

# MULTIDISCIPLINARY INFORMATION SYSTEM OF ASSYRIAN CUNEIFORM TABLETS ENHANCING NEW RESEARCH POSSIBILITIES VIA HETEROGENEOUS DATA IN RECORDS

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**KEY WORDS:** Multidisciplinary information system, cuneiform tablets, 3D digital models, digitalization of collections

## ABSTRACT:

This paper outlines recently started project dedicated to creation and development of information system for cuneiform tablets. The contribution deals with the architecture of a virtual collection of cuneiform tablets, conceived as a complex system combining and integrating several domains of information obtained from various types of analyses. The research team includes experts from the field of collection conservation with philologists and researchers in the 3D scanning and physical measurement. Multidisciplinary databases like the one described, represent a new tool in digital humanities and help to improve accessibility of collections to public and researchers.

## 1. INTRODUCTION

One can assume that information contained in cuneiform tablets is solely present only in their textual component, but in fact, it is only one part. The materiality of the tablets represents another important component of data, that can yield some answers, and especially the combination of the two aspects can elucidate research problems previously non-addressable. In another words, the concept of multidomain database enables to pose queries previously unanswerable and to discover new relations between objects. To assert the extent of goods exchange and communication between historical sites, for example, it is important to know the provenience of the tablets and that is a situation when the knowledge of the tablets' material composition becomes indispensable. Purpose of data acquired in the course of tablets' collection investigation is not limited to the primary scope of the research database, but can be exploited elsewhere, for example in exhibition to enhance users experience adding a new information layer to physical objects presented by means of augmented reality or virtual reality using either mobile application or installed terminals. This enhanced experience can be inner structure of tablet, manipulation with the tablet in virtual reality, listening to the inscribed text and revealing its content, comparing variants of signs similar to ligatures in Latin scripture.

## 2. STRUCTURE AND CONTENT OF DATABASE

In order to achieve the above-mentioned goals a new research project was commenced with the intention to create and make available the complete digital archive of the cuneiform tablets in the Czech Republic. The data records include information related to archaeological uncovering the object, information about its relations to other findings, as well as photo documentation. The records also include data necessary for object identification in collection and detailed linguistics information as well as other

types of metadata including a formalized description of the content of the messages, enabling to posit the collection into the life of the those days society.

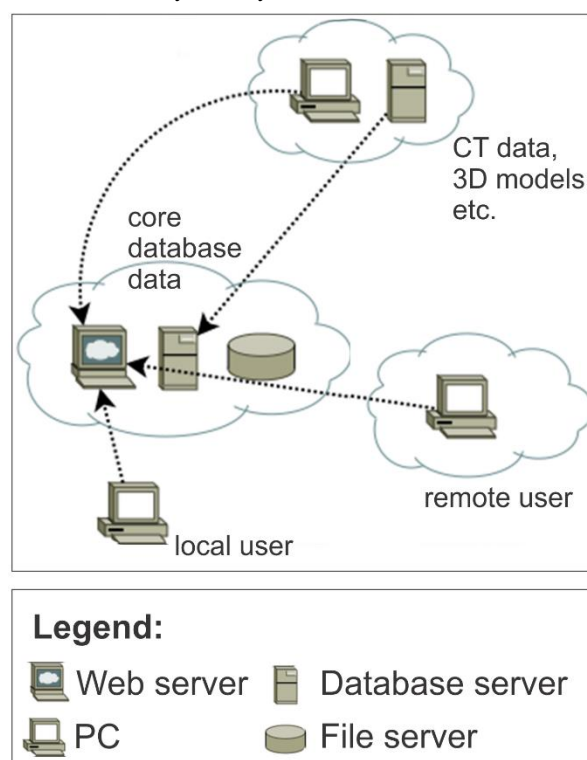


Figure 1. Relations between various servers and distribution of data among them. Users can access data directly or remotely.

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Figure 2 presents in the main panel a cuneiform tablet illuminated by diffuse light. Below there is nine views on the same detail on the table. The striking difference of appearance of the grooves is caused by variation of inclination and horizontal direction of incident light. Shadows casted into grooves visualize their shape and make the scripture legible. Indeed, the scripture is usually studied in such a way, that the tablet faces a different direction towards the light and the complex shape of the grooves is gradually revealed by the shadows. The very procedure explains why photo documentation is insufficient for reading purposes. Therefore, full 3D model is necessary to preserve legibility of virtual copies of cuneiform tablets.

In addition to standard text fields the database record also data in special formats like CT scans, 3D models of objects, XRF spectra, etc. To limit the volume of stored data on the central file server, the records contain mainly links to content distributed on other servers and computers – Figure 1.

### 3. PHYSICS RELATED FIELDS IN RECORDS

There are some databases of cuneiform records available around the world, most of them focus on the graphical and textual part of the analysis of the tablets (CDLI, ORACC), currently only one deals with advanced graphical solution of the problem (Birmingham), but the records in the database being developed

also contain data suitable for new discoveries of previously unknown relations and connections, as they include data on physical measurements like reflectivity, surface color and especially the atomic composition of clay measured by XRF (Artax). XRF spectra of tablets' clay would be correlated to spectra typical for soils in the region to help enhance provenience identification. The integration of the heterogeneous knowledge enable quantitative queries helping to discover new ways how to aggregate, group the objects and how to find "outliers" within collection for more concentrated attention of researchers (this can be carried out by statistical methods like principal component analysis).

Database structure reflects multidisciplinary nature of the data implying uniquely complex queries, e.g. like is there a relation between importance of tablet and the fact the tablet was fired? The query can be answered as temperature to which the tablet was exposed implies its color, which is documented in the database as well as the content of the tablet's text.

Schematic representation of the database record's structure grouped according to main domains of data can be found depicted in Figure 3.

### 4. 3D DIGITAL MODELS OF TABLETS

In addition to standard photo documentation, also 3D digital model of cuneiforms would be acquired and stored in database.

3D documentation of tablets is a necessary step for separating signs from their medium - the tablets. Influence of tablet curvature and tablet surface texture and appearance can be eliminated this way as a prerequisite for any attempt to train optical character recognition procedures and deep learning approaches.

3D digital models can also contribute to preservation of physical objects themselves as comparison of the two models of the same tablet created at different moments can reveal surface abrasion, missing details, etc.

3D models and CT data enable advanced imaging of tablets, enhancing visual experience and offering better than real experience with image data manipulation. CT scans can reveal inner structure of the tablet, this knowledge can help address problem whether the tablet was made at once or whether a core was made first and then fine thin layer has been added. The availability of tablets' digital replicas is crucial for the extension of the knowledge usable in a detailed palaeographic analysis of the Ancient Assyrian tablets (Larsen, Devecchi).

It is well known that the legibility of symbols on the tablet surface is enhanced by laterally incident light forming complex pattern of shadows revealing the signs on the tablet (as documented on Figure 2). These shadows cannot be achieved by standard photography and 3D models are necessary, especially when accompanied with software for the manipulation with the virtual object and allowing rendering the tablet model in simulated illumination (Lewis, Ch'ng, 2012). Users will be given a possibility to manipulate the objects not only on their computer monitors, but also using virtual reality googles, as well as the models would be available in formats suitable for 3D prints of material replicas.

### 5. WHY PRAGUE'S CUNEIFORM COLLECTION?

Another important key for understanding of various types of relations, including the social ones in ancient societies is archaeological context of the findings and known mutual relation between tablets. From this point of view is Prague's collection uncovered by the Czech archaeologist and researcher professor Bedřich Hrozný (Klíma 1953) unique and can serve as a benchmark for contextualization of tablets in another collection.

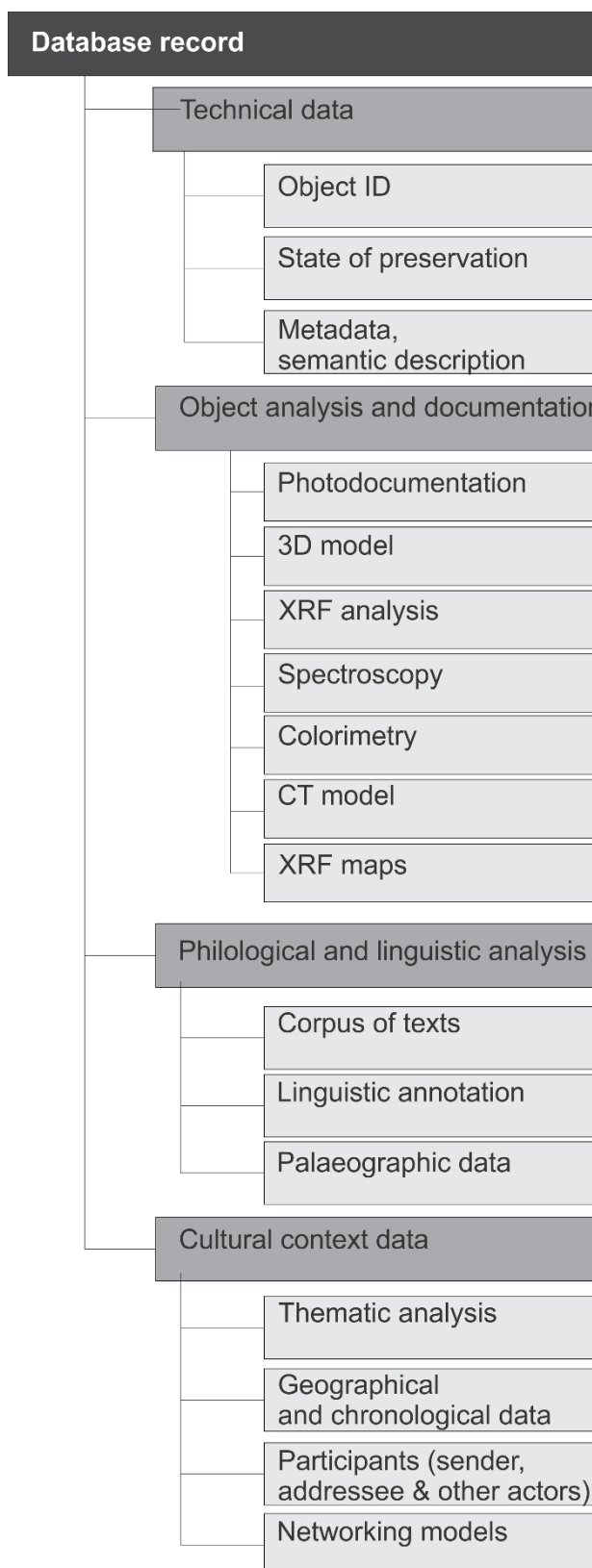


Figure 3. Detailed presentation of Prague's cuneiform database

The collection consists of cuneiform tablets from the Old Assyrian period excavated in Kültepe (Turkey) by Bedřich Hrozný and is almost entirely homogeneous in the sense that it comes from one location and rather narrow chronological layer

(ca 19th century BCE). From the point of view of the content, majority of tablets represent correspondence among the members of the ancient Assyrian society, connected with the Old Assyrian trade network. This motivates the effort to make the collection available to the whole community of researchers and provide them with new data and new tools for discovering connections within the collection and other findings.

The goal is not only to build the database system, but also to increase its visibility, availability and impact in sharing the digital collection. One possibility how to achieve this goal is to integrate the collection under umbrella of large aggregators like Europeana (Doerr). Incorporating complicity with Europeana's Ontology of cultural heritage object and annotations allow location and server agnostic queries giving users an opportunity to simultaneously and effortlessly search many sites of digital collections at once.

## 6. CONCLUSIONS

Multidisciplinary databases like the one described in this paper, represent a new tool in digital humanities and help to improve accessibility of collections to public and researchers. Multidisciplinary of the database offers new synergies in investigations; data from several fields allow posing complex queries assuming input from various domains.

In order to achieve these goals, once the intention of collection digitization is undertaken, it is important to aim for as complete coverage of data as possible, to enable to discover new relations just by searching the data, without "coming back to objects". It means to make the records so robust that it enables finding answers to questions unknown at the time of database creation.

Data would be made accessible to the community via internet and also utilized in National Museum's exhibition to enhance users' experience.

Digital models also can improve collection care – comparison of succession of 3D models of the same unfired tablet can reveal degradation changes. The digital models contained enable extension of use into field of virtual and augmented reality or 3D print.

Unfortunately many digitization project face problem of early obsolescence and low intensity of usage, caused mostly by the fact, that the data are good only to illustrate current knowledge in the field. In order to increase the impact of the database, its data would be integrated into large virtual collections maintained by aggregators like Europeana.

## ACKNOWLEDGEMENT

The presented work is carried out within project "Analysis, description and archivation of aggregate information on properties of cultural heritage artifacts and usage of such data in restoration, conservation and research" is supported by the program of applied research and development of national and cultural identity (NAKI) of the Ministry of Culture of the Czech Republic – grant No. DG16P02M022.

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