



Lumenhaus is Virginia Tech University's 800-square-foot, energy-optimized "smart" home that has the ability to maintain optimal energy performance at all times. It leverages an active system of motion controls from Thomson and Kollmorgen (courtesy M. Cincala).

The Limbs of Lumenhaus:

Motion Systems Bring Virginia Tech's Award-Winning and Energy-Optimizing "Smart House" to Life

Last year's winner of the U.S. Department of Energy's (DOE) Solar Decathlon—Virginia Polytechnic Institute and State University—also took first place in the 2010 Solar Decathlon Europe with an 800-square-foot, energy-optimized "smart" home that leverages an active system of motion controls from Thomson and Kollmorgen to minimize the overall HVAC load on the house.

Working with Thomson and Kollmorgen, the Lumenhaus engineering team was able to implement the technology that met their exact performance needs without having to compromise on any of their design objectives to accommodate available motion technology.

"We needed components that could

handle often-harsh and changing environmental elements, readily accept a third-party control signal and that were flexible and easy to interface," says Robert Dunay, director, Center for Research, Virginia Tech.

"We've been pushing the motion control system very hard, and the Thomson and Kollmorgen motion control solutions have absolutely come through for us," Dunay adds.

The thought behind the Lumenhaus design was to build a sustainable smart house with the ability to maintain optimal energy performance at all times.

"When the weather is good, the house automatically opens up and doesn't use energy. Conversely, when the weather turns bad, a system is in place that enables the house to protect

itself," says professor Joseph Wheeler, project coordinator, Virginia Tech.

Lumenhaus epitomizes a "whole-building-design" construction approach, in which all of the home's components and systems have been designed and built to work together to maximize user comfort with environmental protection. At its heart is an integrated environmental control system.

"The house has its own weather station with a 'passive/active' environmental control system to minimize energy consumption and maximize efficiency," explains Wheeler. "In short, the weather station communicates with the control system, which in turn tells the Thomson and Kollmorgen motion system whether to open or close the house. When the house needs insulation, insu-

lation screens close; when the house needs shading, shading screens close; and when the house needs security, the shade screens close without blocking natural ventilation.”

Making it work. Lumenhaus’s layered systems consist of a series of motorized shade screens and insulation panels that adjust to the changing weather patterns. The screens and panels can weigh up to 1,000 lbs. each, and coupled with potentially highly dynamic loads from exposure to changing environmental elements, the tools that move them need to be extremely robust.

The shade screen assemblies ride on Thomson 60 Case low-profile round-rail assemblies with Super Smart Ball Bushing bearings, and are run by Thomson RapidTrak belt-driven linear motion systems powered by Kollmorgen AKM servomotors. The insulation panels and shade screens serve as the “clam-shell” that protect the house against the elements. The house also uses Thomson PPA PowerPac actuators as part of a photovoltaic array that tracks and generates power from the sun, and that automatically adjusts to accommodate for changes to the angle of the sun on a seasonal basis.

“Variable feedback provides a certain level of speed and power control, and in dabbling with the overall energy control we’ve been able to move the panels at up to 300 inches per minute, if needed, using just 1.5 amps of power,” says David Clark, student team leader, Virginia Tech. “Using such a small amount of energy to operate these panels can have a big impact, as it means we don’t have to turn on HVAC systems.

“Of course power needs vary depending on weather conditions and the changing dynamic loads from high winds and changes in wind direction, so sometimes we need to tweak the power to optimize performance; the bottom line is that we’re able to do so in such a way as to control consumption and maximize efficiency.”

Lumenhaus constantly monitors weather patterns and automatically adjusts the shade screens and insulation panels as needed, so Virginia Tech engineering students used a 1–10 Micron NemaTRUE planetary gearhead from Thomson inserted between



All of Lumenhaus’s components and systems are designed and built to work together to maximize user comfort with environmental protection. At its heart is an integrated, environmental control system (courtesy M. Cincala).

the Kollmorgen AKM servomotor and track drive to increase torque potential, and to help slow down the motor so panels don’t move too fast.


“Generally speaking, we don’t need 10,000 different stops; we just need to reliably get to the right position,” says Clark.

Manual override? Yes, there’s an app for that. As with all things automated, there are times that demand a manual override. Lumenhaus utilizes an iPhone and iPad as the interface element, along with Kollmorgen S200 servo drives with digital and analog inputs to help manually override the building control system.

“The building control system takes the information it receives from the iPhone or iPad, interprets it from 1–10, then sends a low-voltage signal out to each servo drive (0–10 v). When the drive receives the information, it interprets it into an exact position count and then sends the screens and insulation panels to the correct position,” explains Clark.

The iPhone and iPad automatically orient the floor plan of Lumenhaus, and with the swipe of a finger on the iPhone or iPad, not only can users override the control system to reorient the screens and panels, but they can also be used to remotely control any number of aspects of the house, including locking or unlocking doors. For example, the front door of Lumenhaus features an

RFID tag that enables remote control to open or lock remotely with the touch of a button. So if one needs to give a neighbor access to the house to let the dogs out, they can do so from any remote location with cellular phone service.

Potential application, today. “What’s really interesting about some of the concepts brought to life in Lumenhaus is that it gives us a picture of how, on a smaller scale, existing residential and commercial buildings could be made more energy efficient by retrofitting them with smarter louver-type systems that not only shade but also insulate,” says Dunay. “For example, the ability to have a control system that automatically responds to and even harnesses what the weather gives through means such as blinds, shades and shutters that know where the sun is and can adjust accordingly, is potentially pretty significant when it comes to minimizing HVAC use and power consumption.” 

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