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UNIVERSITÀ DEGLI STUDI FIRENZE

GEOLOGICAL CURATORS GROUP GCG

The 3D digitising, -reconstruction, printing and montage of the Portuguese Theropod dinosaur *Lourinhanosaurus antunesi*, based on incomplete remains

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A 3D skeletal reconstruction of the theropod dinosaur *Lourinhanosaurus antunesi* was produced over the last year and this was done entirely by 3D-digitising, -modelling and -printing. 3D-printing was favoured over traditional molding and casting because of the versatility of 3D-printing as well as significant material savings. Here we show some of the processes involved and outline the advantages over more traditional techniques.

Lourinhanosaurus antunesi was found near Lourinhã in Portugal in 1978 by a farmer, who later donated the unprepared Lower-Tithonian material to the Museu da Lourinhã. Before description as a basal allosauroid (Mateus 1998), the material was carefully acid prepared and the remains are in good condition. The preserved skeletal material comprises of 6 articulated cervical vertebrae; the larger parts of the pelvic girdle, including sacrum, ilia and partially preserved pubes and ischiae; some posterior dorsal vertebrae; significant sections of the tail and a nearly complete femur, tibia and fibula. These remains were 3D digitised with photogrammetry and the pictures were processed with Agisoft Metashape™ (v.1.6.2). The material was mirrored where possible, and made complete with 3D-modelling software Autodesk Maya™ and Zbrush™. Missing elements were modelled on *Sinraptor* and *Allosaurus*. Parts of the material were still in articulation, and various freeware software (Autodesk Meshmixer™) were used to separate the visible material in the scans from the rock, making it easier to prepare for further modelling and printing. The main printer used for this reconstruction was a Builder Extreme 1500™, although some material was printed with an Ultimaker 2+™.

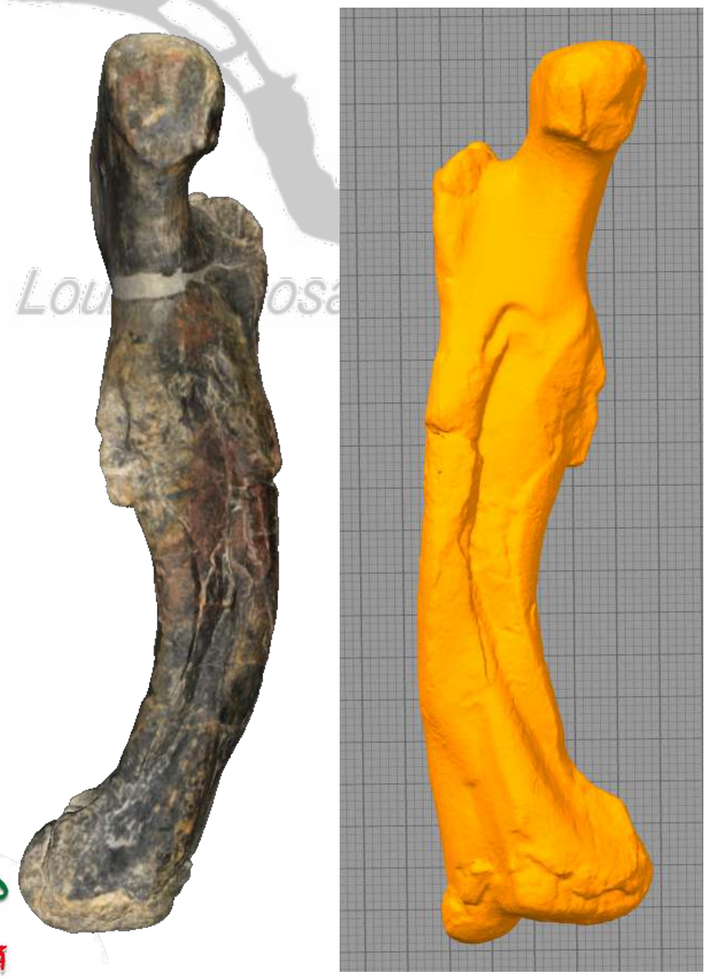
Reconstructed ilia & sacrum combining mirroring & modelling

Image by Octavio & Simão Mateus ©

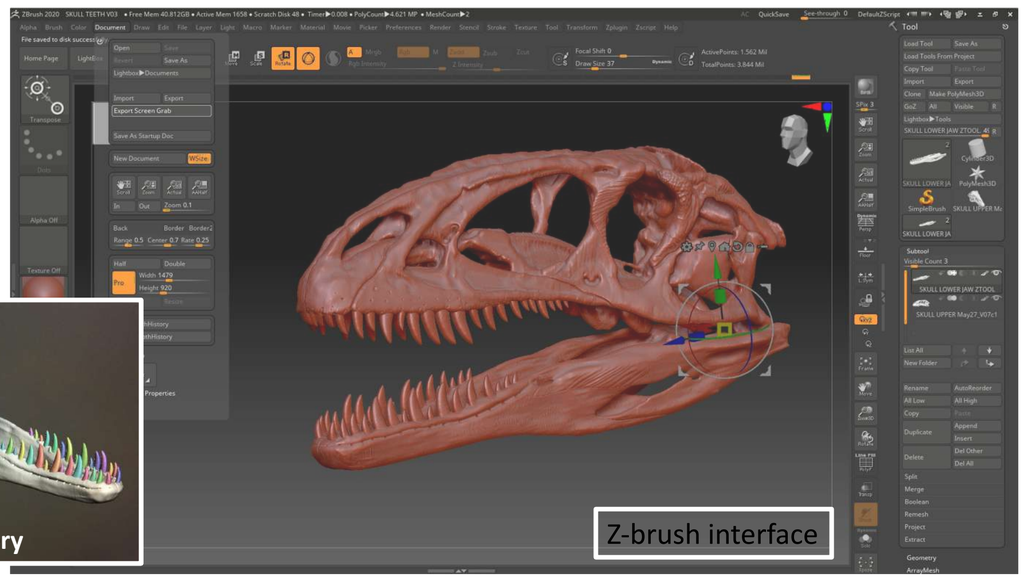
The advantages of working digitally become readily clear when teasing apart fossil material, and using mirroring tools. Often, one side will be better preserved and mirroring allows for a fast workaround.
Below a left femur – mirrored to the right

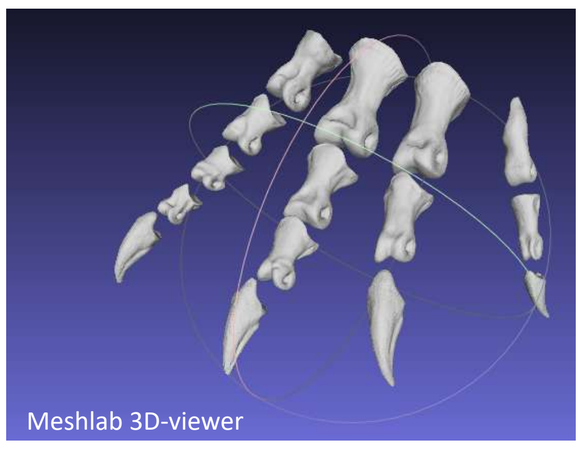
Material savings were made by using 3D printing techniques. A traditional reconstruction would have used an estimated minimum of a 100kg of silicone rubber at significant cost. Casting resins would have added a minimum of a further 20kg. This would have been one size only, whereas 3D files can be printed in any size. The above skeleton is just short of 5 meters long.

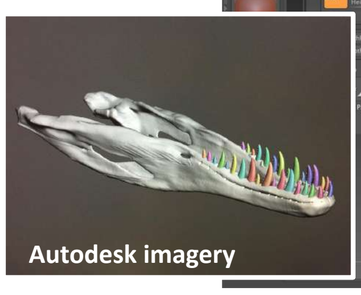
Spot the mistake



Approximately 10kg of plastic (Poly Lactic Acid, PLA) is required for a full skeleton, representing serious material savings. Furthermore, PLA is a bioplastic, which easily can be recycled or industrially composted. Without these processes, the PLA remains very stable and has a long life as a sturdy plastic. Printed with an infill of only 6% internal structure, the replicas are yet very tough & resistant.



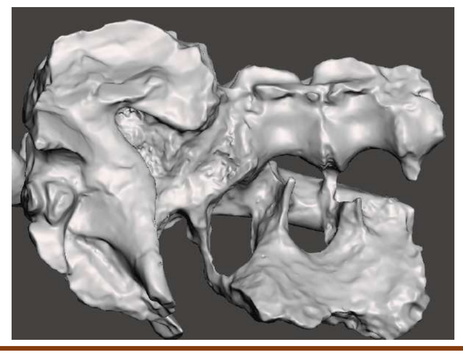


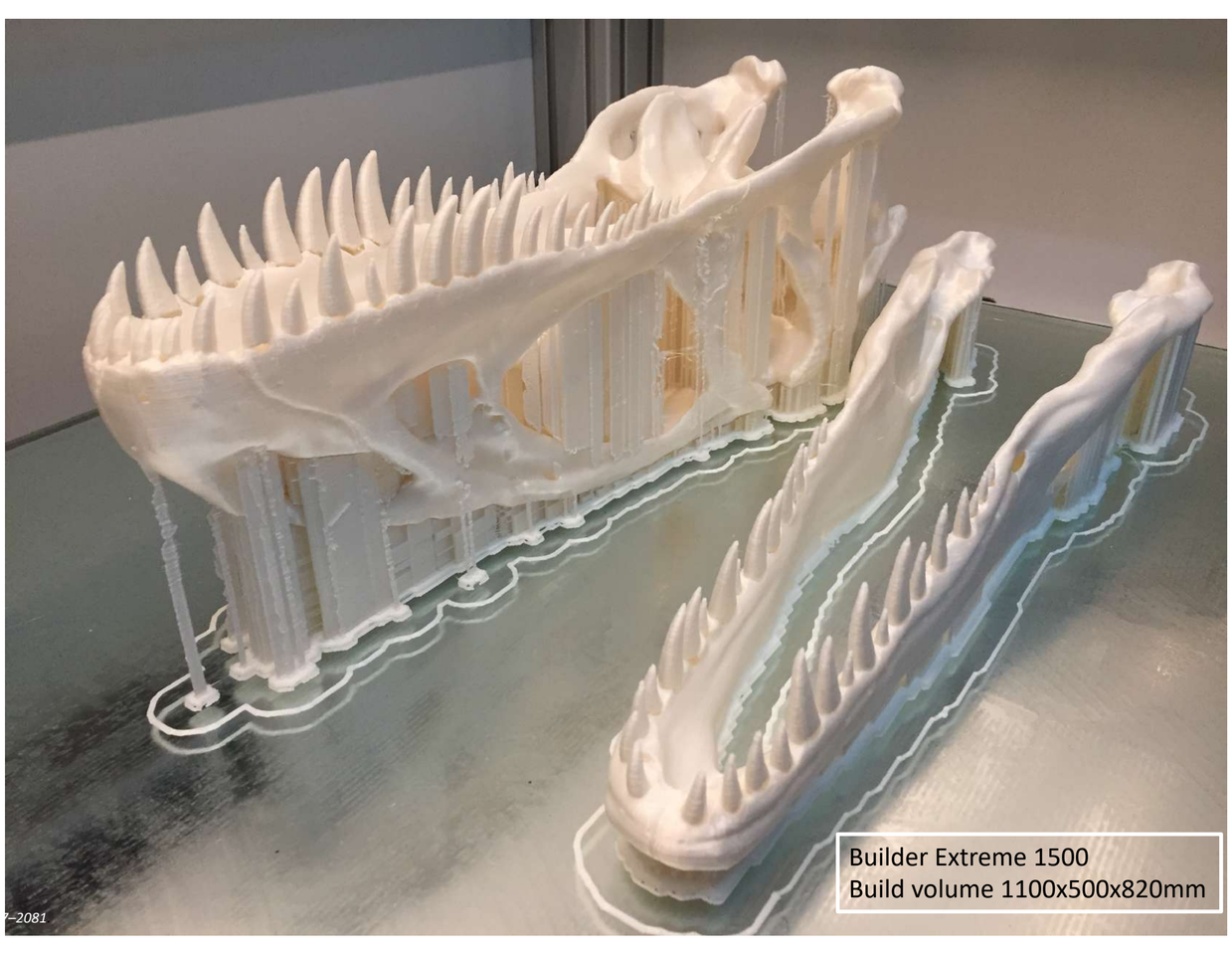


For many of the bones a large build-volume is not necessary. Additionally, larger bones can be digitally sliced and printed in parts, later to be glued together. However, a large build-volume saves time in printing but also allows for efficient organisation. These bones were printed on a 0.3mm resolution.

To the right:

A mirrored posterior left hip to fit the better anterior right hip





Builder Extreme 1500
Build volume 1100x500x820mm

Conclusions: the monetary & time investment in the printing equipment, computer hard- and software and the education is significant, but significant savings are made too in time and resources. Additionally, the investment in traditional reconstruction techniques would also be substantial. A clear advantage is the 3D scanning is the entirely non-intrusive nature. Arguments can be made that the end-product is more versatile and adaptable than a traditional molded replica.

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