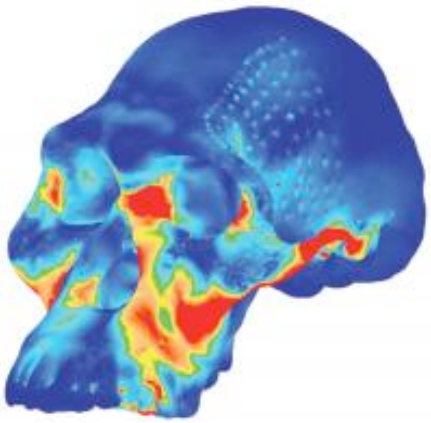
In early humans, “jaws of steel”

Feb. 11, 2009
Courtesy Arizona State University and World Science staff



Your mother always told you not to use your teeth as tools to open something hard, and she was right. Human skulls have small faces and teeth and aren’t well-equipped to bite down forcefully on hard objects. Not so of our earliest ancestors, say scientists.

Research published in last week’s online issue of the research journal Proceedings of the National Academy of Sciences suggests nut-cracking abilities in our 2.5-million-year-old relatives that let them alter their diet to adapt to changing circumstances.

Using computer modeling and simulation – the same techniques engineers use to simulate how a car reacts to forces in a front-end collision – evolutionary scientists built a virtual model of the skull of the human ancestor Australopithecus africanus. The plan was to see how the jaw operated and what forces it could produce.

“We started with a CT scan of a skull that is one of the most complete specimens of A. africanus that we have,” said Mark Spencer, an Arizona State University assistant professor, who with doctoral student Caitlin Schrein at the university is part of an international research team behind the study.

The skull under investigation is believed to come from a later ancestor of the populations that included “Lucy,” the most famous fossil skeleton in anthropology. Dated as about three million years old, Lucy is the most complete known fossil of a genus of prehistoric African human ancestors known as australopithecines.

The Lucy ancestor investigated in the new work was a fossil dubbed STS5 and affectionately known as “Mrs. Ples.” The skull, discovered in 1947, has struts on the side of the nose, but no teeth.

“We meshed those data with another specimen with teeth to make the virtual model of the bone and tooth structure,” Spencer said. “Then we looked at chimpanzees, who share common features with Australopithecus, and took measurements of how their muscles work and added that to the model. We were able to validate this model by comparing it to a similar model built for a species of monkey called macaques.”

The result – a rainbow colored virtual skull that illustrates forces absorbed by the cranial structure in simulated bite scenarios and how their unusual facial features were ideally suited to support the heavy loads of cracking hard nuts.

“It was like watching ‘Mrs. Ples’ come to life,” Spencer said.

“This reinforces the body of research indicating that facial specializations in species of early humans are adaptations due to a specialized diet,” said Spencer. “The enlargement

of the premolars, the heavy tooth enamel and the evidence now that they were loading forcefully on the molars suggest the size of the objects were larger than the previously hypothesized small seeds and nuts. These fall-back foods – hard nuts and seeds – were important survival strategies during a period of changing climates and food scarcity."

Image: Compressive stress in the cranium of Australopi the cusafricanus, an extinct early human, imposed by biting on the premolar teeth. Bright colors correspond to high stresses, and indicate that a bony pillar running along side the open ing of the nasal cavity acts as a strut that structural lyre in forces the face against pre mo-lar loads. (Courtesy of Arizona State University; Hominid Feeding Biomechanics research group)