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Ceramic Technologies Digital Library (CTDL): A Digital Repository of Medieval Ceramics – A Preliminary Report

Abstract: The Ceramic Technologies Digital Library (CTDL) is a digital library for the classification and cultural analysis of historical ceramic technologies from Central Europe, particularly the Germania-Slavica area, for the Medieval period (ca. AD 600–1400). The library is created, maintained, and managed by the Historisches Institut at EMA Greifswald University (EMAG), Germany, in joint partnership with the Partnership for Research in Spatial Modeling (PRISM), the Archaeological Research Institute (ARI) at Arizona State University (ASU), Tempe, Arizona, USA, and the Roskilde University Center (RUC), Denmark. The project is base-funded through a grant from the German Research Foundation (DFG) under the Scientific Literature Supply and Information Systems (LIS 2). We summarize the initial phase of the project with the application of 3D scanning technologies to ceramic vessels from the study area, the application of analytical software for vessel symmetry, and a project website to enhance communication on these research topics.

Introduction

The Ceramic Technologies Digital Library (CTDL) is designed to serve as a digital interface for the classification and cultural analysis of historical ceramic technologies primarily from the Germania-Slavica area of Central Europe for the Middle Ages (ca. AD 600–1400). The CTDL is a Deutsche Forschungsgemeinschaft (DFG) funded project carried out by the Historisches Institut at EMA University, in Greifswald, Germany, in partnership with the Archaeological Research Institute (ARI) and the Partnership for Research in Spatial Modeling (PRISM) at Arizona State University (ASU), in Tempe, Arizona, USA, and the Roskilde University Centre (RUC) in Roskilde, Denmark. The project began in August, 2006, with acquiring and implementing the portable 3D scanning equipment at the Historical Studies Institute of the EMA University in Greifswald and with collaborative work at ARI and PRISM in Tempe. This first report summarizes the work accomplished since August 2006 through April 2007, including the application of the 3D scanning techniques to representative "Slavic ceramics", the application of software for the analysis of vessel symmetry, and the launch of the CTDL website to present ongoing project results and to encourage research on these topics.

Cultural and Archaeological Background

Following the end of the Roman Empire, Europe found itself in a period of reorganization. The consequence of the amalgamation of old and new, of "civilized" and "barbarian", was the appearance of new cultural patterns and trends that are reflected in the manufactured products of that time, ranging from pottery to shipbuilding. Central and Eastern Europe were mostly void of complex state structures until the advent of medieval states. Under the auspices of Avar control, a new kind of ceramics spread throughout Central Europe; these "Slavic ceramics" have been related to the Slavic-speaking groups (Brather 1996; Kempke 2001; Roslund 2001), and have been recognized to have regional variants *(Fig. 1)*.

The goal of the proposed digital library is the development of a web-based, classificatory database of ceramic collections mainly from the Germania-Slavica research area (Central European area including, but not limited to regions of Germany, Poland, Austria, Slovenia, and the Czech Republic). The CTDL will facilitate access to the visual and quantified study of ceramic technologies and their relationship to cultural traditions, ethnic identities, and the social, economic, and political interactions among multi-ethnic communities *(Fig. 2)*. The resulting database and archive of ceramic collections from Central Europe will have a sustained web address where users can gain virtual access to otherwise restricted, endangered, and/or not publicly available material that will be accurately replicated through the use of 3D scanning technology.

Archaeological collection and analysis of ceramics in Europe may be summarized into major periods.

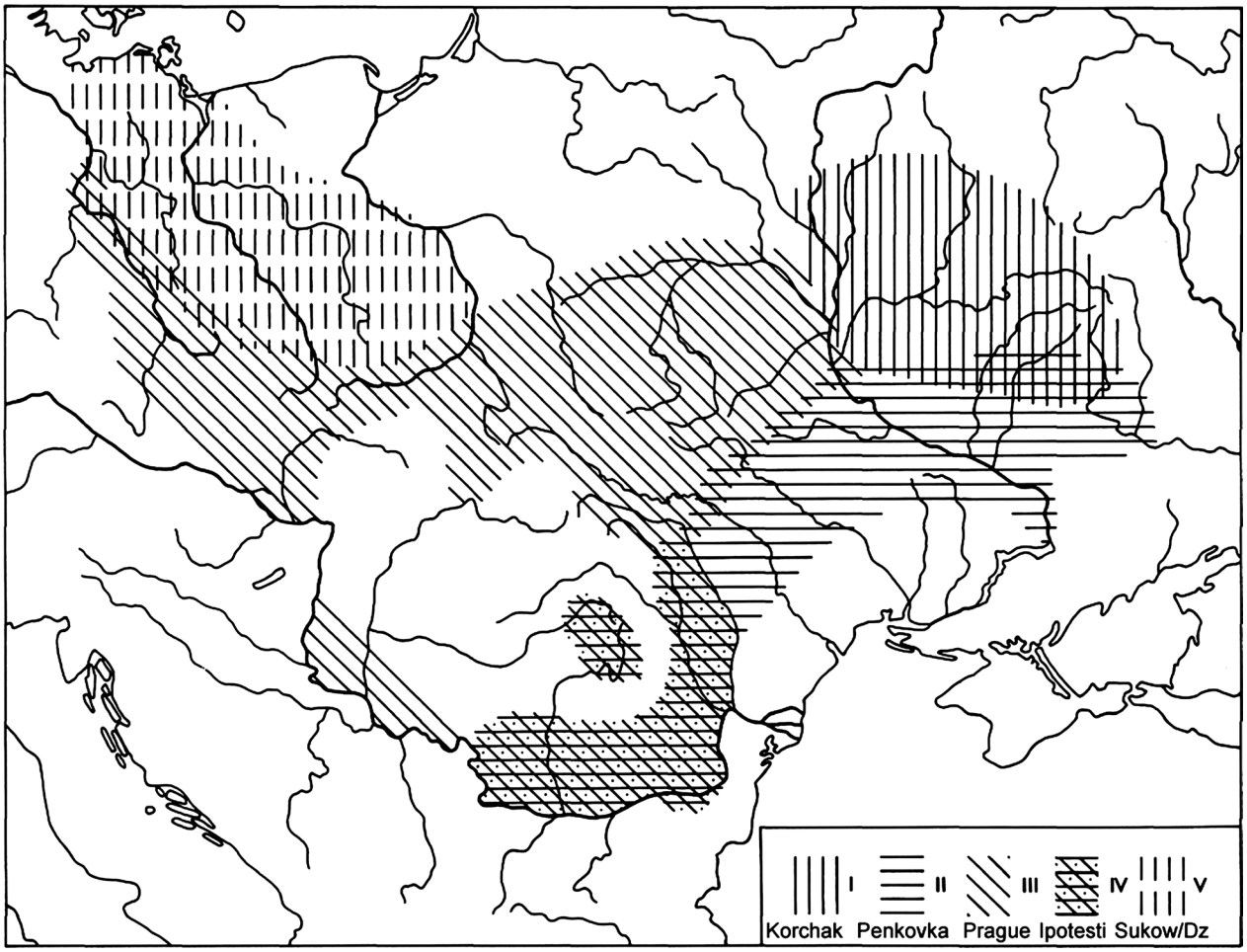

Fig. 1.

The early period (ca. 1880–1950) emphasized massive excavations at a few large, well-known sites and saw the formation of major ceramic collections. These representative samples from important ancient sites were often divided among cooperating institutions or exchanged among major museums. A modern, positivist approach (ca. 1950–1990) followed where the focus was on the analysis and classification of ceramics, more than on the quantity of excavated objects. Comprehensive, multifaceted studies of societies were undertaken at different scales (e.g. intra- and inter-site, trade networks, redistributive networks, catchment areas). Databases and artifact assemblages from this period were curated by different researchers and institutions from different countries. But now (ca. 1990 – present), researchers are actively exploring the technological advantages of global networking; striving to bridge methodologies, cultural views, and analytical approaches to integrate and present the enormous amount of information contained in these various collections.

It has long been recognized that ceramics are a main chronological indicator for those periods lacking written sources, but are also helpful in the reconstruction of older technologies such as pottery manufacture and its associated cultural traditions. Given the widespread distribution of collections and abundance of classification approaches, it is challenging to develop a common structure that is sufficiently accessible to advance regional studies. The Ceramic Technologies Digital Library (CTDL), through its scope, methodology, and internal structure (Simon et al. 2006), seeks to serve the scientific community through the creation of an integrative web-based database on medieval ceramic technology.

CTDL Goals and Phases

To accomplish the goals of the CTDL, the project is organized into several aspects or phases, which are developed in relation to each other as the project

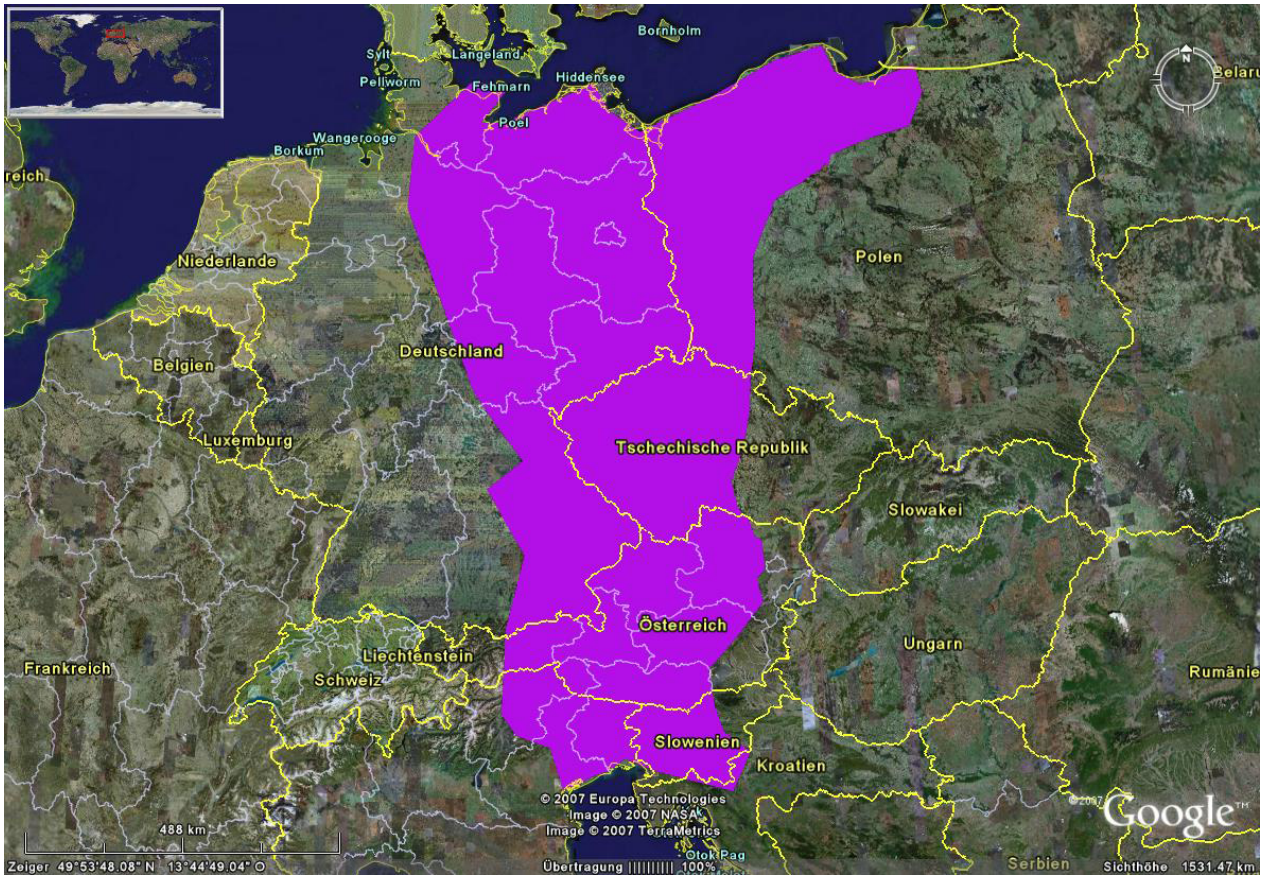

Fig. 2.

progresses: a) data collection, b) data management, c) data dissemination, and d) data curation. Each phase implements appropriate computerized technology and professional standards for web-based 3D database development.

The **Data Collection Phase** began immediately in August 2006, with the purchase of a mobile 3D collection unit comprised of a Konica-Minolta 3D Scanner, a Plustek flat-bed scanner, and a Panasonic digital SLR camera. We chose Geomagic Studio 9 modeling software to process the 3D data on the basis of several factors: ease-of-use, reliability, and integration capability with the Konica Minolta 3D scanner, and also based on the positive experience of the ASU PRISM team on various 3D modeling projects.

The 3D scanning started in February 2007, with the EMA University ceramic collection; scanning continued with the ceramic collection curated by the Pomeranian Land Museum in Greifswald *(Figs. 3–5)*. Concurrently with the 3D scanning, digital images were taken of each vessel; these images are especially useful in documenting use-wear patterns, color variations across the vessel's walls, basal manufacturer's marks, and other important details. After processing the images in *Adobe Suite* and *Silkypix*, the digital imagery was used in "wrapping" the 3D scanned model in its "original texture" *(Fig. 6)*. The flatbed scanner was used to scan vessel imagery from previous publications. The mobile scanning equipment allows these portable tools to be employed at a variety of participating institutions that own and curate the ceramic collections, thus making 3D data acquisition possible and feasible.

The **Data Management Phase** began in tandem with the acquisition of 3D scanning data. The CTDL website interface and structure was designed with a flexible structure to accommodate the addition of data and supporting documentation as the project progresses and additional collections from partnering institutions are added. A Linux-based server was installed at EMA Greifswald University to provide for the electronic archiving of 3D digital data of early medieval ceramics. Data will be curated for the long-term on the multimedia server, while the information for the public will be accessed from the server located in the Historical Studies Institute at the same University *(Fig. 7)*. This information will

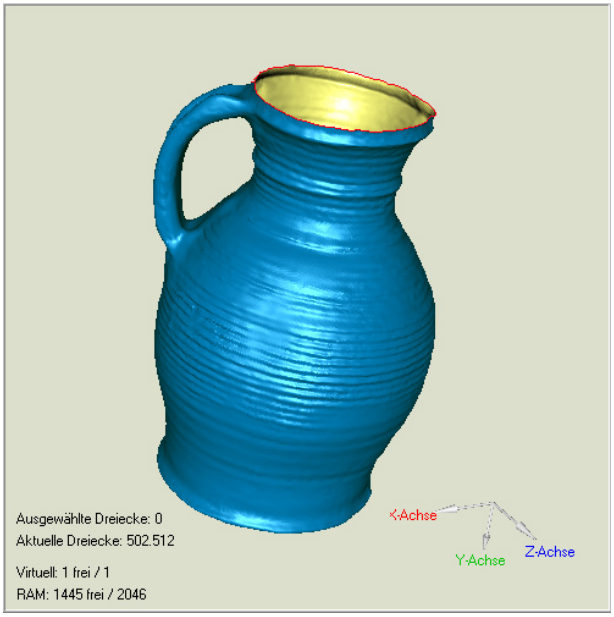

Fig. 3.

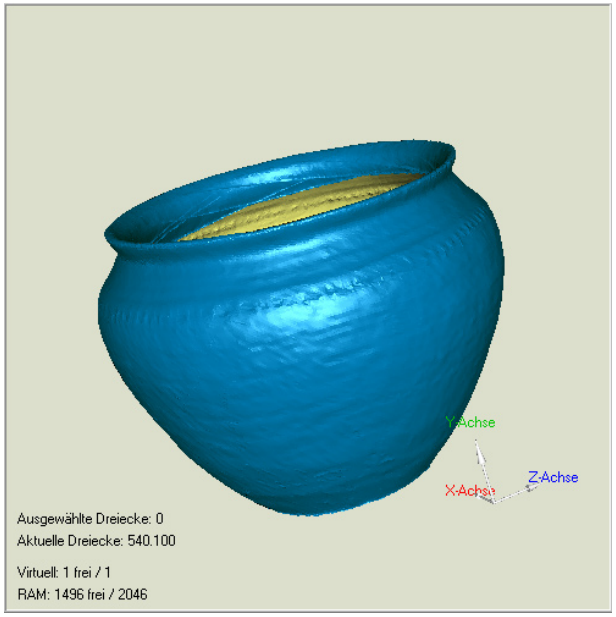

Fig. 4.

be mirrored on a web server from Tempe, Arizona and one from Roskilde, Denmark. During the initiation of the CTDL, the prototype website is available on the ARI server, in Tempe [http://archaeology.asu.edu under the digital library heading].

The data acquired on individual collections and ceramic vessels, including identifiers, provenance, classifications, measurements, is currently stored in a cross-platform database (Filemaker Pro 7 (.fp7)), but is readily transferable to other database programs such as Access and MySQL. The CTDL database was designed following these guidelines:

- ***Metadata Standards.*** The data descriptions and cataloguing procedures for the ***CTDL*** project are consistent with technical collaborative standards (***W3C***, ***Dublin Core***, and ***CoPAR***).
- The ***Dublin Core*** addresses high-level descriptive metadata categories, or universal cataloguing elements common to library, museum, and archival records. A total of 16 variables were selected to represent the valid attributes of the CTDL library.

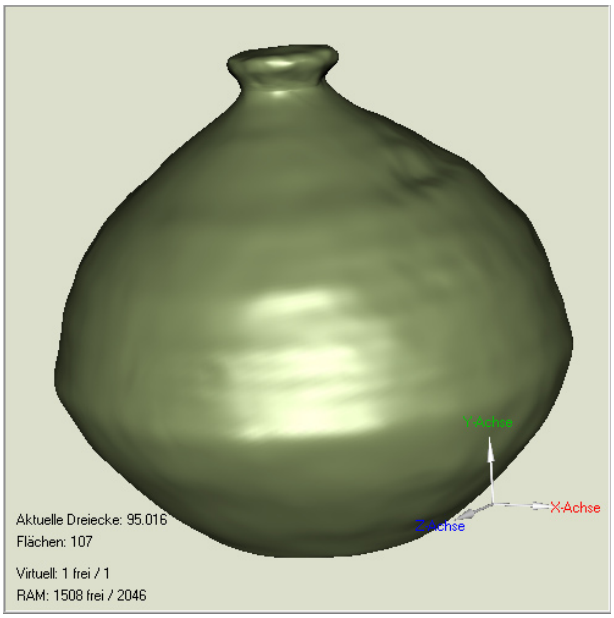

Fig. 5.

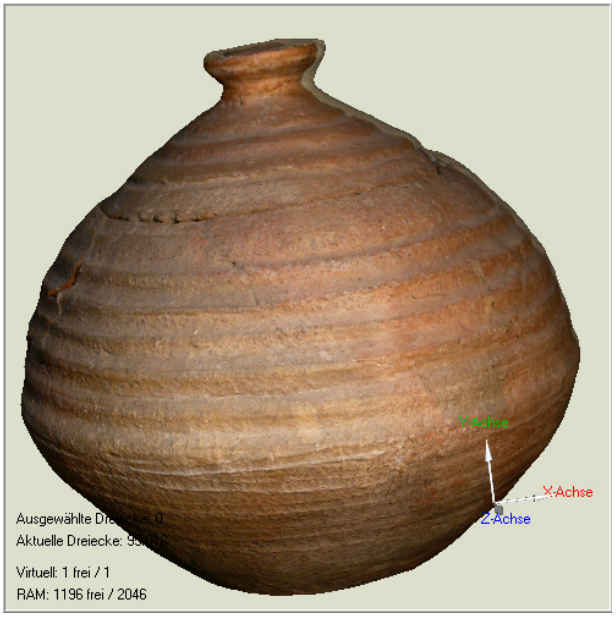

Fig. 6.

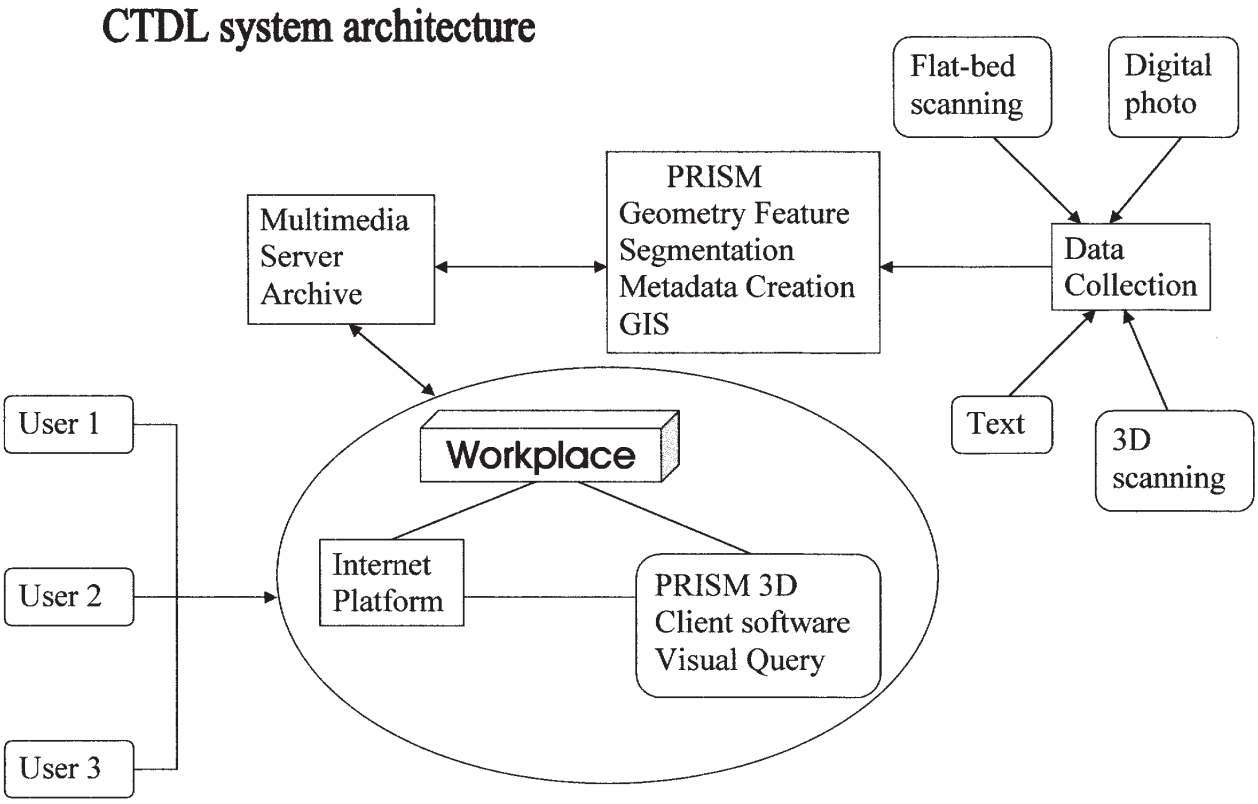

Fig. 7.

- The ***Council for the Preservation of Archaeological Records*** (***CoPar***) provides standards for archaeological collections. These guidelines from computer science, museum collections management, and archaeology incorporate professional and technical standards and promote consistency in database recording.
- The ***CTDL*** will monitor emerging standards and use modular design, cataloguing, and metadata for the digital library that will support and encourage migration to new generations of software in future generations of the digital library (***CEDARS, Lifecycle of Digital Data***).

The acquisition and presentation of 3D data, which is the *sine qua non* for the extraction of highly accurate measurements of the ceramic vessels, are further used in the identification/confirmation of ceramic classification rules. We also characterize the vessel morphology and dimensions through use of the Ceramic Vessel Analysis Software (*CVAS*), developed by ASU PRISM and ARI (Simon et al. 2005), which extracts data from the scanned 3D model. For example, the axis of symmetry is established and a spline-curve is fitted to the curvature that best represents the vessel form *(Fig. 8)*. The ***symmetry measure*** is based on a difference in area between the two halves of a two-dimensional graph of the magnitude and direction of curvature (***curvature plot***) (1 = symmetrical; 0 = asymmetrical) (Indruszewski et al. 2004). The next stage of data management will be the transfer of this ceramic data to the Visual Query Interface *(VQI)* database, which was developed by the ASU PRISM team for web-based 3D database applications (Schurmans et al. 2002). The VQI facilitates textual and graphical queries and ranking of 3D models based on shape and classificatory criteria within a web interface.

The **Data Dissemination Phase** has begun with the design and implementation of the CTDL website, which will be again updated in the summer of 2007. The website is designed to work seamlessly in a variety of browsers (IE, Netscape, Opera, Mozilla) and OS (such as Windows, NT, Unix, Linux, Mac) and web server (Apache, IBIS) environments. The structure and content of the CTDL website is designed with the reader/user in mind and includes a self-explanatory navigation column where additional documentation of the project will be added as it becomes available. The online CTDL will include easy-to-use interfaces for: a) **data management** area (password protected) for data entry and editing by the project team, b) **digital library view** available

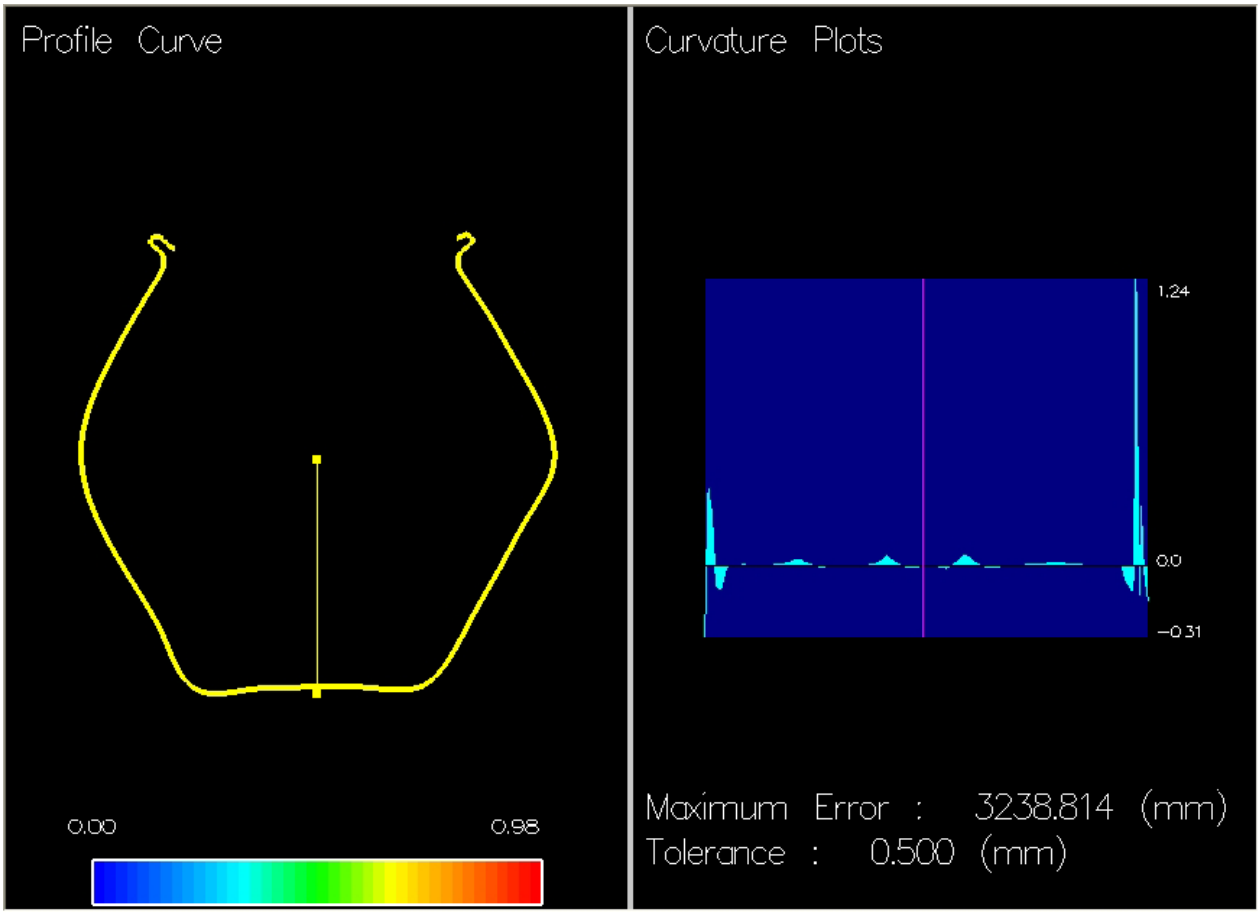

Fig. 8.

for the research team for inputting and managing data, and c) **public site** with viewing and navigation for other researchers and the public.

Conclusion

The primary goal of the CTDL project is the creation, support, and long-term curation of a digital library for Central European ceramics, focusing on the Medieval period (AD 600–1400). The CTDL will be fully accessible via the Internet to both interested specialists and the general public. Data access to this virtual repository will be unrestricted to all organizations and individuals engaged in non-profit activities such as academic and secondary-level education, public outreach, or online museum activities. Virtually indestructible 3D models, made available online through the CTDL website, can thus be used as potent educational and/or research tools, especially when presented together with their GIS-based contextual archaeological information.

The archival of the digital 3D models and related data will use consistent procedures, but remain flexible regarding emerging tools and methodologies (Simon 2006). The archival of the digital library contents will be sustained through cooperation with the host institutions and participating museums. The CTDL is hosted internationally, thus facilitating global digital accessibility. The CTDL website will be developed over the course of the project to include the display of the 3D ceramic database with several levels of access through queries. This database will be openly available to institutions, voluntary contributors, and the larger public audience.

The Ceramic Technologies Digital Library offers several benefits for promoting research and cultural awareness. The development of the CTDL will provide web-based access to numerous significant artifact collections spread among various institutions in many different countries. The CTDL structure and procedures will benefit research on the ceramic collections from the Germania-Slavica area by developing and implementing tools and techniques for classification, analysis, and access that can be

generalized to other collections. The CTDL bilingual (English and German, with a Danish-added version) interface will provide international access to visualization and measurement (2D and 3D) of ceramic dimensions, symmetry, and curvature. The CTDL will advance the methods of database organization for data-mining, promoting Internet-based collaboration, with available tools, techniques, and instructional information for the users. Finally, by utilizing both 2D and 3D methodologies and techniques, the CTDL will advance the development and implementation of digital libraries for complex collections of three-dimensional artifacts.

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