UNDERSTANDING HOW BONES DEVELOP AND RESPOND TO DISEASE AND THE USE OF IMPLANTS

Scientists at the University of Hull have developed their simulation software to utilise ARCHER to model complete bones or large sections of bones. This offers the exciting opportunity to model skeletal development and adaptation. The potential benefits are enormous, ranging from a better understanding of both the fundamental biomechanics of bone and the cause and effects of musculoskeletal conditions, to better implant design.

"This new ability to model the fine details of bone structures provides many exciting opportunities."

– Professor Michael Fagan, University of Hull

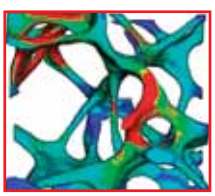
Computational Achievements

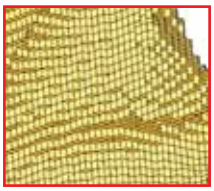
The modelling software VOX-FE2 has been developed and enhanced by EPCC and the University of Hull through a software development award from the ARCHER eCSE programme. As a result the software can now simulate bones at a sufficiently fine level of detail that their true structural behaviour can be represented.

The software is now on average 3 times faster than before and can run on a much larger number of computer cores – over 512. Going to even larger core counts improves the speedup, with the code running a maximum of 30 times faster on very large core counts.

Financial Benefits

In the short term the scientists plan to carry out a series of studies on the human skull and proximal femur, with a high model resolution (~250 million elements). The performance improvements achieved with the code will save an estimated £63,000 on the cost of running these simulations. Longer term these savings will continue to grow as the simulations increase in size and complexity.





Scientific Benefits

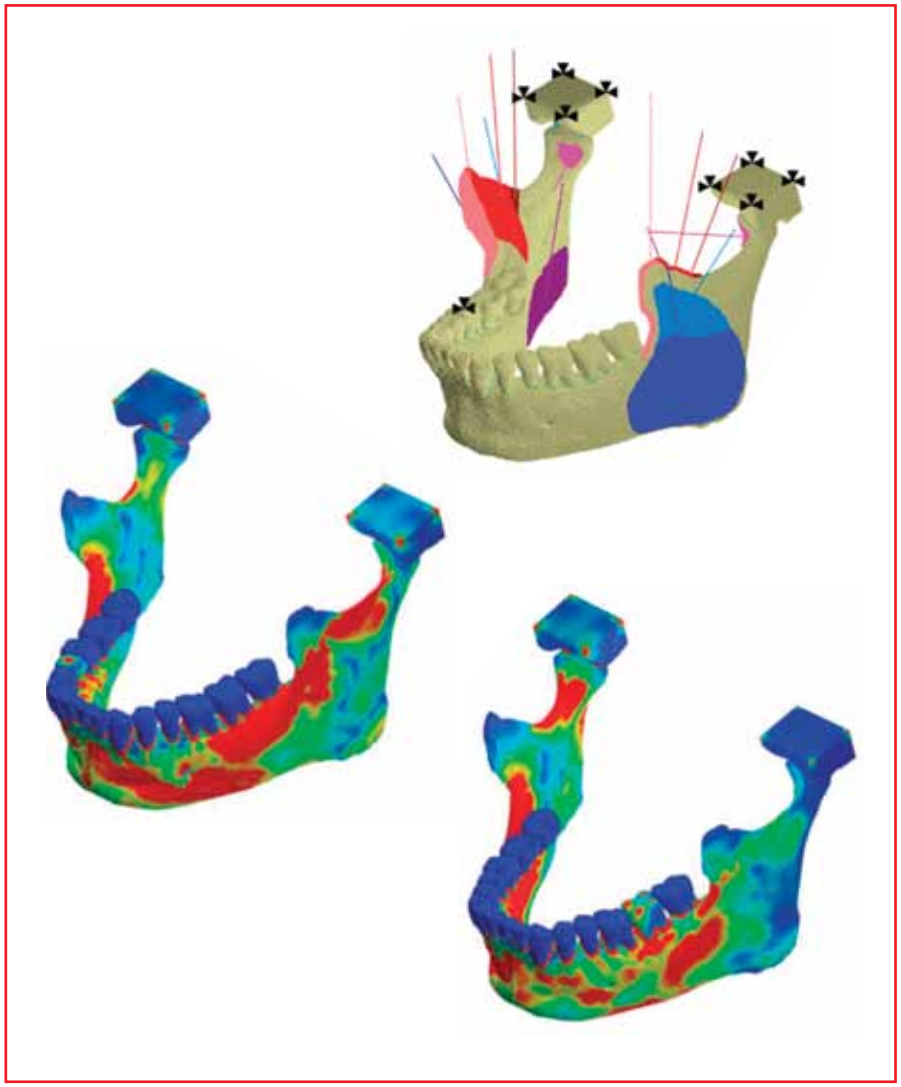
Bones have highly complex architectures that are individually optimized to the loads they experience. This new ability to model the fine details of their structures provides many exciting opportunities not only to understand more about fundamental bone biomechanics, but also to investigate bone diseases and to advance joint repair and replacement. In particular, this allows the following type of investigations:

(1) simulation of the development and growth of the femur and investigation of conditions such as Perthes' disease;

(2) simulation of the biomechanical effects of osteoporosis and response to increased exercise or drug treatments to rebuild bone;

(3) simulation of the response of bone to implants and their osseointegration, for example hip replacements and dental implants.

By understanding these conditions in more detail, the scientists have the potential to make a positive impact on many people's day-to-day lives.



About ARCHER

ARCHER is the UK National Supercomputing Service. The service is provided to the UK research community by EPSRC, UoE HPCx Ltd and its subcontractors: EPCC and STFC's Daresbury Laboratory, and by Cray Inc. The Computational Science and Engineering (CSE) partners provide expertise to support the UK research community in the use of ARCHER. The ARCHER CSE partners are EPSRC and EPCC at the University of Edinburgh.

The eCSE Programme

The Embedded CSE (eCSE) programme provides funding to the ARCHER user community to develop software in a sustainable manner to run on ARCHER. Funding enables the employment of a researcher or code developer to work specifically on the relevant software to enable new features or improve the performance of the code.

The Case Study Series

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