Executive Summary

Lemur Conservation Foundation (LCF) is an Association of Zoos and Aquariums certified related facility that participates in managed breeding programs for lemurs, which are among the most endangered primates in the world. LCF’s conservation efforts, with its colony at the organization’s Myakka City, Florida habitats, help provide a genetic safety net and opportunity for observation and study of lemur behavior. The foundation’s central Florida location experiences periods of extreme heat and some cold temperatures throughout the year, which can be stressful for these small primates. Off-the-shelf solutions to climate challenges are inadequate or unsafe, especially in LCF’s free-ranging forest habitats. In order to provide some comfort from these harsh periods, a ‘branch’ that provides temperature controlled surfaces has been designed and prototyped by a group of UIUC MechSE senior design students.

The Comfort Branch is solar powered, requires no maintenance, and is highly capable. Loadings in excess of nine lemurs are structurally supported with a safety factor of 4.1 and the surfaces are capable of 20-degree temperature differences from ambient, even on the hottest of days. Two on-board batteries provide hours of power on overcast days and work seamlessly with the solar panel and the load seen from the thermoelectric modules. These thermoelectric modules are capable of both heating and cooling and can be used to maintain the desired panel temperature. They are controlled based on both plate and ambient temperature readings.

Waste heat created by the thermoelectrics is rejected via the three forced convection heat sinks attached to the frame which sandwich the thermoelectric modules between the ribs/panels. The Renogy 100-watt solar panel is capable of providing three times the necessary power (on the best of days), but, according to government insolation values, it can be expected to provide approximately 527 watt hours/12 hour day, which exceeds the conservative estimate of 340 watt hours/12 hour day that will be required by the thermal system. A solar charge controller funnels all of the generated power through the batteries where it is either stored or distributed to the thermoelectric modules at the desired voltage. This voltage is controlled by a DC-DC convertor that varies its output based on the controlled digital potentiometer and also a relay which switches the system between heating and cooling.

The frame was constructed entirely out of aluminum angle iron and square tubing, providing an affordable and strong structure. The PVC outer shell provides a branch like surface for lemur lounging and aluminum paneling and ribs that conduct the temperature from the module up to the surface. A hot wire foam cutting technique was used to construct internal insulation which holds the ribs and modules in place while maintaining the temperature differential. Developing an electronics system which agreed with the thermoelectric modules required creativity. The solar panel, welding, and thermoelectric modules were the most expensive parts of this project.

The branch is designed to thermally comfort up to three lemurs reliably without maintenance or an external power supply. The iterative design and analysis process led to a simple and effective plan which was implemented in the form of a fully functioning prototype all within the spring 2013 semester.