

Overview of Biomedical Engineering and Biomedical Informatics in the Computational Sciences and Engineering Division (CSED)

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OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

Biomedical Programs/Overview

- Biomedical Informatics
 - Breast Imaging – National Digital Mammography Archive
 - Electronic Patient Records
 - Data mining/Data fusion
 - Intelligent agent applications
 - Community-wide Secure Information Sharing (CSIS)/
Healthcare Information technologies Enabling Community Care (HITECC)
- Biomedical Engineering
 - Joint ORNL/UT Center for Musculoskeletal Research
 - Biomedical Modeling and Simulation (cardio-vascular; orthopedics; *in vivo* fluoroscopy (3D-2D imaging))
 - Non-linear analysis (SeizAlert)
 - Acoustic Modeling
- Biomechanics (Center for Musculoskeletal Research)
 - Implants; joint replacement, Prosthetics; Biomedical imaging
- Imaging/Modeling Technologies
 - Virtual Human
 - Virtual Soldier
 - Multi-Scale Vascular Modeling
 - Prosthetic Arm - Revolutionizing Prosthetics
- Data Management and Interoperability
 - Virtual Soldier
 - Virtual Autopsy



Biomedical Engineering and Biomedical Informatics and Related Areas

- **Geo-spatial (population dynamics; disease distribution, GIS overlays)**
- **Biomaterials (tissue engineering, grafts, implants)**
- **Center for Musculoskeletal Research**
 - **Computational Biomechanics**
 - **Bio-imaging**
 - **Bio-sensors**
 - **Bio-materials**
- **Image Processing and Machine Vision (small animal imaging, Content-Based Image Retrieval)**
- **Computational and Systems Biology**
- **Biosensors and Micro-arrays**

Joint ORNL/UT Center for Musculoskeletal Research

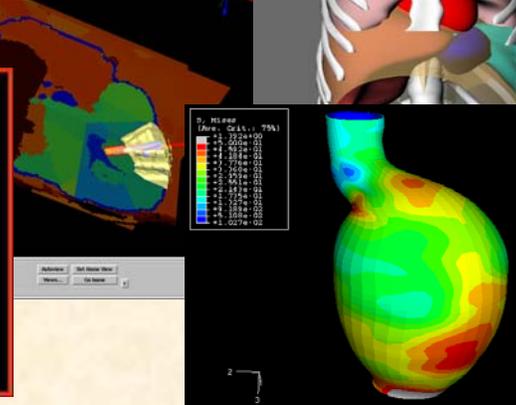
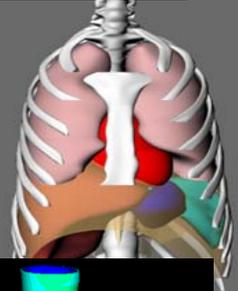
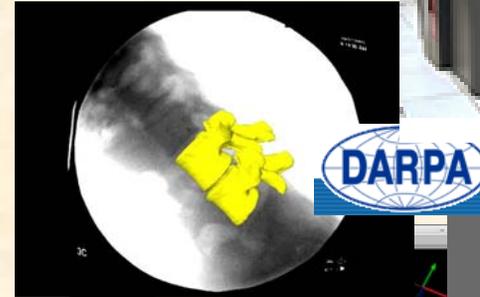
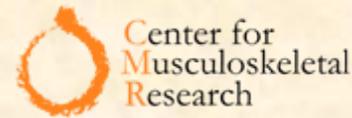
<http://cmr.utk.edu/CMR.htm>

- **Built upon existing biomedical engineering research at ORNL and the University of Tennessee**
- **Leverages strong programs in mechanical engineering, materials, sensors, biology, and computational sciences**
- **Build close collaborations with medical professionals and biomedical companies**
- **Attain recognition as leaders in biomedical engineering research in selected fields**
- **Provide basis for improved health outcomes**

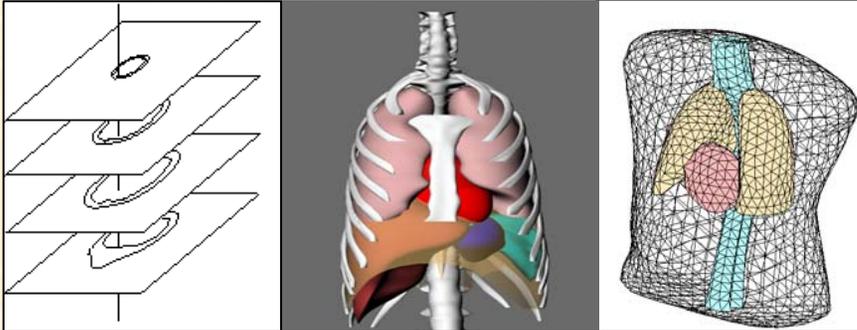


Biomedical Modeling and Simulation at ORNL

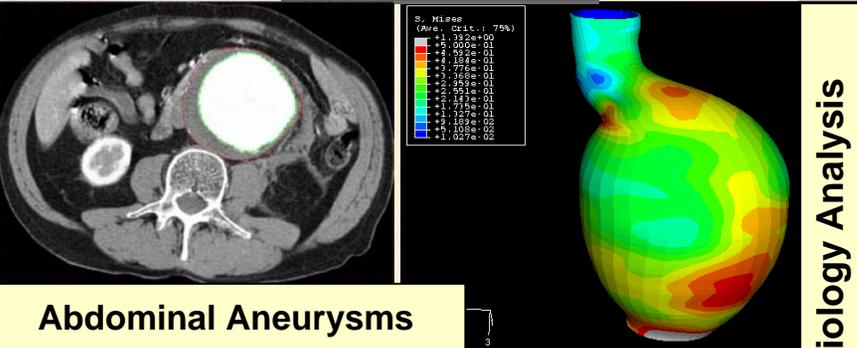
- **National Leadership Class Super-Computing Facilities**
- **Joint ORNL/UT Center for Musculoskeletal Research**
 - Orthopedic kinematic and dynamic models
 - Mathematical models; 2D-3D image models
- **Biofluid modeling**
 - Abdominal aortic aneurisms
 - Airway flow and particle deposition
- **Computational Environments for physiological modeling**
- **Web-based visualization environments**
- **Virtual Soldier Project**
- **Virtual Autopsy Project**
- **Prosthetic Arm**



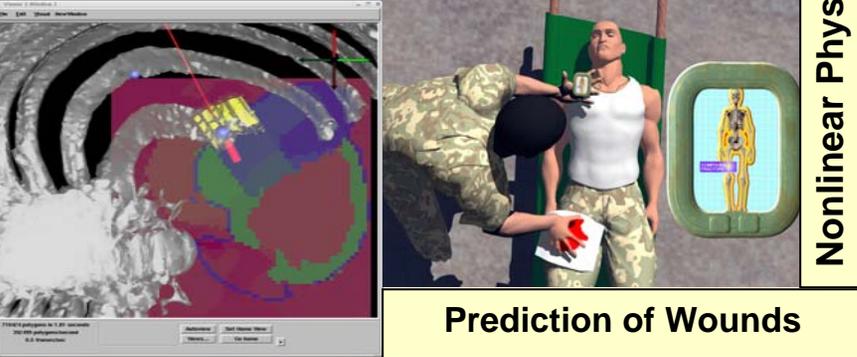
CSED Solves Biomedical Problems



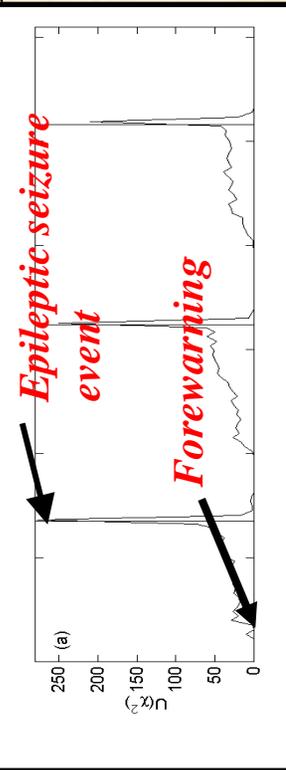
Convert CT Slice Data to Finite Element Mesh



Abdominal Aneurysms



Prediction of Wounds



Nonlinear Physiology Analysis

Bounding Box Data Source: [home/rwd/vh-vs-data/MAVAtlas/Injury List Data Source: [home/rwd/vh-vs-data/Secondary/Geometry Directory: [home/rwd/vh-vs-data/MAVAtlas/Model/HIP data Directory: [home/rwd/vh-vs-data/HIP/Baseline/OQAF MA URL: [http://time.biostr.washington.edu:8082/OQAFM/unknowns Left marginal vein] Upper lobe of left lung Left ventricle Myocardial zone 12 Medastinum Pericardial vein Pericardium Myocardial zone 5

Cursor Location 434.3 229.4 1444.6 Myoc

Cursor Size 1.8 Time

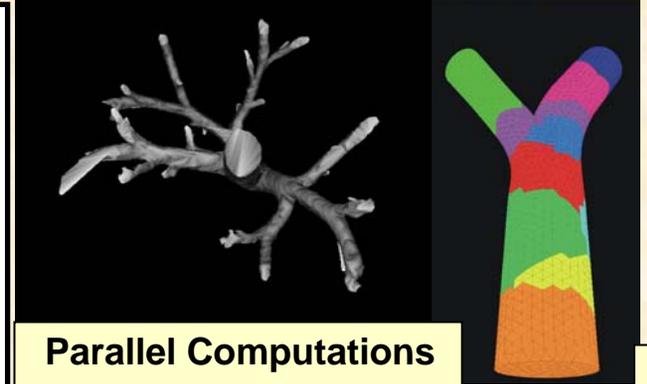
Highlight Selection

Diagnosis

Ontology

Parent	Selection	Child
Heart	Myocardial zone 12	Anterolateral head of lateral papillary muscle of left
Left ventricle		Trabecula carneae of left ventricle
Cardiovascular system		Anterior division of left branch of atrioventricular b
Left side of heart		Cardiac myocyte
Trunk		Cytoskeleton
Wall of heart		Mitochondrion
Body compartment		Lysosome
Thoracic cavity		Centrosome
		Osmioblast
		Cell nucleus

Ontologies and Informatics



Parallel Computations

Simulation Time: 6.8240 days Exposed HgO: 46.8761

Start Pause Stop

Client Update Delay (ms) 0 500 1000

Server Speed 0 50 100

File Edit

Nose Mouth Esophagus Trachea Bronchi Respi_1: 0

Brain Brain_1: 31.0771 Brain_2: 0.3191

Other tissue Other_1: 479.2883 Other_2: 4.7066

Bladder: 0.4211

GI Tract

Liver Liver_1: 63.7371 Liver_2: 33.6330

Stomach: 0.9051

Intestine: 3.1819

LLI cont: 6.7764

Kidney

Urine: 22.6206

Feces: 0.67774

Hg vapor: 0

D Hg++: 1.9085

HO Hg++: 7.4609

Plasma RBC: 900.161448

Time History Plots

Y-Axis Scale D Hg++ vs Time

plasma-diff-hg

Min X Scale: 0 Max X

Min Y Scale: 0 Max Y

Detailed Model

Computational Tools for Toxicants

Problem Solving Environments