Virtual museum brings thousands of digital specimens to the desktop in 3-D

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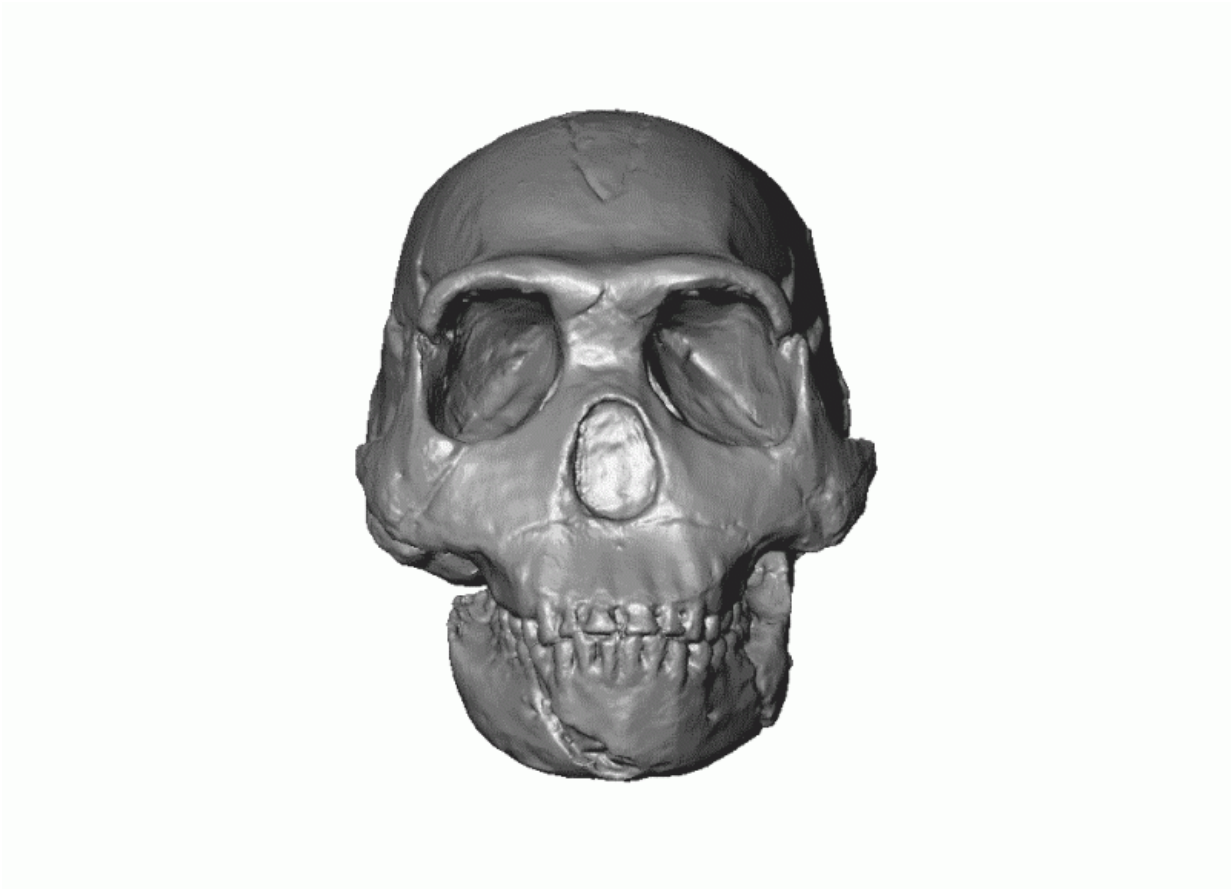

3-D scan of the fossilized skull of Homo naledi, an ancient human whose remains were discovered in a South African cave. The creature is one of more than 500 extinct species whose fossil scans are available for anyone to download at http://MorphoSource.org. Credit: Reconstruction by Peter Schmid and Ashley Kruger, University of the Witwatersrand

Duke assistant professor Doug Boyer's office is more than 8,000 miles away from the vault at the University of Witwatersrand in Johannesburg, South Africa, where the fossil remains of a newly discovered human ancestor, Homo naledi, rest under lock and key.

But with a few clicks of his computer's mouse, he can have models of any one of hundreds of naledi bone fragments delivered to his desk in a matter of minutes.

Paleontologists like Boyer frequently travel halfway around the world to examine such unique and fragile specimens. That is, assuming their curators will even allow such access.

But the Homo naledi specimens are a different story. They, and hundreds of other species, are now available in a free online database of digital scans that anyone can download and print in 3-D.

MorphoSource, which Boyer launched at Duke in 2013, is the largest and most open digital fossil repository of its kind.

"We're essentially taking bones out of museum catacombs and putting them online," Boyer said.

Visitors to the site can zoom in or out and rotate the fossil scans, download them and even make their own physical copies to hold in their hands using 3-D printing.

It's a far cry from past practices in the field of human origins.

"Paleoanthropology is traditionally a closed good ol' boy network where fieldwork is done in secret and findings are kept secret," said Duke evolutionary anthropology professor Steven Churchill, a member of the team that discovered and described Homo naledi.

"Researchers often sit on fossils for years and years before publishing, and then even after publication it can be hard to see the fossils or even see casts of them," Churchill said.

By contrast, the Homo naledi team is taking advantage of MorphoSource to make their discoveries more accessible.

When the discovery was announced in September 2015, the authors released high-resolution scans of more than 80 key specimens to the MorphoSource repository.

The naledi find comes from a deep underground chamber where only a few can ever hope to gain access. The more than 1,500 bones brought to the surface so far represent parts of at least 15 individuals, ranging from infants to adults, making it one of the largest caches of fossil hominins ever found.

Less than 12 hours after the Homo naledi discovery was announced, students in anthropologist Kristina Killgrove's class at the University of West Florida were already poring over 3D printed pieces of the creature's jaw, legs, hands and skull that Killgrove had downloaded and printed on her lab's desktop 3D printer.

Within three months, the Homo naledi 3D scans were viewed a staggering 43,000 times and downloaded an additional 7,600 times.

"We're really proud of that," Churchill said.

3-D imaging of fossils is not new. A technique called micro-computed tomography uses X-rays to create a 3-D model of a fossil from a series of cross-sectional slices, using an amped-up version of the CT scanners found in hospitals and emergency rooms.

The technology makes it possible to capture details many times finer than a human hair, and peer inside specimens without breaking them open or even laying a finger on the fragile originals.

"Many specimens in anthropology collections are pock-marked where dozens of researchers have set their calipers to retake the same measurements," Boyer said.

In the last ten years, faster 3-D scanning and cheaper digital storage have made it possible to scan thousands of bones in a matter of weeks. Numerous institutions have rushed to scan and digitize their fossil collections, but MorphoSource is one of the only efforts to consolidate the resulting data and put it in one place.

In the three years since the archive was created, researchers and educators from more than 70 institutions across the globe have uploaded close to 9,000 image files. To date, the collection represents more than 500 species, including a 40-thousand-year-old Neanderthal skull from Israel, delicate water beetles from New Guinea, and bits of a swamp-dwelling dinosaur called Telmatosaurus.

Visitors will also find nearly two dozen teeth from a 60-foot prehistoric shark named Megalodon, vertebrae from a massive 40-foot, 2500-pound snake called Titanoboa, and the bizarre bones of a 16-inch devil frog from Madagascar that resembled a squashed beach ball.

Many of the fossil scans also come with lesson plans that teachers can use in the classroom through an intiative called PaleoTEACH.

The scans continue to come in. Earlier this month, Boyer and other researchers uploaded 3-D data for more than 400 skulls plus additional bones from 59 species of monkeys, apes and lemurs housed at the Museum of Comparative Zoology at Harvard.

"Paleoanthropology has been relying on digital data more and more," Boyer said. "Before we released this dataset, only a dozen labs around the world had digital samples that large at their fingertips. Overnight we leveled the playing field in a significant way."

More information: Lee R Berger et al. , a new species of the genus from the Dinaledi Chamber, South Africa , *eLife* (2015). DOI: 10.7554/eLife.09560

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