

### **Innovation Description- The Virtual Cybernetic Building Testbed (VCBT)**

The Virtual Cybernetic Building Testbed (VCBT) is a real-time, distributed building emulator. The VCBT is a laboratory approximation of a “cybernetic building”, a building with fully integrated control systems for HVAC, lighting, fire detection, and access control, and communication capability with outside parties such as utility providers. The VCBT consists of a variety of simulation models combined with commercial and prototype BACnet controllers that create a hybrid software/hardware environment suitable for testing various integrated control system components of cybernetic buildings. The VCBT provides a way to emulate normal operations, various mechanical equipment fault conditions, and hazardous events such as fires. The VCBT is innovative because it combines the flexibility and reproducibility of simulations with the realism of field studies using actual building automation systems. It replaces extensive field trials in different types of buildings and climate zones when developing new building automation technology. It also provides a new capability to develop and test the performance of building automation systems under hazardous, emergency conditions that has never previously been possible. It is a unique resource for conducting research and product development that would be impossible to safely carry out in a real building.

The concept of the VCBT was originally proposed in 1997. The idea was developed and refined over a number of years and the current facility and its capabilities were developed and expanded in stages. The VCBT has been successfully used to:

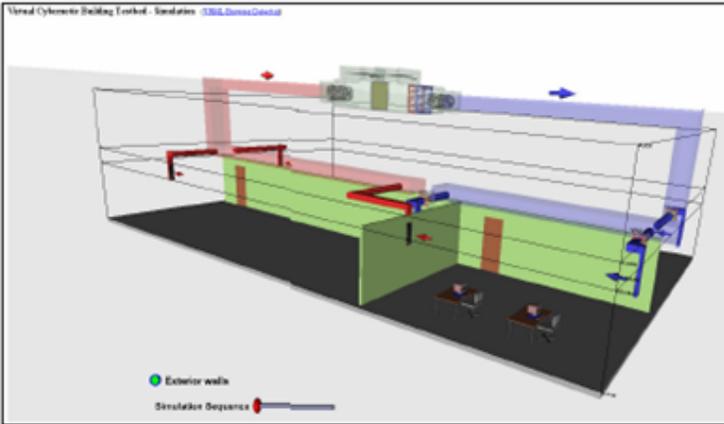
- Develop and test fault detection and diagnostic tools for air-handling units and variable air volume boxes and their controls,
- Develop and test automated tools for commissioning air-handling units and their controls,
- Develop and test a Sensor-Driven Fire Model decision support tool for use by emergency responders,
- Develop and test extensions to the BACnet communication protocol for lighting control and physical access control, and
- Develop and test firewall tools to protect the integrity of building automation systems.

The results of this work have begun to appear in revisions to national and international standards, and in commercial products of control systems from manufacturers who have collaborated in the research and development work. Current and future use of the VCBT will be applied to speeding the development of more capable automated commissioning and fault detection tools, developing standards and products to enable emergency responders to make use of building automation system information, and developing and testing new approaches to improve the energy efficiency and effectiveness of integrated building automation systems.

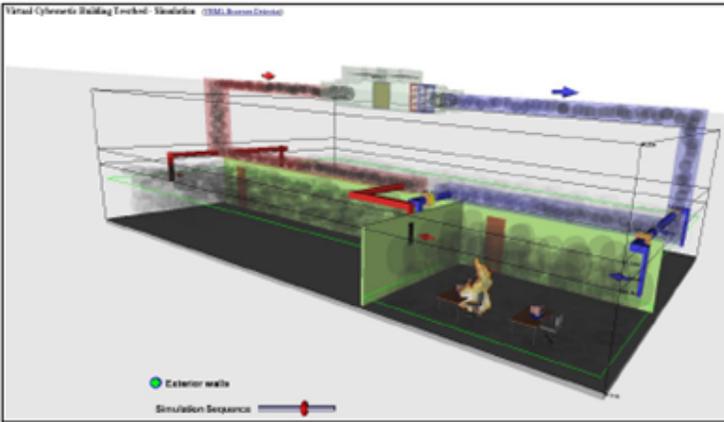
The Virtual Cybernetic Building Testbed (VCBT)



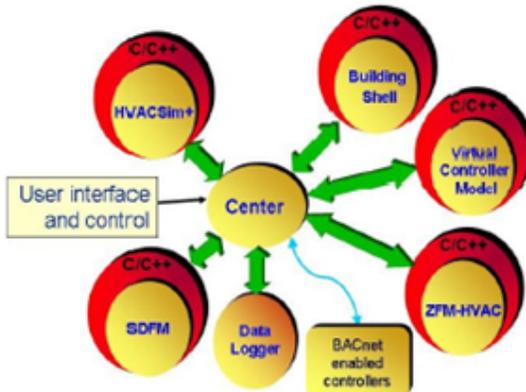
The hardware portion of the VCBT, including the HVAC controllers and data acquisition equipment.



VRML representation of a 3 room model in the VCBT. The data from various building controllers can be shown in real-time.



VRML representation of the VCBT showing smoke and heat migration through the building and HVAC equipment, using a 2 layer fire model.



A representation of the various software components of the VCBT. Included are models which simulate the rooms and HVAC systems in a building, smoke and heat sensors, fire and smoke distribution, and a virtual controller model (to enable emulation of very large buildings). The Center component manages all communications and data transfer between the component models.