DEPARTMENT OF MECHANICAL, INDUSTRIAL, AND NUCLEAR ENGINEERING
College of Engineering

SUMMER RESEARCH OPPORTUNITIES
FOR UNDERGRADUATE WOMEN

APPLICATION DEADLINE: MARCH 3, 2003

The Mechanical Engineering Department is pleased to offer the following research project(s) for the summer of 2003. Interested students are urged to contact the faculty member(s) directing the project(s) that most interest them. By contacting the faculty member, you can discover more about the project, learn what your responsibilities will be, and if possible, develop a timetable for the twelve-week research period.

THE DEVELOPMENT AND EVALUATION OF AN INTRAVITREAL CONTROLLED-RELEASE IMPLANT TO RETARD THE PROGRESSION OF RETINAL DEGENERATION WITH SPECIFIC DRUGS

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Hereditary retinal degeneration, such as that occurring with retinitis pigmentosa [RP], is characterized by progressive degeneration of the retina and often leads to blindness. A new procedure, using a surgically inserted intravitreal implant, with known drug release rate, promises improved delivery of drugs (e.g., nimodipine, nilvadipine) directly into the vitreous chamber of the eye, allowing a sustained and controlled time-release of therapeutic drug levels. It is proposed to test these specific drugs as a therapy for hereditary retinal degeneration, such as that occurring with *RP*. Biodegradable-polymer-based intraocular implant with known drug release rate can deliver therapeutic and non-toxic levels of drugs for treatment of retinal disease within the eye. In order to test this concept, among several steps, the summer student will focus on fabrication of implant and measure its drug release rate, and evaluate the drug transport properties, i.e., solubility and diffusion coefficient, in various compartments of the eye. In addition, the role of fluid convection through various compartments of the eye will be evaluated in conjunction with determination of viscosity and density of the fluid and hydraulic permeability and porosity of the porous components of the eye.

INFLUENCE OF GUIDE-WIRE CATHETER ON PULSATILE FLOW RATE- PRESSURE DIAGNOSTICS IN SIGNIFICANT CORONARY STENOSES

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The proposed study quantifies the influence of guidewires on pulsatile flow rate-pressure drop diagnostics in a wide range of coronary stenoses during Percutaneous Transluminal Coronary Angioplasty (PTCA). A narrowed flow cross-section with the intervention of endovascular guidewires effectively introduce a tighter 'artifactual' stenosis than the physiologic conditions such as either for the native lesions before PTCA or for the enlarged residual stenoses after PTCA; thus elevating the pressure gradient and reducing coronary flow during the measurements. Consequently, for diagnostic purposes, the mean pressure drop-flow rate relationship, measured for flow with a guidewire present within lesions of patients can not be easily correlated with physiological flow conditions. To test the concept, the student will devise and install in vitro stenoses test-sections in laboratory flow-loop systems that replicate common human coronary vascular atherosclerotic plaques, and obtain baseline flow and pressure data upstream, within and downstream of the stenosis without and with a known caliber guidewire. This study will determine lesion flow coefficient, considered being a more comprehensive and an additional hemodynamic endpoint that is applicable for a wide range of lesion sizes, in flows from basal to hyperemic condition during PTCA, in conjunction with quantitative angiographies and measurements of flow and pressure drop in clinical settings.

Synthesis of Carbon Artificial Nerves for Structural Health Monitoring

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This project will explore a very innovative idea which could provide a structural heath monitoring technique that is simple, accurate, and economical for application to anisotropic and heterogeneous materials and large structures. The proposed idea would intersect biomimetics and nanotechnology to produce a distributed parallel processing architecture similar to the biological nervous system that can sense damage on large structures and improve the safety of air vehicles and other transportation systems. The research performed by the WISE student would be to work with a graduate student to develop a carbon nanotube nerve that would be the critical component of an artificial neural system that would monitor strain (analogous to pain) in structures and detect large strains due to damage. The approach and application are shown schematically in Figure 1. As shown in Figure 1, we have made initial progress forming carbon nanotube paper that can form the nerve sensor. The specific work to be performed in the summer by the WISE student is to assist in; (i) casting carbon nanotubes to form different configurations of nerves by varying nanotube alignment, thickness, and testing different coatings on the nanotubes, (ii) building nerves from the nanotubes by following the process developed at the UC for making piezoceramic nerves, (iii) bonding the nerves to structures and monitoring the response of the nerves when they are subjected to cyclic loading, and (iv) reporting the results and participating in writing a technical paper. This cross-cutting research will give the WISE student experience in nanotechnology, chemistry, physics, instrumentation, and smart structures. The work will also help built the nanotechnology research program in the MINE Department.

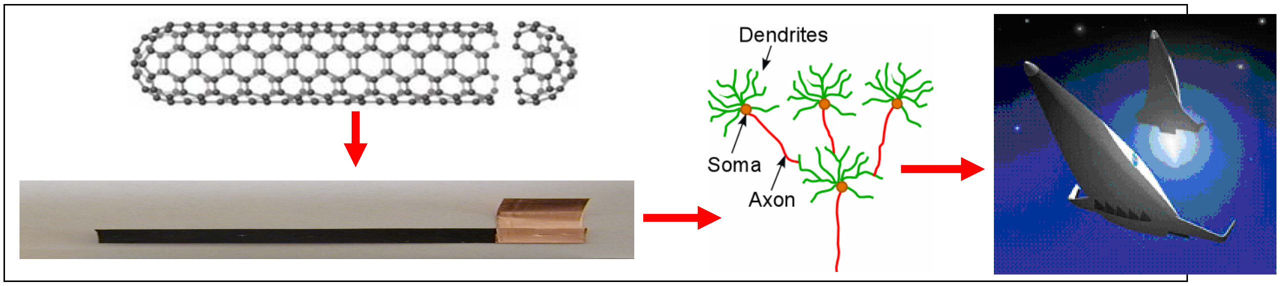

Figure 1. Steps to synthesis and application of carbon artificial nerves; (1) carbon nanotube that is ~2 nm in diameter and ~1 micron in length with all carbon atoms on the surface, (2) casting of aligned single-wall carbon nanotube paper and coating the paper with a structural polymer electrolyte, (3) forming simple artificial nerves using the carbon nanotube fibers, (4) possible application of artificial nerves for health monitoring of a new space shuttle.