FEBio: Finite Elements for Biomechanics

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1. Introduction

FEBio is a nonlinear finite element solver that is specifically designed for the biomechanics and the biophysics communities. Using state-of-the-art simulation technologies it offers features that are highly relevant in these fields. FEBio can solve problems in nonlinear mechanics and has an extensive library of constitutive models that are suitable for large deformation analyses, including hyper-elastic, visco-elastic, rigid body, and more. It can model multiphasic materials using a formulation based on mixture theory that account for the multiple constituents of tissues. It offers various contact formulations for modeling the many ways that objects may interact.

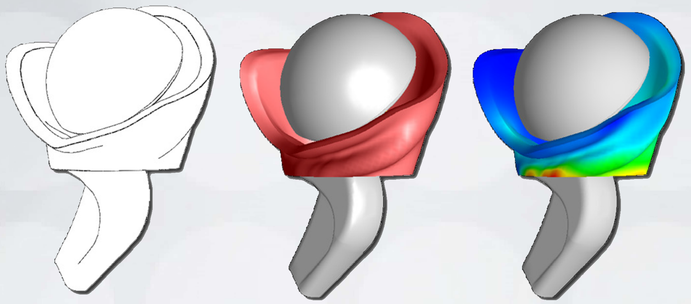

Figure 1. Finite element analysis of a hip implant device showing high stresses in areas of impingement.

2. Verification

Verification is an important aspect of any software development project. Therefore, a large suite of over one hundred verification problems has been developed and is run every night on all supported platforms to make sure new additions to the code don't break existing functionality.

3. Plugins

As of version 2.0, FEBio implements plugins, which allow users to extend FEBio's capabilities in a straightforward and convenient manner. Plugins, which are essentially dynamically linked libraries, are developed and maintained independently from the main code, and do not require users to recompile the entire FEBio source code. Plugins allow users to add new constitutive models, new types of boundary and loading conditions, new data fields for extending FEBio's output file, and more. Plugins can also be used to interface FEBio with other software. Several example plugins are available for download at http://febio.org/plugins.

4. Modern Software Design

- Developed in C++
- Uses OpenMP for parallelization
- Support for Windows, Linux, MAC
- XML based input format
- Extendible output format
- Fast parallel linear solvers (Pardiso, SuperLU, etc.)
- Code documentation by Doxygen
- Custom tensor library for easy material implementations.
- Source code is open-source

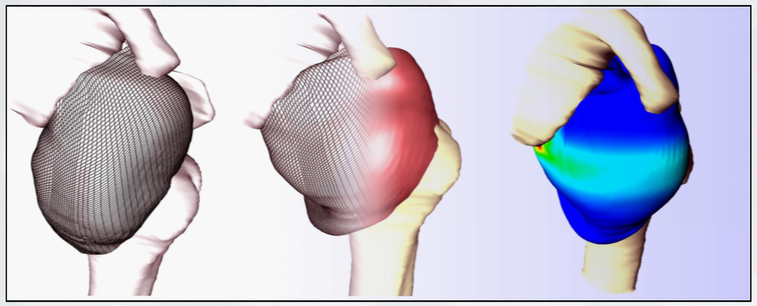

Figure 2: FE Analysis of shoulder capsule stresses during simulated clinical exam.

5. Support

The developers have placed considerable emphasis on supporting new and established users.

- Online and pdf documentation of Theory Manual, User's Manual and Developer's Manual.
- Online User's forum where users can ask questions, report bugs and request features.

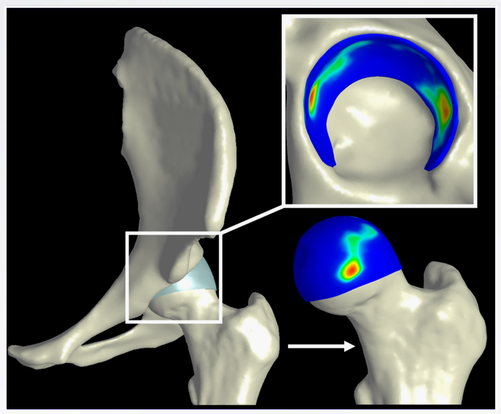

Figure 3. Finite element analysis of articular cartilage pressures in the hip joint of a normal hip during walking.

6. PreView

- PreView is a finite element pre-processor that was specifically designed to create FEBio input files.
- Intuitive GUI-based design of FE models
- Simple geometry and mesh creation
- Tetrahedral meshing with Tetgen (tetgen.berlios.de)
- Support for many input formats (e.g. ABAQUS, NIKE3D, LSDYNA, ANSYS, IDEAS, etc.)

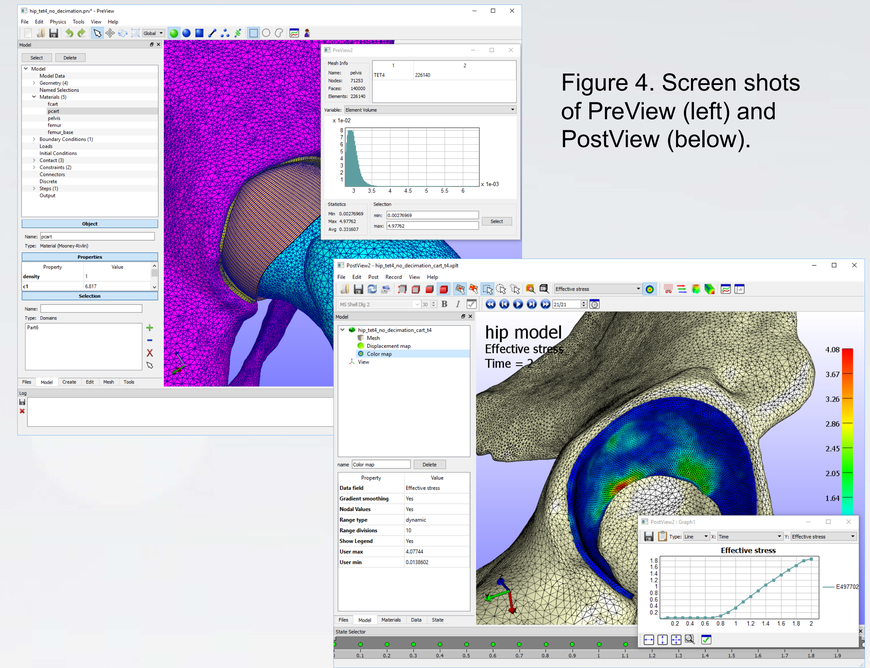

Figure 4. Screen shots of PreView (left) and PostView (below).

7. PostView

- Finite Element post-processor designed for visualizing and analyzing FEBio results.
- Uses OpenGL to create nice graphics.
- Different plot types (contour, isosurface, vector, etc.)
- Screen capture and animation recording capability.

8. Download

- All software, including FEBio source code can be downloaded free of charge from: http://febio.org
- Online documentation is available at: http://help.mrl.sci.utah.edu/help/index.jsp

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