IMPACT Radiological Database – Andrew Nelson and Randall Thompson, principal investigators

Overview – The proximate goal of this project is to establish an online, web assessable, computerized database of radiological studies of ancient Egyptian mummies. The ultimate goal is to move the field of mummy studies beyond its current highly particularistic, case-study approach to a new population approach, by providing access to large numbers of individual studies. It is only through such access that research can be facilitated in such fields as norms of ancient mortuary behaviour and patterns of variability in the expression of diseases. The Ancient Egyptian civilization lies near the root of the tree of Western civilizations and so the better we understand this rich and ancient culture, the better we understand the genesis, adaptations and behaviour of our own.

Challenges and Lessons Learned – Our greatest challenges have not emerged from interdisciplinary issues, but from the fundamental details of dealing with radiological data. Our raw data comes in the form of scans of plain film x-rays, and computed tomographic and magnetic resonance scans. These scan datasets are typically quite large (1-5 GB per study), consisting of several thousand "slices" (individual successive image files) and they are stored in a unique format designed to embed "patient" data in each slice. This format is called Digital Imaging and Communications in Medicine (DICOM). The examination of DICOM data typically requires a Picture Archive and Communications System (PACS) to manage the data, and a viewer to visualize the data. Viewers range from very simple (slice viewers), to very sophisticated (3D imaging where the slices are stacked to become a volume). PACS and associated viewers are typically deployed in hospital settings, where the protection of patient privacy is a key concern. They are rarely deployed in the archaeological/museological community, and there generally only for data management within an institution. This is the first attempt to populate a PACS with data that is then to be made available to scholars anywhere and we have encountered some unique challenges.

First, the PACS database must use a "thin client" model, as concerns about intellectual property require that the data remain on the PACS server, which must also then have the requisite power to do all the image manipulations. Second, given the large datasets, the server must have a lot of hard drive storage, lots of RAM and a powerful video card. Finally, there must be control of access. The first challenge depends on the software, the second on the hardware configuration and the last is done in our case by means of an oversight committee that approves access requests. We have gone through two iterations of software and hardware, as the first package had an excellent PACS, but very poor image manipulation capabilities. The second software package has (ORS Visual) excellent image manipulation capabilities, but has different hardware requirements than the first. In addition, we are actually functioning as a beta testing facility for the software company. Thus, it is only now, in late August, that we are finally approaching full functionality.

The adjunctive tools for data management and storage and for team communication have generally worked well. For example, multi-continent meetings and symposia are carried out routinely using Internet tools such as Skype and Go-To-Meeting. Also, CT data is routinely shared with specialists in 12 locations in 6 countries with the use of cloud solutions and open access DICOM readers (Sutherland et al. 2013).

Indicators of Success – While the database is not yet fully functional, we have been preparing by gathering datasets and we have already begun analysis of those datasets in two different realms. The first is in the area of the Ancient Egyptian Mummification ritual (see Wade & Nelson 2013). For this study we were able to examine primary datasets for 50 mummies, with the following 2 goals: 1) to test veracity of the historical text of Herodotus and 2) to examine patterns of variability through time and between social strata. The classical Herodotean stereotype of the practice of mummification was found to be an inadequate description of this very complex ritual. Our examination of the practice through time demonstrated that specific elements (e.g. removal of the brain through the nose) began first in the elite, and then spread to the lower classes in later time periods. This previously unappreciated variability has important implications for our understanding of status and power relations, foreign influences and changing belief structures through time.

The second is in the area of the study of ancient disease (Thompson et al. 2013). This study focused on the expression of atherosclerosis (hardening of the arteries) in ancient cultures included 137 mummies from 4 different geographic areas. The overarching conclusion was that atherosclerosis, previously thought to be a disease of modern times (and fatty diets) was actually not uncommon in ancient populations, and its expression is likely to be a function of age. This is quite a major shift in our understanding of this disease, made possible only by the access to large numbers of scans of ancient mummies. This portion of the project is ongoing with over 100 mummy CT scans still being analyzed. The team believes that the additional statistical power will allow it to draw conclusions about universal cardiovascular risk factors.

Measuring Impact – Impact can be measured in a variety of ways. The two articles mentioned above are published in high profile journals and received considerable media attention, especially the atherosclerosis study. Beyond the journals, the project has proved to be very popular in the media, including 11 stories featuring the database itself and 44 stories the on research that it has enabled. These stories have appeared worldwide.

Knowledge Dissemination Mechanisms and Tools - The two publications mentioned above are the first items to be disseminated in refereed form to the academic community. At least 14 conference papers have been presented either on the project or on the data being collected for it. The database and its associated SQL context database are themselves means of dissemination, but we are also engaging the public through social media (Wade et al. 2013).

Capacity Building – A key player in this project has been AD Wade, first as a doctoral student then as a post-doc working with Nelson, and now a Faculty member at McMaster University. His role has been critical to the success of the project, but it has also given him the opportunity to gain access to skills, data and to the academic community that would be possible in no other way. We envision that graduate students will be important database users, and we will definitely encourage that.

Summary – This project is poised to transform the study of Ancient Egyptian mummies and to transform our understanding of the culture and biology of this society and their relation our cultures and biology today. It is only through moving from a case-study approach to a broad, comparative, population approach that this transformation can take place. Our data formats, data set sizes and software/ hardware needs are currently quite unique, but we envision that similar databases could be used in museum studies, art history, and many other areas where non-destructive analysis is important.

References Cited

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