PROJECTS

Giving a Helping Hand

System to Measure Elasticity of the Skin on the Feet of Patients with Diabetes

People with diabetes can develop a form of nerve damage that can lead to sores, particularly on the extremities, potentially leading to more severe complications. In order to prevent such sores, the skin properties of both diabetic and non-diabetic people must be clearly understood. Students designed and built a portable device for a clinical study measuring the material properties of the tissue on the underside of the foot (plantar tissue). They also had to write software in LabVIEW to capture data, perform calculations, and prepare reports.

Clinical studies using the device are being conducted by Dr. Juan Garbalosa at Quinnipiac University with the expectation that a better understanding of the plantar tissues will lead to better outcomes of interventions such as surgery.

Chin Support for a 21-year-old with Cerebral Palsy

People with cerebral palsy who cannot hold their heads upright for extended periods of time can develop a condition called kyphosis, an outward curvature of the spine that leads to a rounded upper back. The condition can require surgery and a long recuperation. So providing support for the head of such people is a serious necessity.

One particular person with cerebral palsy, a 21-year-old man who controls his wheel chair with head movements, required a flexible support. Students working with the assistance of Hanger Prosthetics and Orthotics developed three designs, a neck brace, a chin strap, and a chin table, and presented them to the young man for his selection. The chin strap provides him with the support he needs to be able to use his wheelchair.

Support of Homeland Security with Helicopter-Based Systems

Emergency incidents like wildfires, earthquakes, or terrorist attacks usually require the immediate deployment of personnel and equipment and supplies.To simplify the delivery of all the necessary items and people, the federal Department of Homeland Security and the United States Coast Guard are co-sponsoring a project in which students are developing a pod that is modular, flexible and portable and that can be used to ship supplies and then serve as a medical, sanitation, or command facility. The pod design will allow it to be transported via available transportation, such as truck or plane, but the students are designing the pod such that it can also be delivered by helicopters like the Kaman K-MAX that have a large carrying capacity.

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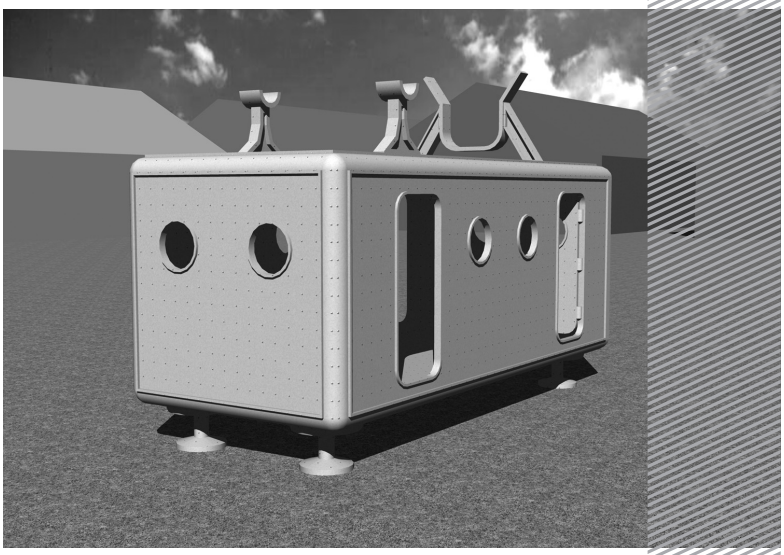

Breathing Cup Analysis

As an astronaut in a spacesuit exhales, the CO_2 and water vapor in the breath must be captured to prevent their buildup in the suit. The best way to remove those contaminants is to do so as close to the astronaut's nose and mouth as possible, before they begin to circulate in the suit.

Before an efficient removal system could be devised, students had to develop a computational fluid dynamic (CFD) model of the oral/nasal area of the astronaut in the suit to understand the flow of air to be captured. Once that model was developed, students began to create various prototypes of a breathing cup that captures CO_2 and water vapor at their highest concentrations immediately upon exhalation. The prototypes are being developed using a rapid prototyper at Central Connecticut State University and will be tested by the students using a simulated ventilation loop.

Computational Fluid Dynamic Analysis of Airflow in Node 1 of the International Space Station

To properly design the air ventilation system and to ensure the safety of the air supply on the International Space Station (ISS), air flow must be thoroughly understood and potential problems identified. Node 1, also called Unity, is an element of the ISS that provides six docking ports for the attachment of other modules. It provides internal storage, serves as a link between other modules of the station, and provides external attachment points as well. Students performed an analysis of the air flow in Node 1 of the station using Fluent 6.1 software under normal operating conditions and several failure scenarios, such as loss of cabin air fan, loss of inter-module ventilation from Node 1 to the lab, and loss of inter-module ventilation from the airlock to Node 1. The students determined that loss of ventilation from the airlock had the most effect on the air supply.

Low-Profile Breathing Device for Improved Prebreathe Procedures

In the space shuttle, the pressure in a space suit is lower than the pressure in the cabin, and the pressure outside the craft is almost non-existent. Hence, the astronaut faces the same risk of decompression illness, with symptoms that can run from simple itching and swelling to paralysis, coma, or death, that a deep-sea diver does.

Therefore, the astronauts must exercise vigorously and breathe pure oxygenfrom a mask, to eliminate as much nitrogen from the body as possible before getting into the space suit. But the space suit is a tight fit, and the astronauts can't keep the oxygen mask on and get into the suit. They have to hold their breath until they switch to the suit's oxygen; if they breathe in cabin air, they have to sit in the suit and breathe from the oxygen mask for one-half hour before they can work outside the shuttle or risk getting the bends.

The solution, as envisioned by Dr. John Graf of NASA's Johnson Space Center, is a smaller oxygen mask, a snorkel, one that the astronaut can keep using until the helmet to the suit is sealed, at which point the mask can simply be dropped away into the suit. Students in the College of Technology have developed such a snorkel and are testing it in conjunction with NASA personnel.

Measurement of Shoulder/Spacesuit Clearances During Activity

The human shoulder is a complex joint and its range of motion is not simply modeled, yet the spacesuit worn by astronauts does not allow the full range of motion. Shoulder injuries occur during training because of the gap in performance between the suit and the wearer's shoulder. Consequently, a better shoulder joint is needed, but before a suit allowing greater mobility and comfort is designed, a better understanding of the interaction between the astronaut and the spacesuit is needed. In a project sponsored by NASA, College of Technology students are developing an instrument that will dynamically measure the clearances between the wearer's shoulder and the shoulder of the suit to enable better design.

Sorbent Development for CO_2 and Water Vapor Removal from the Crew Exploration Vehicle (CEV)

NASA is developing a new crewed space vehicle, the Crew Exploration Vehicle or CEV, to replace the Space Shuttle in low Earth orbit and to allow for a return to the Moon. To achieve a low mass, the CEV has been designed with regenerative life support systems to remove CO_2 and water vapor from the air flow. Through a sub-contract with Hamilton Sundstrand, students are working to develop new, more efficient sorbents (materials that will either absorb, take in, or adsorb, accumulate on the surface) to remove those two chemicals for the CEV.

To develop the sorbents, the students had to design, build, and test an absorption test rig, then begin to test various support materials (carbon, ceramics, and polymers) as well as the potential sorbents themselves. The testing is ongoing as new compounds are developed to experiment with.

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Remotely Piloted Vehicle

For short-range reconnaissance, an electric-powered remotely piloted vehicle (RPV) is ideal. Students at Central Connecticut State University are building a craft with a wingspan of 48 inches, weighing 18 to 22 ounces, and capable of flying for 45 or more minutes. When completed, the RPV will be able to relay a live video feed of the area over which it flies as well as data from a variety of sensors providing real-time information on the craft's performance and orientation. Eventually, the students will develop software to allow the craft to operate semi-autonomously. Right now, the students are testing the first prototype and building a second one that incorporates changes to enhance the durability of the airframe, improve handling of the vehicle and reduce pilot workload. The software is also being tested.

In its final form, the RPV will provide low-cost, real-time aerial surveillance capabilities to infantry, police, and other groups that require situational awareness with reduced risk to people. A small RPV could be carried in a backpack and hand-launched in a few minutes, providing almost instantaneous information on what lies over the next hill or around the next corner.

Camera for Suborbital Rocket

UP-Aerospace, a private launch company, needs small digital cameras to capture video from their suborbital rockets. Because the cameras are small, their memory and battery life are limited, and because they are inaccessible for the last 30 to 45 minutes before launch, the cameras cannot simply be turned on and left running before launch. Rather, they need timer-activated cameras. Using an off-the-shelf digital timer, students developed a circuit board and software to create a system that turns the cameras on ten minutes before launch, switches them into the correct operating mode, and allows them to record. Low cost and light weight mean more efficient video capability. The camera system is scheduled for launch in October 2007.

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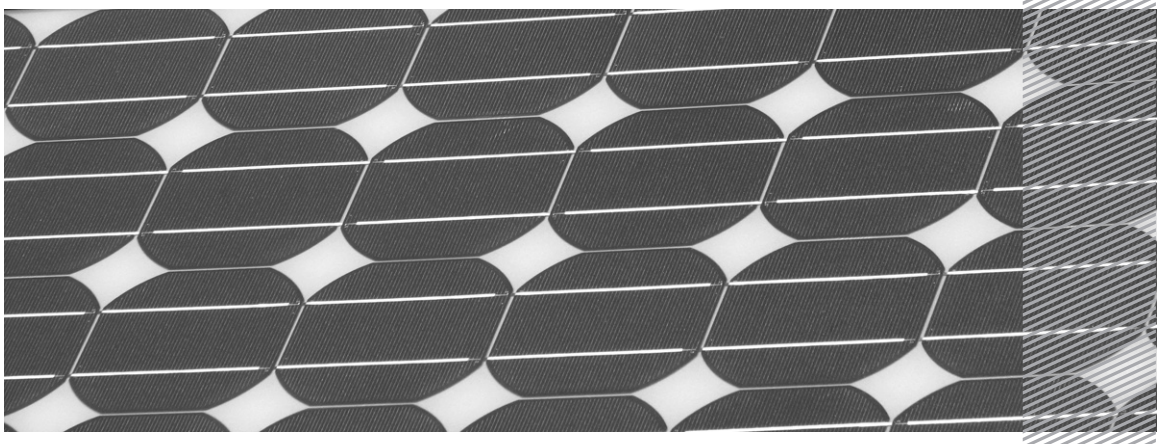
Comparison Between Predicted and Measured Power and a Series of Photovoltaic Array

A first step in designing a photovoltaic array is to determine the amount of solar energy available, typically over the course of a year. A number of models predict such values for specific locations, but local weather conditions and the positioning of the array can influence the actual amount of received solar energy. The objective of the project, overseen by Dr. Peter Markow, Chair of Chemistry at St. Joseph's College in West Hartford, Conn., was to allow students to compare the performance of the predictive models against measured power at a stationary array in Tolland, Conn. Students discovered that humidity and clouds both reduce the actual received solar energy.

Design and Testing of Passive Coolant Devices for Photovoltaic Cells

As their senior design project and without industry sponsorship, students examined natural convection as a means of keeping a photovoltaic array cooler. Cooling photovoltaic arrays is important because the cells in the array have lower electrical output as their temperature rises. Therefore, winter operation tends to offer higher electrical output for a tracking or tilted array. This project examined the effects of coolant passage design on the plate temperature of a simulated tilted array. It produced some fundamental data on the design of these coolant passages.



Apnea Response System

Premature Infants are often born insufficiently developed to remember to breathe, so doctors use an electromechanical system to detect when they forget and alert a caretaker to remind them to breathe. Since the stopping of breath, apnea, may be one of the major causes of Sudden Infant Death Syndrome (SIDS), a reliable detection system can be a way to help keep infants alive.

The systems currently used in hospitals are large and complicated and require sensors to be properly placed on the infant. In addition, false alarms going off even though the infant is actually breathing are fairly common. The complications and false alarms often cause difficulties when the system is sent home with a baby whose breathing needs to be monitored. Sensors may be improperly placed, giving incorrect readings, and the false alarm rate often creates a false sense of security in the parents.

Dr. Leonard Eisenfeld, a neonatologist at the Connecticut Children's Medical Center, has patented the idea for a much simpler apnea detection system, one involving a wireless EKG machine along with a band-aid-sized patch with a sensor and a stimulator to be placed on an infant's chest. Students in the College of Technology are working to develop his idea into a working system to help save the lives of the tiniest patients.

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