Creation of a library of 3D images of human and ape skeletons.

Scott W. Simpson, Ph.D
Department of Anatomy
CWRU-School of Medicine

An understanding of human skeletal anatomy (osteology) is a necessary content area for clinicians, paleoanthropologists, comparative anatomists, and forensic specialists. While direct study and access to skeletal materials is preferred in the study of osteology, access to these materials can be difficult for students. Currently, human bones are available to students for study during the ANAT 377/477 Human Osteology class although limited at other times. The creation of these additional educational resources can perhaps lead to larger class sizes (now limited to 12) providing additional learning opportunities for students. Plus, the bones now available to the students are often damaged and do not belong to single individuals, thus preventing a full understanding of the details of anatomy and the loss of an interrelationship between the bones in an individual. While there are high quality osteology textbooks available to the students (e.g., White, et al., Human Osteology, 3rd Ed.), the photographs cannot provide a full appreciation of the three dimensional spatial relationships necessary to understand the structure of bones. Online resources are also available (e.g., eSkeleton) but these are low resolution static images and the images are not annotated making identification of the important landmarks difficult. The School of Medicine is currently moving away from cadaver dissection and towards a curriculum that will emphasize anatomy training based on models and digital representations. The 3D osteology library can be a valuable resource for this anatomy training.

Funding is requested to develop a 3D atlas of human and primate skeletal materials for teaching as part of the existing ANAT377/477 Human Osteology course, for use in professional (SOM Block 7 Human Gross Anatomy) and graduate (ANAT 411) anatomy courses, and for developing a new course in comparative primate osteology. Students will have online access to these materials during the course as a tool for learning the basic skeletal anatomy remotely in addition to having access to bones during the lab and self-study times. Using readily available software (e.g., PhotoShop) students can examine and rotate the images so the details of the structure can be observed from all sides – this is a marked improvement over traditional still images found in books or online. The model can be annotated (regional coloration of major landmarks, joint surfaces, and muscle attachments and labeling of landmarks) as necessary to highlight the details of the anatomy that are useful for teaching, reviewing, and testing. These high resolution images have metric fidelity allowing the students to conduct 3D morphometric analyses of the bones as a foundation for future research. Currently, we do not have the means to provide this analytic opportunity for the students although a demand exists at the undergraduate and graduate levels.

Other advantages of having these digital models are that the bones can be 3D printed either at their true size or at different scales. For example, the small bones of the hand and feet are often difficult to manipulate and study due to their small size. With these digital skeletons, we can 3D print small bones 2-3 times their natural size using the facilities at think[box] to provide a way to study the fine anatomical details of the small bones. Printing also allows use of the specimens

without damage to the original specimens thus preserving the specimens for future researchers. Funds for printing specimens are not requested here.

The specimens to be scanned will be from the Hamann-Todd Osteological Collection that is housed at the Cleveland Museum of Natural History. This well-curated collection includes over 3100 human and over 900 primate skeletons providing an opportunity to sample a wide range of natural anatomic variation in humans and the range of taxonomic diversity among the many species of primates.

Budget Justification

The NextEngine 3d laser surface scanner is portable, easy to use, affordable, high resolution (0.005" accuracy) tool that has proven its worth for morphometric research and archival documentation. To take full advantage of the capacity of the scanner, a software upgrade (ScanStudio HD Pro) is required that both shortens the scanning time and improves resolution of the scanner. The purchase of a dedicated laptop computer is also required to interface with the scanner and to store and manipulate the data. It is estimated that it will take about 30-60 minutes to scan each bone (depending on its size and complexity) and to clean the image. The goal is to scan at least two human hemi-skeletons and two African ape hemi-skeletons in the upcoming year. Amanda Slotter, an undergraduate major in anthropology who has experience imaging skeletal remains, will be assisting in the project. She has agreed to devote 5 hrs/week to the project in the Spring 2015 term with the balance of time collecting data during the summer of 2015. Clearly, experience will speed data collection time. The scanning equipment can be used in future years to allow the continuing collection of data and creation of a large library of 3D images of human and primate variation, sexual dimorphism, skeletal pathology, as well as examine age changes in critical areas for forensic aging of the skeleton such as the pubic symphysis and auricular surface. Students and other faculty can use this equipment for data collection in service of research or developing educational resources.

Budget

Next Engine 3d Laser Scanner	$2995
ScanStudio HD Pro	$ 995
Hewlett Packard ENVY 17t laptop computer -upgraded with an Intel Core i7 processor -upgraded graphics card	$ 900
Scanning assistant 250hrs x $10/hr	$2500
Total request	**$7380**