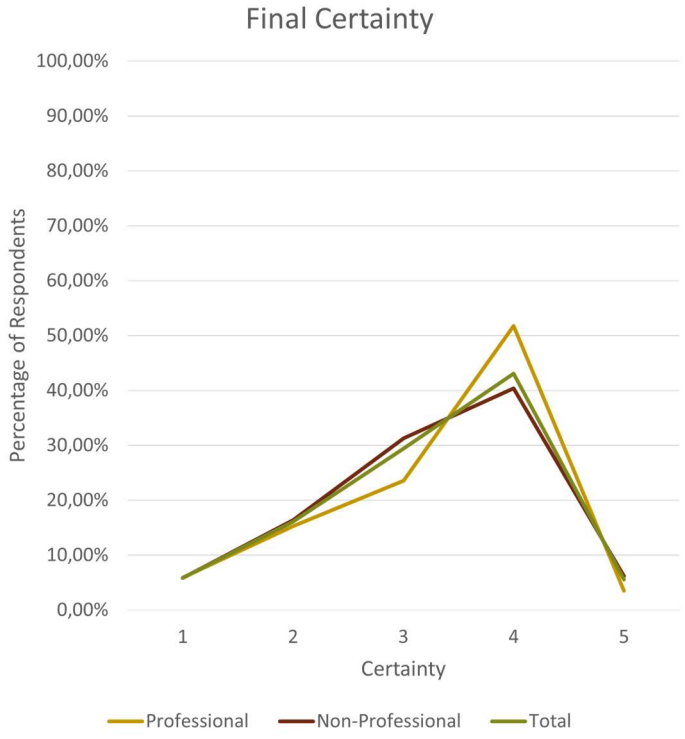
Arguments using relicts, or still remaining original elements, were the fewest but made up a large percentage of the arguments for the “best” reconstruction, showing that where such remains were provided as sources, they were well received.

Certainty and Accuracy

Finally, going through the questionnaire process had a clear effect on users’ certainty that they had made the correct choice in the end, with 57.8% showing an increase, 33.3% remaining the same and only 8.9% growing less certain. Interestingly, over 70% of users indicated that they thought their new choice was more accurate than their initial guess, and only 10% thought the accuracy had stayed the same or was less accurate – which could show that they don’t equate accuracy and certainty, that they didn’t remember which certainty they had chosen earlier, or that a five-point scale was not sufficiently nuanced for their degree of change.

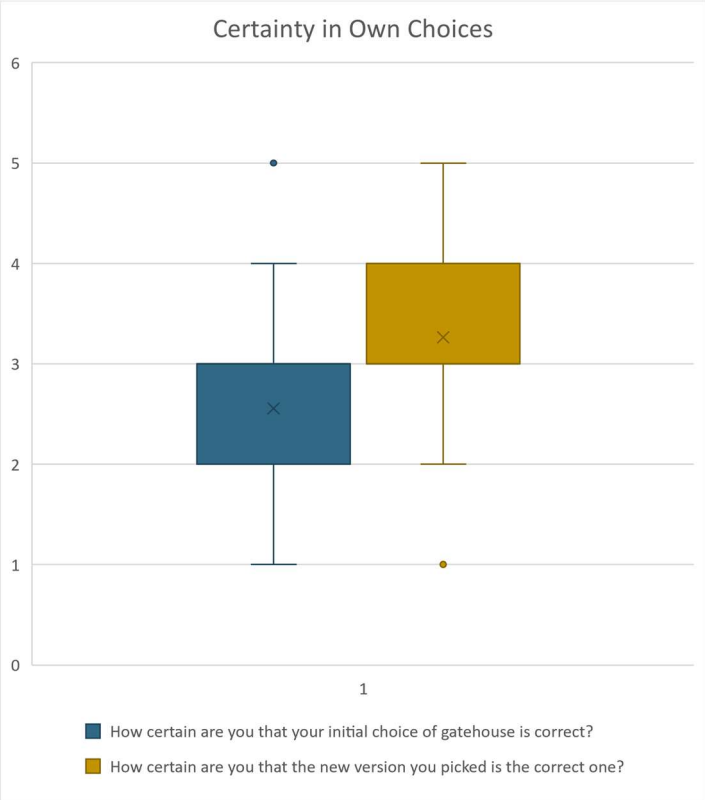






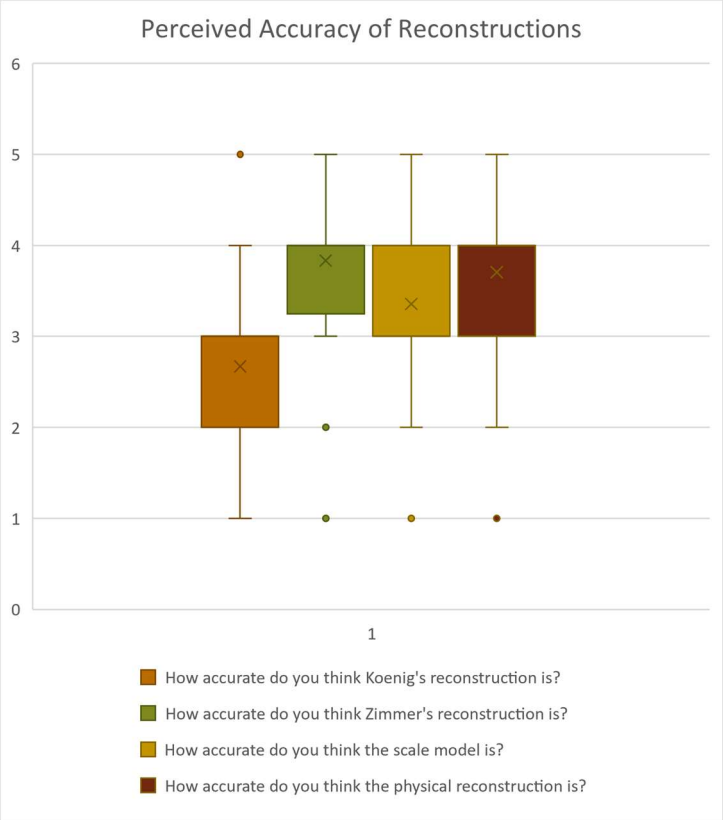
These changes are largely consistent across languages, though German speakers were 63% more likely to see a *decrease* in confidence. In general, confidence in their own choices rises by approximately 30%, with the biggest increase seen among professional respondents (41%) and the smallest among non-professional respondents (24%). This indicates that professionals are more aware of the importance of having metadata; their confidence starts out the lowest when they are just guessing, even though they have the best prerequisites for making a reasonable attempt, and rises to the highest after reviewing available data.

A corollary to the respondents' certainty that their own choices are correct is their perception of the accuracy of the reconstructions shown. In all cases, this perception is, on average, higher than their initial confidence in their own guesses. For all but the Koenig reconstruction, it also exceeds their own confidence in their final choice of reconstruction, showing that they trust a presumed authority more than their own choices. Respondents have a similar level of confidence in the Koenig reconstruction, which is less technical and

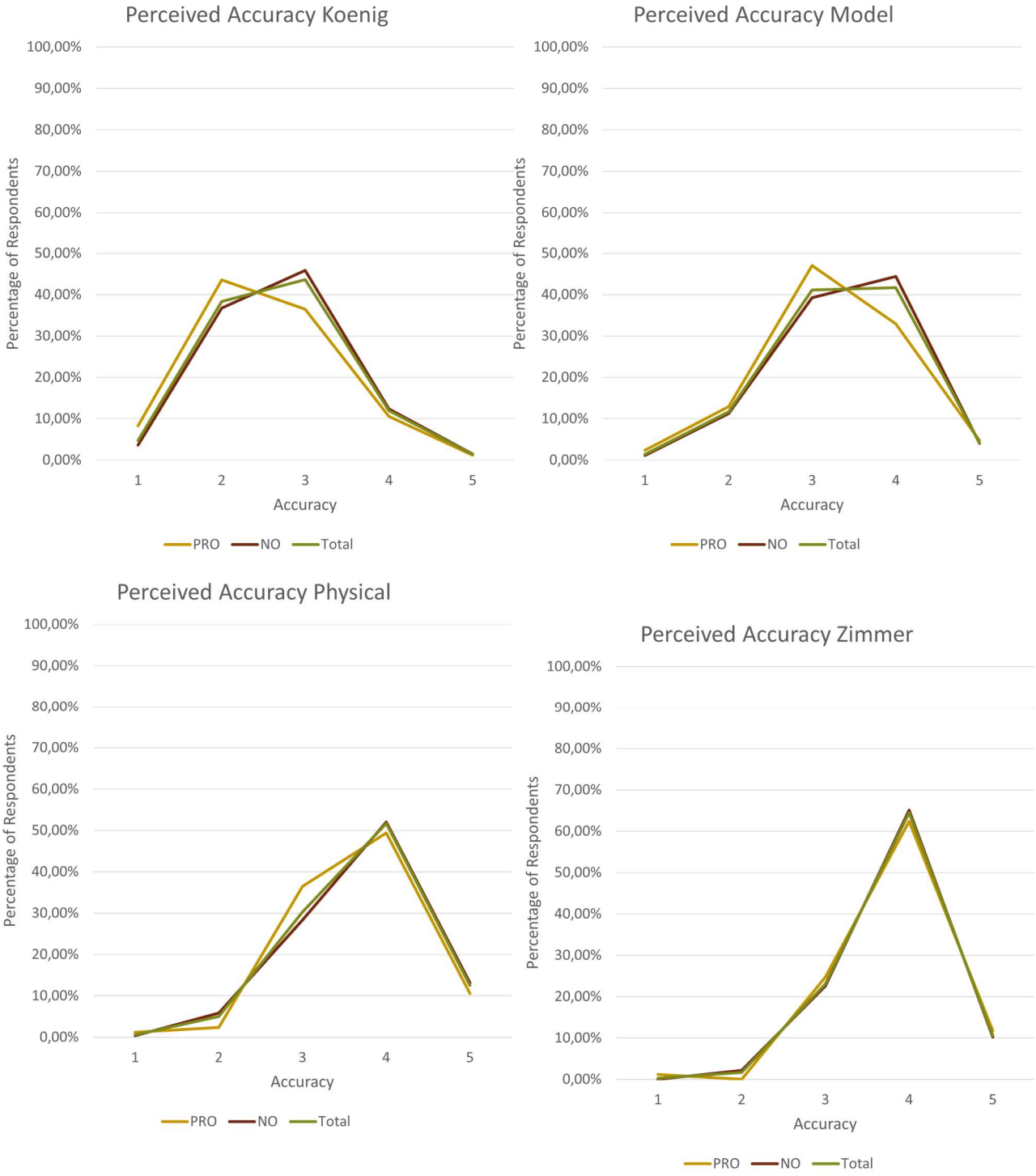


more artistic in its interpretation, as in their own initial guesses formed on the basis of very little data, perhaps implying that they believe his approach was intuitive rather than data-driven.

These perceived levels of accuracy also closely mirror the choices for which reconstruction is “best”, so many users may – consciously or not – have chosen accuracy as the deciding argument in favour of one over the other.

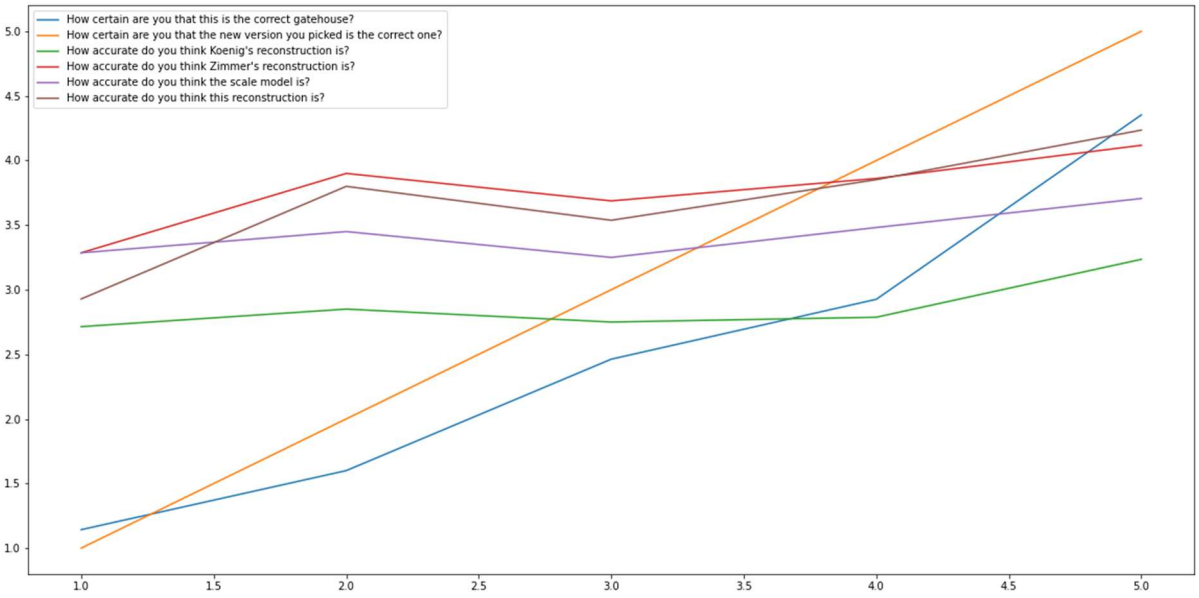


Of the four reconstructions provided, respondents had the highest confidence in John Zimmer’s illustration, averaging 3.8 on a scale of 1-5, closely followed by the physical reconstruction in situ at 3.7. The scale model of unknown origin reaches an average of 3.4, while JP Koenig’s drawing was the only reconstruction to average less than 3 at 2.7. These are similar across all groups.



To check for potential unconscious bias, the relationships between these confidence scores were also investigated, under the assumption that the values would show some correlation, i.e. that respondents might generally tend to favour higher or lower numbers. To visualise this relationship, all responses were grouped by their

confidence score for their final choice, then the other responses for those groups were averaged. This shows a correlation between the scores for their initial and final certainty, but only a very slight upward trend in the accuracy scores for the reconstructions, meaning that respondents generally made deliberate choices rather than just following a preference for high, low, or noncommittal scores.



At the opposite end of the “certainty” spectrum, users’ reaction to ambiguity was also investigated. This was consciously generated by showing conflicting sources and making decisions mandatory to progress in the survey. Of all users, 35% commented on this ambiguity at least once. How many noticed it otherwise or even left the survey unfinished because of their discomfort with it is, of course, not recorded.

Frustration with forced choices in the face of ambiguity could also correlate with the variations on “no comment” or other non-answers entered into required text fields. These fortunately only made up 0.9% of all codes, or 78 total replies. However, they were twice as likely for non-professionals (1% of codes) than for professionals (0.5%), likely because history and heritage professionals are more used to having to resolve conflicting data.

Languages

The two different versions of the survey, English and German, were prepared by the same author, a native speaker of both languages, to minimise the influence of language or tone on the results.

Both were released across various social media channels at the same time, but seem to have travelled by different routes – while the German version was recommended to incoming architecture students by their lecturers and shared among heritage professionals and their acquaintances, many participants in the English version were apparently recruited when it was shared by re-enactment groups. However, these differences in demographics may not be enough to explain some interesting incidental observations.

The most striking of these is that the two groups had very different trends in their mistakes and mismatches – English speakers tended to swap left and right, while German speakers swapped rectangular and round. Overall, German speakers showed a lower rate of bias (19.8% vs. 33.2% of users showing bias at least once), but German speakers had 65% more final choices that confirmed their initial guess rather than being the logical result of their decisions (8.91% vs. 5.41%). English speakers, on the other hand, were almost 4x more likely (7.3% vs. 2%) to make decisions not adding up to any of the variants offered.

Finally, while all German-speaking respondents answered that they had answered the questions seriously and they could be used for research, over 6% of English speakers felt the need to qualify this statement and explain more about their background or reasoning.

Other interesting differences were found in their use of consensus as an argument, which German speakers employed only half as often, and did not use at all to justify what is “best”. They also appealed to the ideas of realism or authenticity much more often, despite having a higher proportion of professionals, who use it less than average.

Discussion

As demonstrated above, one aspect highlighted by this study was the frequent lack of historical knowledge, or the prevalence of half-remembered facts mixed up with Fantasy. This was particularly noticeable in the answers to the question “what else could [the wooden oriel with a chimney and an internal window to the chapel] have been used for?”.

27% of respondents replied with some variation on “toilet” – which demonstrates a vague awareness of castle privies without understanding how they worked, considering the size, prominence, and location of the structure in question. Many other answers suggested that it was purpose-built for spying, lovers’ trysts, secret meetings, or hidden assassins or used as a fancy dungeon, all ideas that owe much to romanticised fantasy and little to actual life in a castle. (Sturtevant 2017)

This means that they are not starting as a blank slate, but rather, we are fighting misconceptions about history as much as providing a “correct” version. Presenting facts that oppose dearly held beliefs does not always convince people to change their minds; at worst, a “backfire effect” could be strengthening their bias and causing them to hold those beliefs even more strongly. (Lewandowsky et al, 2012) Therefore, users should be empowered and encouraged to “discover” those facts for themselves, making connections and being allowed to formulate their own theories within the framework provided, guiding them toward a more appropriate interpretation.

Conclusions

The results of this study show that providing users with bundled, non-specific historical texts of the type often found alongside an exhibit is not enough to fulfil the London Charter's call for allowing users to understand reconstructions. Instead, allowing them to go through the reconstruction process for themselves increases their confidence, and shows that they are aware of and interested in the data underlying such a reconstruction. For some, it was the first time even thinking about how such decisions are made; others, including built heritage professionals, were able to engage more deeply, but still found the exercise worthwhile.

The types of arguments they employ to justify their decisions, evaluate reconstructions, and explain what makes them "good" demonstrates that they prefer reasoning that gives them agency, from their own perspective concerning function and logistics than to examine the remaining ruins at the site and its surroundings – unfortunately, the latter are often the only data available to heritage site visitors.

While many respondents indicated that they were willing to listen to an established authority, the overwhelming majority preferred to be given metadata. Conversely, guide books tend to inform from a position of authority, presenting the "correct" solution rather than tracing the decision-making path that led to it being accepted as fact. (Noakes 2021) In order to increase understanding and engagement, these should be supplemented by further data.

While some users embraced the ambiguity of the "correctness" of their choices or the interpretations suggested by professionals, others were frustrated, requesting options to answer "I don't know" or pointing out that it was impossible to be sure. This discomfort is valuable, as it illustrates how a scientific theory works: it is the best possible interpretation of the known facts, but is subject to change in the face of new data. Making this explicit is rare in the humanities[3] – a missed opportunity to show

[3] In fact, an older meta-study suggests that the decline in quantitative methods in published journal articles in the field of history observed from the 1970s to the 1990s is due to their being treated hypercritically by reviewers, a trend the author expected to increase. (Reynolds 1998, p 146)

that historical knowledge creation happens through a similar process, and the results are not set in stone.

However, the survey also demonstrates that the average user requires guidance – overwhelming them with uncurated data would lead to more frustration and confusion, as it was often difficult for them to do so even with this carefully chosen, progressive selection.

The high rate of mismatches between logical sum of decisions and final choice shows that future surveys of this type require fine-tuning through an iterative design process that explores whether users could not remember their decisions, decided to ignore their conclusions in favour of an intuitive choice, or did not understand the task at hand.

This is an important data point in itself – it is more difficult for the average user to successfully complete this guided reconstruction process than initially assumed. Any such material used as part of a museum exhibit or educational programme must therefore be constructed so that any frustration experienced by the user is at the inherent ambiguity of making decisions using incomplete data – good, a learning experience – and not because of comprehension difficulties or technical issues.

Future Work

This study is an initial attempt at investigating the problem of how laypeople can be guided toward engaging meaningfully with a reconstruction and understanding its methodology, limits, and potential. Future work should focus on understanding where the barriers to understanding lie, in a larger team incorporating further disciplines. For example, users could be guided through a similar process under observation by psychologists, to determine whether the decisions they are self-reporting matches the actual arguments that can make them change their minds.

The introduction of a control group could also help determine the impact of guiding users through the process, with half completing an exercise related to demonstrating understanding of a 3D model and its data and metadata before being shown how the decision-making behind reconstructions works, the other half after.

Other stakeholders that should be involved include representatives of the site in question, curators or other experts who can identify the most significant or data-rich aspects for inclusion, (museum) educators to achieve the correct tone and scope, and finally, the researchers and graphic artists making the reconstructions, to tie the different aspects together and include recurring themes for users to discover.

Fully incorporating an exercise such as this into the visitor exhibition of a heritage site could be used to monitor engagement – how many visitors are interested – as well as increasing their understanding.

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No Need to Reinvent the Wheel – Retracing Older Reconstructions

The preceding study demonstrates that users understand and appreciate the data behind a reconstruction. They are generally interested in being provided with metadata and paradata to show how it came about but prefer them to be mediated by a subject matter expert, who curates and interprets the data for users while still allowing them access to the underlying information and their reasoning.

In this age of fake news, an increasing distrust of science and the rise of self-proclaimed experts, this is a positive finding – it shows that users do not in fact want unsubstantiated arguments from a position of authority, but understand the role that trained professionals play in providing them with accurate information.

The question, then, is how to reform the on-site interpretation, the guidebooks and tours to reflect this. This does not mean starting with a blank slate and entirely new research, though gaps may become apparent that can be filled in through further investigation. Instead, it means re-tracing the research to reproduce the underlying reasoning – reproducing the experiment that led to this theory and confirming the results is a basic part of the scientific method. We do not assume that the creators were wrong, or that they were correct, but simply see whether investigating the same data leads us to the same conclusions, and document the process. It also means embracing ambiguity – the realisation that there may not be a single correct answer – but delineating it from those theories that cannot be correct.

The following paper takes an existing reconstruction of the case study site and explores the existing research and information, supplementing it where possible through insights gained in the preceding investigations. This is then used to evaluate the reconstructions and explain how digital models based on them could be used to enrich them with levels of certainty, lines of reasoning, and links to the underlying data.

A major challenge in this approach is that the two earlier reconstructions – a series of architectural illustrations produced around 1900 and a text written in 1938[37] – rely heavily on the inherent authority of their creators, an architect and a historian respectively. Whether the drawings were once accompanied by reasoning is unknown; they are reproduced in a local history magazine without any metadata beyond the name of their creator. The text in the same volume, which is illustrated using some of these drawings, does mention some concrete details of the castle ruins it describes, but leaps to wildly wrong conclusions based on a false understanding of history. Both are heavily influenced by the fashion of their times[38] and by unreflected adoption of the 19th-century ideas that still haunt medievalism today, which arose amid romanticism and historicism.

The third reconstruction, by the architectural surveyor John Zimmer, was attempted in the 1980s, and is based on his detailed survey of the castle ruins prior to their restoration; his monograph on the castles of Luxembourg also includes a summary of the results of various archaeological excavations. In the foreword to his book, he explains how he wants to separate information and interpretation – an admirable goal –but this approach means that very few connections are made between the evidence he gathers and the theories he presents. Furthermore, this approach is diluted by his inclusion of interpretation of archaeological evidence in the descriptions of the buildings, before that evidence is ever shown; it is also not cross-referenced beyond the chapter number. This cries out for a digital format that allows hyperlinking and inclusion of the same object in different collections, or different forms of data linked to the same object.

Each reconstruction –- for a total of three building phases – is summarised in 100-150 words, as a description rather than an explanation. It is left to the reader to examine all the evidence and link it to parts of the reconstruction, where it is available; speculative elements are not distinguished from better-established ones, and “we know this from an

[37] Both in Victor Dasburg, ‘Die Schlossruinen von Fels’, *Les Cahiers Luxembourgeois- Revue Libre des Lettres des Sciences et des Arts – Freie Rundschau für Kunst und Wissenschaft*, 1938.

[38] Which is not to claim that I am, or the current generation is, free of bias, but we now have better tools to reflect on and counteract that bias in our approach. Future scholars may remark on how they were still sorely lacking.

unorthodox excavation of which no records whatsoever exist"[39] is defined as "proof" on an equal footing with "a specific coin from a specific place was found in a specific location, as recorded in this particular document".[40]

Some of the archaeological evidence, particularly the stratigraphy, is briefly described along with suggested interpretations; other data are included as exhaustive lists of all individual items found with no descriptions or meanings, better suited to an appendix.

This odd mixture of raw data and unreferenced interpretation shows that clearly, Zimmer's theories are based on research, but he struggles to communicate his methodology and to differentiate between conclusion and conjecture. The following paper seeks to address this issue by showing examples of how each of Zimmer's conclusions could be classified by accuracy, and seeks to close some gaps in the knowledge by combining archaeological evidence with clues from the contemporary documents and contracts that form the other primary source.

NOTE: due to copyright issues, some images could not be included in this paper – however, they can be found in the appendices to this thesis.

[39] John Zimmer, *Die Burgen Des Luxemburger Landes*, vol. Die archäologisch und bauhistorisch untersuchten Burgen von: Befort, Bourscheid, Fels Luxemburg und Vianden, 3 vols (Luxembourg: Saint-Paul, 1996). p 142

[40] Zimmer 1996, p 166

Journal Article: Zur Rekonstruktion der Burg Fels: von Relikt bis Spekulation

In the process of submission to *Hémecht* in German.

An English translation is available in the digital appendices.

Zur Rekonstruktion der Burg Fels: von Relikt bis Spekulation

Marleen de Kramer, IHIST/C²DH, Universität Luxemburg
marleen@dekramer.eu

I. Einleitung

Dieser Beitrag umfasst eine kurze Übersicht über die Geschichte der Burg Fels und die Quellenlage, und beschäftigt sich dann mit den Rekonstruktionsversuchen zur Bausubstanz und deren Nutzung. Dabei werden die Rekonstruktionen nach den Grundsätzen der *Londoner Charta für die computergestützte Visualisierung von kulturellem Erbe* evaluiert und exemplarisch nach Gewissheitsgrad kategorisiert.

Zur Burg Fels und ihrer Grundherrschaft

Die Luxemburger Burg Fels, im gleichnamigen Ort[1], wird 1176 erstmals urkundlich[2] erwähnt. Archäologische Ausgrabung zeigen, dass die mittelalterliche Burg auf die Mitte des 11. Jahrhunderts zurück geht und anscheinend auf einer keltischen Wallanlage steht. Wer die Burgengründung veranlasst hat, ist unbekannt, als erster Burgherr tritt Arnold aus der Familie von Ouren in Erscheinung, genannt Arnold (I). von Fels. Der Bauplatz als solches ist strategisch klug gewählt, da die Burg auf einem zu drei Seiten abfallenden Felssporn mit fast senkrechten Wänden 150 m über dem Tal thront, und nur über einen einzigen steilen Fußweg oder einen beträchtlichen Umweg[3] erreichbar ist. So reichte auch ursprünglich ein einziger Wall aus, um ein großes Areal

[1]Luxemburgisch „Fiels“, Französisch „Larochette“
[2]Bzw. Arnold von Fels wird als solcher erwähnt, als Zeuge für eine Urkunde – vgl Jens Friedhoff, „Die Ganerbschaft zu Fels (Larochette): ein Fallbeispiel gemeinschaftlichen Burgenbesitzes im Luxemburgischen“, in *Burgen und Befestigungen in der Eifel. Von der Antike bis ins 20. Jahrhundert*, 2013, S.127.
[3]Vom oberen Stadttor aus knapp 1,7 km.

zu sichern. Ein weiterer Standortvorteil ist dadurch gegeben, dass sie die Stelle überwacht[4], an der die einst schiffbare Weiße Ernz von der Handelsstraße zwischen Mersch und Echternach gekreuzt wird, und somit auch von Reisenden als Machtsymbol wahrgenommen werden kann. Außerdem konnte ein Brunnen angelegt werden, der Trinkwasser sammelte, das durch den Stein sickerte, also auch nicht durch das Eindämmen eines Bachs abgeschnitten werden konnte.

Anscheinend[5] gab es vor der Burg eine kleine Siedlung auf dem Elsbethplateau, benannt nach der St-Elisabeth-Kapelle, aber der eigentliche Ort Fels wuchs im Tal unter der Burg als kleiner, wohlhabender Marktflecken. Der Reichtum von Fels war nicht nur den Mühlen entlang der Ernz sondern auch der Tuchproduktion geschuldet, bei der sie durch einen Patentbrief Johanns des Blinden einen entscheidenden Vorteil hatte – am 25. März 1343 gab er die Erlaubnis, in Fels vier Webstühle aufzustellen, während anderen Ortschaften nur einer erlaubt war[6].

Das machte die Burg und die damit verbundenen Besitztümer und Grundherrschaftsrechte – inklusive eben jenen Ortes - zu einem begehrten Eigentum. Im Laufe des 14. Jahrhunderts wurden die Burg und ihre Liegenschaften durch Käufe, Verpfändung, Schenkungen und Erbschaften regelrecht zerstückelt. So entstand aus dem Sitz der Familie von Fels[7] eine Ganerbenburg[8], an der

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[4] Wenngleich die Burg keine optische Überwachung eines großen Gebiets erlaubt. Unsere GIS-gestützte topographische Analyse ergab, dass der von den Türmen der Burg aus am weitesten entfernte sichtbare Punkt weniger als 5 km entfernt ist, und auf einer bewaldeten Höhe liegt. Die weitesten von Menschen geschaffenen Strukturen sind nur 2,5 km entfernt. Sie dazu: Marleen de Kramer, Sam Mersch, und Christopher Morse. Reconstructing the Historic Landscape of Larochette, Luxembourg. Springer International Publishing, 2018. https://doi.org/10.1007/978-3-030-01765-1_4. S.4

[5] Erste archäologische Ausgrabungen deuten darauf hin, aber die Siedlung ist noch nicht eindeutig gesichert.

[6] Victor Dasburg, „Kurzer Abriss der Geschichte der Herrschaft ‚von der Veltz'", *Les Cahiers Luxembourgeois- Revue Libre des Lettres des Sciences et des Arts - Freie Rundschau für Kunst und Wissenschaft*, 1938. S. 111.

[7] Auf die Stammbäume der Familien soll hier nicht näher eingegangen werden, da es sich um eine architekturhistorische Untersuchung handelt. Diese wurden aber schon mehrfach gründlich aufgearbeitet. Siehe dazu die *Les Cahiers Luxembourgeois- Revue Libre des Lettres des Sciences et des Arts - Freie Rundschau für Kunst und Wissenschaft*, 1938, insbesondere Victor Dasburg, „Kurzer Abriss der Geschichte der Herrschaft ‚von der Veltz'", Paul Schroell „Le Château-Fort et les Seigneurs de Larochette" und die „Notes Biographiques" und Jens Friedhoff, „Die Ganerbschaft zu Fels (Larochette): ein Fallbeispiel gemeinschaftlichen Burgenbesitzes im Luxemburgischen", in *Burgen und Befestigungen in der Eifel. Von der Antike bis ins 20. Jahrhundert*, 2013, 124–37. und John Zimmer, *Die Burgen des Luxemburger Landes*, Bd. Die archäologisch und bauhistorisch untersuchten Burgen von: Befort, Bourscheid, Fels Luxemburg und Vianden, 3 Bde. (Luxembourg: Saint-Paul, 1996). S. 157 ff .

[8] Horst Wolfgang Böhme u.a., „Wörterbuch der Burgen, Schlösser und Festungen", 2020, https://doi.org/10.11588/ARTHISTORICUM.535.

mehrere „Gemeiner“, also Miteigentümer, unterschiedlich große Anteile hatten[9]. Damit verbunden war stets ein Wohnrecht auf der Burg, so besaß Burg Fels in ihrer letzten Bauphase insgesamt 5 Wohnhäuser, von denen mindestens eines sogar zwei herrschaftliche Geschosse für zwei Familien hatte. Der Großteil dieser Gemeinern hatte auch Anteile an anderen Burgen[10] und Häuser in der Stadt[11], lebte also nicht ständig auf der Burg Fels. So wurde im Burgfrieden auch das Recht des „Enthalts“ verbrieft[12], gegen Entgelt Dritte in seinem Anteil der Burg zu beherbergen, eine Art käufliches, vorübergehendes Öffnungsrecht.

Im Zuge einer Streitschlichtung 1384 wurde den Gemeinern aufgetragen, einen Burgfrieden aufzusetzen, einen Vertrag, der die Rechte und Pflichten der Ganerben festhielt. Dieser wurde mehrfach erweitert, wenn es neue Beschlüsse oder beigelegten Streit gab. Da er auch immer von allen Gemeinern unterzeichnet wurde, kann man anhand der Namen verfolgen, welche Familien und wie viele von ihnen Anteile an der Burg besaßen – waren es beim ersten Burgfrieden 1384 nur vier Unterzeichner, war die Liste der Ganerben bis 1429 schon auf 13 Personen angewachsen[13].

Obwohl der Ort heute eher klein ist, waren Fels und seine Grundherren einst bedeutend. Arnold I. von der Fels erhielt schon 1182 das erbliche Amt des Bannerherrn, eine hohe Würde, die ihn und seine Nachfolger eng an den Grafen von Luxemburg band.[14] Die Bedeutung der Familie von der

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[9] Zu dieser Entwicklung allgemein, siehe auch Michel Margue, ...„...Eynen rechten, festen und steden Burchfryden zu halden uff unser Burch. Burgfrieden als Quellen für das Zusammenleben auf der mittelalterlichen Burg“, 2009, https://orbilu.uni.lu/handle/10993/2214. Sowie Rapp, Francois. „Zur Geschichte der Burgen im Elsaß mit besonderer Berücksichtigung der Ganerbschaften und der Burgfrieden“. In: Die Burgen im deutschen Sprachraum. Ihre rechts- und verfassungsgeschichtliche Bedeutung., herausgegeben von Hans Patzke, 2:229–48. Sigmaringen: Thorbecke, 1974. S 243 ff.

[10] Vgl. hierzu Dasburg 1938, S. 101 ff, eine Übersicht über urkundliche Erwähnungen der Burgherren und deren weiteren Besitztümer.

[11] Laut Dasburg (1938, S. 101) hatte bereits Arnold I. Häuser in Trier zum Lehen, Zimmer (1996, S. 158.) gibt an, dass Johann III. bekanntermaßen in Trier residierte.

[12] Diese Klausel taucht bereits im ersten Burgfrieden vom 12. Juli 1384 auf (bei Martine Scheiwen, *Actes des seigneurs de Fels dans le fonds de Reinach (1318-1384)*. Présentation et édition, mémoire de Master 1 inédit, Université Paul Verlaine-Metz, 2006), und wird auch in den folgenden Ergänzungen immer wieder aufgeführt, mit sich verändernden Preisen (siehe Abschriften in Mathias Hardt, „Burgfrieden von Uren und Fels - ein diplomatischer Beitrag zur Untersuchung luxemburgischer Urkunden“ Publications de la Section historique de l’Institute grand-ducal de Luxembourg“, in *Publications de la Société pour la Recherche et la Conservation des Monuments Historiques dans le Grand-Duché de Luxembourg*, Bd. Année 1849 V, Luxembourg, 1850.)

[13] Friedhoff 2013, S. 129 f

[14] Nicolas Ries, „Puissance et Privilèges des Seigneurs de Fels“, *Les Cahiers Luxembourgeois- Revue Libre des Lettres des Sciences et des Arts - Freie Rundschau für Kunst und Wissenschaft*, 1938.

Fels wurde noch einmal unterstrichen, als gleich zwei Vertreter der Familie 1398 dem Bündnis Wenzeslaus II. beitraten, und ihre Stadt Fels bzw. „Veltz“ wird in dem dazugehörigen Brief ausdrücklich erwähnt.[15]

Seinen Freiheitsbrief[16] erhielt die Gemeinde Fels am 28. Juli 1348 von Johann II. von Fels, und die damit verbrieften Rechte der Bürger wurden auch von seinen Nachfolgern in den Burgfrieden noch einmal bestätigt. Dies bedeutete, dass an die Bürger keine neuen Forderungen gestellt werden konnten – keine neuen Steuern, Abgaben, oder Dienste. Da die zu leistenden Abgaben aber zumeist in absoluten Zahlen und nicht als Anteil angegeben werden, führte dies dazu, dass nach und nach die Grundherrschaft an Wert verlor., Da nicht alle zur Burg gehörenden Dörfer[17] zur Freiheit gehörten, blieben einige Erträge zum Beispiel durch Bannmühlen hiervon unbeeinträchtigt[18].

Circa 1565 wurde die Burganlage weitgehend von einer Feuersbrunst zerstört[19]. Zumindest einer der Erben wollte die Burg wieder aufbauen, hat laut den Erkenntnissen aus den archäologischen Ausgrabungen[20] sogar damit angefangen, aber die restlichen Gemeiner wollten dafür weder das Geld aufbringen noch ihren Anteil verkaufen – weil damit auch die mit der Burg verbundenen Rechte und Einkommen erloschen wären. So endete die Burg schließlich als Steinbruch für Neubauten im Ort[21], wurde vom Wald überwuchert, und wurde erst 1979 ausgegraben, untersucht und gesichert, als sie vom luxemburgischen Staat gekauft wurde.

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[15] Dasburg 1938, S. 132

[16] Vgl. Nicolas Ries, „L’Affranchissement de Larochette“, *Les Cahiers Luxembourgeois- Revue Libre des Lettres des Sciences et des Arts - Freie Rundschau für Kunst und Wissenschaft*, 1938.

[17] Eine ausführliche Beschreibung von Dörfern und Höfen, die 1614 zur Herrschaft gehören gibt es im „Ausganck, umbrit und beleidt“, nachzulesen bei Nicolas Majerus, *Die Luxemburger Gemeinden nach den Weistümern, Lehenerklärungen und Prozessen*, Bd. 4, 7 Bde. (Luxembourg: Imprimerie St Paul, 1957)., S. 58 ff.

[18] Vgl. Dasburg 1938, S. 138

[19] Dokumentiert ist dies in einem Schriftstück von 1568, das ein Feuer „vor wenigen Jahren“ beschreibt. Siehe Jean Vedruns, „L’Incindie Désastreux, vers 1565, du Château de Larochette“, *Les Cahiers Luxembourgeois- Revue Libre des Lettres des Sciences et des Arts - Freie Rundschau für Kunst und Wissenschaft*, 1938. S. 85.

[20] Zimmer 1996, S. 156

[21] Vgl. Zimmer 1996, S. 159 und die in der Inventarisierung der Baukultur erwähnten Spolien in einigen Häusern im Ort, Wiepke van Aaken, Stéphanie Toussaint, und Christina Mayer, „Nationale Inventarisierung der Baukultur im Großherzogtum Luxemburg - Kanton Mersch, Gemeinde Larochette“ (Luxembourg: Service des sites et monuments nationaux Luxembourg, 25. September 2017), S. 105 und S. 161

Quellenlage

Zu den wichtigsten Quellen zur Baugeschichte der Burg zählt die Burgruine selbst[22], von der noch große Teile erhalten sind und die teilweise archäologisch untersucht wurde.[23] Zeitgenössische Dokumente wie Gerichtsurteile, Verträge und der über die Jahrzehnte immer wieder ergänzte Burgfrieden der Ganerben, aus dem zumindest teilweise hervorgeht, wie die Burg genutzt und erweitert wurde, sind leider nur noch aus Editionen des 19. und 20. Jahrhunderts zu erschließen.[24].

Leider gibt es keine bekannte zeitgenössische Bildquelle. Die früheste bekannte Abbildung ist der Ferraris-Atlas, für den die Ruine zwischen 1771 und 1778 aufgenommen wurde; auch auf dem Urkataster von 1824[25] ist sie deutlich zu sehen. Im Zuge der Burgenromantik[26] wird die Ruine im 19. und frühen 20. Jahrhundert regelmäßig abgebildet, oft stilisiert oder mit hinzugedichteten Elementen[27]. Dennoch kann man durch vergleichende Betrachtung Rückschlüsse auf den Erhalt der Burg zu dieser Zeit ziehen.

Eine der frühsten detaillierten schriftlichen Beschreibungen von Fels findet sich in Heinrich Adolphe Reulands Reiseführer „Das romantische Ernztal oder Fels und seine Umgegend“, veröffentlicht in Luxemburg 1880 – das Buch enthält unter anderem Beschreibungen der Stadtmauer vor dem Abriss für die Stadterweiterung und die Nutzung der Vorburg als Bleiche für die Tuchhersteller im 19. Jahrhundert. Leider war es für diese Arbeit nicht verfügbar.

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[22] Montée du Château, L-7622 Larochette, Luxemburg https://www.chateaularochette.lu/

[23] Zu finden bei Zimmer 1996, S. 160 ff

[24] Diese liegen leider nur in Sekundarquellen vor: die Burgfrieden von 1399-1464 bei Mathias Hardt, „Burgfrieden von Uren und Fels - ein diplomatischer Beitrag zur Untersuchung luxemburgischer Urkunden’ Publications de la Section historique de l’Institute grand-ducal de Luxembourg“, in *Publications de la Société pour la Recherche et la Conservation des Monuments Historiques dans le Grand-Duché de Luxembourg*, Bd. Année 1849 V (Luxembourg, 1850). Die Schiedsvereinbarung von 1381 und der erste Burgfrieden von 1384 bei bei Martine Scheiwen, Actes des seigneurs de Fels dans le fonds de Reinach (1318-1384). Présentation et édition, mémoire de Master 1 inédit, Université Paul Verlaine-Metz, 2006. Der Freiheitsbrief bei Dasburg 1938. S. 112 f, dort auch eine Übersicht der sonstigen die Familie von der Veltz betreffenden Urkunden.

[25] Abgebildet bei Van Aaken et al, S. 10

[26] Siehe z.B. Asker Pelgrom, *Gemalt für den König - B. C. Koekkoek und die luxemburgische Landschaft* (Publications du Musée national d’histoire et d’art Luxembourg, 2012). S. 97

[27] Man vergleiche zum Beispiel die Unterschiede zwischen den Skizzen vor Ort und den fertigen Gemälden bei Koekkoek, ebenda

Forschungsliteratur

Die umfassendste bauhistorische Literatur zur Burg sind die Werke des Luxemburger Vermessungstechnikers John Zimmer. Ausführlich behandelt wird Burg Fels im 3. Band der Reihe „Die Burgen des Luxemburger Landes“ sowie „Die Burg Fels: Ihre Baugeschichte“. John Zimmer (1942-2021) hat ab 1980 für den Service des Sites et Monuments Nationaux detaillierte Bestandsaufnahmen der Burgruinen des Landes erstellt. Die daraus entstandenen Aufrisse, eine Zusammenfassung der archäologischen Grabungen, aber auch Vorschläge zur Rekonstruktion der Burgen inklusive einzelner Gebäudeteile und eine Theorie zur historischen Entwicklung des gesamten Ensembles findet man in seinen Monografien. Leider sind diese Theorien nicht immer nachvollziehbar, in dem Sinne, dass es unklar ist, auf welchen Erkenntnissen sie beruhen – und somit auch nicht, was daran Spekulation ist und was gesichert ist.

Auch die „Cahiers Luxembourgeois“, welche im Jahr 1938 Fels und seiner Burg zwei Bände widmeten[28], sind mit Vorsicht zu genießen. Zwar tragen sie viel gebündeltes Wissen der Lokalhistoriker zusammen, enthalten aber in den allerwenigsten Fällen Quellenhinweise, sondern stützen sich auf die Autorität der Verfasser der Beiträge. Deshalb müssen auch die darin vorgestellten Theorien sorgfältig überprüft werden, wenn sie als gesichert gelten sollen.

Ergänzt werden diese durch die in diesem Beitrag zitierten Werke zur allgemeinen Forschung zum mitteleuropäischen Burgenbau und zur Geschichte der Ganerben-Familien und der Gemeinde, durch Toponyme, Gesteinsanalysen und weiteren Kontext.

[28] *Les Cahiers Luxembourgeois - Revue Libre des Lettres des Sciences et des Arts - Freie Rundschau für Kunst und Wissenschaft*, Luxemburg, 1938. Redakteur: Paul Schroell

II. Quellenauswertungen

Burgfrieden und andere zeitgenössische Dokumente

Über die Gestaltung der Burg selbst gibt es keine bekannten Dokumente, wohl aber solche, die indirekt Einblicke in die Baugeschichte geben. Neben den Burgfrieden sind dies Pfändungen, Schenkungen, Gerichtsurteile, und Erbverträge, welche die Gemeiner betreffen, aber auch zum Beispiel die Freiheitsurkunde für die Stadt oder Bündnisse mit anderen Adeligen[29].

Im Wesentlichen lässt sich dadurch folgende Entwicklung nachvollziehen: Die Familie von Fels war im 12. Jahrhundert noch der alleinige Eigentümer der Burg. Bis 1359 kamen durch eine Erbschaft die Familie der Homburger hinzu, weil Johann II. von Fels kinderlos verstarb und seine beiden Schwestern und Erbinnen, mit zwei Brüdern derer von Homburg verheiratet waren[30]. Das gemeinsame Leben auf der Burg führte zu einem Streit, der 1381 geschlichtet wurde. Im Kern war die gemeinsame Nutzung des Brunnens und die Tatsache, dass die Homburger einen Durchbruch in der Ringmauer geschaffen hatten, strittig. Letzteres geschah, um einen direkten Zugang zum eigenen Haus zu schaffen, war jedoch verteidigungstechnisch äußerst ungünstig. Dieser Durchgang musste wieder geschlossen werden. Jeder Partei wurde der Bauplatz zugesprochen, den sie bereits besaß, auf der sie in die Höhe jedoch bauen durften, soweit sie wollten.[31]

Im Laufe der Jahre kamen noch weitere Familien hinzu – bei der Unterzeichnung des ersten Burgfriedens 1384 waren es schon vier Parteien – denen innerhalb der knappen Fläche der Hauptburg weitere Bauplätze zugesprochen wurden; so wurde auch der Brunnen überbaut (musste aber für Alle zugänglich bleiben). Um ein Mindestmaß an Wehrhaftigkeit zu erhalten, wurde festgelegt, wie viele Wachen und Pförtner es geben sollte und welche Bereiche – Brunnen, Tor, Ringmauer, Wachturm – gemeinsam unterhalten werden sollten, später[32] dann auch Pförtner für

[29] Dasburg 1938, S. 132
[30] Dasburg 1938, S. 114
[31] „Sonbriff von Wentzeslas dern von der Velsz deß mißels der herrschaft Velsz“, 28. Juni 1381, wie 17
[32] Burgfrieden von 1412, bei Hardt 1850, S. 23

die Stadttore angewiesen werden[33]. Nachdem immer seltener einer der Gemeiner auf der Burg anzutreffen war, kam neben dem Amt des Baumeisters (das jährlich zwischen den Gemeinern wechselte) noch das Amt des Burggrafen hinzu, eines professionellen Burgen-Managers der von den Gemeinern gemeinsam bezahlt wurde und die eigentliche alltägliche Führung der Burg übernahm.[34]

Jeder der Burgfrieden beschäftigt sich mit der inneren Sicherheit der Gemeinschaft[35]; man war stark darauf bedacht, weder einen Gegner in die Burg mit aufzunehmen noch das Machtgefüge innerhalb zu stören, indem ein hochrangiger Adeliger dazu kam. Erbschaften, Verkäufe und Schenkungen mussten also von der Gemeinschaft abgesegnet werden, was nicht immer geschah: Beispielsweise wurde 1454 Gerhard von Rodemachern als neuer Gemeiner abgelehnt – der Hauptgrund dafür war wohl, dass er den Herzögen von Burgund gegenüber feindlich eingestellt war[36]. Für den „Enthalt", die zeitweilige, kostenpflichtige Nutzung der Burg durch Dritte, haftete der jeweilige Gastgeber gegenüber der Gemeinschaft[37].

Dies war eine wichtige Einnahmequelle, denn die Burgfrieden zeigen auch, wie der Wert der Burganteile bzw. der Grundherrschaft selbst immer weiter sank. Dies betrifft sowohl den ideellen als auch den materiellen Wert. Fels war spätestens ab dem 15. Jahrhundert für keine Familie mehr der Adelssitz, sondern eine Burg von Vielen, an denen man Anteile hatte. Man wohnte ohnehin nicht ständig dort, sondern oftmals lieber in den komfortableren Stadthäusern, welche zum Beispiel die Familie von Fels nachweislich bereits 1206 besaßen[38]. Deshalb wurden die Anteile

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[33] *„Auch syn wir gemeyner vurg. eindrechtigt wurden dasz wir unser burger in der fryheid zu der Veiltz underysen und darzu halden sullen dasz sy an den tzweyn porten in der vryheit da man in und us feyrt alltyt tzwene gedynigde portner halden di two porten woel zu hoeden oin geverede."* – Burgfrieden von 1415, bei Hardt 1850, S. 25

[34] Burgfrieden von 1399, bei Hardt 1850, S. 16 f

[35] Vgl. Margue 2009, S. 69 ff

[36] Friedhoff 2013 S. 132

[37] *„Auch wellen wir dass unser keiner einen anderen Inthalden solle der an Unsers andere gemeyners lyf oder gut gryffe so lang der Inhalt wert, das soll Ihener bewaren der Jeme Inthalten hette, umb dass ob der enthaldene breche, des sulde der der In enthalden hette, richten Inwendig den nebsten echt tagen nachs prechen dreyer der herschafft Manne von der Veltz…"* – Burgfrieden von 1399 bei Hardt 1850, S. 11 f

[38] Siehe hierzu Friedrich Toepfer, *Urkundenbuch für die Geschichte des graeflichen und freiherrlichen Hauses der Voegte von Hunolstein. 1 (1866)* (Zeiser „in Comm.", 1866). S. 45

regelmäßig verpfändet oder verkauft, wenn auch die Burgfrieden versuchten, dem einen Riegel vorzuschieben, indem sie die Zustimmung aller Gemeiner dafür vorsehen[39].

Den sinkenden materiellen Wert beziehungsweise die nicht mehr ausreichenden Einnahmen, die mit dem Anteil verknüpft waren,[40] erkennt man auch im Wandel der Bestimmungen für den Baumeister. Anfangs[41] darf er für einen säumigen Zahler noch in dessen Namen Geld leihen, unter der Annahme, er könne dann für die Summe und die Zinsen aufkommen. Später wird hingegen direkt der Anteil der Burg gepfändet oder es dürfen sogar Güter veräußert werden.[42] Die sinkenden Einnahmen erklären sich zum Beispiel durch einen Blick in den Freiheitsbrief[43] der Stadt. Dieser garantiert, dass es keine neuen Abgaben geben wird, und es werden keine prozentualen Anteile, sondern feste Beträge bestimmt, meist in Naturalien statt Geld. Durch Inflation und den Übergang aus der Naturalien- zur Geldwirtschaft[44] sank aber die dadurch gegebene Kaufkraft.

Abbildungen und Darstellungen

Die frühste bekannte Abbildung der Burgruine ist 1778 im Ferraris-Atlas[45] zu finden, wobei sie hier als gekritzelte Linie auf dem Felsen auftaucht und eher die St-Elisabeth-Kapelle auf dem Plateau dargestellt wird. Das Urkataster von 1824[46] zeigt nur das Criechinger Haus, den am besten erhaltenen Teil der Burg, als Umriss, wobei die Gemarkungsgrenze der Ringmauer folgt. Vannérus

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[39] Während die Gemeiner 1399 nur an Kaiser, Könige, Fürsten, Herzöge und Städte *„nymer keynerley deyl an dem vurg. Schlosz […] versetzen, verkauffen, noch verpenden, noch geben noch in keyner wysze an Ir einchen wenden sullen an guden willen un verhencknisze der anderen gemeyner zu der veltz gemeinlich“* (Hardt 1850, S. 15), waren deshalb 1412 schon *„fast tzweyonge under uns gewest“* weshalb die Gemeiner *„…eyndrechtlich worden syn dass wir und unse erben die na uns gemeyner in dem vurg. slosz geben, verwenden oder verussern mogen und nyman anders ussgenomen eyn gemeyner dem anderen“*, also alle außer direkten Erben als weitere Gemeiner auszuschließen. (Hardt 1850, S. 19)

[40] Vgl. Margue 2009, S. 62

[41] Burgfrieden von 1384 und 1399

[42] Burgfrieden von 1464

[43] Bei Dasburg 1938, S. 112 f

[44] Vgl. Margue 2009, S. 62

[45] „La carte de Ferraris • KBR“, Königliche Bibliothek Belgiens, https://www.kbr.be/fr/la-carte-de-ferraris/

[46] Abgebildet bei van Aaken et al 2017, S. 10

zeigt 1938 einen angeblichen[47] Auszug aus einem Katasterplan von 1810[48], auf dem das Criechinger Haus, das Homburger Haus, die Burgmauern und einige Gebäude der Vorburg eingetragen sind.

Ab dem frühen 19. Jahrhundert ist Burg Fels regelmäßig Gegenstand von Abbildungen: Skizzen, Stiche, Radierungen, Gemälde und Fotografien[49]. Meist werden diese vom „Welterich", der Anhöhe auf der anderen Seite der Ernz aufgenommen; man blickt also auf die Südostfassade. Außerdem gelegentlich vom „Verlorenkost" aus auf die Südseite oberhalb der Stadt oder entlang des Ernztals von Norden aus, also auf die Turmfassade des Criechinger Hauses schauend. Vom Burgtor bzw. überhaupt der Ansicht vom Elsbethplateau aus sind bis in die 1930er keine Abbildungen bekannt; dies mag auch daran liegen, dass es zu dieser Zeit dicht bewaldet war. Man kann also die Abbildungen des Homburger und Criechinger Hauses gut vergleichen und durch die Gemeinsamkeiten feststellen, was als gesichert und was als künstlerische Freiheit angenommen werden kann. Die Fotografien, meist in Form von Fotokarten, weisen dieselben Ähnlichkeiten auf[50].

Die frühste bekannte Innenansicht ist eine Zeichnung von MA Kuytenbrouwer, 1865; diese wird bei Dasburg[51] wiedergegeben. Sie zeigt einen Blick von der westlichen Ecke des Criechinger Hauses nach Osten. Zu sehen sind die Innenfassaden von drei Geschossen, inklusive der Peterskapelle, ein großer Bogen im Vordergrund und ein offensichtlich moderner

[47] Dies wäre noch vor dem Urkataster von 1824 – umfasst aber eventuell auch einfach einen anderen Bereich.
[48] Jules Vannérus, „La Toponymie de Larochette", *Les Cahiers Luxembourgeois- Revue Libre des Lettres des Sciences et des Arts - Freie Rundschau für Kunst und Wissenschaft*, 1938. S. 14 – woher dieser Plan stammt ist unklar, da er sonst nicht auffindbar war.
[49] Zum Beispiel: die Gemälde und Vorskizzen Koekoeks 1845-1848, die frühen Fotografien von Nicolas Maroldt, 1883, der Stich von Jean-Baptiste Fresez 1853 und die Litographie von Dewarme 1823, auf denen noch Teile der unteren Stadtmauer und die alte Kirche zu sehen sind, der Stich von N Liez, 1835, auf dem der eingezäunte Garten auf halber Höhe abgebildet wird, oder den Stich von M. Henry de la Fontaine, der 1865 die Folgen des Großbrands im Ort zeigt, darunter die zerstörte Nikolauskirche, welche im Vordergrund schon ihren Nachfolger hat.
[50] Der Großteil dieser Abbildungen ist reproduziert in den beiden Bänden der Cahiers Luxembourgeois zu Larochette, weitere findet man bei Pelgrom, 2012.
[51] Victor Dasburg, „Die Schlossruinen von Fels", *Les Cahiers Luxembourgeois- Revue Libre des Lettres des Sciences et des Arts - Freie Rundschau für Kunst und Wissenschaft*, 1938.

Zahnradmechanismus am Brunnen im Vordergrund, der also noch in Benutzung ist – vielleicht von den Tuchmachern, die laut Reuland[52] die Vorburg zum Trocknen der Ware nutzen sollen.

Für die Cahiers Luxembourgeois wurden dann 1937 weitere Skizzen des Inneren und Fotografien der erhaltenen Bausubstanz angefertigt[53], diesmal Nahaufnahmen. Zusammen mit der Bestandsaufnahme des Architekten R. Leer von 1943[54] bilden diese den Zustand der Burg ab, bevor im Zuge der Sicherungs- und Restaurierungsarbeiten die Bäume gefällt und der Schutt beiseite geräumt wurden.

Diese Abbildungen, wie auch die Burgruine selbst, sind allerdings nicht als absolut gewiss einzustufen; durch einige undokumentierte Sicherungsversuche des 19. und frühen 20. Jahrhunderts[55] sowie der Spolien[56] als Baumaterial in der Ortschaft wurde mehr als nur durch Verwitterung die Bausubstanz verändert.

[52] Berichtet in: Van Aaken et al, S. 297
[53] Zu finden bei Dasburg 1938, S. 57-78
[54] Leer, Rob., Bestandsplanung, ANLux, provisorische Signatur BP-210.01, Larochette, 1943. Ein Grundriss ist auch reproduziert bei Van Aaken et al 2017, S. 302
[55] Zimmer 1996, S. 160 ff
[56] Van Aaken et al 2017, S. 160

III. Rekonstruktionsprinzipien

Der wissenschaftlich korrekte Umgang mit Rekonstruktionen

Dieser Arbeit geht ein digitales Volumenmodell zur Darstellung der Rekonstruktionsvorschläge John Zimmers voraus, das genutzt wurde, um einzelne Aspekte der Theorien sichtbar zu machen und zu überprüfen. Selbstverständlich soll dies keine Nacherzählung der Werke John Zimmers sein, sondern eine Ergänzung – ein Nachtrag zu seiner Forschung, welche einen Überblick schafft, wo es sich um gesicherte Erkenntnisse handelt und was eher spekulativ ergänzt wurde.

Dieser Beitrag befasst sich somit für die Rekonstruktion der Burg Fels mit der Umsetzung der Grundsätze 1 und 3 der Londoner Charta: intellektuelle Integrität und Dokumentation.
Die *Londoner Charta für die computergestützte Visualisierung von kulturellem Erbe*[57] beschreibt den wissenschaftlich und ethisch korrekten Umgang mit (digitalen) Rekonstruktionen, um sie als eigenständige Dokumente mit einer ähnlichen Autorität und gesicherten Provenienz wie die altbekannte Textform zu etablieren. Ihre zentralen Grundsätze für die Erforschung und Vermittlung von Kulturgut sind intellektuelle Integrität, Seriosität, Dokumentation, Nachhaltigkeit und Zugänglichkeit.

[57] Hugh Denard, „Die Londoner Charta für die computergestützte Visualisierung von kulturellem Erbe“, übers. von Susanne Krömker, 2009, https://www.londoncharter.org/fileadmin/templates/main/docs/london_charter_2_1_de.pdf.

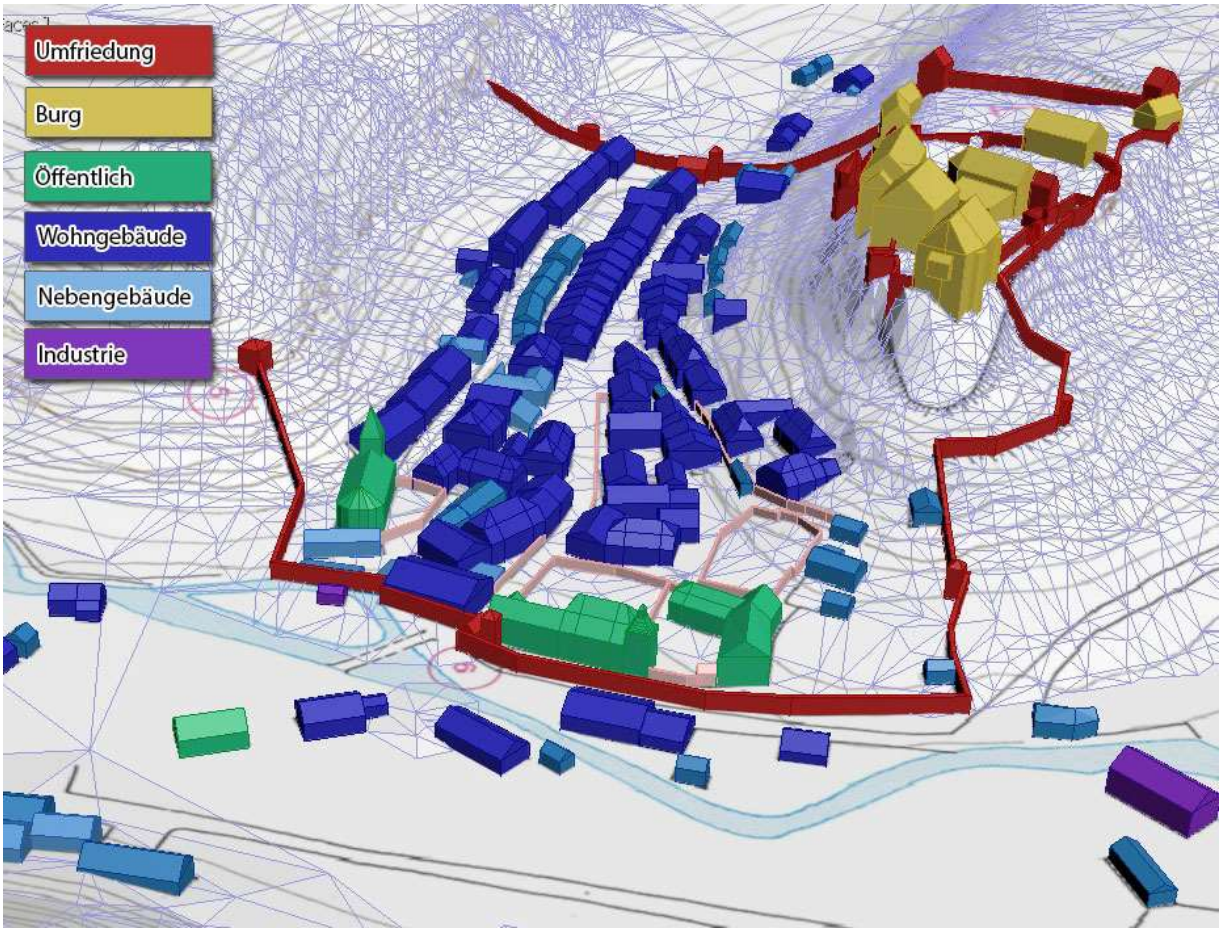

Abbildung 1 - ein digitales Massenmodell, nach Funktion gegliedert

Dabei gibt die Charta keine genauen Umsetzungsrichtlinien vor, weil sowohl das Anwendungsgebiet als auch die Methoden im stetigen Wandel begriffen sind, „sondern stellt vielmehr jene umfassenden Nutzungsrichtlinien für computergestützte Visualisierungsmethoden in Forschung und Kommunikation von Kulturgut auf, von denen die intellektuelle Integrität solcher Methoden und Ergebnisse abhängen.“ [58] Rein künstlerische Absichten lässt sie bewusst außen vor – Kunst muss nicht akademisch rigoros sein – versteht ihr Aufgabengebiet aber über die Forschung hinaus als „quer durch akademische, pädagogische, kuratorische und kommerzielle Bereiche“[59], inklusive der Unterhaltungsindustrie, wie etwa Film oder Computerspiele.

[58] Denard, S. 3
[59] Ebenda, S. 3

Wichtig ist dabei auch der Leitsatz 2.1: „Es soll nicht angenommen werden, dass computergestützte Visualisierung das geeignetste Mittel ist, um alle Ziele in der Forschung und Kommunikation von Kulturgut anzusprechen.“ [60] Damit erkennt die Londoner Charta an, dass auch traditionelle Methoden ihre Berechtigung behalten und eine angemessene Lösung für die vorliegende Aufgabe sein können.

Allerdings sollten solche analogen Rekonstruktionen – ob in Textform, als architektonisches Modell oder auch als architektonische oder perspektivische Zeichnung – den gleichen strengen Maßstäben unterliegen. Bislang geschieht dies eher spärlich; so findet man auf Bildtafeln und Modellen oft keinen Hinweis darauf, wie, wann, von wem und auf welcher Grundlage sie erstellt wurden, oder aber sie werden mit Worten wie „künstlerische Visualisierung“[61], „Neuvorstellung“[62] oder „virtuelle Annäherung“[63] vom wissenschaftlichen Anspruch des Wortes „Rekonstruktion“ befreit.

Das Modell der Burg Fels das man auf dem Dachboden des Criechinger Hauses findet, hat zum Beispiel überhaupt keine damit verbundenen Metadaten; angegeben ist weder der Maßstab noch das Baujahr noch der Erbauer noch welche Baustufe es darstellt, noch, dass es sich überhaupt um diese Burg handelt. Somit ist es vielleicht hübsch anzusehen, aber keine wissenschaftlich korrekte Ressource. Dass der Betrachter ihm Glauben schenkt, geschieht allein durch die Autorität[64], die ihm durch die Platzierung innerhalb des Denkmals verliehen wird.

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[60] Ebenda, S. 6

[61] „Artist’s Impression of the Tower of London Site, 1700 | Art UK“, zugegriffen 31. August 2021, https://artuk.org/discover/artworks/artists-impression-of-the-tower-of-london-site-1700-135141.

[62] Museum von Chertsey, *Chertsey Abbey 1362 Re-Imagined*, 2020, https://www.youtube.com/watch?v=OcU8MkRWsdg.

[63] Deutsche Stiftung Denkmalschutz, „Schein und Sein – Folge 4 | Monumente Online“, zugegriffen 31. August 2021, https://www.monumente-online.de/de/ausgaben/2021/4/Schein-und-Sein-4-Das-virtuelle-Denkmal.php.

[64] Zur „voice of instututional authority“ siehe Lawrence Weschler, *Mr. Wilson’s Cabinet of Wonder*, 1st Vintage Books ed (New York: Vintage Books, 1996), S. 101

Angabe der Gewissheit

Wenn sie vorhanden sind, werden bei Rekonstruktionen oft Prozent-Angaben für die Gewissheit gemacht, ohne aber darauf einzugehen, wie diese Zahlen berechnet werden. So sind sie nicht mehr als eine subjektive Skala von 0-100, von denen man nur weiß, dass sie von relativ niedrig bis relativ hoch geht. Das System, das hier verwendet wird[65], weniger nuanciert - es hat nur vier Stufen - aber gleichzeitig für den Anwender und den Betrachter deutlich einfacher zu benutzen, da die Kriterien für die Einteilung bereits den Namen der Kategorien zu entnehmen sind und sie auch klar gegeneinander abgegrenzt werden.

Diese lauten:

Relikt – im Wesentlichen gesichert, da es sich um noch vorhandene zeitgenössische Elemente handelt, wie etwa die Überreste einer Mauer, oder aber zeitgenössische Quellen wie den Burgfrieden.

Interpoliert - eine Lücke zwischen gesicherten Elementen wird nach einem eindeutigen Muster gefüllt, zum Beispiel eine Bresche in einer sonst noch vorhandenen Mauer.

Extrapoliert – von festen Anhaltspunkten ausgehend, werden fehlende Bauteile logisch, aber ungesichert ergänzt, zum Beispiel eine Mauer, die entlang eines vorhandenen Fundamentes wieder hochgezogen wird. Gesichert ist dabei, wo sie stand; die Höhe und Beschaffenheit sind spekulativ.

Spekulativ - für diese Kategorie gibt es weniger Anhaltspunkte, man benutzt Vergleichsobjekte und allgemeinere Forschung, um das Modell zu ergänzen – zum Beispiel, dass die Mauer verputzt war, obwohl von diesem Putz an der Ruine nichts übrigbleibt.

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[65] Siehe: Marleen de Kramer, „Relict-Interpolated-Extrapolated-Speculative: An Approach to Degrees of Accuracy in Virtual Heritage Reconstruction.“, in *Visual Computing for Cultural Heritage*, 2020, 409–22, https://doi.org/10.1007/978-3-030-37191-3_21.

Am einfachsten wäre es, zu den Teilen mit schlechter Quellenlage einfach keine Aussage zu machen; allerdings ist diese Leere aus Unsicherheit für den Betrachter nicht zu unterscheiden von der Annahme, dort wäre nichts gewesen, was dann wiederum zu verzerrten Sehgewohnheiten führt - zum Beispiel der Annahme[66], die Wände würden aus unverputztem, rauem Mauerwerk bestehen, nur weil die genaue Art der Verzierung nicht genau bekannt ist. Bei Zeichnungen oder virtuellen Modellen, die beliebig veränderbar und erweiterbar sind, gilt das Argument des Sich-Festlegens nicht, das Eingriffe in die originale Bausubstanz verhindert.

Selbstverständlich hat diese Matrize auch noch eine dritte Dimension: die Genauigkeit, also die zeitliche Eingrenzung beziehungsweise der architektonische Maßstab. Man kann viel sicherer sagen, dass ein Turm im 15. Jahrhundert vorhanden war als dass am 13. Mai 1488 an der Fensterlaibung in jenem Turm die Putzstärke genau 18mm betrug; umgekehrt aber kann man von solchen Momentaufnahmen, etwa aus einem datierten Brief, auf eine längere Zeitspanne schließen. Ein Turm, der am 13. Mai 1488 stand, wird wohl kaum am Vortag auf- und danach sofort wieder abgebaut worden sein.

Der große Vorteil eines digitalen Modells ist natürlich, dass man solche Daten direkt mit dem Modell verknüpfen und auch mit mehreren Bedeutungsebenen parallel arbeiten kann. So kann der Benutzer vom künstlerischen Gesamteindruck zur Metadatenebene wechseln – Informationen über Funktion, Baumaterial usw. – aber auch zu den Paradaten, den Daten über die Metadaten. Wie kamen sie zustande? Welche Quellen und Belege gibt es dafür? Wie sicher ist es, dass sie stimmen?

Auch kann die Darstellung dynamisch variiert werden, um zum Beispiel über den Detaillierungsgrad oder die Transparenz zu veranschaulichen, wie gut welche Bereiche belegt wurden. Dies alles ist aber auch für traditionelle Rekonstruktionen möglich, ob als Zeichnung, architektonisches Modell oder gar als Wiederaufbau.

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[66] inforo1300, „Können wir einmal kurz über Putz reden?“, *In Foro - Städtisches Leben um 1300* (Blog), 10. Mai 2017, https://inforo1300.wordpress.com/2017/05/10/koennen-wir-einmal-kurz-ueber-putz-reden/.

IV. Gewissheiten einzelner Aspekte

Üblich scheint es, die Beschreibung eines historischen Gebäudeensembles nach einem dreier Schemen vorzunehmen: entweder rein nach Geometrie, am Tor beginnend und auf dem Dach des hintersten Hauses endend, nach Bauphasen, sich also meist von der Mitte her langsam ausdehnend, oder aber nach Funktion und Bedeutung, vom Burgfried zum Lagerraum. Dies hängt auch von der Art der Rekonstruktion ab.

Obwohl er auch Rekonstruktionszeichnungen liefert, ist John Zimmers Beschreibung der Burg im Wesentlichen eine Textrekonstruktion nach dem ersten Schema. Im Folgenden wird für jedes Element exemplarisch gezeigt, was darüber bekannt ist und wo es sich um Spekulation handelt, mit Verweisen auf die einzelnen Quellen.

Tor und Ringmauer

Das Haupttor zur Burg ist im Wesentlichen gut erhalten, inklusive des Grabens, der es absichert. Die Toranlage liegt in einem eckigen Turm, der über die Wand hinausragt, und bestand aus mehreren Toren hintereinander.

Kategorie	**Aspekt**	**Quelle oder Beleg**
Relikt	Grundmaße und Bauweise des Tors	die Ruine ist bis zur Dachkante erhalten[67]
Interpoliert	Verschlussbalken	die Löcher dafür sind noch vorhanden[68]
Extrapoliert	Wehrgang auf der Ringmauer	Bögen bis in 5m Höhe erhalten, Vergleichsobjekte[69]
Spekulativ	Fallgitter im 2. Tor	laut Zimmer „wenige Spuren“ vorhanden[70]

[67] Fotografien bei Vannérus, Bildtafeln nach S. 78
[68] Zimmer, John, *Le Château de Larochette - L'Histoire de son Architecture*. (1990) Hrsg. Les amis du château de Larochette, Luxembourg Saint-Paul, 1990., Fig. 9
[69] Zimmer 1996, S. 142
[70] Ebenda

Das Tor schließt an eine Ringmauer an, welche im vorderen Bereich dicker ist, nach dem Wachturm an der südlichen Ecke dünner, weil sie dort bereits direkt auf der Geländekante steht. Anhand dieser Mauer kann man auch gut aufzeigen, was unsere Sehgewohnheiten ausmachen. In der parallel zu dieser Arbeit ausgewerteten Umfrage[71] zum Verständnis der Allgemeinheit zu Rekonstruktionsprozessen wurden zwei Dinge regelmäßig als unglaubwürdig kritisiert: die blauen Schieferdächer und die Farbfassung der Gebäude, und die Bögen entlang der vorderen Ringmauer. Die Schieferdächer sind ortstypisch, wenn sie auch eher grau als blau erscheinen; die verputzen und stellenweise farbig gefassten Mauern in ihrer Zeit eigentlich eine Selbstverständlichkeit[72]. Auch die Sparbögen sind ein ab dem 13. Jahrhundert ein nicht unübliches Mittel, um bei Ringmauern und auch Stadtmauern an Material zu sparen und ein Auflager für die Wehrgänge zu schaffen[73].

[71] Diese Arbeit beruht auf den Antworten von 360 deutsch- und englischsprachigen Teilnehmern aus, die auf eine Umfrage über Entscheidungen bei Rekonstruktionen geantwortet haben. Das entsprechende Paper soll unter meinem Namen und dem Titel „Understanding by Doing - Guided Decision-Making as a Tool for User Engagement with Reconstructions" erscheinen.

[72] Vgl. Roland Möller „Außengestaltung – Putz, Farbe, Architekturfarbigkeit" in: Horst Wolfgang Böhme und Deutsche Burgenvereinigung, Hrsg., *Burgen in Mitteleuropa: ein Handbuch* (Stuttgart: K. Theiss, 1999). S 270 ff

[73] Vgl. G. Ulrich Großmann, *Die Welt der Burgen: Geschichte, Architektur, Kultur* (München: Beck, 2013). S. 63

Gebäude in der Vorburg

Die Gebäude in der Vorburg wurden noch nicht archäologisch untersucht, deshalb ist darüber wenig bekannt. Allerdings kann man ihre ungefähre Lage und Größe anhand der Fundamente gut abschätzen. Es wird angenommen, dass es sich um Wirtschaftsgebäude handelt.

Kategorie	**Aspekt**	**Quelle oder Beleg**
Relikt	Grundfläche der Gebäude	durch noch vorhandene Fundamente vorgegeben
Interpoliert	Hinteres Tor der Vorburg	Viel befahrener Weg, Auflager für Torbogen[74]
Extrapoliert	Funktion: Wirtschaftsgebäude	Durch Lage und Vergleichsobjekte[75]
Spekulativ	Bauweise: Fachwerk	Art der Fundamente[76]

Den Bereich des heutigen Wächterhauses behandelt Zimmer nicht; dort bedürfte es wohl auch archäologischer Untersuchungen, um zu erkennen, ob es auf einem älteren Fundament gebaut ist.

Tor zur Kernburg und Verteidigungsanlagen

Hinter der Vorburg gibt es einen zweiten Graben, der seinen Ursprung anscheinend in einer natürlichen Felsspalte hat. An dessen Ende lag der zweite Eingang zur Burg, der sowohl von einer eigenen Toranlage als auch vom Flankierungsturm in der Hauptburg beschützt wurde. Dass es sich um einen Artillerieturm handelt, zeigt die Bauweise; sowohl die durch ein Gewölbe verstärkte Zwischendecke als auch die Form der Schießscharten. Daraus lässt sich auf eine Bauzeit im späten 15. Bis frühen 16. Jahrhundert schließen[77].

[74] Zimmer 1996, S. 142
[75] Vgl. Stefan Uhl „Wirtschaftsarchitektur und andere bauliche Einrichtungen" in Horst Wolfgang Böhme und Deutsche Burgenvereinigung, Hrsg., *Burgen in Mitteleuropa: ein Handbuch* (Stuttgart: K. Theiss, 1999). S. 307f
[76] Zimmer 1996, S. 203
[77] Vgl. „Türme" in Böhme 1999 S. 247 ff

Kategorie	Aspekt	Quelle oder Beleg
Relikt	Eingang über die Vorburg und zweiter Aufgang vom Ort aus	Erhaltene Bauteile
Interpoliert	Bauzeit des Wachturms am 2. Graben	Bauweise zeigt, dass es sich um einen Artillerieturm handelt[78]
Extrapoliert	Verteidigungsanlagen der früheren Bauphasen	Die Mauerreste sind unter dem späteren Haus A erhalten; es gibt einen zugemauerten Eingang[79]
Spekulativ	Der Flankierungsturm ist Allgemeingut[80]	Im Burgfrieden wird „der große Turm“[81] genannt, der gemeinsam zu bewachen ist.

Das Torhaus der Kernburg wurde später gebaut als Haus A[82] und ist im Mauerwerk deutlich von diesem Haus abgesetzt, worauf auch Zimmer explizit hinweist, ohne diesen Anbau zu begründen. Im Burgfrieden findet man allerdings einen wichtigen Hinweis auf diesen neuen Bauteil. So wird im Burgfrieden von 1415 eine Liste erstellt, was alles für den Verteidigungsfall eingelagert werden soll – hundert Malter Korn, acht Malter Salz, je vier Steinbressen und vier Bleibressen (frühe Pulvergeschütze), zwölf eiserne Armbrüste, eine Tonne Pulver und viertausend Pfeile. Der Lebensmittelvorrat sollte in verschließbaren Speichern in den jeweiligen Häusern gelagert werden, die Waffen hingegen in einem eigens dafür neu gebauten gemeinsamen Haus „uff der burchporten“[83] untergebracht werden. Um welches Tor es sich genau handelt ist nicht klar, allerdings ist dies das Tor zur Kernburg und ein taktisch geschickter Aufbewahrungsort, falls man die Vorburg aufgeben musste.

[78] Zimmer 1996. S. 142
[79] Zimmer 1996, S. 143
[80] Zimmer verweist auf einen Text bei Dasburg, der aber nur den Text des Burgfriedens wiedergibt – dieser „bezeugt“ allerdings nicht, um welchen Turm es sich genau handelt. Da der Burgfried aber nicht mehr vorhanden war, ist dies der größte verbleibende Turm; er überblickt auch beide Eingänge, das Nebentor von der Ortschaft aus oder den Weg durch die Vorburg.
[81] Burgfrieden 1399, Bei Hardt 1850, S. 16
[82] Zimmer 1996, S. 143
[83] Hardt 1850, S. 21

Die Lebensmittel sollen dezentral verwahrt werden, in den jeweiligen Häusern der Gemeiner aber in separaten Räumen, zu denen nur der Burggraf die Schlüssel hat, wohl aus Misstrauen den anderen Bewohnern gegenüber. Welches „Malter" genau gemeint ist, ist unbekannt, und dieses Maß schwankt stark zwischen ca. 80 und 300 Litern. Allerdings werden in der Stiftung eines Altars in der St-Elisabeth-Kapelle 1342[84] und in einem Vertrag von 1440[85] das Trierer Malter für Roggen explizit angegeben, weshalb man spekulativ davon ausgehen kann, dass dieses Maß auch sonst verwendet wird. Bleibtreu gibt 1863 das „alte" Trierer Malter mit 213,2 Litern an[86], was bei einem Raumgewicht von 80kg/Hektoliter[87] 17 Tonnen entspricht. 1000g (modernen) Weizens haben ca. 3300kcal[88], was historisch ein eher niedriger durchschnittlicher Energiebedarf[89] für körperlich arbeitende Männer ist. Dies könnte im Belagerungsfall noch durch das Schlachten des Viehs aus der Vorburg ergänzt werden – das Fleisch könnte dann mit dem Salzvorrat gepökelt werden, und das Vieh würde kein weiteres Futter verbrauchen.

Rechnet man also überschlagsmäßig die Menge, kommt man auf circa 17 Tonnen Korn, was 17.000 Tagesrationen entspricht; so könnte man zum Beispiel 47 Menschen ein ganzes Jahr lang davon ernähren. Ob diese Mengen tatsächlich eingelagert wurden oder nur einer Wunschvorstellung entsprechen, ist nicht bekannt – produziert werden sie jedenfalls, da allein die vorhin erwähnte Rente für den Altar in der St-Elisabeth-Kapelle 9 Malter Getreide aus der Felser Mühle beträgt[90]. Pro Familie bzw. Wohnhaus betrügen Korn und Salz insgesamt fast zwei Tonnen einzulagernden Schüttguts, die einzeln verschließbar lagern sollten; vielleicht erklärt dies den

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[84] Siehe Dasburg 1938, S. 110

[85] Ebenda, S. 144

[86] Leopold Carl Bleibtreu, *Handbuch der Münz-, Maaß- und Gewichtskunde und des Wechsel-Staatspapier- Bank- und Actienwesens europäischer und außereuropäischer Länder und Städte* (Engelhorn, 1863), http://www.ub.uni-koeln.de/cdm/ref/collection/digitalis/id/837. S 541

[87] Siehe: Janine Berberich, „Ermittlung des Hektolitergewichts durch Bestimmung des luftgefüllten Porenvolumens in Getreideschüttungen", *Landtechnik Agricultural Engineering* 74, Nr. 1 (2019): 9, https://doi.org/10.15150/lt.2019.3199.

[88] Nährwerttabelle des Deutschen Ernährungsberatungs- und Informationsnetzes, https://www.ernaehrung.de/lebensmittel/de/C110000/Weizen-roh.php.

[89] Vgl. die Berechnungen für Seeleute bei: Patrick W. Hayes u. a., „European naval diets in the sixteenth century: A quantitative method for comparative and nutritional analysis", *Historical Methods: A Journal of Quantitative and Interdisciplinary History* 52, Nr. 4 (2. Oktober 2019): 195–212, https://doi.org/10.1080/01615440.2019.1580170.

[90] Siehe Dasburg 1938, S. 110

kleinen, etwas umständlich zugänglichen halbrunden Raum über der Küche des Criechinger Hauses.

Die Kernburg selbst besaß in der letzten Bauphase nicht viele Verteidigungsanlagen. Der Nebeneingang von der Stadt aus wurde durch einen Geschützturm und einen Flankierungsturm bewacht und es gab ein gut gesichertes Tor hinter einem zweiten Graben, jedoch wurde die Ringmauer nach und nach regelrecht mit Wohnraum überbaut. Dies ist in erster Linie durch die besondere Lage der Burg an der Kante des Steilhangs möglich, weil sie so einen natürlichen Schutz zu drei Seiten hat, und außerdem noch von der Stadtmauer mit beschützt wurde. Diese zu unterhalten war den Gemeinern ein wichtiges Anliegen, so wurde dann auch die Steuer auf Wein explizit dafür verwendet, die Türme, Tore, Mauern, Graben und Brücken zu unterhalten und Waffen zu kaufen: Büchsen, Pulver und Lunten, „sampt allem waß zur wehr gehoerigh und nützlich“[91].

Wohngebäude A

Das Wohngebäude A steht an einem Bauplatz mit einer relativ hohen Dynamik, der wiederholt den sich ändernden Bedürfnissen der Burg angepasst wurde. Die Überreste dieser älteren Strukturen verbleiben noch unter dem neueren Gebäude und sind bis heute sichtbar, wenngleich bei ihrer „unorthodoxen“ und undokumentierten Freilegung[92] während einer „Ausgrabung“ der 1930er Jahre viel zerstört wurde. Diese Problematik betrifft auch andere Bereiche der Burg – da in vielen Bereichen der Schutt bereits beiseite geräumt wurde und sogar undokumentierte Sicherungsarbeiten durchgeführt wurden[93], wurde die archäologische Stratigraphie stellenweise erheblich gestört[94]; die Gründung auf nacktem Felsen verhindert auch, dass sich im Erdreich noch etwas erhalten hat.

[91] Bei Majerus 1957, S. 50 f
[92] Zimmer 1996, S. 142
[93] Zimmer 1990, S. 7
[94] Zimmer 1996, S. 160

Kategorie	Aspekt	Quelle oder Beleg
Relikt	Dacheindeckung mit Schiefer	Schieferreste im Brandschutt[95]
Interpoliert	Nutzung des EG als Küche	Backofen und Ausguss[96]
Extrapoliert	Alte Ringmauer zwischen Burgfried und Homburger Haus	Abdrücke und Mörtelspuren[97]
Spekulativ	Eigentümer: von Pittingen	Ausschlussverfahren

Teilweise steht die westliche Fassade dieses Hauses auf bzw. über der Wehrmauer. Dies impliziert, dass das Gebäude nach außen erweitert wurde, nachdem die Wehrfunktion an Bedeutung verloren hatte. Ursprünglich stand es wohl in einigem Abstand hinter der Mauer, vielleicht unter Wiederverwendung der Mauer der ersten Bauphase und mit dem Bergfried verbunden, und wurde ausgedehnt, als auch der Bergfried weichen musste.

Insgesamt sind vier Wohnhäuser definitiv belegt, weil sie 1574 im sogenannten „Scheffenweistum“ genannt werden: das sogenannte „Bannerhaus“ derer von Fels, das Homburger Haus, das Criechinger Haus und das Haus von Pittingen[98]. Das Criechinger Haus und das Homburger Haus sind bis heute als solche bekannt; welches der Verbleibenden welches ist, ist allerdings nicht eindeutig belegt. Zu den Gründen, warum dies vermutlich das Haus von Pittingen und nicht das Bannerhaus ist, siehe die Erklärungen bei Haus E.

Das Homburger Haus

Das Homburger Haus war das erste der insgesamt fünf Wohngebäude in der Kernburg, auch als das „große Haus“ bekannt – mit ca. 230m² Grundfläche ist es auch tatsächlich das größte Gebäude der Kernburg. Es stammt aus der Mitte des 14. Jahrhunderts, hatte aber einen Vorgängerbau an der gleichen Stelle, der allerdings nicht genauer datiert wird. Es beherbergt nicht nur die

[95] Zimmer 1996, S. 165
[96] Zimmer 1996, S. 143, Zimmer 1996, Fig. 27
[97] Zimmer 1996, S. 144
[98] Bei Majerus 1957, S. 42

Quirinuskapelle, sondern gleich zwei gleichwertige herrschaftliche Etagen. Durch die Bauspuren im Inneren sieht man, dass Räume im Erdgeschoss später unterteilt wurden. Das Homburger Haus war eng mit dem Gebäude C verflochten; seine Treppe erlaubte den Bewohnern, die darin befindliche Küche zu benutzen. Vermutlich war es also ein Familienzweig, der beide Gebäude zusammen in Anspruch nahm.

Kategorie	**Aspekt**	**Quelle oder Beleg**
Relikt	Süd- und Ostfassaden	Noch als Ruinen vorhanden
Interpoliert	Dachneigung	Abdruck der Pfetten am Mauerwerk[99]
Extrapoliert	Entstehungszeit	Die Quirinuskapelle wird bereits 1341 dokumentiert[100], also muss das Haus bereits vor diesem Datum gestanden haben. Allerdings wurde sie ggf. später verlagert.[101]
Spekulativ	Spätere Teilung des Rittersaals im Erdgeschoss	Die Quirinuskapelle wurde Gemeinschaftsbesitz und musste allgemein zugänglich gemacht werden.[102]

Wohngebäude C

Dieses etwas kleinere Gebäude schloss direkt an das Homburger Haus an und teilt mit ihm einige Funktionen, so dass es unklar ist, ob es sich um ein eigenständiges Haus oder einen Anbau bzw. eine Erweiterung des Wohnraums der Homburger handelt, da nur vier Häuser definitiv belegt sind. Es kann sich aber auch um einen späteren Umbau handeln, entweder um aus einem Haus zwei oder aus zwei Häusern eines zu machen.

[99] Zimmer 1996, S. 147
[100] Dasburg 1928, S. 110
[101] Zimmer 1996, S. 146
[102] Zimmer 1996, S. 157

Kategorie	Aspekt	Quelle oder Beleg
Relikt	Bauvolumen und Dachneigung	Erhaltene Fassade inklusive Dachschrägen[103]
Interpoliert	Es gab an dieser Stelle ein früheres, quadratisches Gebäude	Überreste einer älteren Mauer im Erdgeschoss[104]
Extrapoliert	Der große Raum im Erdgeschoss war ein Rittersaal	Prachtvolle Architektur mit einem Kreuzgewölbe, großer, offener Kamin[105]
Spekulativ	Die Nutzung als eigenständiges Wohnhaus	Wegen der Verschränkung unklar, ob es zum Homburger Haus gehört oder ob es sich um ein separates Gebäude handelt.[106]

Das Criechinger Haus

Das Criechinger Haus ist der am besten erhaltene Teil des gesamten Burgenensembles. Es besteht aus einer großen Küche im Erdgeschoss, in deren Eingangsbereich sich der Brunnen für die gesamte Burganlage befindet; dass dieser Brunnen Gemeinschaftsgut ist, wird mehrfach in den Burgfrieden betont[107]. Die herrschaftlichen Geschosse werden über eine hölzerne Freitreppe erreicht und sind luxuriös ausgestattet, mit einer eigenen Kapelle, St. Petrus von Mailand geweiht[108], einem gemauerten Kachelofen in den Privatgemächern und einer Bettnische, welche die Abwärme des Brotbackofens darunter ausnutzt. Es wurde als einziges Haus in den 1980er Jahren wieder aufgebaut.

[103] Zimmer 1996, S. 149
[104] Zimmer 1996, S. 160
[105] Zimmer 1996, S. 149
[106] Zimmer 1996, S. 149
[107] Die Tatsache, dass dies 1384 im ersten Burgfrieden festgehalten wird und trotzdem bereits 1385 wieder ein Streit darüber geschlichtet werden muss (nachzulesen bei Dasburg) zeigt, dass dies ein wichtiger Reibungspunkt im Zusammenleben auf der Burg war.
[108] Zum Beispiel 1405 beschrieben als „den elter in meinem vorg. Junckers Haus zu der Veltz, der da steht in dem Saal und genannt ist St. Peters-Altar“ – bei Dasburg 1938, S. 129

Kategorie	**Aspekt**	**Quelle oder Beleg**
Relikt	Die Außenmauern, inklusive der Kapelle und Innenfassaden	Erhaltene Bausubstanz
Interpoliert	Das Laufrad, um Wasser aus dem Brunnen zu schöpfen	Auflager und Abnutzungsspuren an der Wand[109], Vergleichsobjekte
Extrapoliert	Die Verbindungstreppe zwischen den Obergeschossen	Die Kragsteine deuten auf einen Wechsel der Balkenrichtung hin, welcher wiederum den Bau einer Treppe erlaubt; es muss eine solche Verbindung geben.[110]
Spekulativ	Die Nutzung des großen Erkers	Lage, Größe und Kamin

Um den Erker an der Giebelseite des Criechinger Hauses gibt es einige Debatten, denn er ist recht groß, liegt an einer sehr prominenten Stelle und ist sowohl mit einem eigenen Kamin als auch einer Sichtverbindung zum Altar der Peterskapelle versehen. Zimmer postuliert erst (1990) einen Verteidigungserker und dann (1996) eine Abortanlage; heute hängt im rekonstruierten Erker eine Plakette, die ihn als Baderaum ausweist. Großmann hingegen postuliert eine private Kammer für den Burgherrn, in der er auch bei geschlossener Tür dem Gottesdienst folgen kann[111].

Für letztere Theorie sprechen mehrere Faktoren. Erstens gibt es sonst keine Hinweise auf eine große, hölzerne und luxuriös beheizte Abtrittsanlage auf dieser Burg, oder entsprechende Vergleichsobjekte; die Sichtverbindung könnte auch als ziemlich pietätslos empfunden werden. Zweitens liegt dieser Erker an einer sehr prominenten Stelle über dem Ort, der nicht nur eine gute

[109] Zimmer 1990, Fig. 64
[110] Zimmer 1996, S. 154
[111] Simon Matzerath und Guido von Büren, *Steinerne Macht: Burgen, Festungen, Schlösser in Lothringen, Luxemburg und im Saarland* (Schnell & Steiner, 2020). S. 312

Abbildung 2 - Rekonstruiertes Laufrad am Brunnen der Ronneburg

Aussicht über das Ernztal liefert, sondern auch ein Flurstück mit dem Namen „Bongert“ innerhalb der eigens darum erweiterten Stadtmauer überschaut. Dort liegen auch auf den historischen und modernen Karten noch Freiflächen bzw. Gärten. In diesem Baumgarten war vermutlich der Lustgarten der Burg angesiedelt[112]; eine solche Fläche würde man kaum unter einem Abort ohne Schacht anlegen.

Gegen einen Badezuber spricht die Physik, denn dort kommt durch das Wasser einiges an Masse zusammen; die vier Kragsteine sind allerdings nur knapp 2m lang, was bei einer entsprechenden Raumtiefe eine große Hebelwirkung bedeuten würde, da man natürlich auch den entsprechenden Abstand vor dem großen Kamin hinzurechnen muss. Eine hölzerne Möblierung würde eine deutlich größere Raumtiefe ermöglichen.

Natürlich wäre ein solcher Raum prächtiger und besser gebaut als die heutige Rekonstruktion in einfach beplanktem Fachwerk, wäre vermutlich wie der Rest der Burg verputzt und farbig gefasst – auch ein Zeichen der Macht, das über Stadt und Tal weithin sichtbar ist. Anhand der Ruine kann man nur rekonstruieren, dass es einen solchen Erker gab, der eine Tür

[112] Vgl. Johann Nepomuk Cori, *Bau und Einrichtung der deutschen Burgen im Mittelalter*, Unveränderter Nachdruck der Ausgabe von Städtebilder-Verlag (E. Mareis), 1895 (Augsburg: Bechtermünz-Verlag im Weltbild-Verlag GmbH, 1895). S. 32

und einen Kamin besaß und dessen Holzkonstruktion in Breite und Höhe durch Kragsteine und Balkenköcher vorgegeben wird. Form und Funktion sind also extrapoliert; die Gestaltung ist spekulativ.

Über die Abortfunktion lässt sich auch ein zweites Rätsel lösen: der schmale Gang zwischen dem Criechinger Haus und dem Haus E, den Zimmer als „baurechtliche Lösung“ beschreibt. Denn eben an jener Fassade, die sonst mit dem Haus E verbunden wäre, liegt der Abtritt an den Gemächern der Familie und nur von dort ist auch der Schacht erreichbar; man wollte also vermutlich nicht auf den Komfort der kurzen Wege verzichten.

Abbildung 3 - die Ruine der Burg Fels; rechts das teilweise rekonstruierte Criechinger Haus

Wohngebäude E

Dies ist eines der drei tatsächlich ausgegrabenen Gebäude. Bis auf die Grundmauern ist davon nicht viel übrig; man sah aber, dass es einen Versuch gab, dieses Gebäude nach dem Großbrand wieder aufzubauen. Diese Initiative ging von Oswald und Paul von Fels aus[113] – es liegt also nahe, dass es sich dabei um das „Bannerhaus" handelt, das Haus der Familie von Fels; wenn es sich nicht um ihr Gebäude handeln würde, hätten sie kaum mit einem der am meisten zerstörten Teile[114] der Burg begonnen.

Kategorie	**Aspekt**	**Quelle oder Beleg**
Relikt	Kellerraum und Küche im EG	Noch vorhandene Bausubstanz
Interpoliert	Herrschaftliches Geschoss im 1. OG	Reste einer aufgehenden Treppe[115], Vergleichsobjekte
Extrapoliert	Funktionsänderung des Gebäudes	Keller bereits im 15. Jhdt verfüllt, neue Türöffnungen[116]
Spekulativ	Eigentümer: von Fels	Indizien – Wiederaufbau nach Großbrand

Dass das Haus E und nicht das Haus A das Bannerhaus ist, lässt sich auch aufgrund des Bauprozesses vermuten: es wäre unlogisch, die Wehranlage abzureißen und zu überbauen, solange der Rest der Kernburg noch leer ist. In seiner Rekonstruktion der 2. Bauphase stellt Zimmer irritierenderweise an dieser Stelle kein Gebäude dar, obwohl er in seiner Beschreibung zumindest vermutet, es könne sich hier um einen der ältesten Teile der Burg handeln[117].

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[113] Vedruns 1938, S. 85 f

[114] Münzfunde legen nahe, dass das Gebäude durch den Brand und nicht erst später durch Steinraub oder Verwitterung stark beschädigt war und nur noch bis zu einer Höhe von 1,50m überhaupt noch stand. Vgl. Zimmer 1996, S. 156

[115] Zimmer 1996, S. 156

[116] Ebenda

[117] Zimmer 1996, S. 156

V. Rekonstruktionen

Frühere Bauphasen

Die Darstellung der Rekonstruktionsvorschläge Zimmers ist deshalb interessant, weil sie zwei sehr unterschiedliche Herangehensweisen zeigt. Für die erste Bauphase ist dies eine sehr einfache, volumetrische Darstellung der Verteidigungsanlagen[118]. Diese ist bewusst in einem unstrukturierten neutralen Grau gehalten und schließt nach oben mit einer umlaufenden, geraden Linie auf einer Höhe ab, ohne die Türme zu überdachen oder gegenüber der Mauer zu überhöhen. Nur in der unteren Ecke sieht man einzelne Steine in der Farbe des ortsüblichen Sandsteins; hier handelt es sich um den Befund der archäologischen Ausgrabung, also um ein Relikt. Nach interpoliert (zwischen den Fundstücken bzw. in der Höhe darüber), extrapoliert (Annahme einer Symmetrie) und spekulativ (Verlauf des hinteren Bereiches) unterscheidet er in der Zeichnung nicht weiter, sondern erklärt dies im Begleittext. Diese Zeichnung vermittelt zwar einen räumlichen Eindruck der Verteidigungsanlagen, stellt aber keine funktionsfähige Burg dar, weder als Flieh- noch als Wohnburg.

Die zweite Bauphase ist in ihrer Darstellung[119] ganz anders, da sie das gesamte Areal zeichnerisch gleichbehandelt, also mit einheitlichem Detaillierungsgrad, gleicher Farbgebung, etc. Es geht hier also um das Vermitteln einer Gesamttheorie, nicht um die Differenzierung nach Relikt und Rekonstruktion. Interessanterweise fällt die Textbeschreibung hierzu aber noch knapper aus als bei der Ersten; man erfährt nur, dass es im Wesentlichen um einen Vorschlag für die Verteidigungsanlagen des Eingangs geht und der Rest „unter den nötigen Vorbehalten“ so sein könnte, also eher spekulativ ist. Auch bei den Wehrbauten gibt es aber solche Vorbehalte, sind doch die Details des Bergfrieds Erkenntnisse einer „unorthodoxen“ Ausgrabung der 1930er Jahre, zu der es „nicht die geringsten Unterlagen“[120] gibt, die also höchstens mündlich überliefert sein können, wenngleich die Grundmauern noch heute deutlich zu erkennen sind. Diese

[118] Zimmer 1996, S. 200, Abb. 77
[119] Zimmer 1996, S. 202, Abb. 79
[120] Zimmer 1996, S. 142

Rekonstruktionszeichnung ist also ein Gegenentwurf zur Zeichnung der ersten Bauphase und spekuliert bis in Details wie einzelne Steine über Geometrie, Nutzung und Material. Das Fehlen der Kamine ist hier kein vergessenes Detail, sondern ist der dargestellten Zeit geschuldet; beim genaueren Hinschauen erkennt man die Rauchlöcher knapp unter den Firsten.

Auch dies ist durchaus eine angemessene Aufgabe einer Rekonstruktionsdarstellung, wie auch die fotorealistischen digitalen Renderings, die heute allgegenwärtig sind – nur müssen sie dann auch klar als spekulativ gekennzeichnet sein bzw. dem Betrachter verdeutlicht werden, welche Bereiche mit welcher Gewissheit rekonstruiert wurden, da es der stilistisch einheitlichen Zeichnung nicht anzusehen ist.

Die Rekonstruktion der dritten Bauphase[121] ist ähnlich aufgebaut, hier hält sich Zimmer allerdings mit Spekulationen über die *Funktion* zurück, wenngleich er die *Gebäudegeometrie* in allen Bereichen gleichberechtigt darstellt. Diesmal sind die Kamine dafür ein Indiz: während sie an den herrschaftlichen Wohnhäusern in der Kernburg vorhanden sind, hat keines der Gebäude auf der Vorburg einen Kamin. Dabei werden diese noch nicht archäologisch untersuchten Wirtschaftsgebäude teilweise auch Kamine gehabt haben – ob für Schmieden, Brauhäuser, und andere Handwerksbetriebe oder aber für Gesindehäuser, die angesichts der beengten Verhältnisse in der Hauptburg sicher in der Vorburg zu finden waren. So fehlen auch die weiteren Strukturen der Vorburg, die Ställe, Schuppen, Gatter und sonstige vergängliche Anonymarchitektur; die Burg wird so auf ihre Verteidigungsfunktion und den Wohnsitz des Adels reduziert. Dies kann jedoch auch eine bewusste Entscheidung sein, da sie damit den repräsentativen Charakter einer solchen Burg unterstreicht, bei der Alltagsabläufe möglichst ausgeblendet werden.

[121] Zimmer 1996, S. 204, Abb. 80

Ältere Rekonstruktionen

Auch die funktionelle Rekonstruktion der Burg in der Textbeschreibung von Victor Dasburg[122] ist noch klar vom verklärenden Geschichtsverständnis der Burgenromantik[123] geprägt; so nimmt er an, die „Kemenate“ wäre ein Frauengemach[124], aus dem auserwählte Damen an Festtagen hervorgeholt wurden, um dekorativ in den Fensternischen des Rittersaals den Gästen präsentiert zu werden; für den Rest sollten die Speisen durch die kleine Öffnung mit Sichtachse auf den Altar gereicht werden, die eigentlich dazu diente, dem Gottesdienst auch aus den Privatgemächern der Familie zu folgen. Die große Küche mit dem Brunnen im Erdgeschoss interpretiert er als „Waffensaal“ und Rüstungsschmiede, eine Funktion die in der Regel nicht im Wohnhaus sondern in einem Gebäude der Vorburg untergebracht wäre. Dieses im 19. Jahrhundert geschaffene Mittelalterverständnis und sein Frauenbild prägen leider noch immer das „populäre“ Mittelalter, wie es in Fantasyfilmen[125] oder Computerspielen[126] dargestellt wird, zeugen aber davon, dass der Verfasser sich nicht ausreichend mit den alltäglichen Abläufen des Burglebens vertraut war.

Obwohl sie in den auch von Zimmer zitierten Cahiers abgebildet werden, bezieht Dasburg sich nicht direkt auf die Rekonstruktionen Jean Pierre Koenigs und seiner Schüler für den Verschönerungsverein, entstanden um 1900. Diese Rekonstruktion ist allerdings stark romantisierend und eher vom Geschmack der Zeit geprägt. Dass es dabei eher um den ästhetischen Ausdruck als um genaue Beobachtungen handelt, merkt man an vielen Details, wie den überhöhten und in ihren Vertikalen leicht geschwungenen Türme, den Stufengiebeln, für die es keinerlei Beleg gibt,[127] die Unmöglichkeit einer Verteidigungsanlage, an deren Tor die Türbänder an der *Außenseite* angebracht wurden. Auch merkt man ihr an, dass sie vor den Räumungsarbeiten und

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[122] Victor Dasburg, „Die Schlossruinen von Fels“ in *Les Cahiers Luxembourgeois- Revue Libre des Lettres des Sciences et des Arts - Freie Rundschau für Kunst und Wissenschaft*, 1938. S. 57-78

[123] Vgl. Joachim Zeune, *Burgen - Symbole der Macht: ein neues Bild der mittelalterlichen Burg* (F. Pustet, 1996). S. 18 ff

[124] Vgl. Großmann 2013 S. 84

[125] Siehe z.B. Paul B Sturtevant, „Based on a True History?: The Impact of Popular ‘Medieval Film’ on the Public Understanding of the Middle Ages“, o.J., S. 309.

[126] Siehe z.B. Juan Jiménez, „Videogames and the Middle Ages“, *Imago temporis: medium Aevum; Núm.: 3*, 1. Januar 2010.

[127] Welche aber interessanterweise Koekkoek in einer Bleifstiftskizze der Ruinen 1845 auch darstellt – allerdings handelte es sich um Vorstudien für romantisierende Gemälde, die nicht unbedingt der Wahrheit entsprechen.

archäologischen Untersuchungen in der Burg entstand; so nimmt Koenig an, der Flankierungsturm des Nebentors sei der Burgfried[128] – dass es in der 3. Bauphase keinen Burgfried mehr gab und dieser unter einem Wohnhaus verschwunden war[129], war ihm nicht bewusst.

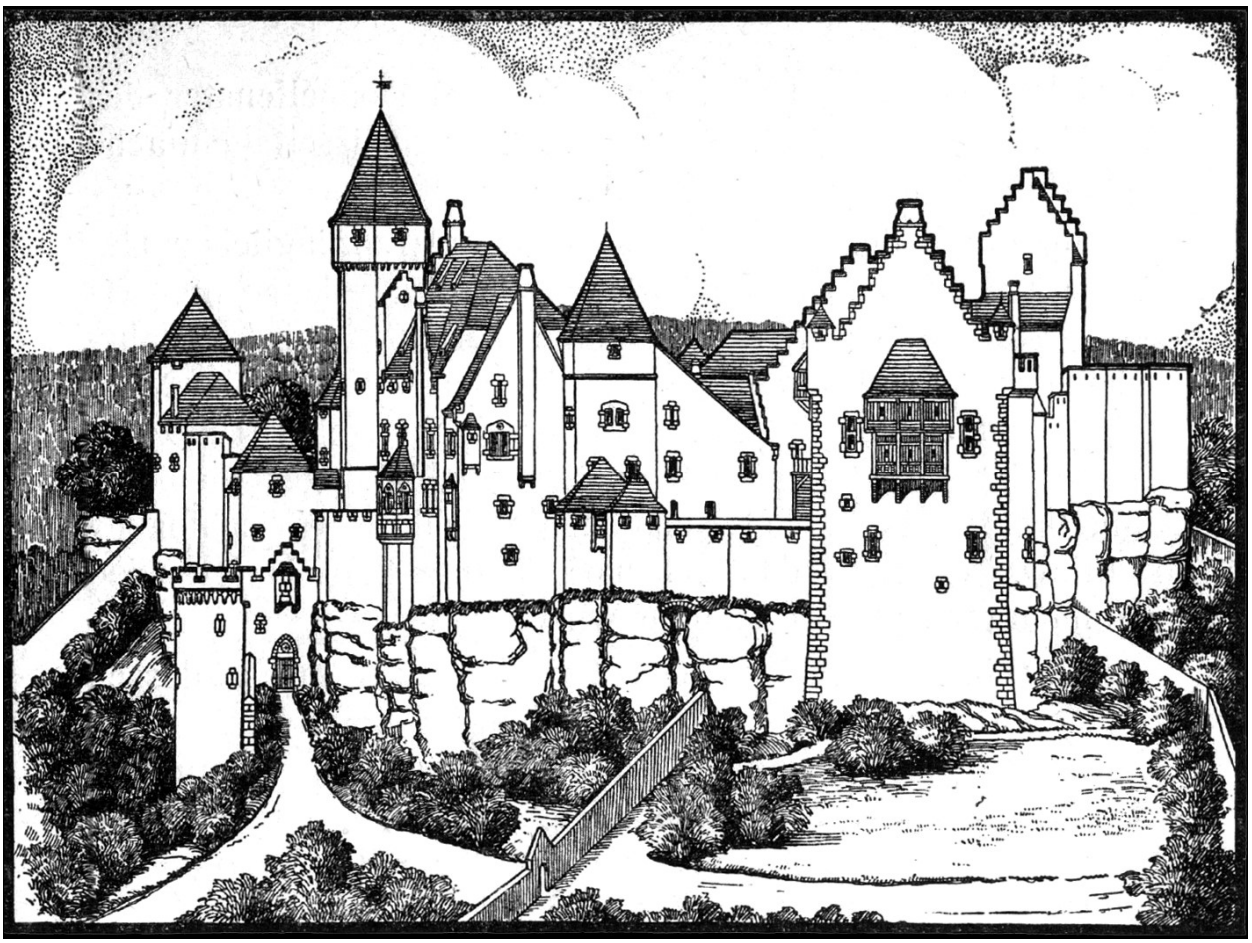

Abbildung 4 -"Die Rekonstitution des Felser Schlosses", JP Koenig, vor 1919

Anhand dieser Beispiele erkennt man auch die Problematik der Nutzung der *Cahiers Luxembourgeois*, denen die Quellenangaben fehlen, die aber trotzdem anhand des Rufs der Verfasser eine gewisse Autorität vermitteln. In dieser Arbeit wurden deshalb die Beschreibungen in den Cahiers als gültig angenommen, die Interpretationen aber mit großer Vorsicht behandelt.

[128] Darauf deutet zumindest die große Überhöhung dieses Turms in seinem Rekonstruktionsversuch hin.
[129] Vgl. Zimmer 1996, S. 143

Wiederaufbau der Ruine

Die verbleibenden Ruinen der Burg Fels wurden nach der Baubestandsaufnahme gesichert und wieder der Öffentlichkeit zugänglich gemacht. Dabei wurde ab 1983 das Criechinger Haus, welches am besten erhalten war, teilweise wieder aufgebaut.

Leider vermittelt diese halbfertige Rekonstruktion ein unvollständiges Bild der Burg – nicht nur in dem Sinne, dass der Großteil der Gebäude noch immer aus Ruinen besteht, sondern dass das Gebäude innen und außen roh und unverputzt bleibt,[130] und so einen falschen Eindruck erweckt. Da die Rekonstruktion sowieso in Teilen spekulativ ist, wäre es besser eine ungesicherte, eventuell auch zurückhaltende, aber angemessene Farbfassung zu wählen, wie das zum Beispiel in der Kapelle der Burg Vianden geschah, als der Öffentlichkeit gegenüber eine unbeabsichtigte Falschaussage zu treffen.

Dies mag allerdings auf die Charta von Venedig von 1964 zurückzuführen sein, dem grundlegenden denkmalpflegerischen Dokument des 20. Jahrhunderts, das klar formuliert „[die Rekonstruktion] findet dort ihre Grenze, wo die Hypothese beginnt."[131] Wenn man also annimmt, man könne den Rohbau als belegbar sehen, die Oberflächenbehandlung aber als zu spekulativ, dann kann dies die „richtige" Lösung sein. Allerdings reibt sich diese Lösung dann am Artikel 12, *„Die Elemente, welche fehlende Teile ersetzen sollen, müssen sich dem Ganzen harmonisch einfügen und vom Originalbestand unterscheidbar sein, damit die Restaurierung den Wert des Denkmals als Kunst und Geschichtsdokument nicht verfälscht."*[132] Für den Laien ist der Neubau nicht unmittelbar zu erkennen; diese Unterscheidung zu sichern war eines der Ziele der Baubestandsaufnahme vor dem Beginn der Sicherungsarbeiten, wird vor Ort aber nicht kommuniziert.

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[130] Interessanterweise sieht man diese „Lösung" häufig bei mittelalterlichen Burgen, aber nicht bei Rekonstruktionen antiker Römischer Gebäude, wie etwa in Carnuntum oder Borg. Dabei ist diese Oberflächenbehandlung für Gebäude beider Epochen belegt.

[131] ICOMOS. „The Venice Charter of 1964". 2nd International Congress of Architects and Technicians of Historic Monuments, Venice., 1964. Verwendet wird hier die Übersetzung auf http://www.charta-von-venedig.de/denkmalpflege-kongress_praeambel_deutsch.html

[132] Ebenda

Dennoch hilft dieser Wiederaufbau, die Burg im wörtlichen Sinne zugänglich zu machen, einen Raumeindruck zu vermitteln, die Interpretation der Innenfassaden und der Aufteilung verständlich zu machen und die nähere Betrachtung der Architekturdetails zu ermöglichen. Außerdem wird durch den Aufbau und das neue Dach die verbleibende Architektur gesichert und vor weiterer Zerstörung bewahrt, und bietet auf der Anlage den einzigen trockenen, überdachten Bereich für Besucher. Das wiederaufgebaute Criechinger Haus dient so nicht nur dem Tourismus, sondern ist auch Veranstaltungsort für die Gemeinde Fels, über der es als sichtbares Wahrzeichen thront. Dies stellt auch ein immaterielles Kulturgut[133] wieder her: die Verknüpfung zwischen der Burg und der Siedlung, wenn auch in abgewandelter Form. Deshalb ist ein solcher Wiederaufbau nicht abzulehnen, sondern er sollte so dokumentiert und präsentiert werden, dass Besucher den Unterschied zwischen Alt und Neu, Relikt und Spekulation erkennen können – zum Beispiel mit Hilfe eines digitalen Modells.

[133] Siehe dazu auch unseren Vorschlag für ein Serious Game zum Aufzeigen der Geschichte der Landschaft um die Burg mittels Flurnamen: Christopher Morse und Marleen de Kramer, *What's in a Name: Gamifying the Intangible History of Larochette, Luxembourg* (Museen der Stadt Wien – Stadtarchäologie, 2019), https://orbilu.uni.lu/handle/10993/41724.

Rekonstruktion der Siedlung

Zur Entstehung der Siedlung Fels schreibt Zimmer nicht viel, trägt nur anhand des Urkatasters die Burg, den Verlauf der Stadtmauer und einen Schwarzplan der übrigen Gebäude auf eine topographische Karte ein. Zum Verständnis der Burg gehört jedoch auf jeden Fall auch ein Blick auf den damit verbundenen Burgflecken, denn beide fungieren als Einheit.

Die gleichen Techniken der Rekonstruktion können auch auf den Ort Fels angewendet werden um Aufschluss über seine Struktur im 16. Jahrhundert zu geben. Manche Elemente sind dynamisch: die Nutzung einzelner Gebäude, die Nebengebäude und zu einem gewissen Grad auch Fassaden und Baustile. Andere überdauern die Jahrhunderte relativ unverändert, wie Topografie, Straßen, Grundstücksgrenzen und die allgemeine Gliederung des Ortes.

Um den allgemeinen Aufbau zu verstehen, beginnt man mit der Stadtmauer und den Ein- und Ausgängen. Auf der Karte[134] sieht es aus, als sei diese Mauer unvollständig und bestehe nur aus einem kurzen Abschnitt im Norden und einem etwas Längeren, gebogenen im Süden. Dies ist allerdings durch den Geländeverlauf bedingt; die Seiten des Tals bestehen aus steilen Felshängen, die eine natürlichen Schutz bieten. Diese Ringmauer wird um 1400 das erste Mal urkundlich erwähnt[135].

Der Verlauf der oberen Mauer ist der Kategorie *Relikt* bis *Extrapoliert* zuzuordnen, da sie in Teilen noch als Ruine vorhanden ist und sonst klar in den Grundstücksgrenzen des modernen Katasterplans zu erkennen ist[136]. Auch an der Stelle des bei Ferraris noch zu erkennenden ehemaligen Wachturms steht bis heute ein Turm, jetzt Teil eines großen Wohnhauses; in der Denkmalliste des Ortes[137] wird dieser allerdings nicht als Teil der Verteidigungsanlage aufgeführt, sondern als später hinzugekommen deklariert – vielleicht eine Wiederverwendung alter Fundamente.

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[134] Vgl. Zimmer 1996, S. 139
[135] Vannérus 1938, S. 13
[136] Siehe den Eintrag zu „Haus Dhame“ in Van Aaken et al 2017 S. 160
[137] Ebenda

Die untere Mauer ist deutlich schwieriger zu verfolgen; sie verlief nicht in einer geraden Linie sondern machte einen Bogen von den Enden der Steilhänge bis fast zum Fluss. Am westlichen Ende beginnt sie an einem Turm mit dem Namen „Verlorenkost“, der wohl als Wachturm gedient hat. Der Verlauf der Mauer entlang des Flusses ist schwerer zu bestimmen, da die Mauer dort im Zuge der Ortserweiterung im frühen 19. Jahrhundert abgerissen wurde, allerdings kann man ihn über Archäologie und frühere Ortsansichten zumindest extrapolieren. Auch das andere Ende der Mauer, wo sie wieder nach Osten auf die Burg zuläuft, ist teilweise erhalten. Ein kleiner Knick in diesem Verlauf suggeriert, dass auch das Gebäude an dieser Stelle schon länger steht und in den Mauerverlauf einbezogen wurde.

Das untere Stadttor wird von Zimmer als rechteckiges Gebäude dargestellt, durch das man anscheinend quer zur Hauptachse die den Ort betritt; als Quelle für die zugrunde liegende Karte wird der Katasterplan von 1810 angegeben. Allerdings handelt es sich hierbei wohl um einen Transkriptionsfehler eines nicht näher untersuchten Gebäudes, denn auf mehreren historischen Ansichten ist auf der rechten Seite der Brücke ein runder Turmstumpf zu sehen, und die Straße verläuft daneben weiter geradeaus. Reuland soll wohl einen zweiten runden Turm links dokumentiert haben, der nicht archäologisch belegt ist, wobei Ferraris nur links einen Turm darstellt und der zweite Turm auch 1810 in einer Akte, nicht aber auf dem Katasterplan oder den Abbildungen auftaucht. Laut Reuland war die Stadtmauer[138] an der niedrigsten Stelle 15 Meter hoch.

Innerhalb der Stadtmauern ist das bestimmende Element einer im Mittelalter gewachsenen Stadt die Platzierung der Kirche, gefolgt von der Lage des Marktplatzes, welche in ihrem Umfeld die Hauptverkehrswege definieren. Auffällig ist deshalb, dass Fels innerhalb seiner alten Stadtgrenzen überhaupt keine Kirche aufweist; die Pfarrkirche Sankt Donatus wurde erst 1862 gebaut und liegt auf der anderen Seite des Flusses. Die mittelalterliche Vorgängerkirche Sankt Nikolas lag bereits

[138] Van Aaken et al, S. 305

Ende des 14. Jahrhunderts „in dem nyedersten furburge“[139], also in der Siedlung im Tal, wurde aber 1824 bei einem Sturm schwer beschädigt und anschließend ersetzt.

Darauf gibt es auch heute noch weitere Hinweise: die Ansichten der Stadt aus dem früheren 19. Jahrhundert und einige Mikrotoponyme im Ort. So führt eine kleine Sackgasse namens „Rue St Nicolas“ zum heutigen Parkplatz mit der Bezeichnung „Kierfecht“. An dieser Stelle sieht man auf den älteren Karten und auf der Darstellung des Ortes nach dem Großbrand[140] am 24. Juni 1865 auch eine Kirche samt Friedhof.

Der heutige Marktplatz, bzw. auch der Großteil der gewerblich genutzen Gebäude im Ortskern befinden sich heute auch südlich der Weißen Ernz, auf einer Parzelle mit dem Flurnamen „op der Bleech“[141], welcher darauf hindeutet, dass es sich um eine ehemalige Wiesenfläche handelt, die auch als Bleiche benutzt wurde. Da es im Ortskern keine Hinweise auf einen größeren Platz gibt fanden dort vielleicht auch bereits während des zu rekonstruierenden Zeitraumes die Jahrmärkte statt; dies ist allerdings *spekulativ*.

Schon seit dem Erlass Johanns des Blinden, welcher der Stadt Fels vier statt des üblichen einen Tuchrahmen[142] zugestand, war die Tuchmanufaktur ein wichtiger wirtschaftlicher Faktor; diese Felser Industrie dauerte bis ins 20. Jahrhundert an[143]. Dass man deshalb sowohl eine große Bleiche als auch eine große Marktfläche benötigte, liegt also nahe.

Die Grundflächen der Wohnhäuser werden sich im Wandel der Zeit nicht nennenswert verändert haben – meist handelt es sich um Reihenhäuser, die Wände mit den Nachbarhäusern teilen und deshalb in Baulücken meist so wieder aufgebaut werden; dies bedeutet auch, dass sich ortstypische Dachneigungen lange erhalten, wenngleich sie in vorbarocker Zeit auch mit dem Giebel zur Straße

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[139] Van Aaken et al, S. 78

[140] Stich von M. Henry de la Fontaine in den *Cahiers Luxembourgeois* 1938, Band 1, Bildtafel nach S. 28

[141] Diesen Namen trägt der Platz noch heute, inzwischen auch auf einem Straßenschild.

[142] Dasburg 1938, S. 111

[143] 1938 ist man sich noch sicher, die Tuchfabrik sei „heute konkurrenz- und exportfähig und kann einer sicheren Zukunft entgegensehen“. Schmitz, J.L., „Fels und die Tuchmacher“, *Les Cahiers Luxembourgeois- Revue Libre des Lettres des Sciences et des Arts - Freie Rundschau für Kunst und Wissenschaft*, 1938. S. 199 – in dieser Ausgabe der Cahiers erscheint auch noch eine Werbeanzeige für die „Draperies de Larochette“

stehen könnten[144]. Für die Rekonstruktion kann man also *extrapolieren*, indem man die Grundmauern zweigeschossig hochzieht und mit einem Satteldach oder bei bedeutenderen Häusern mit einem Krüppelwalmdach versieht; dies schafft einen relativ gesicherten räumlichen Eindruck, wenn auch die Oberflächen und Farbfassungen nicht bekannt sind.

Die Nebengebäude hingegen stehen oft an den Grundstücksgrenzen, man erkennt aber an den Baukörpern, dass sie additiv nachverdichtet werden. Für die spekulative Rekonstruktion dieser Bereiche – Ställe, Werkstätten und Lagerräume – wurden also von der vorhandenen Ansammlung Baukörper entfernt und der Rest in überwiegend eingeschossiger Bauweise mit Sattel- oder Sheddächern dargestellt. Zeitgenössische Abbildungen von solchen oft deutlich weniger langlebigen Gebäuden sind selten; einen Eindruck vermitteln oft Darstellungen der Anbetung des Jesuskindes, auf denen der ansonsten nicht abbildungswürdige Stall gezeigt wird.

Während die Dächer des Altbaubestandes heute größtenteils mit Schiefer gedeckt sind, weiß man, dass die Häuser der „Freiheit Fels“ 1430 noch mit Stroh gedeckt waren und so im Zuge einer Fehde mit den Bürgern Luxemburgs[145] leicht in Brand gesteckt werden konnten. Man kann also im 16. Jahrhundert eine Mischform annehmen, mit Hauptgebäuden aus Stein mit Schieferdächern und Nebengebäuden und ärmeren Häusern aus Fachwerk, mit Stroh gedeckt.

Auch der Straßenverlauf wird im Kern des Ortes weitgehend erhalten bleiben[146], bedingt durch Grundstücksgrenzen und Topografie. Außerhalb der Mauer aber gab es große Veränderungen, denn zwei fast parallele Straßen durch das Ernztal wichen im 19. Jahrhundert einer Einzigen als der Fluss begradigt wurde[147] – dies sollte Platz schaffen für die neue Schmalspurbahn, an welche die inzwischen industrielle Kleinstadt 1882[148] angeschlossen wurde.

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[144] Van Aaken et al, S.153
[145] Dasburg 1938, S. 137
[146] So blieben zum Beispiel auch nach dem Großbrand von 1865 die Grundmauern erhalten, wie auf dem Stich von M. Henry de la Fontaine zu sehen.
[147] Siehe Vergleichskarte
[148] Die Linie Cruchten-Fels war 12,1km lang und vom 20.02.1882 - 02.05.1948 in Betrieb. Vgl. „Ligne Cruchten - Larochette“, zugegriffen 2. September 2021, https://rail.lu/lignecruchtenlarochette.html.

Abbildung 5 - das Urkataster georektifiziert auf der modernen Karte, um die Veränderungen zu zeigen

Den Wandel der Bedeutung des Ortes und seiner Hauptindustrie kann man anhand der kleinen Insel nachvollziehen, die vor dem Stadttor liegt. Stellt Ferraris dort noch eine Wassermühle dar, entstand an dieser Stelle im 19. Jahrhundert der Bahnhof neben dem jetzt begradigten, unterirdischen Fluss. Dieses Bahnhofsgebäude[149] beherbergt heute das Felser Textilmuseum, ein Zeichen für den Tourismus, der inzwischen eine wichtige Einnahmequelle für die Gegend darstellt.

[149] Vgl. Van Aaken et al, S. 264 ff

VI. Digitalisierung

Bereits 1964 wird in der Charta von Venedig bestimmt, dass ein gelungener Denkmalschutz sich „aller Wissenschaften und Techniken bedient, die zur Erforschung und Erhaltung des kulturellen Erbes beitragen können.“[150] Heute gehört dazu auch in jedem Fall die Digitalisierung, nicht nur um ihrer selbst willen sondern als weiteres Werkzeug, das neue Möglichkeiten eröffnet. Ein digitales Modell hilft ebenso, den Artikel 5 der Charta zu erfüllen – die „der Gesellschaft nützliche Funktion“[151] – wie auch Artikel 9, der „vorbereitende und begleitende archäologische, kunst- und geschichtswissenschaftliche Untersuchungen“[152] fordert, und die Spekulation in der Rekonstruktion der tatsächlichen Bausubstanz einschränkt, welche im digitalen Modell problemlos geschehen kann, ohne in die Originalsubstanz einzugreifen.

Das vorhandene volumetrische digitale Modell - erstellt im städtebaulichen Maßstab nach Zimmers Zeichnungen - dient primär zur Übersicht der Theorie, die bereits in perspektivischen Zeichnungen erfasst wurde, um so auch verdeckte Bereiche sichtbar zu machen, räumliche Zusammenhänge klarzustellen und den Kontext zu ergänzen. Fotorealismus wird dabei bewusst vermieden, um durch Abstraktion klarzustellen, dass es sich um eine Theorie über den räumlichen Aufbau handelt.

Um diese Theorien den Besuchern vor Ort zu vermitteln oder auch um sie zu vergleichen wäre ein segmentiertes Modell mit einem höheren Detaillierungsgrad hilfreich. Als Basis dafür dient üblicherweise eine Aufnahme des „Relikts“ mittels Laserscan oder Fotogrammmetrie[153], was einer größer angelegten Datenakquiseaktion entspricht, die für ein größer dimensioniertes Projekt aufgespart werden muss. Einige Teilbereiche des Criechinger Hauses wurden jedoch bereits

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[150] Artikel 2 der Charta von Venedig, ICOMOS 1964

[151] Ebenda

[152] Ebenda

[153] Es wurde bereits bei der ursprünglichen Baubestandsaufnahme mit damals noch analoger Fotogrammmetrie gearbeitet. Allerdings sind diese Aufnahmen nicht verfügbar und werden auch im Buch nicht behandelt. In unserem Gespräch 2018 erklärte John Zimmer, er würde von solchen Digitalisierungsmethoden auch nichts halten, da die manuelle Aufnahme immer genauer wäre. Allerdings lässt sich mit beiden Verfahren inzwischen eine Genauigkeit im Submillimeterbereich erzielen, wo sie benötigt wird.

mittels 3D-Fotogrammmetrie digitalisiert, um zu zeigen, wie aufgenommene Architekturdetails ein ansonsten neu gezeichnetes Modell zu einem Hybriden ergänzen können, der an den kritischen Stellen der „wahren“ Geometrie entspricht. Ein solches Verfahren wurde auch bereits für das volumetrische Modell angewendet, bei dem die Topografie aus einem mittels LiDAR aufgenommenen Terrainmodell[154] generiert wurde.

Abbildung 6 - Fotografie eines verzierten Sturzes im Criechinger Haus

[154] Modèle numérique de terrain avec un maillage de 5x5m, Datum - Projection : LUREF EPSG2169, Administration du cadastre et de la topographie Luxembourg

Abbildung 7 - Fotogrammetrische Aufnahme des gleichen Architekturdetails als 3D-Oberfläche

Diese Aufnahme erzeugt eine Punktwolke, aus der dann eine Oberfläche generiert wird; diese wird je nach Nutzung dann weiterverarbeitet – bereinigt, selektiv vereinfacht, und mit einer Textur versehen – um dann in das digitale Modell eingepasst zu werden. Andere Bauteile werden „durchgepaust“, um reduziertere Formen zu erhalten; dies macht einerseits die Struktur klarer, vereinfacht aber auch die Geometrie, um bessere Rechenleistung zu erzielen. Wo dies geschieht, hängt von der geplanten Endanwendung ab; ein hochauflösendes Rendering in einer Zeitschrift benötigt eine andere Herangehensweise als ein kleines Modell in einer Handy-App.

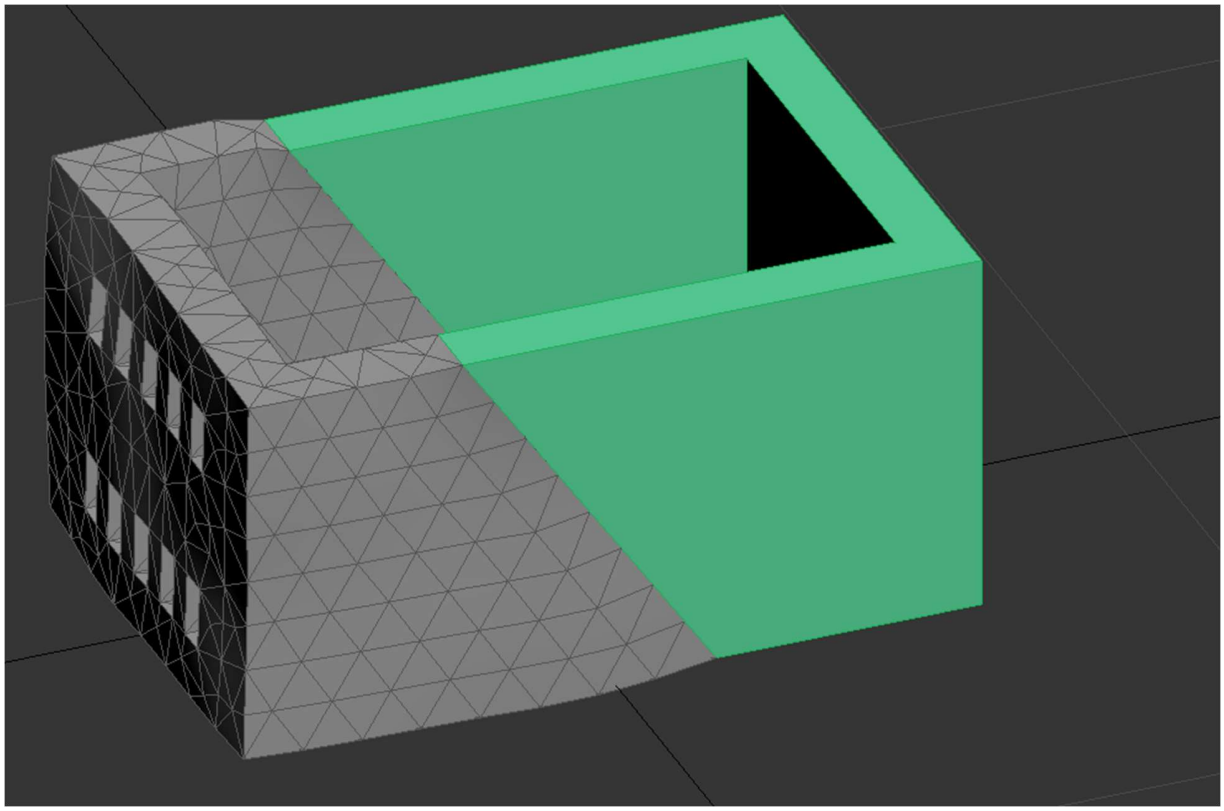

Abbildung 8 - Vereinfachung einer Geometrie

Auf dieser Basis kann man dann fehlende Bauteile zeichnerisch ergänzen; dabei geht man oft in der gleichen Reihenfolge vor, wie im materiellen Bauwesen, um sicherzustellen, dass die Theorie auch „funktioniert“ – zum Beispiel werden erst die Deckenbalken auf den Kragsteinen platziert und anschließend mit Fußböden beplankt. Nicht jede Theorie bedarf einer dreidimensionalen Darstellung; wenn es zum Beispiel um Materialien, Oberflächen oder Farbfassungen geht, reicht es auch, eine zweidimensionale Abbildung darauf zu projizieren, also das Modell zu texturieren.

Konkurrierende Interpretationsmöglichkeiten können dabei einfach verglichen werden, indem verschiedene Elemente an- und ausgeschaltet werden, um unterschiedliche Theorien zu zeigen oder Bauphasen darzustellen.

Dies kann auch dynamisch, vom Anwender gesteuert geschehen, oder aber der Anwender kann einzelne Teile auswählen, um damit zu interagieren. Dazu wird das Modell segmentiert, also in

logisch zusammenhängende Bereiche zerteilt, denen dann unterschiedliche Funktionen zugeordnet werden können. Dies könnte zum Beispiel sein:

- Die fotorealistischen Oberflächentexturen durch Farben zu ersetzen, die den Gewissheitsgrad, die Bauphase oder die Funktion der Teile darstellen.
- Damit Verknüpfte Textinformationen anzeigen.
- Den ausgewählten Bereich vergrößern/mit höherer Auflösung darstellen.

Dieses Modell muss dann nicht nur geschaffen, sondern dauerhaft zugänglich gemacht werden – also nicht dem Fehler unterliegen, nur für eine Publikation, eine Konferenz oder eine Ausstellung verwendet zu werden und dann wieder zu verschwinden; so wäre es eine Illustration, aber keine eigenständige wissenschaftliche Ressource – siehe hierzu auch die Metastudie von Champion & Rahaman[155], die aufzeigt, dass von 1483 untersuchten Papers zu digitalem Kulturerbe keines den Zugang zum besprochenen digitalen Objekt ermöglichte. Dies bedeutet wiederum, dass es so beschaffen sein muss, dass es auch in Zukunft technisch zugänglich bleibt, ein Problem, dem traditionelle Zeichnungen und Modelle nicht unterliegen, und einer angemessenen Langzeitarchivierung bedarf.

So wird ein digitales Modell dann auch keine Neuerfindung des Rads, sondern eine Weiterentwicklung der traditionellen Methodik nach wissenschaftlichen Grundsätzen, ist überprüfbar, replizierbar und zitierbar.

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[155] Erik Champion und Hafizur Rahaman, „3D Digital Heritage Models as Sustainable Scholarly Resources“, *Sustainability* 11, Nr. 8 (Januar 2019): 2425, https://doi.org/10.3390/su11082425.

Future Work

Clearly, the next step – which is outside the scope of this work – is the creation of a new reconstruction independent of the previous interpretations, well-documented from its inception using the new Dokuvis[41] tool. In order to meet the needs of its end users, this should be preceded by a report investigating who these users and other stakeholders are, which resources are available, and where and in which format the end result is to be displayed; this must also cover the available expertise and technical solutions to ensure that the virtual model is fulfilling a particular purpose and not being made simply because "digital" is the fashion of the day.

Furthermore, especially when dealing with medieval subjects, we must keep in mind that they have been depicted in popular culture over the past several hundred years, from Romanticism's "melting away […] the very notion of objective truth"[42] in favour of inventing their own artistic renderings that express their inner vision, to today's re-enactment hobbyists recreating "the Middle Ages as they should have been"[43] or the current representations of the past in media such as television series or video games.

This has given rise to some dearly-held but erroneous belief formed from a certain level of general knowledge, which the introduction to Paul Sturtevant's *The Middle Ages in Popular Imagination: Memory, Film and Medievalism* summarises thus:

> *"It is often assumed that those outside of academia know very little about the Middle Ages. But the truth is not so simple. Non-specialists in fact learn*

[41] 'DokuVis – Documentation Tool for Digital 3D Reconstructions'. Accessed 10 September 2021. http://dokuvis.org/#!/home.

[42] Berlin, Isaiah. The Crooked Timber of Humanity: Chapters in the History of Ideas – Second Edition. Princeton University Press, 2013. p. 60

[43] Muhlberger, Stephen. 'The Middle Ages as They Were, or As They Should Have Been?' Presented at the Conference 'The Middle Ages in Contemporary Popular Culture', McMAster University, Ontario, 1996. https://uts.nipissingu.ca/muhlberger/SCAREC2.HTM.

> *a great deal from the myriad medievalisms – post-medieval imaginings of the medieval world–- that pervade our everyday culture. These, like Lord of the Rings or Game of Thrones, offer compelling, if not necessarily accurate, visions of the medieval world. And more, they have an impact on the popular imagination, particularly since there are new medievalisms constantly being developed, synthesised and remade. But what does the public really know? How do the conflicting medievalisms they consume contribute to their knowledge? And why is this important?"*[44]

We cannot, therefore, assume that our audience starts from a position of ignorance – this would carry the risk of having them become bored of what they consider redundant information or feeling condescended to – but must carefully investigate what is known, what is thought to be known, and what is new, then communicating the updated information in a narrative compelling enough to replace the preconceptions.

Furthermore, users must be introduced to the uncomfortable ambiguity inherent in such models – we must communicate that this, like all history, is not "the truth", but a more or less accurate theory, describe how it was formed and how it might be adapted in future. This requires truly interdisciplinary work, moving beyond architectural history and 3D modelling into digital storytelling, educational psychology, and user experience design.

Carefully implemented, it can very much enhance the visitor experience and educational value of a heritage site or a virtual visit.

Conclusion

The problem of documentation, of enriching a reconstruction with the necessary data and paradata to make it a reliable scholarly resource and tool for communicating with the public, is significant, and its solution non-trivial.

[44]Sturtevant, Paul B. The Middle Ages in Popular Imagination: Memory, Film and Medievalism. Bloomsbury Publishing, 2018.

In reality, it consists of two separate problems: gathering and recording the metadata and paradata, and communicating them to others, who may or may not have specialised knowledge in the field. This does not mean only the general public – museum visitors, school groups, heritage open days attendees, readers of magazines and video gamers – but also professionals of other disciplines that may be involved in an interdisciplinary project.

Some standard data formats to record provenance of both objects and knowledge have been developed and are being deployed successfully, but mostly at an institutional level. They are still highly complex and require specialised work environments and technical resources, and no such standards yet exist for paradata – nor is there even a general awareness of paradata and their importance.

Whether through what they learned at school, through their work, or even just by reading the citations on Wikipedia, most end users will understand footnotes and image captions. However, they are currently not used to seeing them in 3D models, which do not yet have easily recognisable conventions. The problem, then, goes beyond which format to use and how to implement it – it means educating the users to expect such data, communicating that there is more information to be found and what its significance is.

This is the same general issue of finding communication paths and a common vocabulary to facilitate interdisciplinary projects, in which the approaches, mindsets, and awareness of the parties involved can vary greatly even if – or perhaps, because – they are all experts in their fields.

Therefore, much like any successful project, a reconstruction must start with an analysis of its purpose and who will be using it.

Because reconstructions depend.

Selected Bibliography

The papers that make up this thesis are self-contained and each include their own citations in the style preferred by their corresponding publication venues. This is not, therefore, an exhaustive bibliography, but contains items of particular interest or significance and omits minor citations, links to datasets, or negative examples.

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Appendices

Appendices included in this document

- Supplementary images
- The survey used in the 4th paper, “Understanding by Doing – Guided Decision-Making as a Tool for User Engagement with Reconstructions”

Digital appendices

Further supplementary data can be found online at:

https://tinyurl.com/Appendices-MCK-Thesis

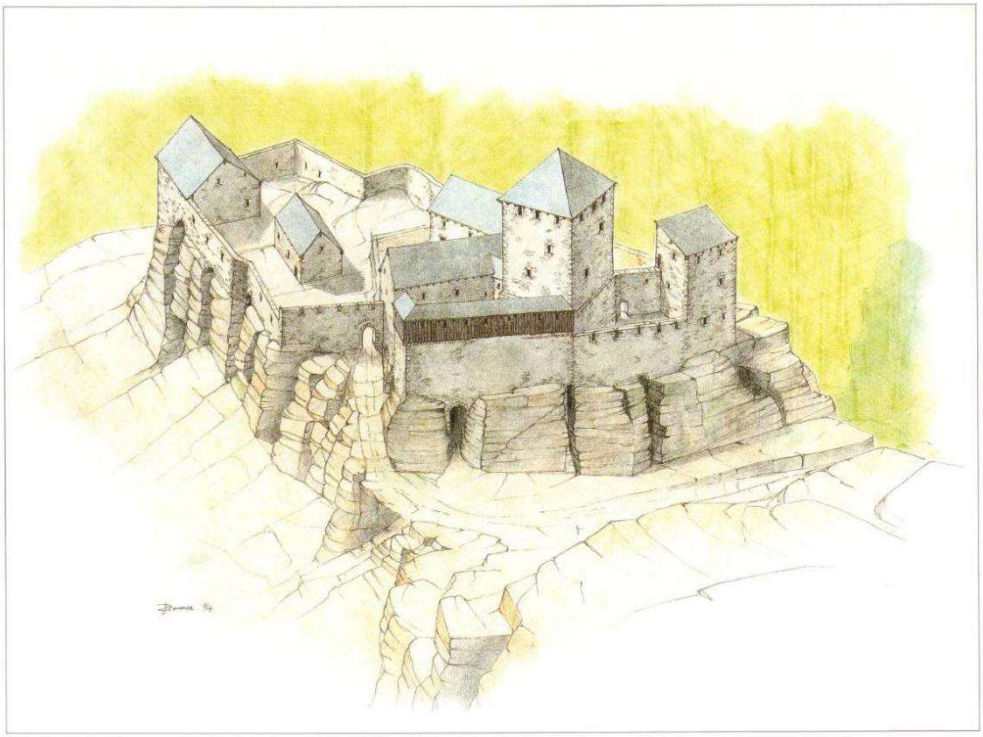
These include:

- An English translation of the German paper
- Copies of the surveys as Google Forms
- Survey results as spreadsheets with encoding and analysis
- Further photographs
- GIS files
- The TEDx talk pertaining to this project

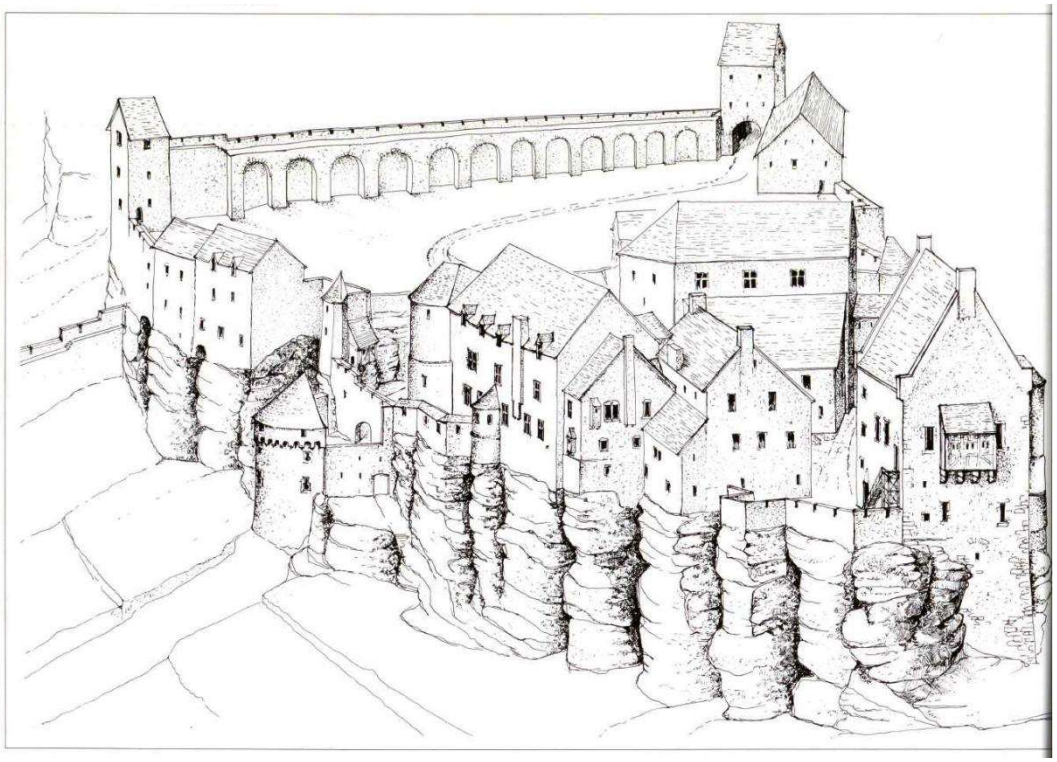
Supplementary Images

Reconstructions by John Zimmer

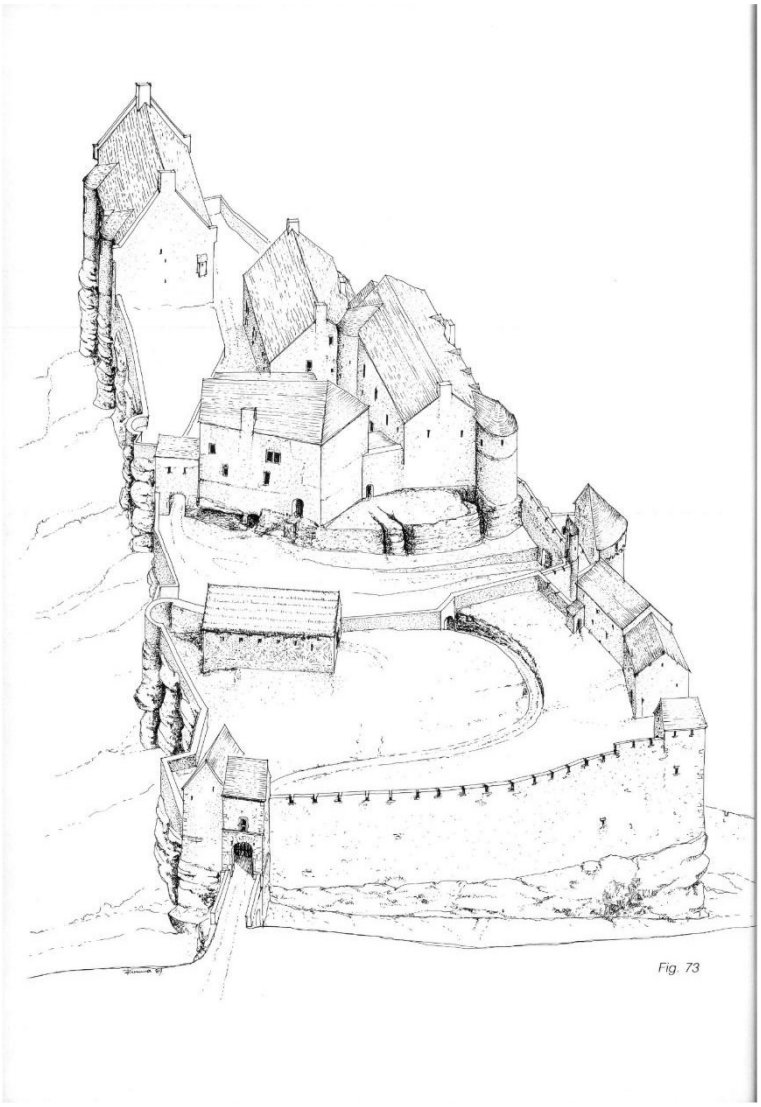
Phase 1 as reconstructed by John Zimmer, from Zimmer 1996, p. 200



Phase 2 as reconstructed by John Zimmer, from Zimmer 1996, p. 202

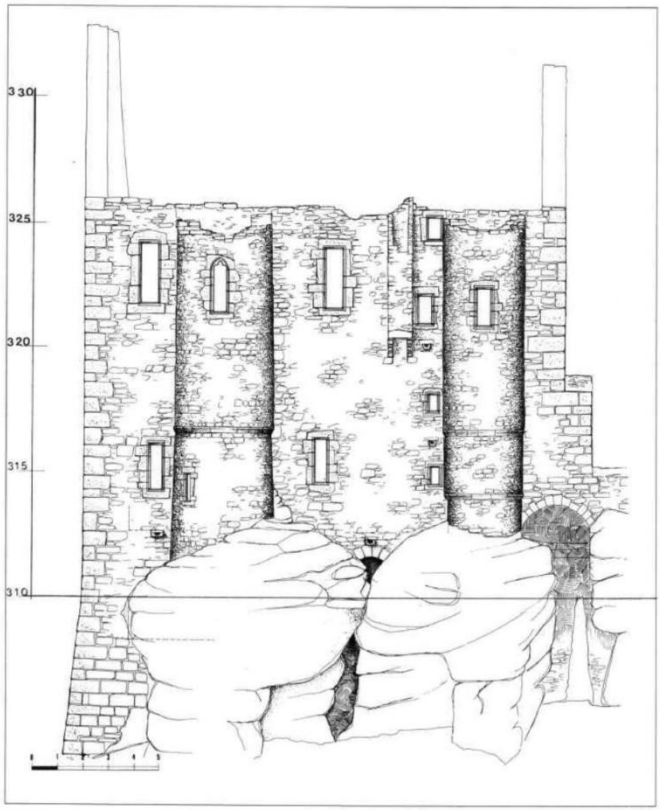


Phase 3 as reconstructed by John Zimmer, from Zimmer 1996, p. 204

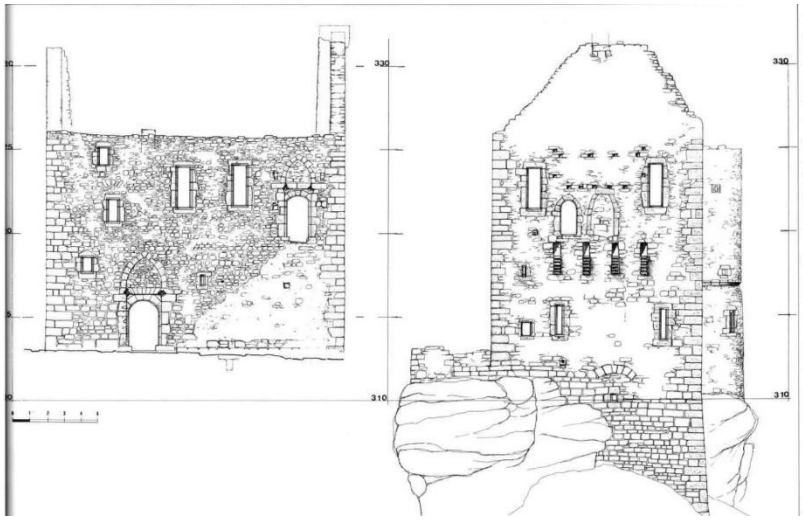


Phase 3 as reconstructed by John Zimmer, from Zimmer 1990

Samples of Architectural Survey by John Zimmer

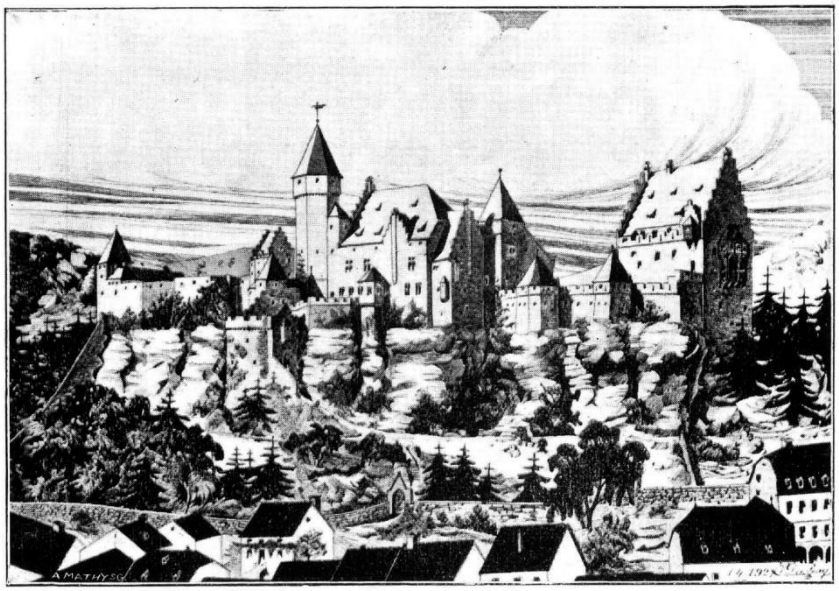


Zimmer 1996, p. 159 f



Reconstructions by JP Koenig

From the Cahiers Luxembourgeois, 1938. Drawings completed before 1919.

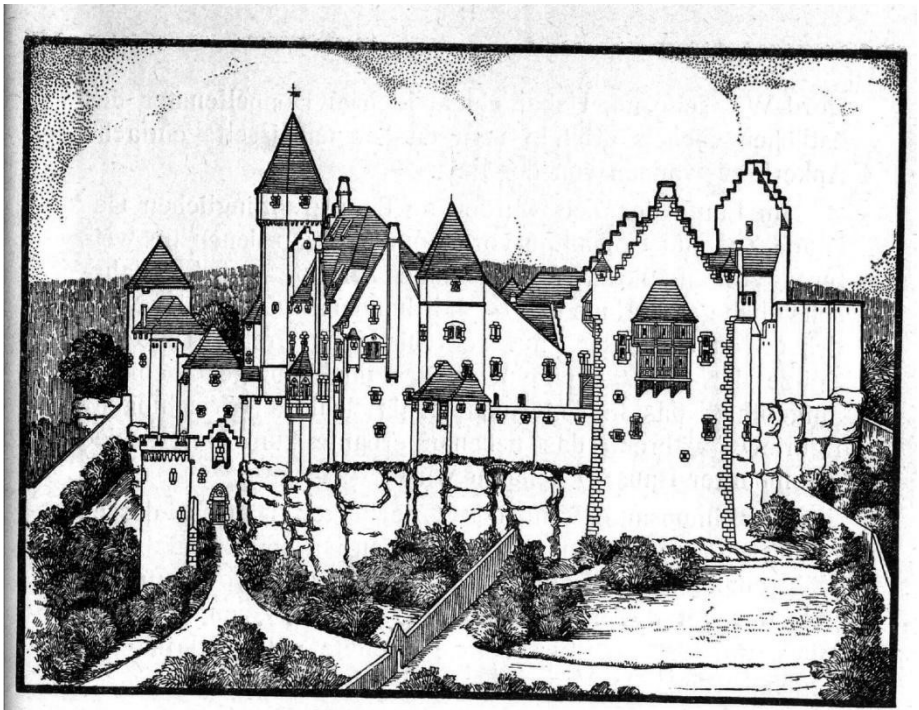


RECONSTITUTION DES CHATEAUX DE LAROCHETTE

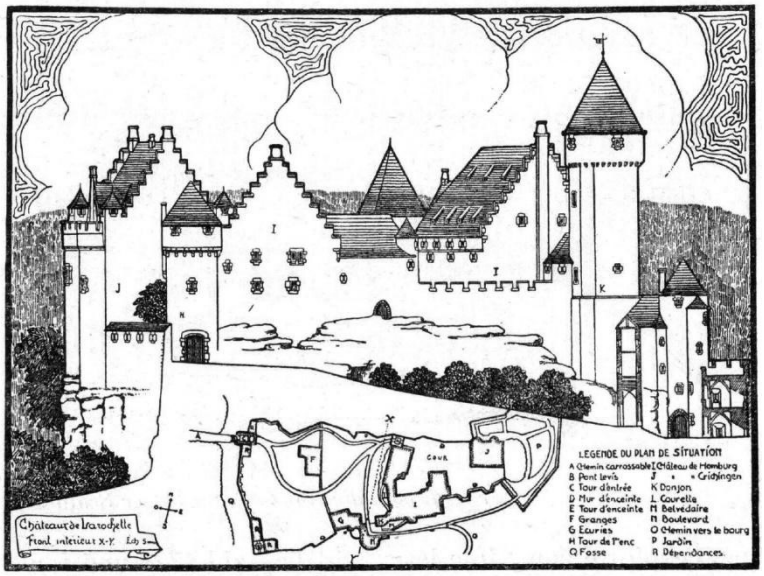
Projet : J.-P. Koenig, architecte, — La vue est prise du sud-est.

Au centre : le château de Hombourg. — A droite : Le château de Créhange. A l'extrême gauche : le mur d'enceinte.

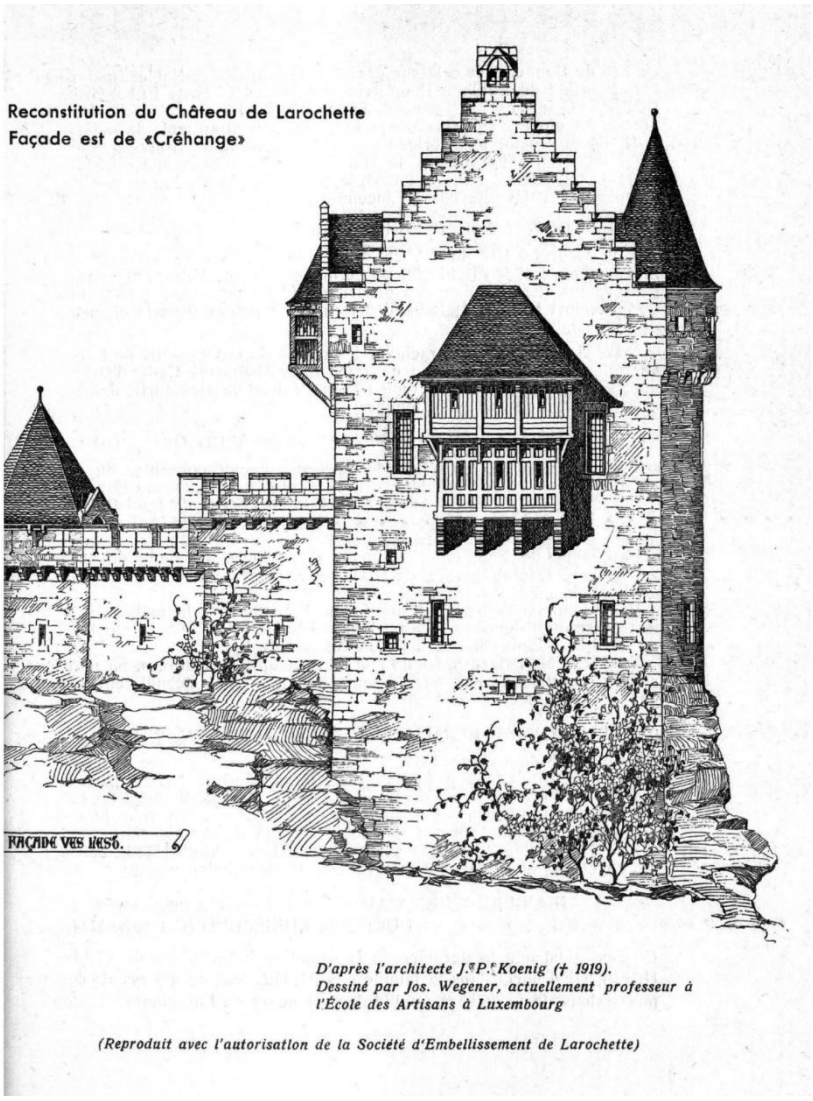
(Cliché : Société d'Embellissement de Larochette)



Rekonstitution des Felser Schlosses (von J. P. König)

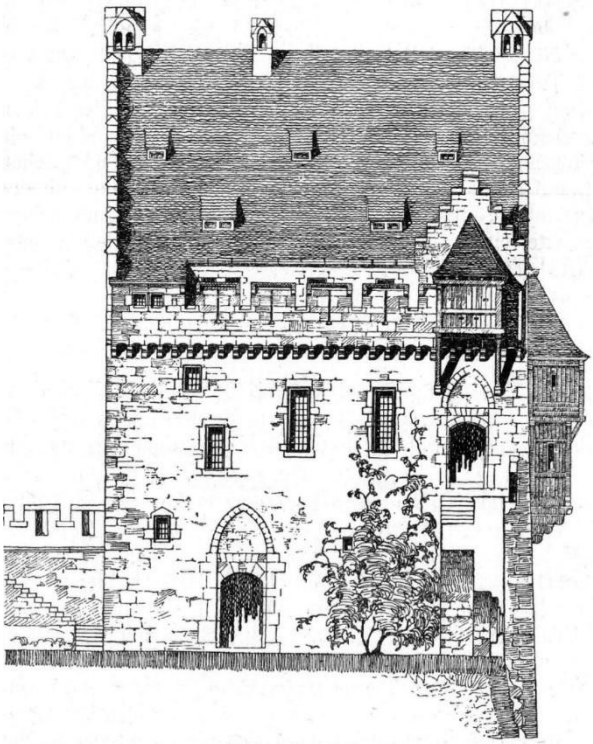


Die Rekonstitution des Felser Schlosses (J. P. Kœnig) vom Elsbethplateau aus gesehen (Nord-Westseite)



D'après l'architecte J.P. Koenig († 1919).
Dessiné par Jos. Wegener, actuellement professeur à l'École des Artisans à Luxembourg

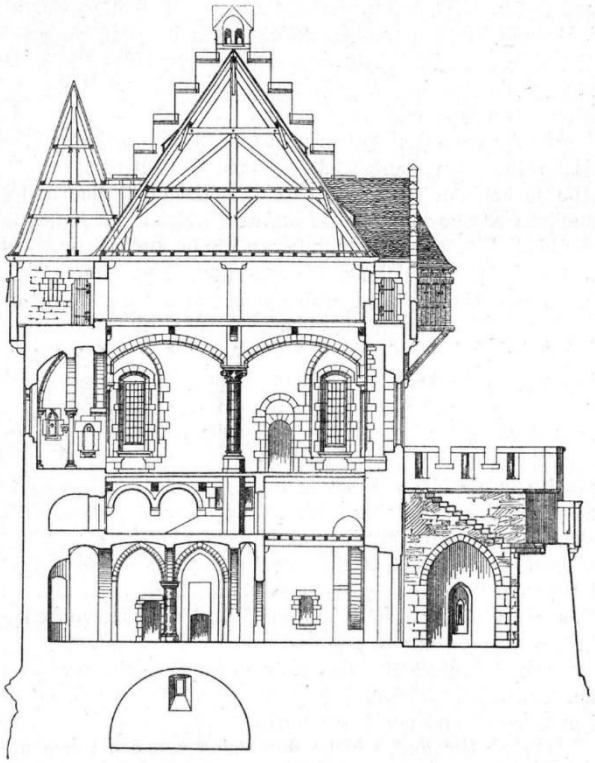
(Reproduit avec l'autorisation de la Société d'Embellissement de Larochette)



Schloss Criechingen von Süden gesehen
(Zeichn. J. P. Koenig und J. Wegener)

Mit Genehmigung des Verschönerungsvereins

2



Querschnitt A—B durch das Criechinger Gebäude
(Zeichnung Koenig und Wegener)

Mit Genehmigung des Felser Verschönerungsvereins

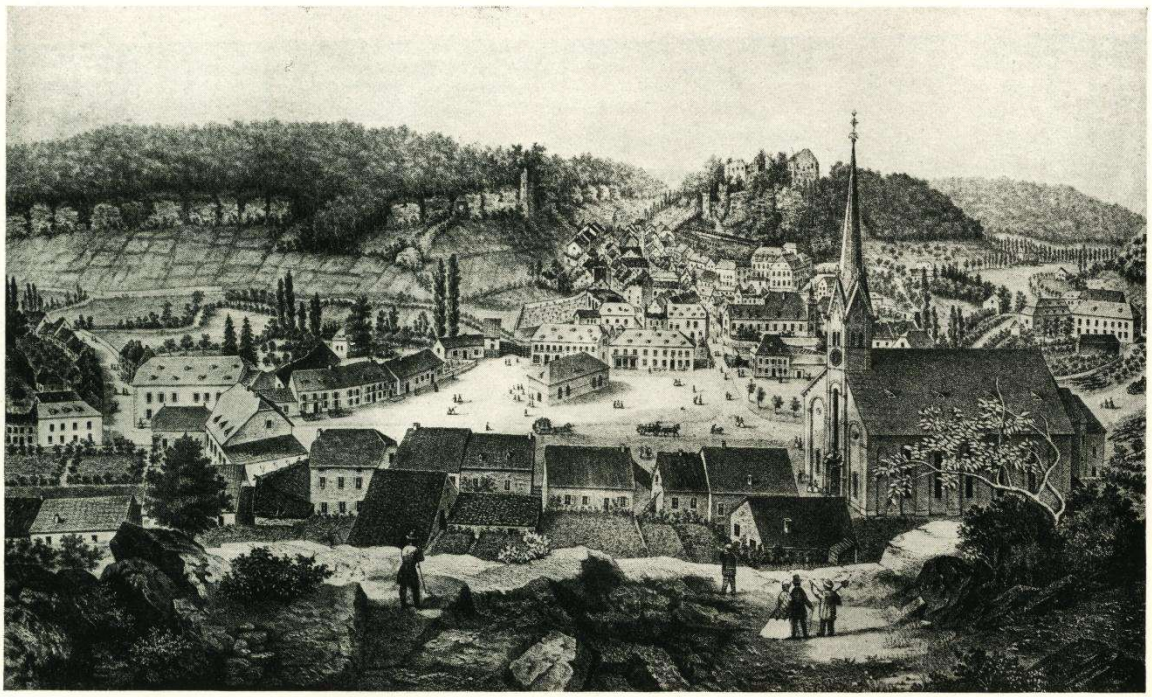
69

The Scale Model

19th-Century Depictions

LAROCHETTE - GRAVURE PAR J. B. FRESEZ, DATANT DE 1853

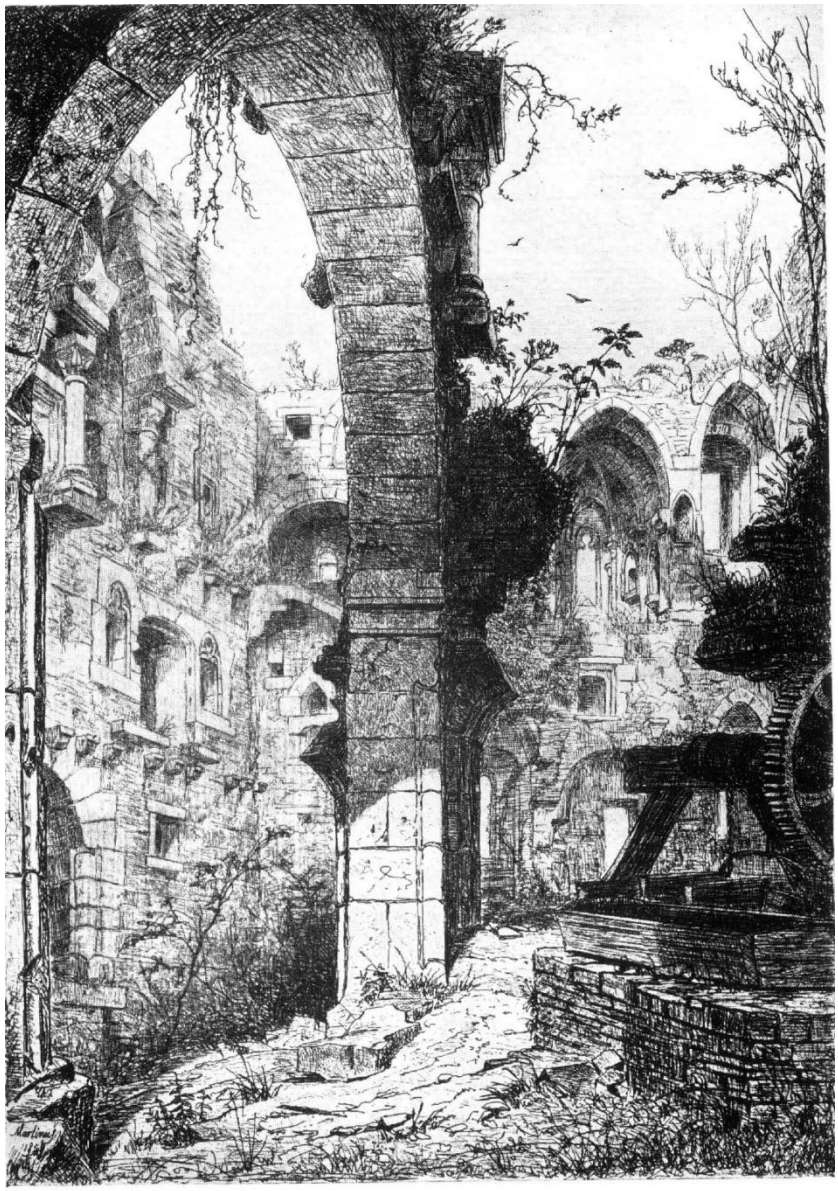
Au gauche : la Croix de justice sur son emplacement primitif et l'ancienne Église St. Nicolas, démolie en 1860.



LAROCHETTE APRÈS L'INCENDIE DE 1865

Au centre de la Place dite „Bleiche" l'ancienne Ecole communale où Michel Rodange enseigna de 1854 – 1859

(Cliché de la Société Philharmonique) *(Gravure appartenant à M. Henry de la Fontaine)*

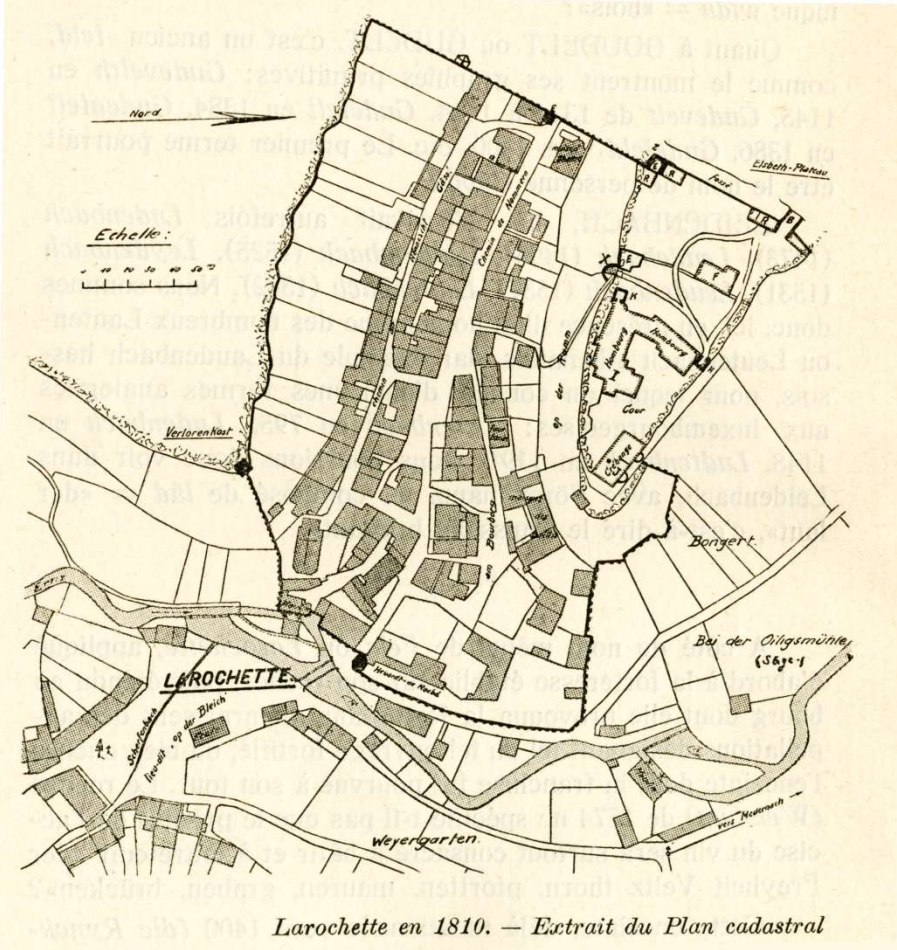


DIE PETERSKIRCHE (CRIECHINGER SCHLOSS) IM JAHRE 1865

Composition von M.-A. Kuytenbrouwer

Early Maps

From the Ferraris Atlas, 1777



Larochette en 1810. — Extrait du Plan cadastral

From the Cahiers Luxembourgeois

Castle Photographs

Survey

The following is a print-out of the survey used for the study presented in the fourth paper, in the English Adult version. There are four slightly different versions in total: English Adult and Youth and German Adult and Youth. To see them as presented, and view the other three, please refer to the digital copies under the link provided above.

Reconstructing the Historic Town of Larochette, Luxembourg and its Castle

Responsible researcher: Marleen de Kramer, C²DH/IHIST, University of Luxembourg
marleen.dekramer@uni.lu

* Required

Welcome!

I'm inviting you to take part in this survey as part of my research at the University of Luxembourg. Participation is entirely voluntary, and you can choose to withdraw at any point. There are no wrong or right answers.

Goals

The purpose of this study is to see how going through a guided reconstruction process can help you better understand building reconstructions. This is part of my PhD research in documenting historic reconstructions.

Limits

Due to university guidelines, this study is limited to adult participants. If you are under 18, you are welcome to try the youth version available at [LINK]. As the study relies on interpreting images, it is unfortunately not accessible for visually impaired users. A screen larger than a mobile phone is recommended, but not necessary.

Process

You will be asked to look at different historic images of buildings, then decide which reconstruction you think is more likely, along with your reasoning.

You will be asked some questions about your age and educational background, but nothing that could identify you personally. You may skip any questions about yourself that you do not want to answer.

Survey Structure - total time approximately 20 minutes

1. Introduction to Larochette
2. Quiz Part 1 - Gatehouse
3. Quiz Part 2 - Castle Buildings
4. Questions About You

Data Storage and Use

Replies to this survey are submitted through a dedicated Google account. Results will be analysed and published as part of my PhD thesis in Digital History, but will not be linked to individual respondents. An anonymised data set may be published by the university as part of its open data initiative.

1. Consent confirmation *

Mark only one oval.

I am 18 or older, understand how my data will be used and agree to participate.

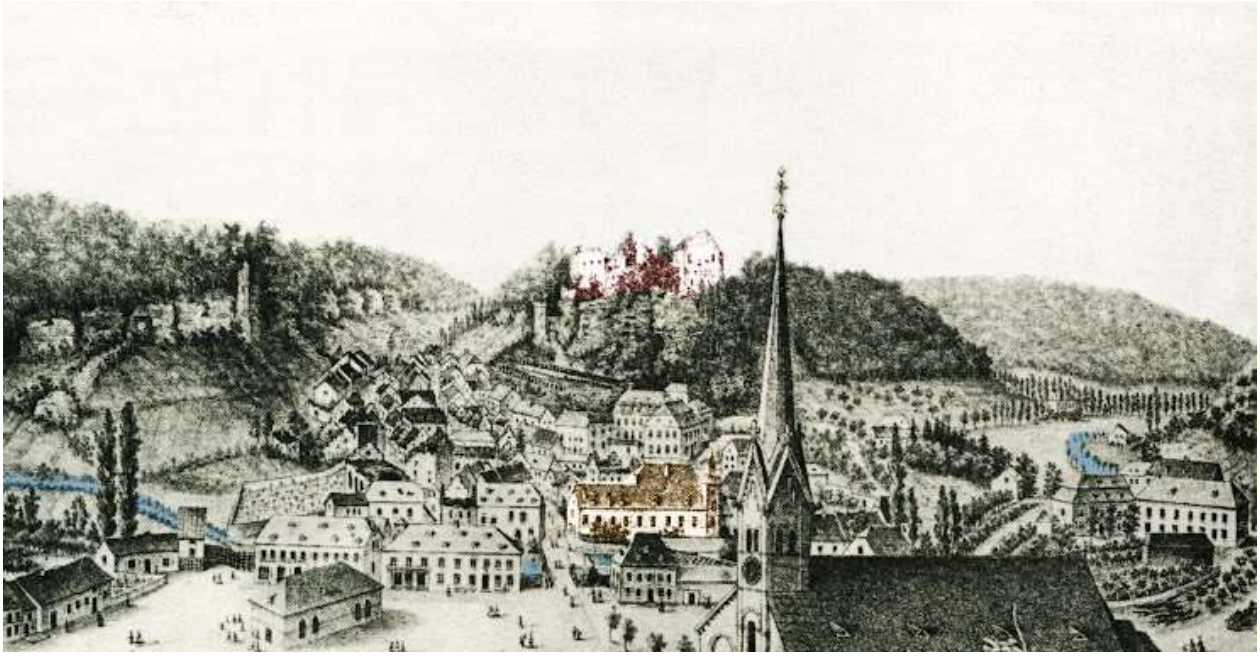
Introduction to Larochette

Larochette is located in central Luxembourg, near Mersch.

Larochette Town (Luxembourgish: Fiels, German: Fels)

The town of Larochette lies in a small valley beside the White Ernz river, along the road connecting the more significant towns of Mersch and Echternach where it crosses a historic trade route between Diekirch and Luxembourg City. It is known to have been settled as far back as the Celtic era. In the Middle Ages, it was enclosed by a high wall meeting the steep cliffs on both sides to surround the town.

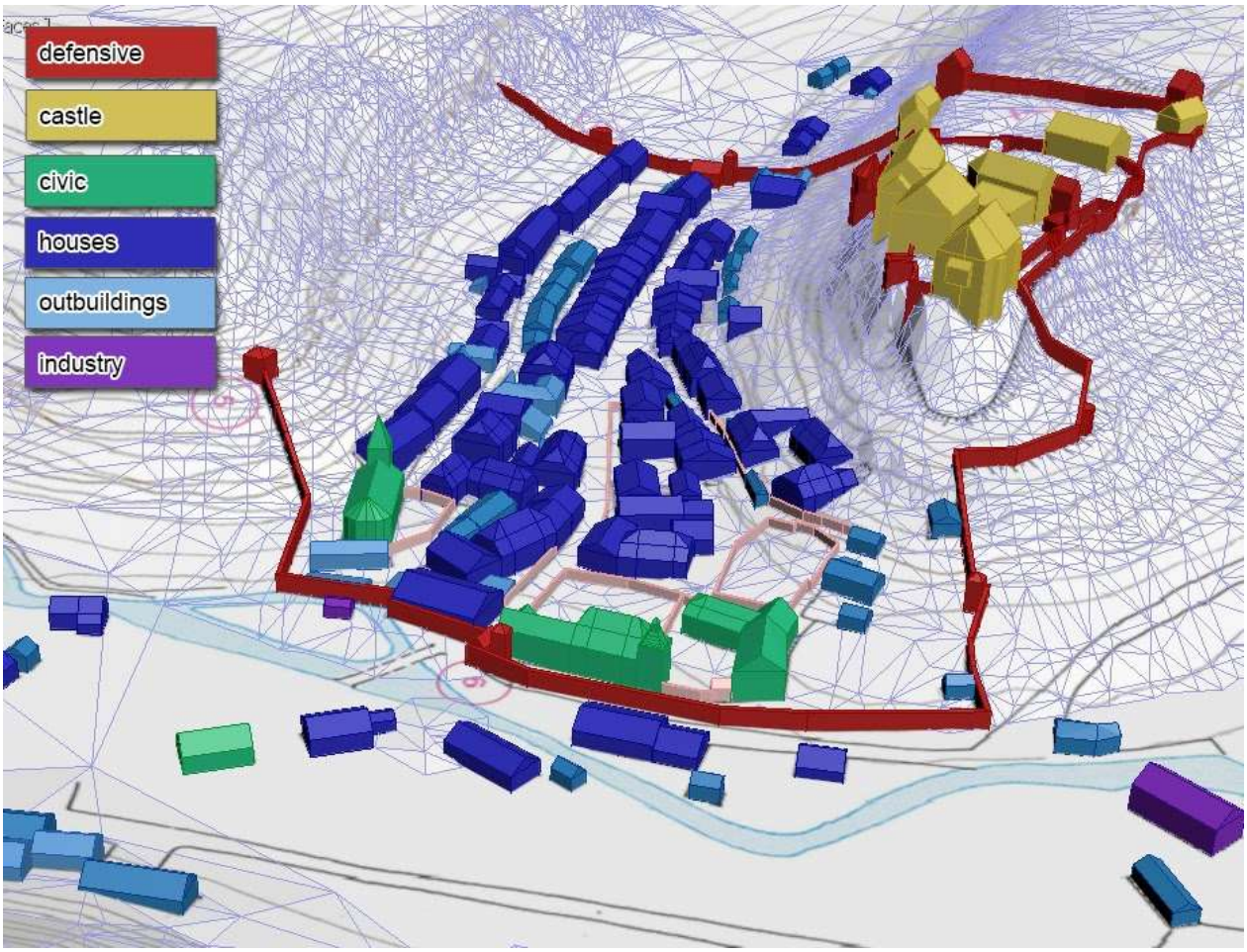
A view of the town from the southeast around 1865, with the castle ruins visible on the cliff above.



Larochette Castle

The castle sits high on the cliff after which the town is named. It is presumably built on the foundations of an older Roman fortress. The castle was founded in the 12th century and progressively expanded until it was destroyed in a fire in 1565. Because the castle was shared by up to five families, it contained several large manor houses as well as the usual defensive structures and outbuildings. The castle is a ruin today, but still a popular visitor attraction.

A model of the historic town showing the functions of the buildings



More information?

If you would like more information about Larochette's history, please download the info sheet at [LINK] - you can refer to it during the survey.

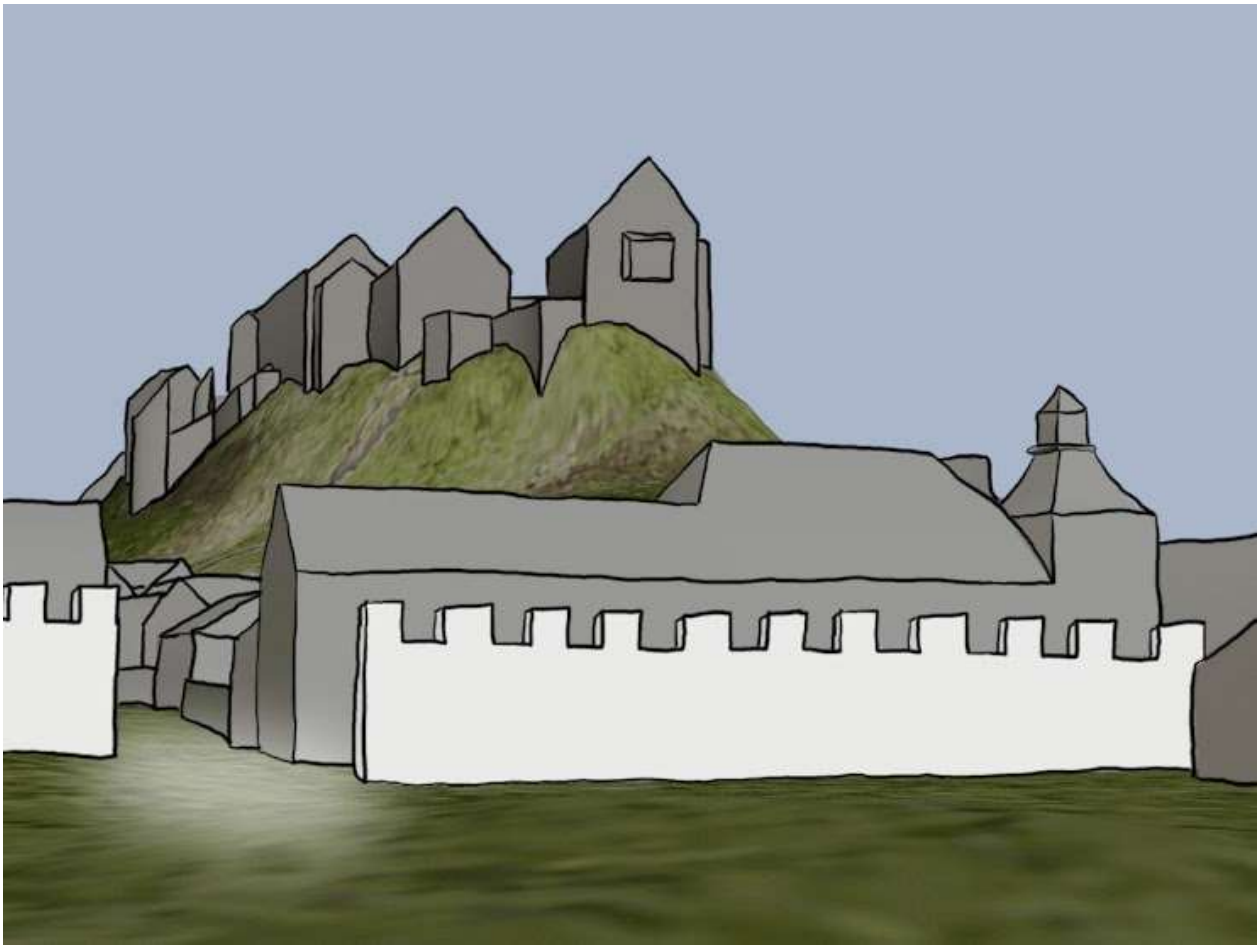
Image credits

Excerpt of the historical view of the town from "Les Cahiers Luxembourgeois - Larochette", 1938

Pick a Gatehouse!

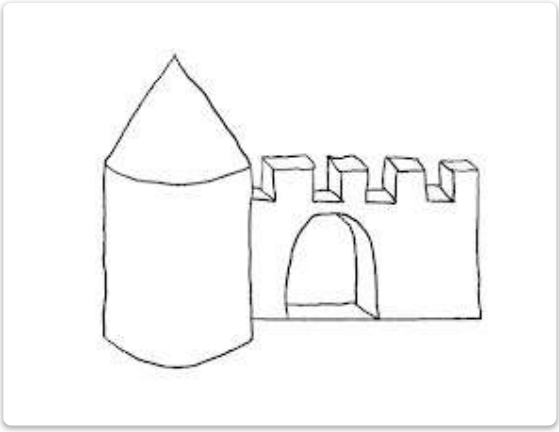
This is modern-day Larochette. While the ruins of the castle still overlook the town, the river is now built over and you can simply walk in, as the town walls are gone.

This sketch of 16th-century Larochette is drawn from the same viewpoint. It's only missing the lower gate, which closed the gap in the wall (to the left of the image). No trace of the gate remains in the modern town. Unfortunately, no images or descriptions from the time have survived, either, so we don't know exactly what went here! Instead, we can only try to reconstruct it from later sources.

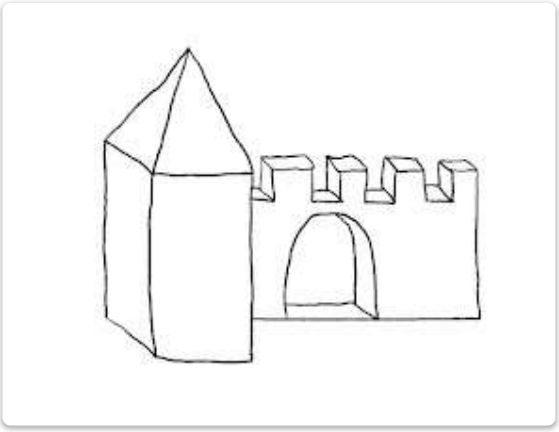


2. Please start by picking the gatehouse you think would fit best in this gap in the wall. *

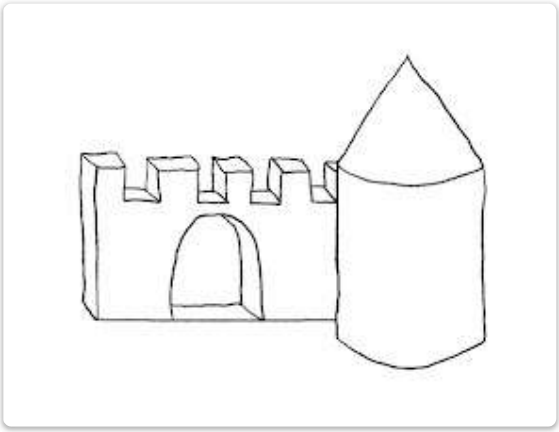
Mark only one oval.



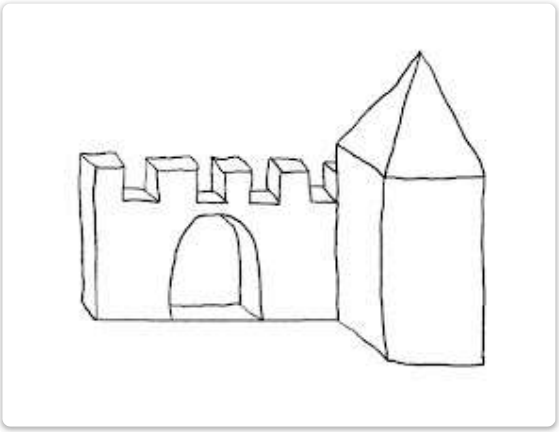
Round tower on left



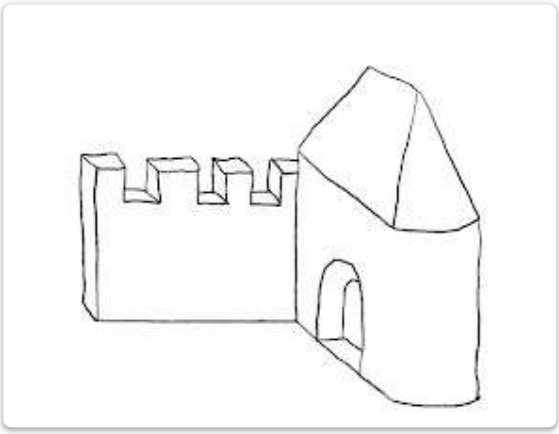
Square tower on left



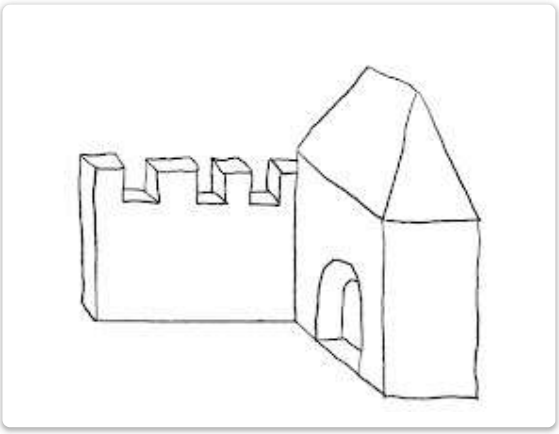
Round tower on right



Square tower on right



Gate in round tower



Gate in rectangular tower

3. How certain are you that this is the correct gatehouse? *

Mark only one oval.

	1	2	3	4	5	
Not at all certain	◯	◯	◯	◯	◯	Very certain

4. Why did you choose that version? *

Looking at sources

Now, we'll look at some historic sources and see whether they match your first choice!

Position of the Tower

Some of the earliest information we have about the town comes from historic maps. They include the tower of the gatehouse.

The Ferraris Atlas contains the earliest known map of Larochette, dated 1778. The highlighted area shows the road running toward the town, across the bridge and to the gate.

The first official cadastral map of Larochette, dated 1824. It also shows the river, the bridge, and the tower.

5. These historic maps don't agree on whether the tower was on the left or the right side of the bridge. Which one do you believe? *

Mark only one oval.

Left

Right *Skip to question 9*

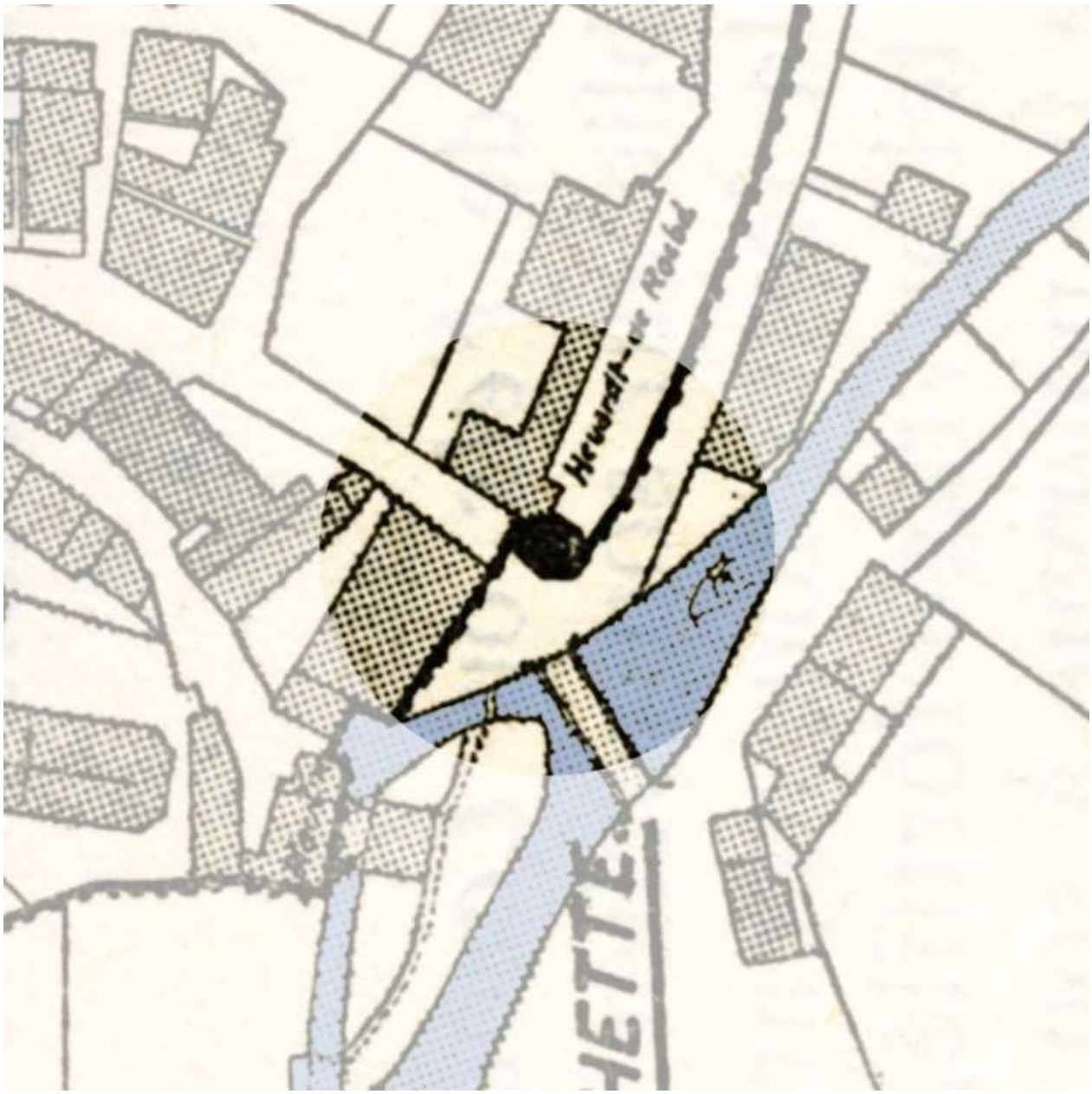
6. How did you decide which one to believe? *

Image credits

Excerpt of the Ferraris Atlas via the Royal Library of Belgium (KBR)
Excerpt of the cadastral map via the Luxembourg Land Registry and Topography office (ACT)

Are you sure?

7. This map, which was drawn in 1933 but is based on a map from 1810, also shows the tower on the right side of the bridge. Are you sure you want to position it on the left? *



Mark only one oval.

- ◯ No, I think it's on the right after all.
- ◯ Yes, I'm sure. It's on the left.

8. Why did you make that choice? *

Image credits

Map excerpt from "Les Cahiers Luxembourgeois - Larochette", 1938

Shape of the Tower

Different historic drawings of the town include views of the remains of the tower.

1800

1845

1883

9. Based on these images of the ruins, what shape do you think the tower was? *

Mark only one oval.

- ◯ round
- ◯ rectangular

10. Why did you pick that answer? *

Image credits

1800 image excerpt from "Les Cahiers Luxembourgeois - Larochette", 1938
1845 and 1883 image excerpts from the Luxembourg National Museum of History and Art (MNHA) exhibition catalogue for "Gemalt für den König - B.C. Koekkoek und die luxemburgische Landschaft"

Direction of the Road

The town gate controls traffic into the town - but how was the traffic directed through it?

Map of two possible ways into the city.

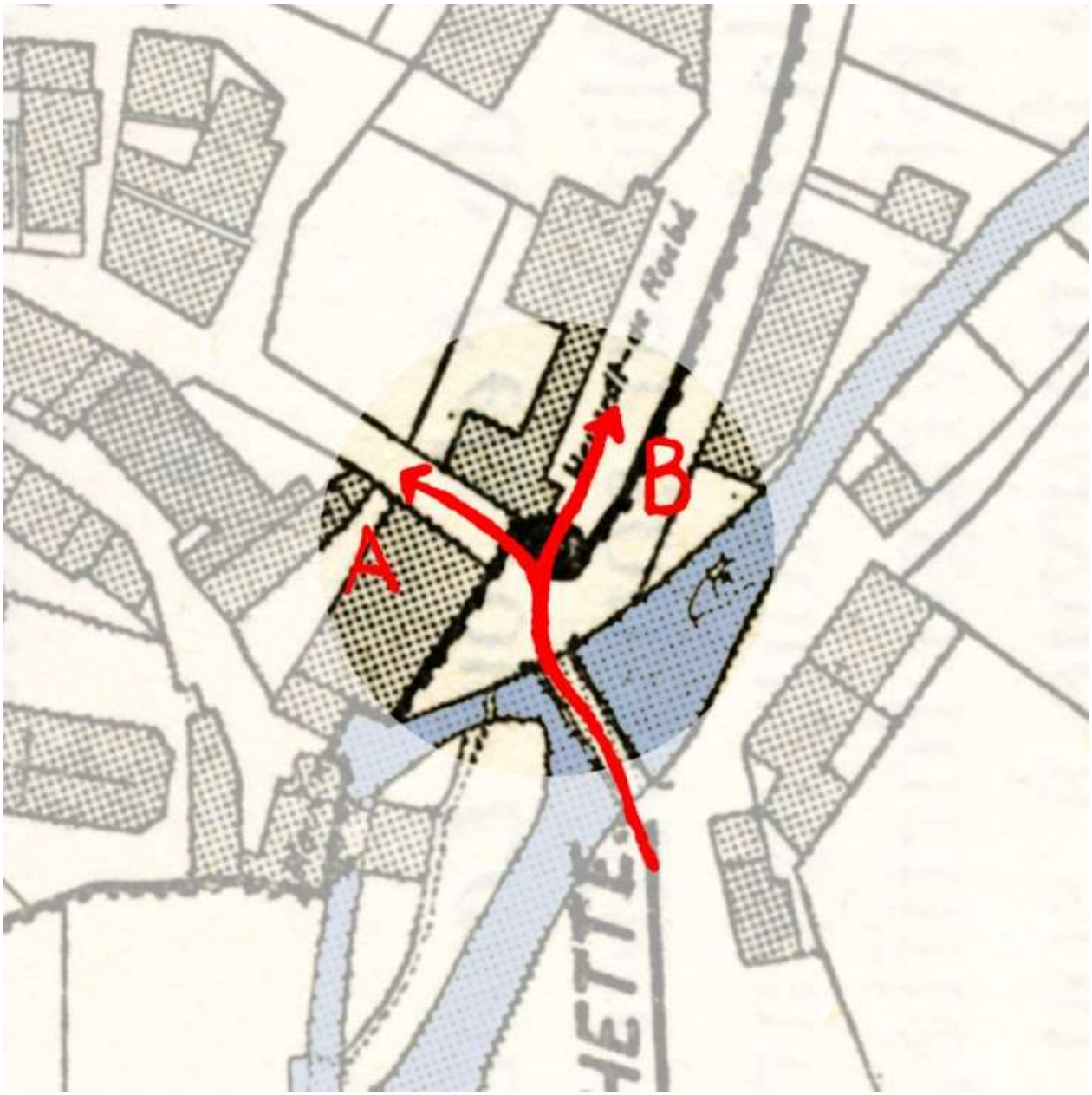
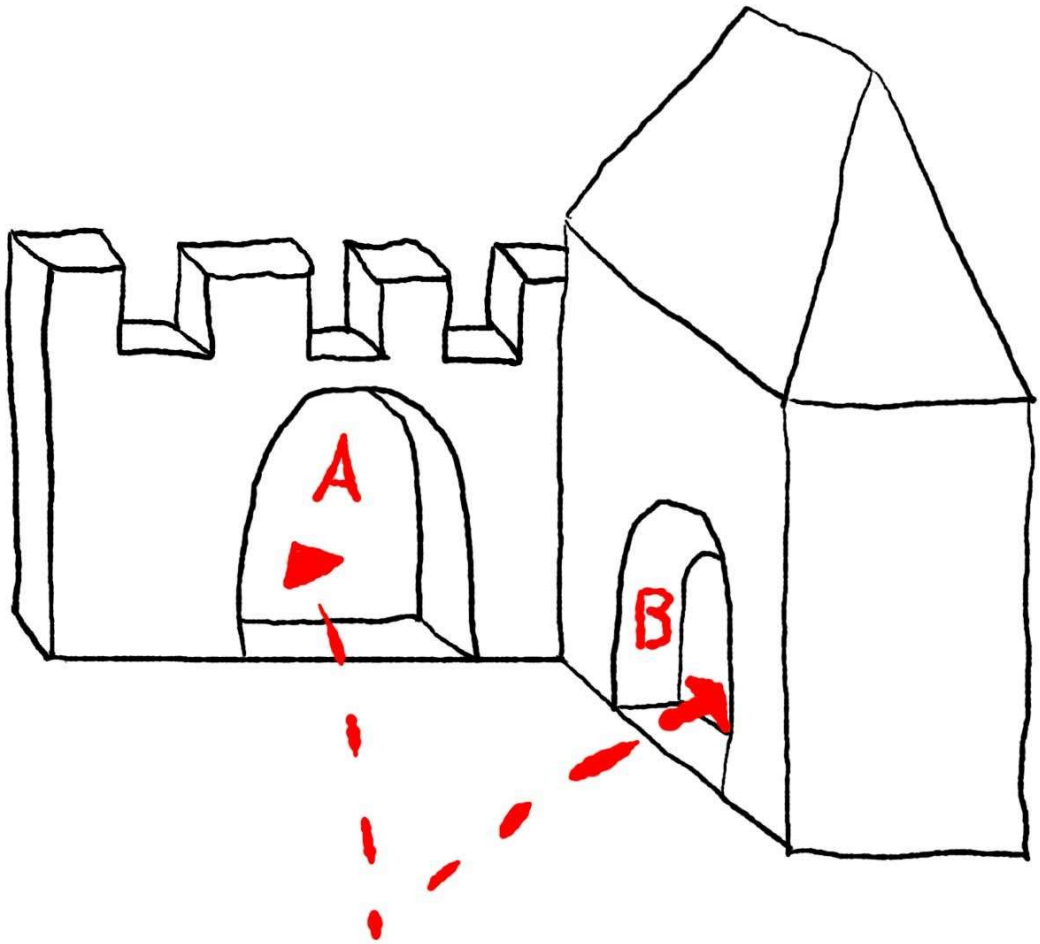


Diagram of two possible ways into the city.



11. The gatehouse stood near the bridge, barring the road. We know where, approximately, the houses were, but not the streets themselves. How do you think the road continues through the gate? *

Mark only one oval.

- ◯ A: The gatehouse tower is next to a gate in the wall and the road continues straight.
- ◯ B: The road makes a sharp turn and goes through the gatehouse tower, parallel to the wall.

12. How did you come to that conclusion? *

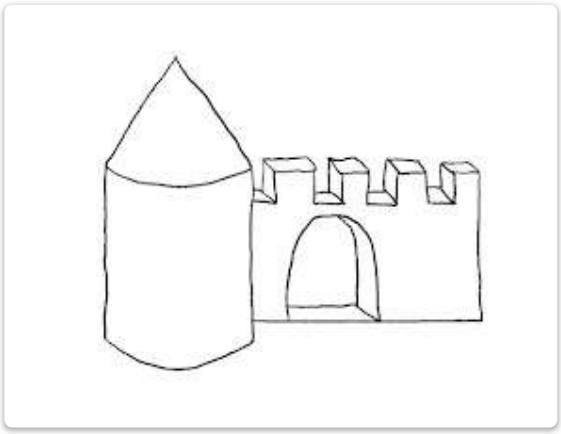
Image credits

Map excerpt from "Les Cahiers Luxembourgeois - Larochette", 1938

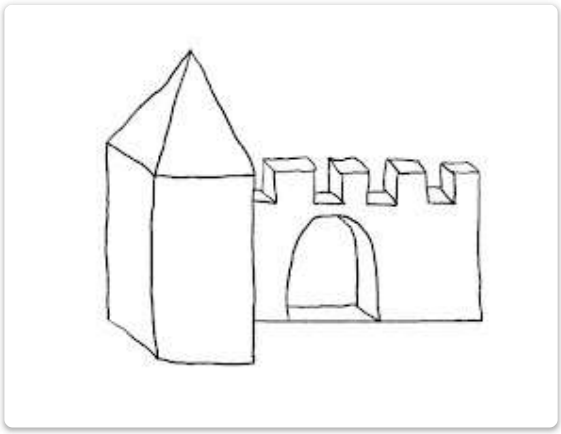
Your Conclusions

13. Which gate reconstruction would you pick based on this analysis? *

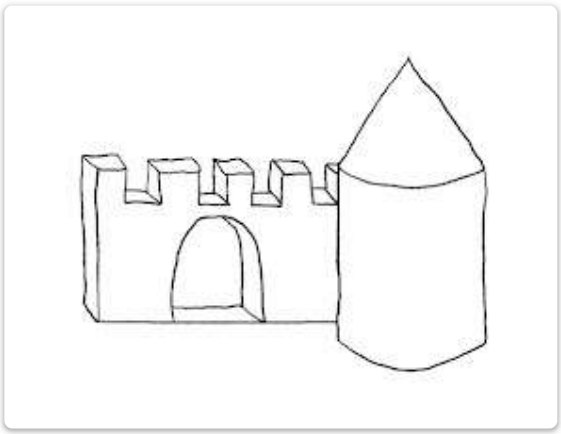
Mark only one oval.



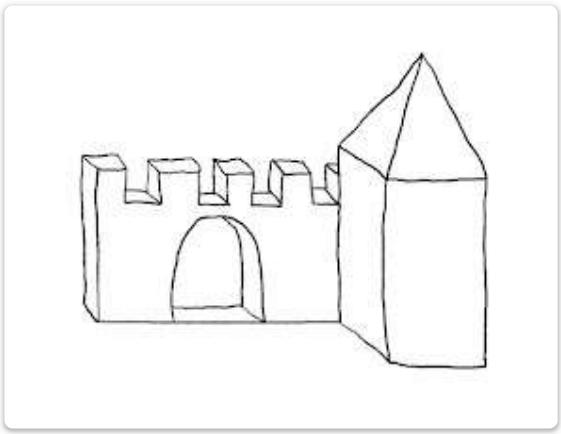
Round tower on left



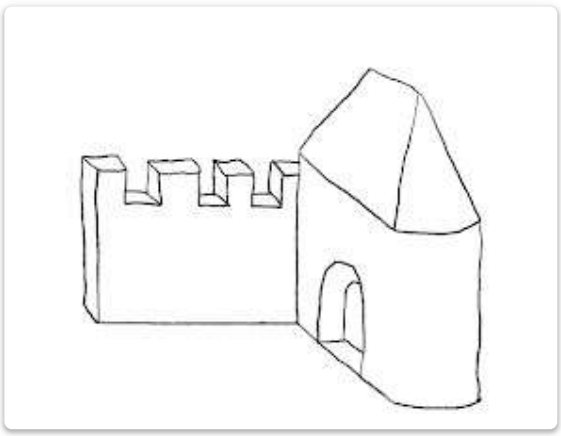
Square tower on left



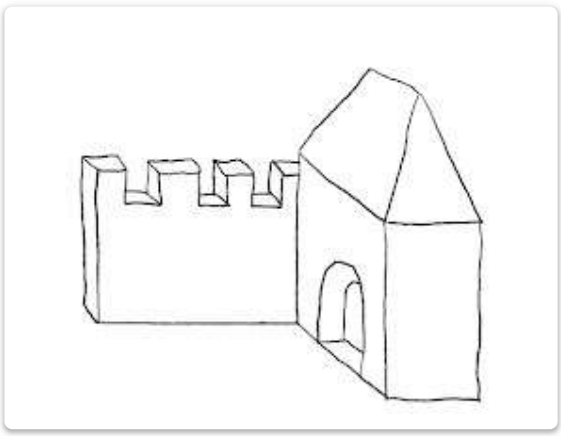
Round tower on right



Square tower on right



Gate in round tower



Gate in rectangular tower

14. Is your result the same as the gate you picked first? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Can't remember.

15. Do you think your new result is more accurate than the one you first picked? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ It's the same.

16. How certain are you that the new version you picked is the correct one? *

Mark only one oval.

	1	2	3	4	5	
Not at all certain	◯	◯	◯	◯	◯	Very certain

17. Which of these could make you change your mind? *

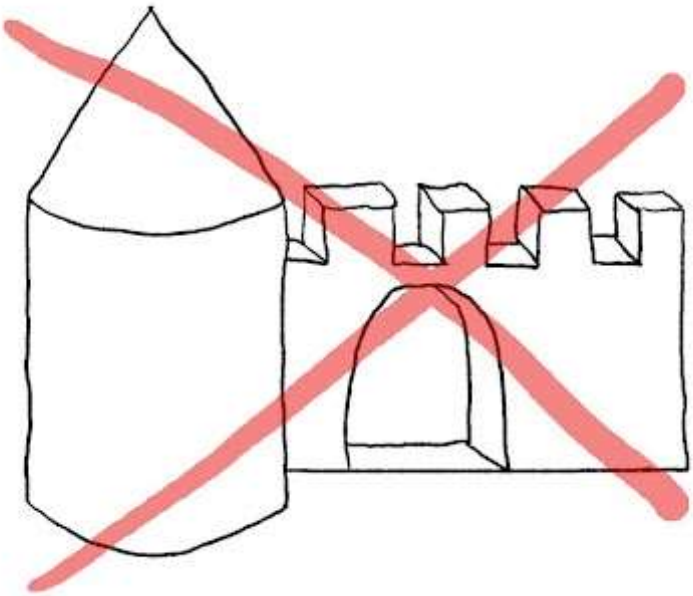
Check all that apply.

- ☐ Most people getting a different result.
- ☐ A 3D model that looks very real.
- ☐ A historian writing something different in a book.
- ☐ A reconstruction in a museum that shows a different gate.
- ☐ A drawing that shows a different gate, with an explanation of why they drew it that way.
- ☐ Seeing a medieval painting where the gate looks different.
- ☐ An archaeological excavation that found remains of something different.
- Other: ☐ _____

Was I Right?

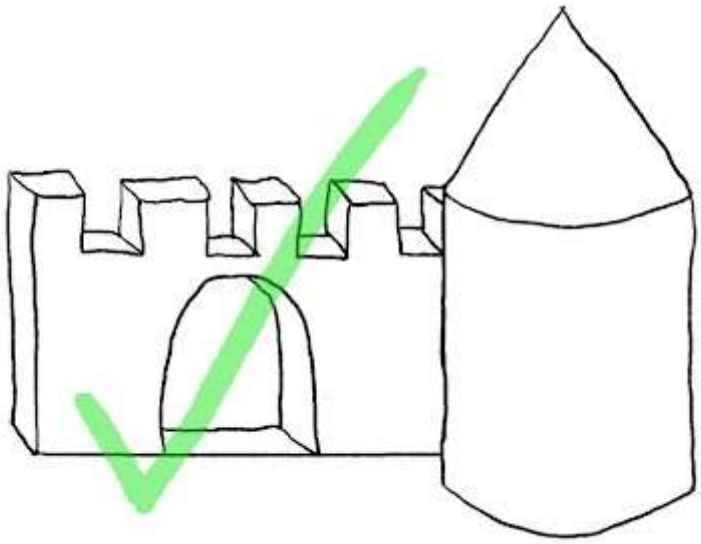
Of course, you would like to know which version is correct. The problem is: we don't know, because there is no conclusive evidence. However, there are more and less likely versions:

The tower on the left only appears in a single source, so it is not likely to be correct.



The square tower with the gate leading through it was my original working hypothesis because it's shown on a map in the book about the castle. However, it appears to be an error, as the visual sources don't agree and there is no alternate evidence given to explain this version.

Judging by the sources shown above, this version is the most likely to be correct. But new evidence, like an archaeological excavation, could change that!



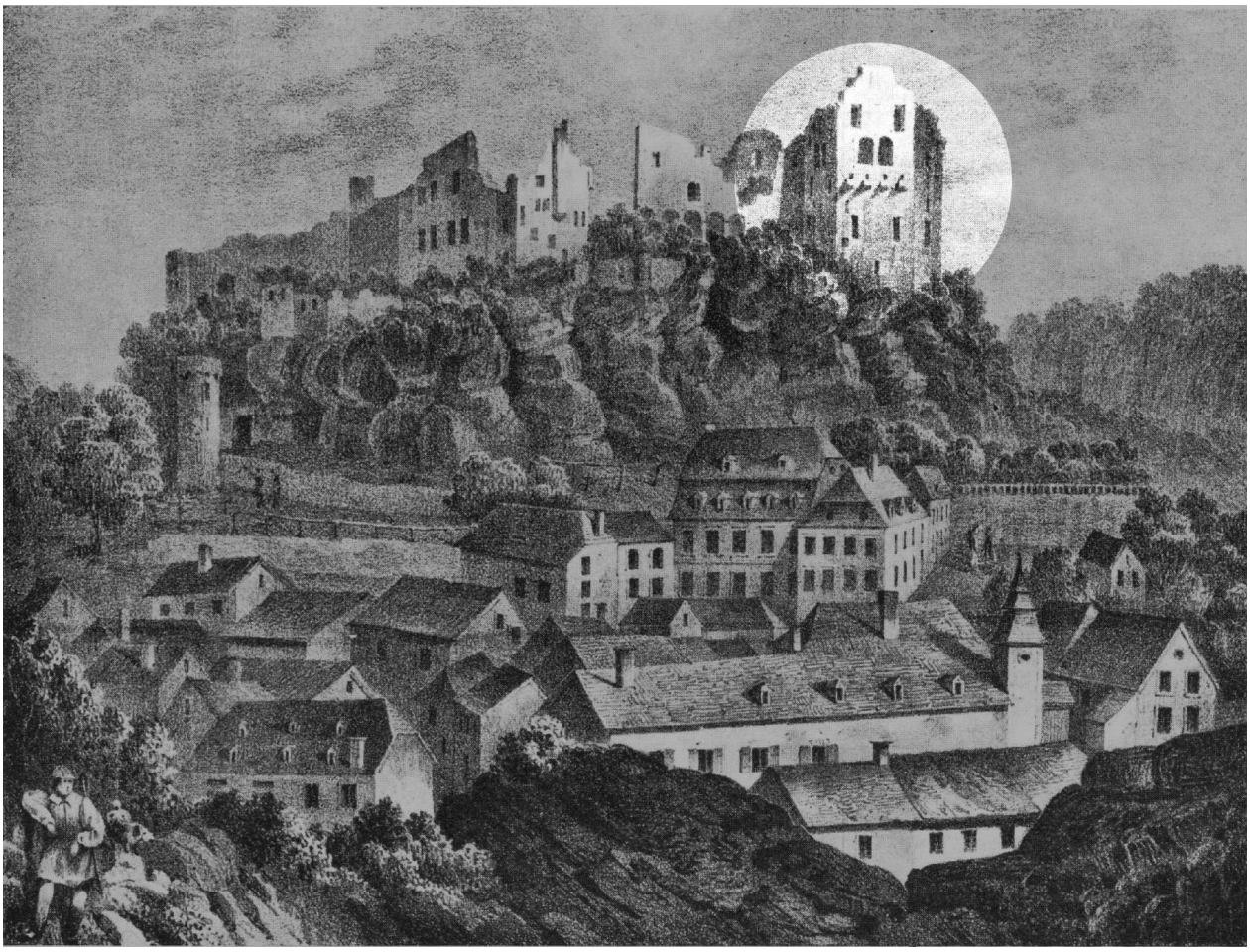
Next, we will take the methods you've just used and apply them to a more complex problem.

The Créhange Manor House stood at the southeastern corner of the castle. It contained sleeping and living spaces for one of the castle's owners, as well as a large kitchen and the castle's well. It is the best-preserved of all the castle buildings, and has been physically reconstructed. You can see three different views of the ruins below.

The drawings all show some architectural details like windows, doors and other stonework. Corbels - stones that stick out from the wall - and sockets - indentations in the wall - held wooden beams that formed the castle's floors.

View of the town and castle around 1800.

View of the town and castle in 1835.



View of the town and castle around 1850.

18. Why do you think the different pictures show different details on the walls? *

Check all that apply.

- [ ] Change over time
- [ ] Artistic licence
- [ ] Too far away to see properly
- [ ] Bad artist

Other: [ ] _____

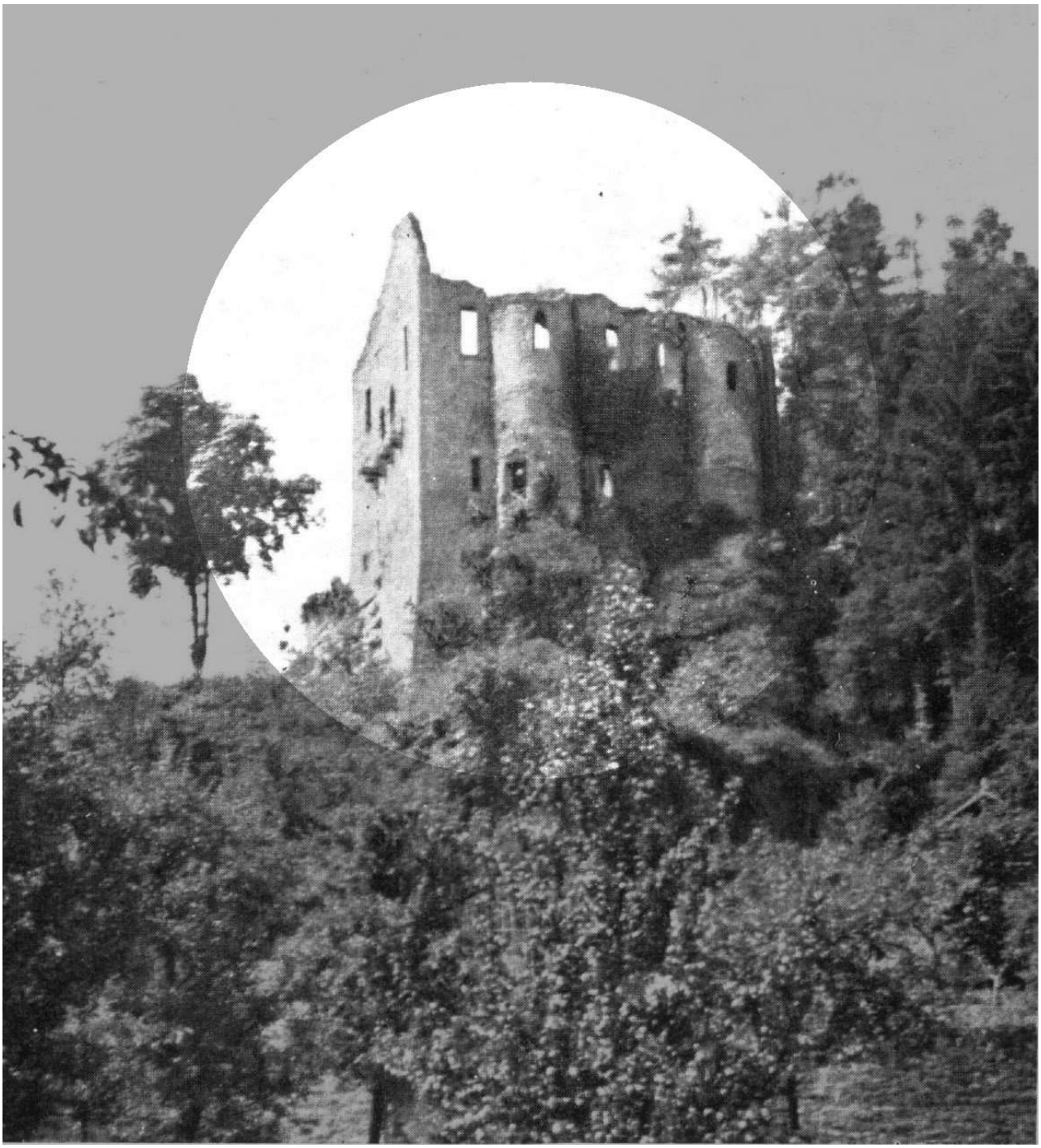
Image credits

Image excerpts from "Les Cahiers Luxembourgeois - Larochette", 1938

Créhange House - Southeastern Façade

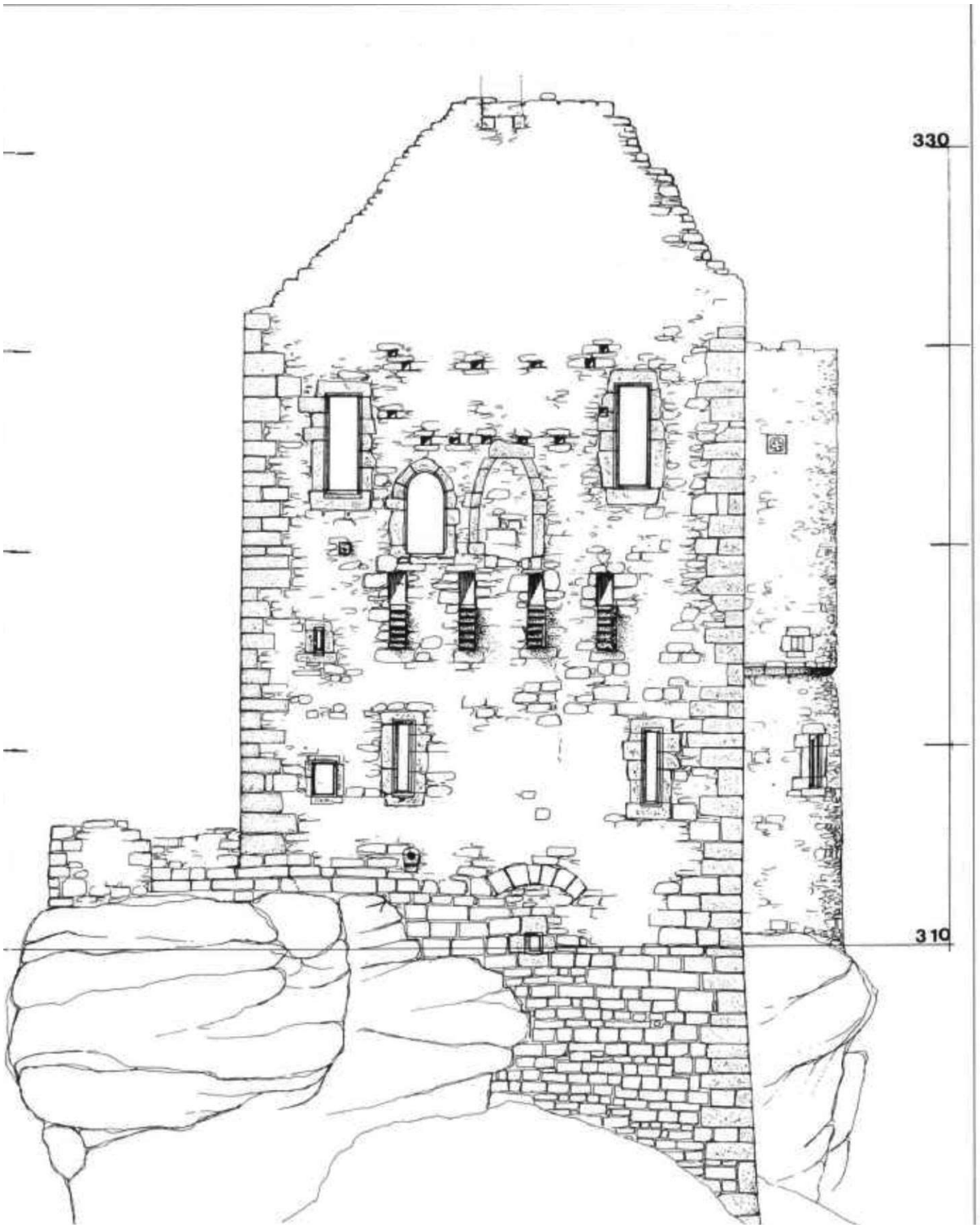
This façade is the most visible from the town, and appears in numerous drawings and paintings.

Early 20th century photograph of Créhange House



1930s painting of Créhange House

The gable wall as surveyed around 1980 by John Zimmer



19. What do you think was attached to the gable wall of this building? *

Mark only one oval.

- ◯ A balcony
- ◯ An enclosed porch or oriel
- ◯ A defensive structure
- ◯ A large room
- ◯ Other: _____

20. Which material do you think was used to build it? *

Mark only one oval.

- ◯ Stone
- ◯ Wood
- ◯ Iron
- ◯ Other: _____

21. What is your reasoning for those choices? *

_____

_____

_____

_____

_____

Image credits

Image excerpts from "Les Cahiers Luxembourgeois - Larochette", 1938
Elevation drawing from "Die Burgen des Luxemburger Landes", J. Zimmer, 1996

Was I Right?

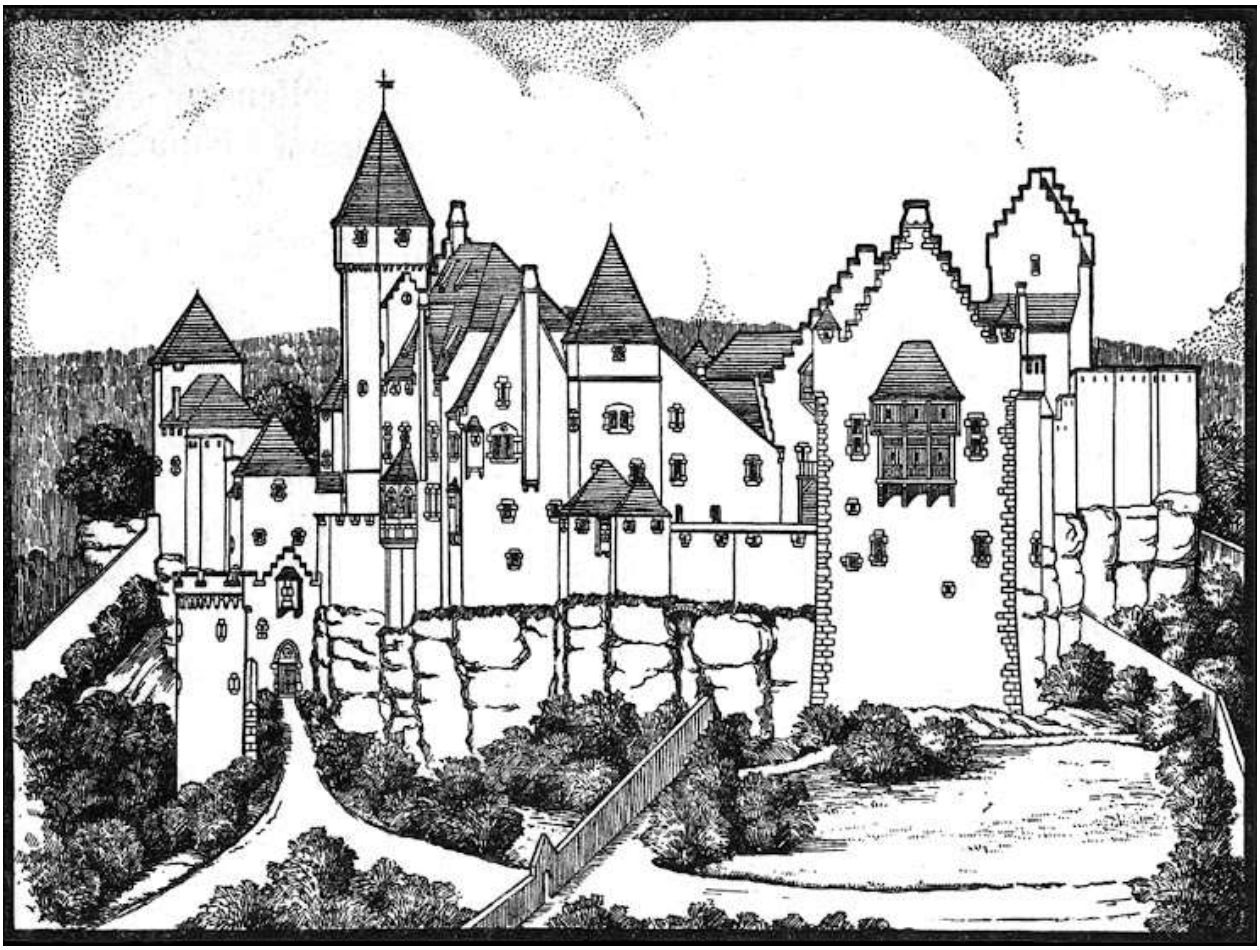
The sockets and corbels, as well as the door-sized opening in the facade, indicate that there was a small, enclosed wooden structure projecting from the gable wall. It has a fireplace, and, remarkably, an internal window with a view of the altar in chapel that adjoins the great hall! As it is too small and exposed to be a bedroom or living area, the current theory is that it housed the bath, and allowed someone soaking in the tub to follow church services at the same time.

22. What else do you think such a room might have been used for? *

Evaluating Reconstructions

Different professionals have reconstructed Larochette Castle in different ways.

Reconstruction drawn around 1900, by the architect JP Koenig



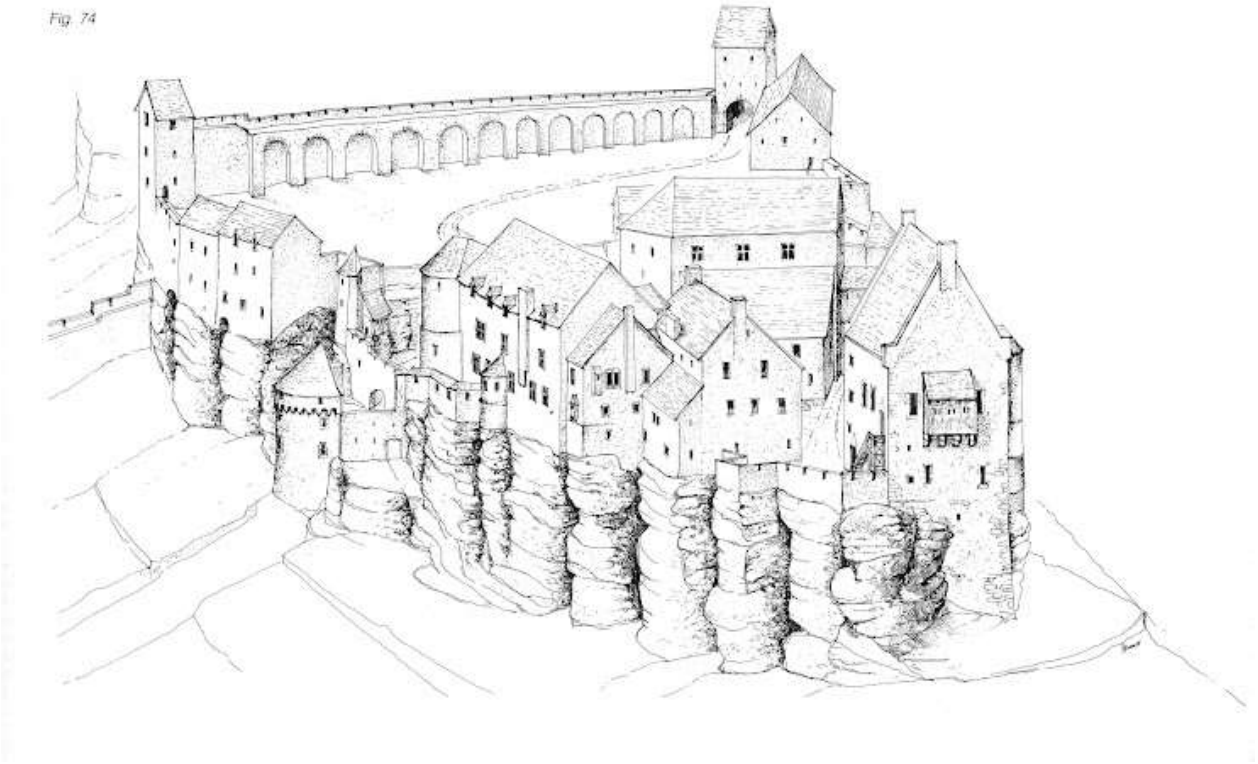
23. What are your impressions of this reconstruction by JP Koenig? *

24. How accurate do you think Koenig's reconstruction is? *

Mark only one oval.

	1	2	3	4	5	
Not at all accurate	◯	◯	◯	◯	◯	Very accurate

Reconstruction drawn around 1980, by the architectural surveyor John Zimmer



25. What are your impressions of this reconstruction by John Zimmer? *

26. How accurate do you think Zimmer's reconstruction is? *

Mark only one oval.

	1	2	3	4	5	
Not at all accurate	◯	◯	◯	◯	◯	Very accurate

Scale model, artist and date unknown

27. What are your impressions of this scale model? *

28. How accurate do you think the scale model is? *

Mark only one oval.

	1	2	3	4	5	
Not at all accurate	◯	◯	◯	◯	◯	Very accurate

Physical reconstruction of Créchange House built after 1979 by the Luxembourgish site and monument service

29. What are your impressions of this physical reconstruction? *

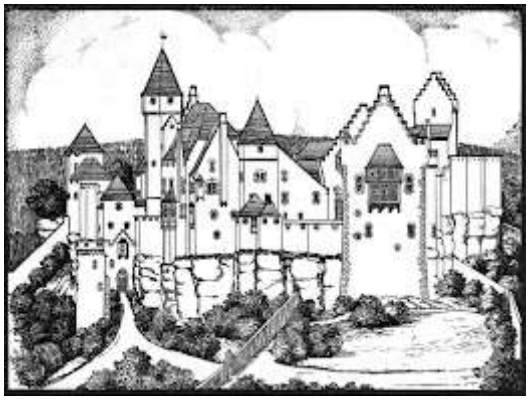
30. How accurate do you think this reconstruction is? *

Mark only one oval.

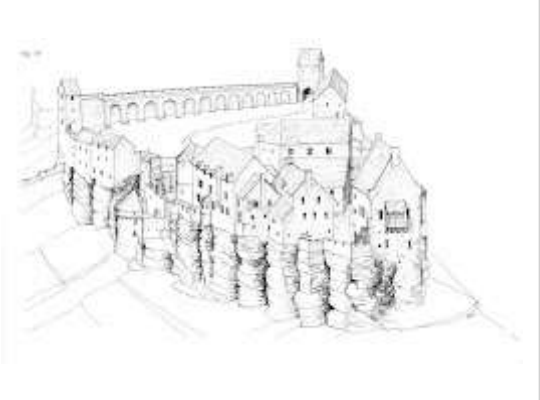
	1	2	3	4	5	
Not at all accurate	◯	◯	◯	◯	◯	Very accurate

31. Which reconstruction do you think is the best? *

Mark only one oval.



JP Koenig's drawing



John Zimmer's drawing

The scale model

The physical reconstruction

32. What makes it the best? *

Image credits

Koenig reconstruction drawing from "Les Cahiers Luxembourgeois - Larochette", 1938
Zimmer reconstruction drawing from "Die Burg Fels: Ihre Baugeschichte ", J. Zimmer, 1990

About You

These questions about you are optional, but will help me evaluate your responses.

33. What age are you?

Mark only one oval.

- 18-25
- 26-40
- 41-65
- Over 65
- Prefer not to say

34. What's your educational background?

Check all that apply.

- Currently in school
- Finished high school
- Currently in vocational school/training
- Finished vocational school/training
- Currently enrolled in university
- Finished Bachelor's degree or equivalent
- Finished Master's degree or equivalent
- Finished PhD or higher

Other: _____

35. Do you work in any of the following fields?

Check all that apply.

- Architecture
- History
- Cultural Heritage
- Archaeology
- None of the above

Other: _____

36. Any additional comments?

Thank you for your help!

Your responses will not be recorded until you submit them. If you think of further questions or comments later, remember, you can contact me at marleen.dekramer@uni.lu . You can follow the progress of the project at [LINK]

37. One final question: did you answer the questions seriously? *

Mark only one oval.

- ◯ Yes - I answered them seriously, so you can use them for your research.
- ◯ No - I just picked something so I could proceed.
- ◯ Other: _____

Acknowledgements

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