UNIVERSITY OF COLORADO
SOLAR DECATHLON 2005

Architecture of the CU "Bio-S(H)IP"

Firmness, Commodity, and Delight are discovered in the Architecture of the CU Home through the Team's use of ***natural materials*** in combination with a newly developed, ***structural and modular*** environmental building system. In the CU Home, natural materials and systems are used to create an ***adaptable*** home design that can travel to a number of sites and provide a dwelling that will enhance many lifestyles. For the 2005 Solar Decathlon, the CU Team developed a revolutionary new building system, called Bio-SIPs, which will be demonstrated for the first time in the Team's solar home, the **Bio*S(h)IP.***

Structural Integrity and Freedom from Petroleum as "Firmness" in Home Design
Modular construction offers a strong, economical, lightweight building method. However, the words "modularity" and "environmental" are practically mutually exclusive, so the CU Team developed a new environmentally-derived, structural insulated panel system from waste paper and soy for construction of their **Bio*S(h)IP*** home. The system, named Bio-SIPs, is a low- to no-petroleum, lightweight, high-thermal-performance modular panel product that is being patented by the Team. Bio-SIPs are based on research by Julee Herdt, CU Faculty Advisor, and John Hunt, Research Engineer at the U.S. Department of Agriculture Forest Products Laboratory in Madison, Wisconsin. To create Bio-SIPs, a process called engineered molded fiber technology, or EMF, is employed. In EMF technology, cellulose sources such as waste paper, wood waste, and agricultural by-products are molded into structural layers, which are then used to sandwich layers of high R-value, expanded, soy-based foam insulation.

In March 2005, the CU Team tested their Bio-SIP prototypes at CU's structural laboratory. Test specimens included full-sized Bio-SIPs, measuring 8 feet in height, 4 feet in width, and 7-inches in thickness. Two types of tests were conducted. The first was an axial compression analysis using an MTS 1000-kip universal-testing machine. The second was an in-plane shear analysis using an MTS 22-kip horizontal actuator. The Bio-SIP panel assemblies surpassed structural requirements for both tests, enabling the CU Team to use them as load-bearing members in the **Bio*S(h)IP*** wall construction.

By using Bio-SIPs, the CU Team has created a strong, highly insulative, lightweight, "green" solar residence from a structural system that has little dependence on petroleum-based manufacturing. The CU Team believes that independence from oil for both construction and operation of America's homes is a new and critical definition of "Firmness" in Architecture.

The CU Solar Decathlon Team collaborated with Genesis Homes of Colorado, a division of Champion Homebuilders Corporation, one of the world's largest modular homebuilders, and the Colorado Division of Housing (CDH) for construction of the team's modular home. Genesis and CU worked together to create a custom-built chassis to support and transport the lightweight, modular **Bio*S(h)IP*** to and from Washington, D.C. The CDH is the regulatory agency that monitors factory-built housing and manufactured homes in Colorado. The CDH worked with the CU Team to ensure that the **Bio*S(h)IP*** meets required safety standards and building codes. CU plans to work with both Genesis and the Colorado Division of Housing on future modular, environmental, solar housing, since this residential typology is developing as a major part of CU's Architecture and Planning curriculum and as a collaborative program with CU's engineering school. This development came about in large part as a result of CU's work on the 2002 Solar Decathlon competition.

Function and Comfort, "Commodity" through the Use of Natural Materials

One of the most unique features of the **Bio*S*$^{(h)}$*IP*** is that it is constructed from “low- to no-petroleum” resources, meaning less fossil feedstock was used in manufacturing the home's materials and, thus, the home itself. This feature, combined with renewable energy systems that power the residence, enables the CU Home to have a lifetime environmental footprint that is dramatically lower than that of most homes built in the U.S. If more residences were built and operated using such techniques, overall U.S. energy use and associated pollution emissions could be greatly reduced. Natural materials in the CU **Bio*S*$^{(h)}$*IP*** come together to create a clean and serene environment both inside and outside the home. By using these products, the CU Team predicts that its solar home will have an environment with increased interior comfort and measurably cleaner indoor air.

Natural, low- to no-petroleum construction resources for the **Bio*S*$^{(h)}$*IP*** include the following material categories. All materials used in construction of the CU Home have met the required testing standards and building codes.

1 Biobased

Biobased (cellulose fiber) building materials are produced from agricultural and forestry by-products such as soy, wheat, corn, kenaf, jute, hemp, bamboo, wood, and waste paper.

2 Recycled Content

Recycled Content building products are manufactured from pre- or post- consumer recycled feedstocks such as paper, glass, metals, woods, and plastics.

3 Re-Used

For the CU home, Re-Used or "Experienced” Materials were purchased from Resource 2000, a local salvage materials yard. Salvaged structural aluminum for the project was acquired from ALRECO, Aluminum Recycling Company, in nearby Brighton, Colorado.

4 Sustainably Harvested

Sustainably Harvested products include fast-growing woods from managed forests. Examples of these materials in the CU Home include bamboo for cabinets, furniture, and wall panels, and engineered lumber framing members.

5 Low- to No-Volatile Organic Compounds (VOCs).

To maintain a clean indoor and outdoor environment for the CU Home, the Team selected Low- to No-VOC products for use as building materials, paints, and cleaning products.

Aesthetic Appeal, "Delight” through the Freedom of Adaptability

The architecture of the **Bio*S*$^{(h)}$*IP*** is adaptable on several levels. Inside the home, an open floor plan with radiant heating means that interiors are free of ductwork, thus allowing any number of spatial arrangements and wall placements. The CU Team worked with ADAPT, a Boulder-based disabilities activist group, in planning the interior of the home. A number of features are designed specifically for people in wheelchairs -- kitchen sink, dining counter -- however, Prospect New Town, the client for the CU Home, wished to keep ADA features to a minimum in order that the home be marketable to a number of potential clients. Prospect will include the **Bio*S*$^{(h)}$*IP*** as a cutting-edge renewable energy architectural feature in their Solar Village, which is currently under construction. The solar roof design for the **Bio*S*$^{(h)}$*IP*** can be modified to respond to a range of sites. While the specific roof for the **Bio*S*$^{(h)}$*IP*** is designed for a site in Prospect New Town, a New Urbanist community in Longmont, Colorado, the roofline can be rotated 180 degrees for sites with opposite solar conditions. The roof is hinged so that it can be lowered for travel and raised once the house reaches a permanent location. The "slices" created between the home's walls and roof when the roof is lifted yield a wonderful upper plane of natural light and openness that can be enjoyed during the day or night. Daylight, moonlight, natural, and artificial light can be enjoyed through the roof's glazing slices.