expression of MK-STYX encourages neurite production. Neurite expression is seen in the presence and absence of NGF, nerve growth factor. Finally, MK-STYX can induce neurite outgrowth when MEK is inhibited. Together, these data are significant because they provide more insight into MK-STYX's potential role in neuronal differentiation. Future directions should explore other proliferation and differentiation pathways to determine MK-STYX's role.

## Biomedical and General Engineering

VARIABLE CRACKING PRESSURE SWING CHECK VALVE. Cameron J. Grover, Samantha L. Leach, Graham S. Kelly, Stephen J. Warren, Charles E. Taylor & Gerald E. Miller, Dept. of Biomedical Engineering, Virginia Commonwealth University, Richmond VA. 23220. Aortic Valve Sclerosis is a heart condition affecting up to thirty percent of the population over the age of sixty-five. It is characterized by a calcification of the aortic valve leaflets. If the condition is left unchecked, it can lead to aortic valve sclerosis, which may significantly impede blood flow to the heart. This leads to an increased left ventricular load and an increased pulse pressure, both of which may cause complications and undue stress on the body. This project models aortic valve sclerosis by developing a variable cracking pressure swing check valve. Using laser printed acrylic of quarter-inch thickness, a casing for the valve was built with openings comparable to that of a sclerotic valve. The valve was built with sixteenth-inch thick acrylic and pivots on a pin hinge. The elastic material Thera-band Silver was affixed to the valve and attached to a linear-actuator. The linear-actuator pulls the strip of Thera-band, making it more difficult for the valve to open. In future studies, this model can be used in mock circulatory loops to test left ventricular assist devices interaction with pathological valve states.

IN VITRO STEREOSCOPIC FLOW INVESTIGATION OF A TILTING DISC VALVE AT AN AORTIC ROOT MODEL. Stephen J. Warren, Graham S. Kelly, Charles E. Taylor, Gerald E. Miller., Dept. of Biomedical Engineering, Virginia Commonwealth University, Richmond VA. 23220. Currently, bench top experimental fluid mechanics study for biomedical applications require physiologically accurate flow and geometries. Because of this, it was necessary to include working anatomical models in the mock circulatory systems being used to simulate cardiovascular hemodynamics. The first step in this process was a rigid model of the aortic root, which would serve as accurate exit geometry from the aortic valve. An acrylic aortic model was created from cryoslice data from the National Library of Medicines Visible Human project. The model was implemented into an automated mock circulatory loop that would provide the downstream resistance and compliance to create relevant flow patterns. A tilting disc valve (Bjork-Shiley®) was used in this experiment to display the effects of a central occluder on the exit flow of the valve into the aortic root. Stereoscopic Particle Image Velocimetry was included to allow for three velocity components to be taken in to account at once rather than a multi-planar comparison. The studies concluded that the large central occluder design confirms the presence of large low flow regions in the sinuses of the aortic root. These flow patterns could result in thrombosis formation in coronary sinuses, which could result in myocardial infarction if coronary flow becomes interrupted.

PHOSPHOLEMMAN IS A NEGATIVE FEED-FORWARD REGULATOR OF $CA^{2+}$ IN B-ADRENERGIC SIGNALING, ACCELERATING B-ADRENERGIC INOTROPY. Jason H. Yang & Jeffrey J. Saucerman, Dept. of Biomedical Engineering, University of Virginia, Charlottesville VA 22903. Sympathetic stimulation enhances cardiac contractility by stimulating β-adrenergic signaling and protein kinase A (PKA). Recently, phospholemman (PLM) has emerged as an important PKA substrate capable of regulating cytosolic $Ca^{2+}$ transients. However, it remains unclear how PLM contributes to β-adrenergic inotropy. Here we developed a computational model to clarify PLM's role in the β-adrenergic signaling response. Simulating $Na^{+}$ and sarcoplasmic reticulum (SR) $Ca^{2+}$ clamps, we identify an effect of PLM phosphorylation on SR unloading as the key mechanism by which PLM confers cytosolic $Ca^{2+}$ adaptation to long-term β-adrenergic receptor (β-AR) stimulation. Moreover, we show phospholamban (PLB) opposes and overtakes these actions on SR load, forming a negative feed-forward loop in the β-adrenergic signaling cascade. This network motif dominates the negative feedback conferred by β-AR desensitization and accelerates β-AR-induced inotropy. Model analysis therefore unmasks key actions of PLM phosphorylation during β-adrenergic signaling, indicating that PLM is a critical component of the fight-or-flight response.

SUCCESS OF FLATFOOT SURGICAL CORRECTION ON PLANTAR PRESSURE DISTRIBUTION. Erika A Matheis, Edward M Spratley, Charles W Hayes, Robert S Adelaar & Jennifer S Wayne, Virginia Commonwealth University, Richmond VA. Adult Acquired Flatfoot Deformity (AAFD) is a progressive disease affecting the soft tissue structures of the foot in which joint alignment degenerates and significant dysfunction results. This pre-operative/post-operative study focused on the plantar pressure foot patterns of both stance and walking of AAFD participants to determine the effectiveness of surgical correction. The pressure pattern was divided into nine regions, from toes to heel and medial to lateral, with peak pressure and % body weight loading in each region calculated. Arch index was also determined to quantify flatness as the area of midfoot loading relative to the entire foot. Additionally, participants completed two health questionnaires (SF-36 and FAOS surveys). A lateral shift in pressure loading was evident post-operatively in both the forefoot and midfoot regions. Scores on both surveys increased post-operatively. Arch index was inconclusive. Clinically, plantar pressures as well as surveys may be useful to assess the success of the surgical technique for AAFD.

SEARCH ENGINE OF PHYSIOLOGICAL CONDITIONS IN THE PHYSIOBANK DATABASE. Nitin S. Panwar, Graham S. Kelly, Charles E. Taylor & Gerald E. Miller, Dept. of Biomedical Engineering, Virginia Commonwealth University, Richmond VA. 23220. PhysioBank is an open source database where patient information from multiple sources is collected. The patient data of interest to this laboratory is the blood pressure waveform data and physician annotations pertaining to pathological events that occurred during data collection. However, the size of the library (27000 files) makes it difficult to locate files of interest. This Matlab program has been implemented to sort and categorize these files to make relevant data easily accessible. A search of the databases was performed to obtain a list of files that contain blood pressure waveform data. This list is then compared against every annotation (57)

in the PhysioBank approved annotation list to filter for records that contain pathological events; yielding 3700 records. The list is filtered to include only the databases of interest (Mimic I, Mimic II, MGH/MF, Fantasia, SLPDB); as these databases have the most complete waveform data. Finally, the records are narrowed to create a unique download list of individual files each with a physiological annotation (1990 records). This method provides a faster alternative to the Waveform Database (WFDB) toolbox for Matlab, as it accesses the database information directly from the website. It delivers functionality not seen in the WFDB tools through the identification of blood pressure waveform records containing specified annotations. This projects assists the current work of identifying gold standards for pathological event effects on blood pressure waveforms.

FINITE ELEMENT ANALYSIS OF TRANSVERSE MEDIAL MALLEOLAR FRACTURE FIXATION. Ruchi D. Chande, John R. Owen & Jennifer S. Wayne, Virginia Commonwealth University, Richmond VA. Fracture of the medial malleolus, or distal end of the tibia, can occur in pronation loading scenarios. If such ankle injury is left untreated, more severe conditions such as osteoarthritis can result. Via various devices, open reduction/internal fixation (ORIF) may be utilized to secure the malleolar fragment to the proximal tibia. In this study, finite element analysis (FEA) was employed to investigate transverse fracture fixation by two cancellous screws or a relatively newer fixation device known as the Medial Malleolar Sled™. The performance of these two devices in both tension and torsion was first assessed during cadaveric testing. Following experimentation, SolidWorks was used to develop a computer model of the study, and this model was then validated against experimental results by performing FEA. Force, torque, and displacement results demonstrated the validity of the models, and stress analyses were successful in predicting regions of failure corresponding to those observed during experimentation. Such results illustrate the general utility of computational modeling for the investigation of biomechanical systems.

DESIGN OF A COMPUTATIONAL MODEL FOR ELBOW JOINT BIOMECHANICS. C. A. Woodcock, E. M. Spratley & J. S. Wayne, Orthopaedic Research Laboratory, Virginia Commonwealth University, Richmond VA 23284. Computational modeling is an effective but underutilized method to study the biomechanics of joints. It provides a high degree of adaptivity and reproducibility, while enabling the investigator to study parameters such as stress, strain and forces that are not easily measured otherwise. Using computed topography scans of a cadaver specimen and Mimics™ (Materialise) software, three-dimensional representations of bony anatomy were created using masking and remeshing tools. A functional computational model of the elbow was then developed using the commercially available software package SolidWorks™. Soft tissue constraints were defined and modeled using osteoarticular surfaces and in situ strains. The model was validated through an abbreviated reproduction of the cadaver study Hull et al (2005), which explored the effects of coronoid process resections on varus stability of the elbow. Thus, it was shown that the model accurately represented elbow joint biomechanics via physiological movement and quantitative constraining loads during applied perturbations throughout a range of motion. Further expansion upon the computational

model will focus on radial head contributions to stability, as its effects are under researched despite being the secondary constraint against valgus instability.

REAL-TIME DIGITAL SIGNAL PROCESSING OF MOCK CIRCULATORY LOOP PRESSURE SENSOR DATA USING AN XPC TARGET SOLUTION. Robert B. Thompson, Charles E. Taylor & Gerald E. Miller, Dept. of Biomedical Engineering, Virginia Commonwealth University, Richmond VA. 23220. Real time analysis and control of a mock circulatory loop is highly desirable. Mock Circulatory loop experimentation involves extensive analysis of the cause and effect relationship between many parameters, including pressure at determined points in the mock circulatory loop. Real time analysis allows for dynamic experimentation; high frequency iterative acquisition of parallel sensor data with automatic or host operator controlled response of control of mock circulatory loop parameters. A National Instruments Embedded Controller, operating a parallel Input/Output device, under the LabVIEW Real-Time Kernel is proposed as an xPC target to run a LabVIEW Virtual Instrument (VI) to accomplish dynamic mock circulatory loop experimentation. A VI consisting of an eight Hertz timed loop and network published variables is created to acquire pressure sensor data from a mock circulatory loop. Pressure sensor voltage, acquired at 512Hz, is mathematically manipulated as a dynamic data type on the xPC target to determine real time measurements of cardiac output and total peripheral resistance. The network published variables are read and displayed by a host computer, allowing for operator monitoring and control. An xPC target will perform mock circulatory loop signal processing and control outside of a PC operating system environment, enabling high frequency sampling, up to 1MHz, and unloading the processor requirements of the PC.

APPLICATION OF SIMULINK CODER™ TO A COMPUTATIONAL MODEL OF A SYSTEMIC MOCK CIRCULATORY LOOP. Charles E. Taylor & Gerald E. Miller. Dept. of Biomedical Engineering, Virginia Commonwealth University, Richmond VA 23220. Mock circulatory loops provide an essential in vitro assessment tool for evaluating cardiovascular devices through their operation as a hydraulic analog to the human circulatory system. A computational model of this physical system enables experimental settings to be pre-determined, which assists the efficiency of in vitro experimentation. The development of computational models has been traditionally an intensive programming effort. Utilization of Simulink® Simscape™ toolboxes expedites the model construction process and yields a high fidelity computer model. However, these pre-constructed physical modeling components are computationally intensive. The simulation times for large models may take longer than the experimental run time in the mock circulatory loop. Simulink Coder™ can accelerate these models by compiling the code into more efficient C code, which can be executed more efficiently outside of the Matlab® runtime environment. Various levels of the Simulink Coder™ (Accelerator, Rapid Accelerator, Rapid Accelerator Standalone) provide improvements in execution, and the approach of each level in code packaging will be discussed. The impact of the acceleration on a computational model of a mock circulatory loop will be discussed with a focus on the topology of the model and what sections prevented simulation time reduction.

DESIGN OF AUTOMATED DETECTION OF INCOMPLETE EMPTYING FROM VENTILATOR GRAPHICS: EVALUATING THRESHOLD VALUES. Nyimas Y. Isti Arief, Curtis N. Sessler, Paul A. Wetzel, and Mary Jo E. Grap, Dept. of Biomedical Engineering, Virginia Commonwealth University. Auto-PEEP stemming from incomplete emptying of breath inhalation is an undesired excessive pressure in the lungs of patients on invasive mechanical ventilator has been a hidden presence that hinders optimal care. Noninvasive indicator for the presence of auto-PEEP is known to those who specialize in ventilator graphics whom are very rare. Incomplete emptying of the breath indicative of auto-PEEP can be automatically detected through a computerized algorithm. Two distinct algorithms have been developed; the first being dependent upon pressure waveform and the second is evaluating flow waveform independent from pressure. Both algorithms are dependent upon varying threshold values. For one criterion of the threshold, the first algorithm yields a sensitivity of 84.7% and specificity of 92.6%, and the second algorithm yields sensitivity of 90.1% and specificity of 82%. Thresholds are adjustable for finding the optimum rate of detection for incomplete emptying that can eventually be used for an automated detection of auto-PEEP.

HIGH-LEVEL GPU COMPUTING IN MATLAB®: TWO CASE STUDIES OF ACCELEREYES JACKET IN BIOMEDICAL ENGINEERING APPLICATIONS. Graham S. Kelly, Charles E. Taylor & Gerald E. Miller, Dept. of Biomedical Engineering, Virginia Commonwealth University, Richmond VA. 23220. Graphical Processing Units, or GPUs, have emerged as important scientific computing tools due to their ability to handle computationally intensive algorithms in parallel, providing drastic reductions in execution time. As the demand for GPU acceleration has increased, higher-level computing languages have emerged to streamline the process of memory transfer to and from the device and executing custom kernels (e.g. CUDA, OpenCL). AccelerEyes Jacket, a GPU computing environment for MATLAB®, provides the very-high-level functionality of MATLAB® with speed and overhead superior to the native MATLAB® Parallel Computing Toolbox™. We illuminate the usefulness of Jacket through two differently structured Particle Image Velocimetry algorithms, which track particle displacement in moving fluid. These algorithms show marked improvements in execution time with minimal changes in code between the CPU and GPU variants.

## Botany

THE EFFECT BY HYDROLOGIC REGIMES AND SAHDE ON ATLANTIC WHITE CEDAR (*CHAMAECYPARIS THYOIDES*) GROWTH IN THE CAVALIER WILDLIFE MANAGEMENT AREA IN CHESAPEAKE, VIRGINIA. Justin L. Weiser, Jackie Roquemore, & Robert B. Atkinson, Department of Organismal and Environmental Biology, Christopher Newport University, Newport News VA. 23606. The Virginia Department of Game Inland Fisheries began restoring a 1538-ha Atlantic white cedar (AWC) Swamp in Chesapeake, Virginia in 2007. Reestablishment of AWC is critical in restoration of this globally- threatened ecosystem. The purpose of this study is to compare morphometric parameters of two tree planting types, propagated seedlings and rooted cuttings, at two locations characterized by hydric and mesic