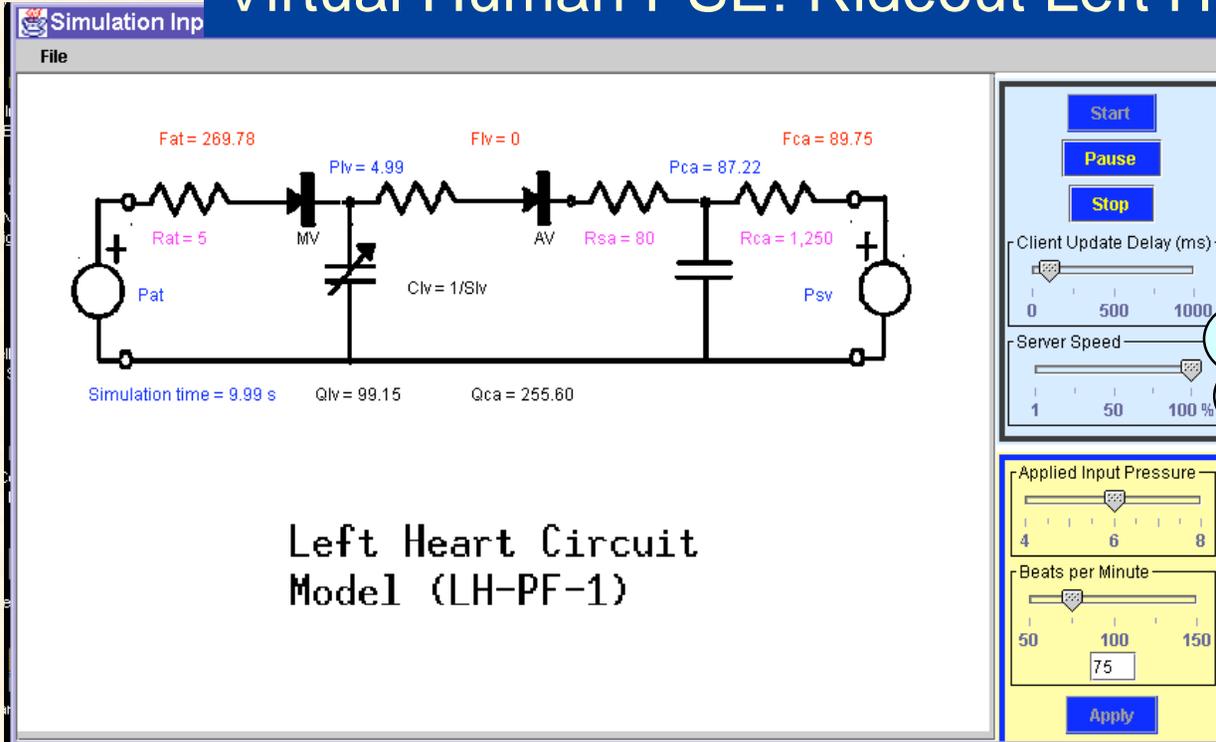


Virtual Human Modeling

Richard C. Ward
Computational Sciences and Engineering Division

- **Virtual Human Computational Environment**
- **Integrated Respiratory System Modeling**
- **Virtual Soldier Project (DARPA)**
- **Virtual Autopsy Project (DARPA)**
- **Revolutionizing Prosthetics (DARPA)**

Virtual Human PSE: Rideout Left Heart Model



Left Heart Circuit Model (LH-PF-1)

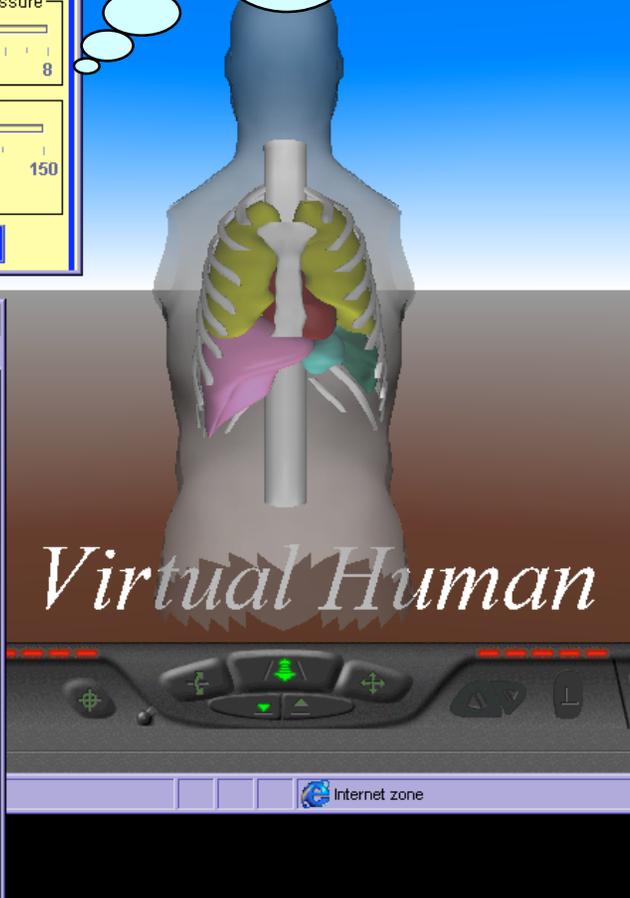
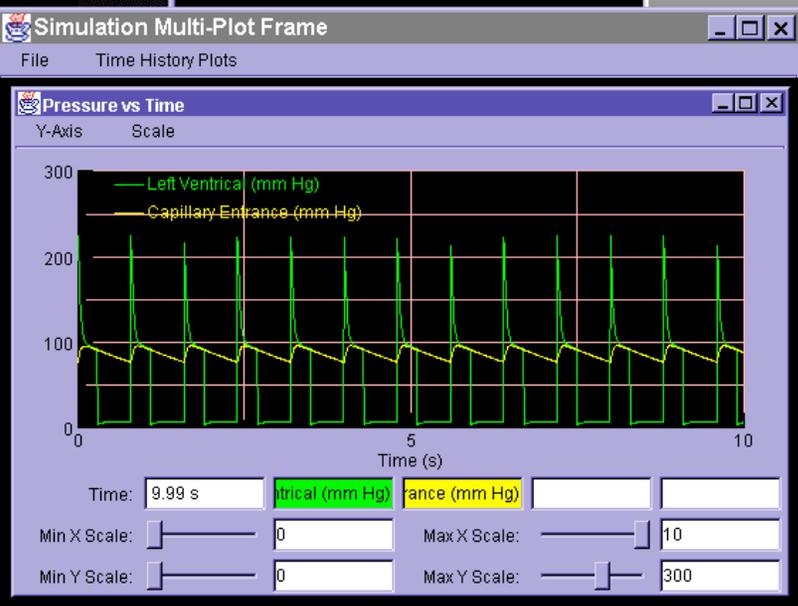
Control panel for the simulation:

- Start
- Pause
- Stop
- Client Update Delay (ms): 0 to 1000
- Server Speed: 1 to 100%
- Applied Input Pressure: 4 to 8
- Beats per Minute: 50 to 150 (set to 75)
- Apply

Model sliders control simulation

LH Simulation Applet interface:

- Using UID: rwd
- Will use RMI server at: rmi://ca34.cad.ornl.gov:2003
- LH Scenario
- Help
- WARNING. If you close this



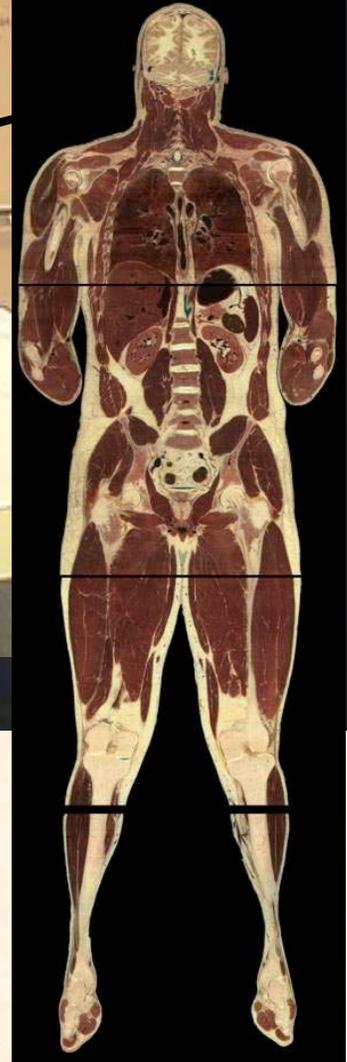
Virtual Human

Virtual Soldier

Or

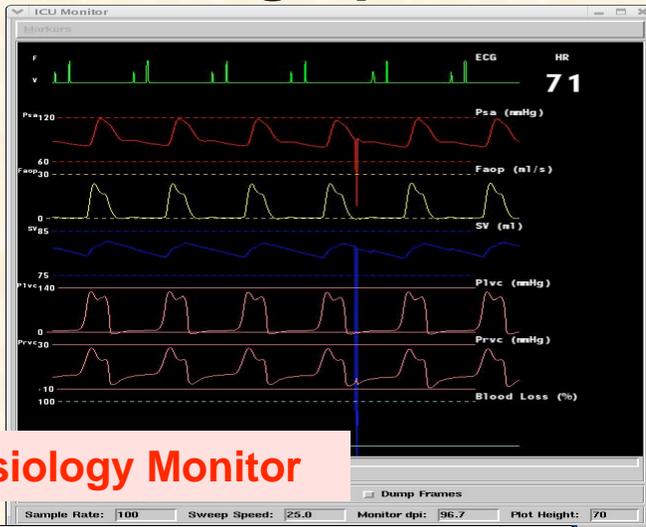
Combat Medical Support Enters the Information Age

OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY



UT-BATTELLE

One Goal of Virtual Soldier Project: Create a Holographic Medical Electronic Representation



Physiology Monitor

uiVS_DataFlow_HotBox_0

Data Sources

Anatomy Data Source: /home/rwd/vh-vs-data/FMAAtlas/MasterAnatomyFMA.csv Browse...

Adjacency Data Source: /home/rwd/vh-vs-data/FMAAtlas/AdjacencyMappingFMA.cs Browse...

Bounding Box Data Source: /home/rwd/vh-vs-data/FMAAtlas/VHBoundingBoxesFMA.cs Browse...

Injury List Data Source: /home/rwd/vh-vs-data/secondaryInjuryWS-zone12-2005041 Browse...

Geometry Directory: /home/rwd/vh-vs-data/FMAAtlas/Models/decimField Browse...

HIP data Directory: /home/rwd/vh-vs-data/HIPBaseline Browse...

OQAFMA URL: http://fme.biostr.washington.edu:8082/OQAFMA_Service/s/

unknown Left marginal vein Upper lobe of left lung

Left ventricle Myocardial zone 12 Mediastinum

Pericardial vein Pericardium Myocardial zone 5

Cursor Location 434.3 229.4 1444.6 Myocardial zone 12,434.3, 229.4, 1444.6

Cursor Size 1.8

Time 00:00:02

0.0 10.0 20.0 30.0 40.0

Highlight Selection Diagnosis: exsanguination

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
		Centriole
		Cell nucleus

Query Type: Contains Parts Part Contains

OQAFMA Files Connect to FME Enable Viewer HotBox

Close

The HotBox interface

The HotBox connects:

- Physiology display
- Geometry window
- Anatomical ontology

SCIRun Net

Viewer 1 Window 1

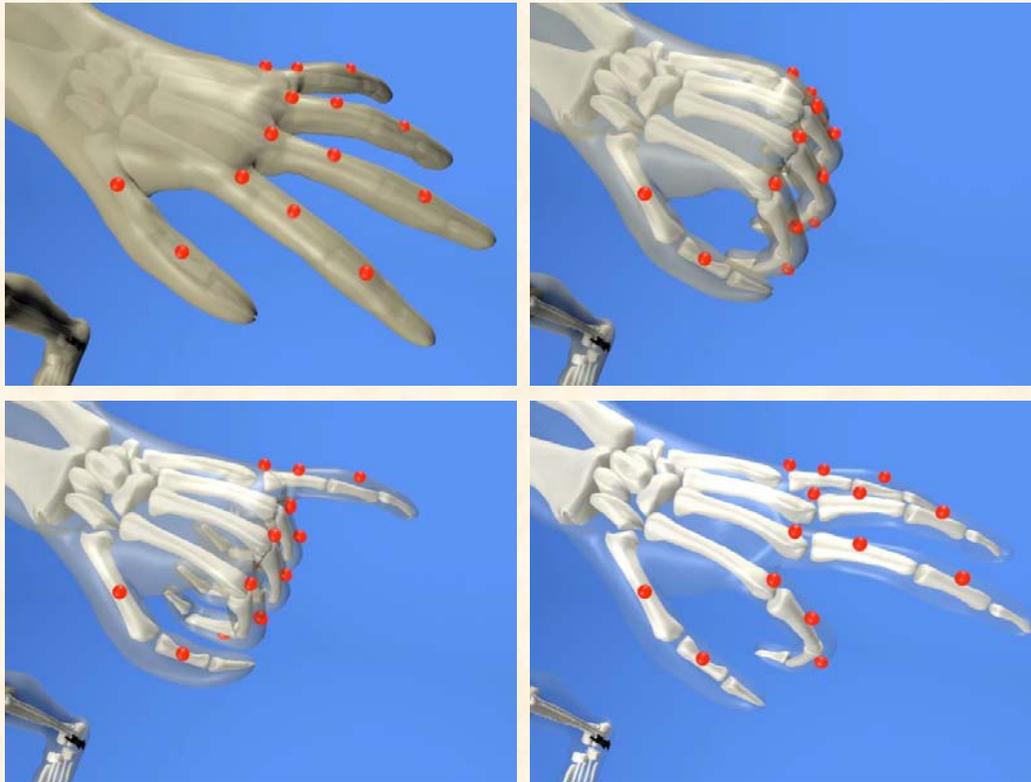
Thorax model

710424 polygons in 1.81 seconds
332459 polygons/second
0.5 frames/sec

Autoview Set Home View
Views... Go home

Revolutionizing Prosthetics

Create revolutionary design of forearm/hand prosthesis with realistic look, feel and action.



Students Contribute Significantly to Virtual Human Modeling

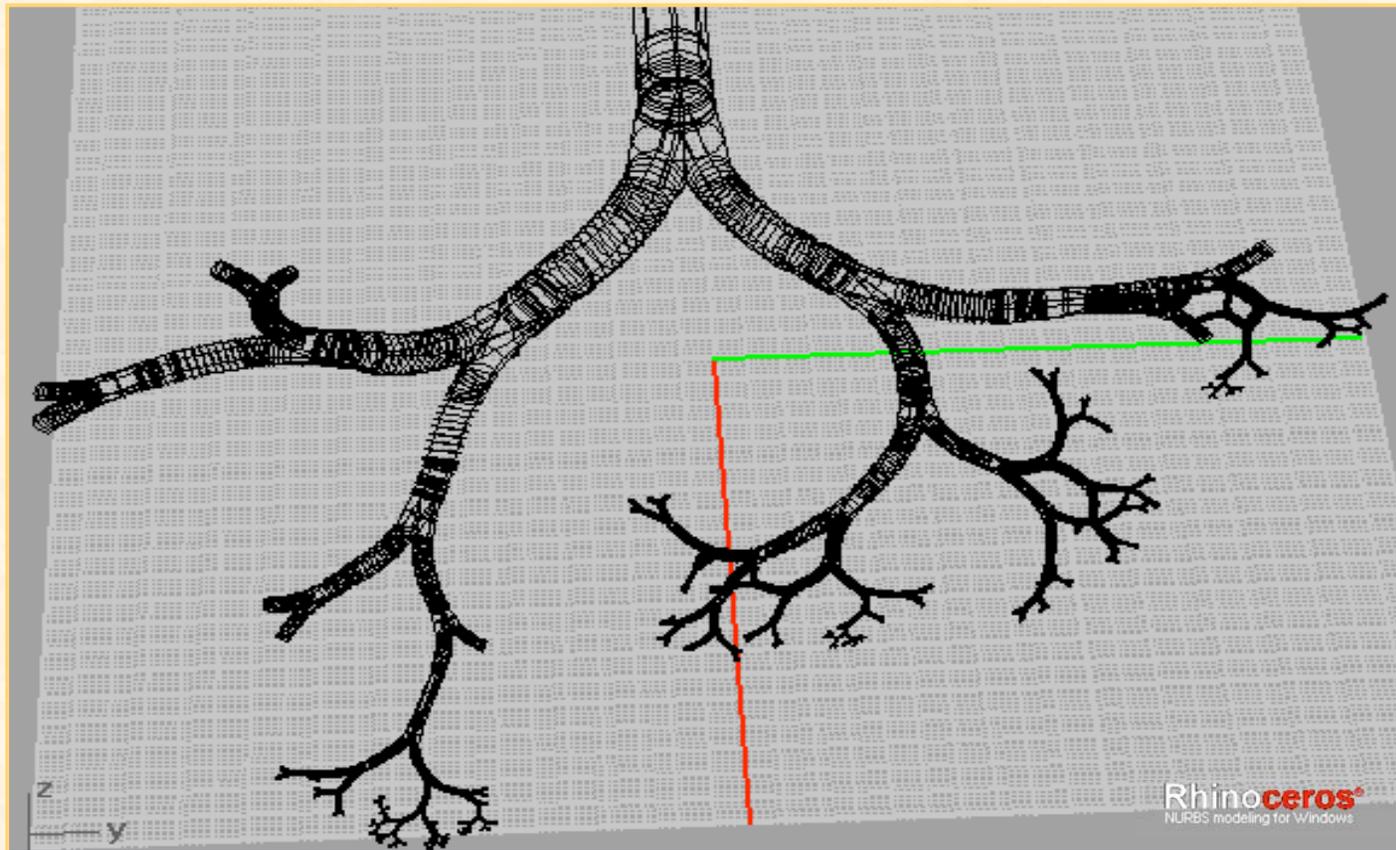
- **Virtual Human Computational Environment**
 - Eduardo Difilippo, SULI 1999
 - Dan Price, SULI 2000
 - Joy Wright, PST, 2000
 - Ming Gu, GLCA 2001
- **Integrated Respiratory System Modeling**
 - Jacob McMurray, SULI 2000
 - Todd Miller, CCT 2000
 - Erica Sherritze, PST 2003
- **Human Abdominal Aortic Aneurysm (Kara Kruse)**
 - William Jenkins, SULI 2001
 - Joel Outten, SULI 2002
- **Virtual Soldier Project (DARPA)**
 - Gary Atkins, RAMS 2004
 - Sarah Wing, SULI 2004
 - Pearl Flath, SULI 2005
 - Jennifer Bennett, RAMS 2005
 - Matt Woerner, HERE 2005

Virtual Human Modeling

Example Projects

Erica Sherritze

Use NURBS Software to Design Pulmonary Airway



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Display Surfaces of Organ Segments using VTK Software

- **Simulate a fragment wound to the right ventricle.**
- **Display each organ segment as fragment traverses that segment.**
- **Surfaces rendered using VTK.**
- **Work with program obtained GE Global Research.**



Gary Atkins

Link 3D Imagery to Ontology

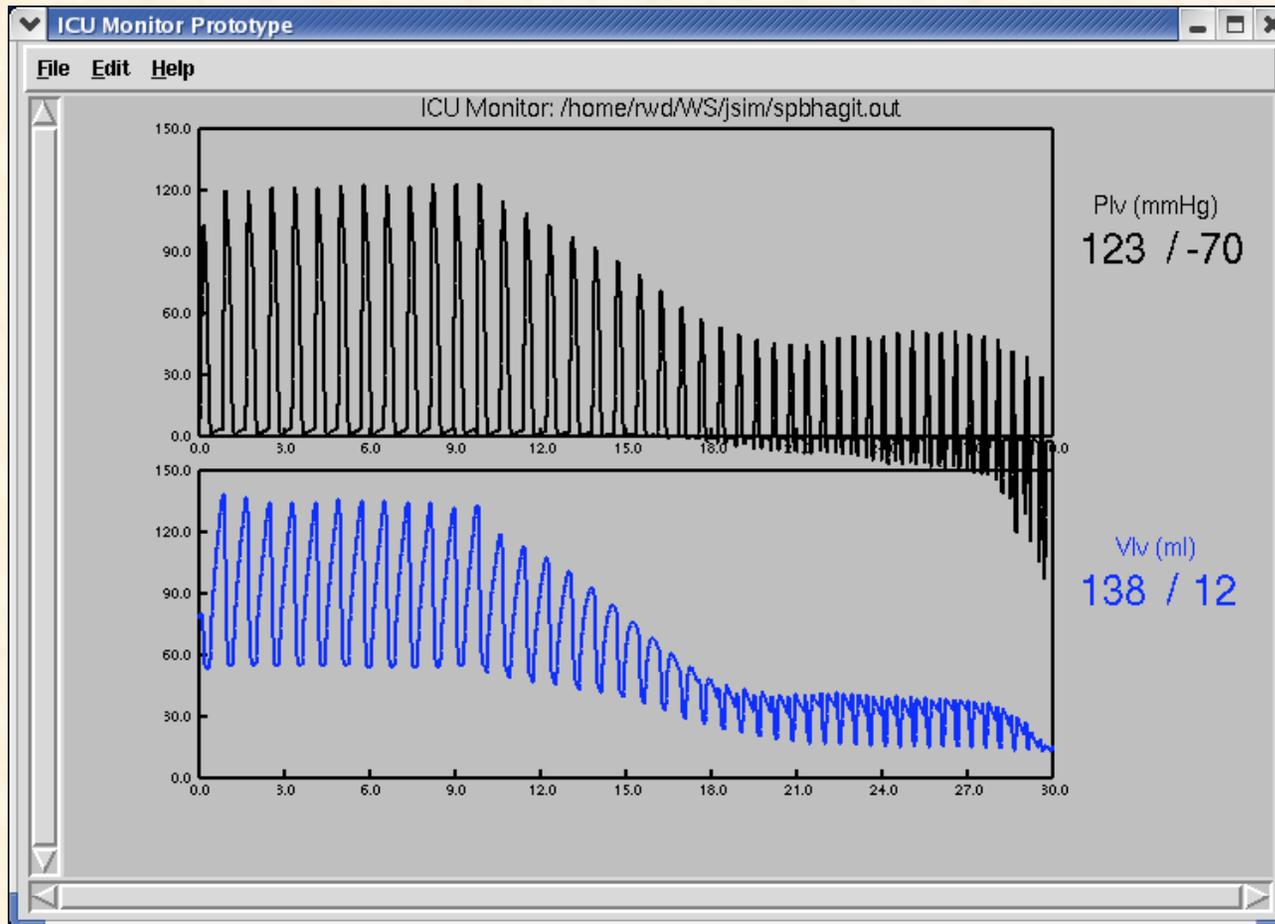
Use Foundational Model of Anatomy and Web Services

The image shows a 3D anatomical model of a heart, split vertically to show internal structures. A white pointer indicates a specific location on the right ventricle. Below the model is a 'Structure List' panel with a 'Dismiss' button and several anatomical terms: 'right_ventricle', 'left_ventricle', 'pericardium', 'mediastinum', 'left_upper_lobe_of_lung', and 'third_internal_intercostal_muscle'. An orange arrow points from the 'right_ventricle' entry to the 'Foundational Model Explorer' window. The window displays the 'FME' logo, 'Options', and 'Help' buttons. It features a search bar, a 'Select navigation tree type:' dropdown set to 'part', and a search results list. The 'Right ventricle' entry is highlighted, showing its sub-structures: 'Wall of right side of heart', 'Cavity of right side of heart', 'Right atrium', 'Left side of heart', 'Left atrium', 'Left ventricle', 'Papillary muscle', 'Fibrous skeleton of heart', 'Tricuspid valve', 'Mitral valve', 'Aortic valve', 'Pulmonary valve', and 'Interatrial septum'. To the right, the 'PREFERRED NAME:' is 'Right ventricle', 'SYNONYMS:' includes 'Right ventricle of heart', 'NON-ENGLISH EQUIVALENTS:' includes 'Ventriculus dexter' and 'Ventriculus cordis dexter', and the 'DEFINITION:' is 'Right cardiac chamber connected to the right atrium and the pulmonary artery.'

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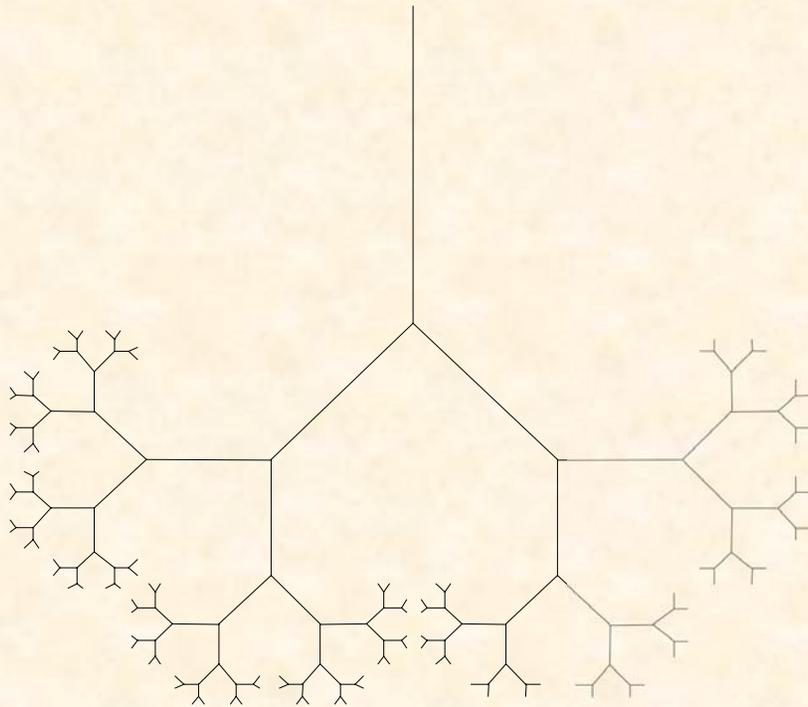


Web Service Implementation of Physiology Models

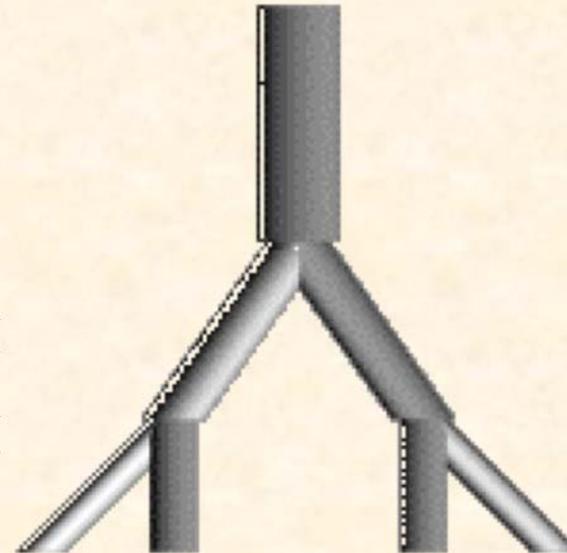


Injury to left ventricle of the heart. Results plotted using tcl/tk.
Model supplied by U. of Washington.

Mathematical Visualization of the Lungs Using Fractal Geometry



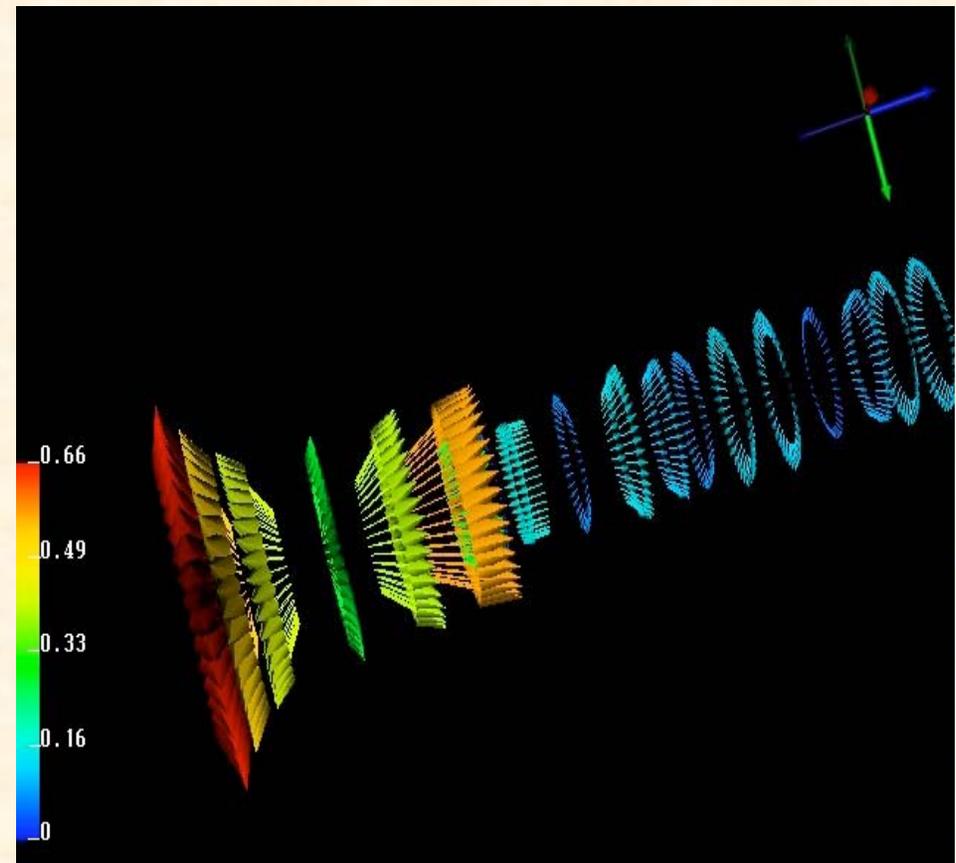
Fractal Tree



CAD Model

Visualize Arterial Fluid Flow

- Data supplied by Pearl Flath
- Convert original data to HDF5 format
- Create a SCIRun network of modules to compute and interpret data
- Launch the SCIRun Viewer module, a GUI (Graphical User Interface)
- Network makes possible interactive exploration of scalar and vector flow fields



Summary

Students Have Contributed Significantly to Virtual Human Modeling!

- **Students learned:**
 - **Visualization**
 - **Representations of information in ontologies**
 - **Practical programming (Java, Tcl/Tk and VTK)**
 - **Integration of software components**
- **Concepts learned are applicable to real world**
 - **IT Industry**
 - **e-Commerce**
 - **Games and animation industry**
 - **Modeling and simulation**