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BY HARRY GORDON, FAIA, LEED AP
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INTEGRATION AND IMPLEMENTATION

WHEN RENSSELAER POLYTECHNIC INSTITUTE MADE A COMMITMENT TO ENHANCING ITS VISIBILITY IN THE LIFE SCIENCES AND BIOTECHNOLOGY SECTORS, IT SOUGHT TO DEVELOP AN ADVANCED, INTERDISCIPLINARY FACILITY ON ITS NEW YORK CAMPUS.

BY **HARRY T. GORDON** FAIA, LEED AP AND **DAVID R. LINAMEN** PE, LEED AP, CEM

FLEXIBLE LAB DESIGN PROVIDES PLATFORM FOR COLLABORATIVE RESEARCH AT RENSSELAER

Rensselaer Polytechnic Institute (RPI) in Troy, N.Y., has forever changed the course of its life sciences research program by building the Center for Biotechnology and Interdisciplinary Studies, a facility that benefits the university as well as the surrounding community. In 2001, RPI set out to enhance its research programs in biotechnology and its leadership role among technological research universities. To reach this goal, the institute needed a state-of-the-art platform for collaborative research, focusing on the application of engineering, physical and information sciences to the life sciences. The new facility would need to provide a technologically advanced environment to attract and retain Rensselaer faculty and researchers engaging in interdisciplinary research, as well as bolster the school's visibility in the science and technology sector.

In an effort to steer away from the one-scientist-one-lab model, the Center for Biotechnology and Interdisciplinary Studies is designed with the 147 offices physically separated from the labs, but visually connected. The top three floors have offices lining the outside of the long south wing and the shorter east wing, connecting to the rest of the building through a four-story atrium. The flexible lab design and the interactive spaces in the atrium optimize the opportunity for interdisciplinary research by altering the day-to-day interactions among researchers. This enables the scientists to view the same problem from different perspectives. Since the researchers work in "faculty constellations" in disciplines such as biocatalysis and metabolic engineering, they are able to transcend conventional academic disciplines. As researchers develop collaborations, they reconfigure their position within the building, something that would not be possible with a less flexible lab design.

The importance of the Center for Biotechnology and Interdisciplinary Studies to the advancement of science at RPI was highlighted by University President Shirley Ann Jackson, Ph.D. who stated:

"All research and technology indicators suggest that biotechnology and information technology (IT), coupled with the convergence of microsystems and nanotechnologies, are closely aligned with global and societal priorities, and primary drivers of economic growth. They will dominate the future.

Biotechnology is already transforming health care and agriculture, and opening up enormous possibilities for sustainable resource management. IT is the driving force in every industry today, transforming many of them and enabling new areas of research, such as the human genome, and enterprise, such as e-business. Both IT and biotechnology are challenging and transforming the world's underlying social, economic and political structures."

INNOVATIVE APPROACH TO SUSTAINABILITY: NATURAL VENTILATION + DAYLIGHTING

The Center for Biotechnology and Interdisciplinary Studies at RPI contains many unique examples of sustainable design applied to a laboratory. The laboratories are separated from the offices by an "L" shaped atrium of 140 feet on one leg and 220 feet on the other. The atrium is the main circulation area of the building and forms the spine from which many conference and interaction areas open. The atrium admits large quantities of natural light into the interior of the 220,000-square-foot building, and provides natural ventilation, while significantly reducing construction costs.

From the beginning of the design process, the team sought strategies to harmonize the inherently high-energy use of laboratory buildings, with the goal of environmental sustainability. The team incorporated many cost-effective approaches to reduce resource consumption, and the atrium is one of the most visible of these strategies. We assessed the annual climatic patterns and the opportunities that were present in the building program, and concluded that it would be feasible to condition the atrium without using primary space conditioning.

The fenestration system in the atrium was carefully designed to eliminate overheating in the summertime and heat loss in the wintertime, while still providing the greatest amount of natural light possible. The skylight consists of three sloping planes of Low-E glazing, each with a custom frit pattern designed to maximize the glass' shading coefficient relative to its solar orientation. Offices and internal core lab spaces enjoy natural light borrowed from the atrium. Windows into the core laboratory spaces are provided with sunscreens to reduce the penetration of direct sunlight deep into the spaces, but still provide a visual cue to the outdoors. With its generous natural light, multiple patterns of human movement and multi-level character, the atrium is the true interactive heart for this intense research environment — a place to see and be seen by one's colleagues.

Photo Credit: © Nic Lehoux

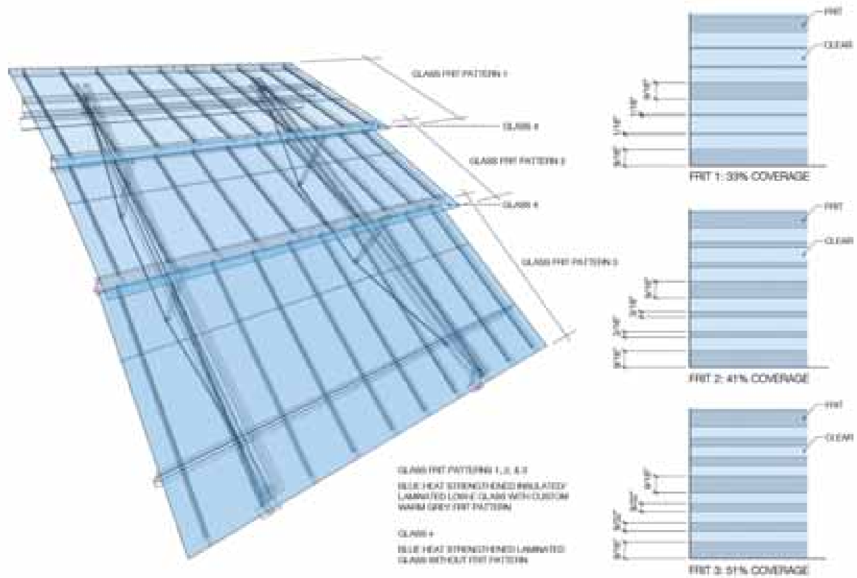
OTHER SUSTAINABLE DESIGN ELEMENTS

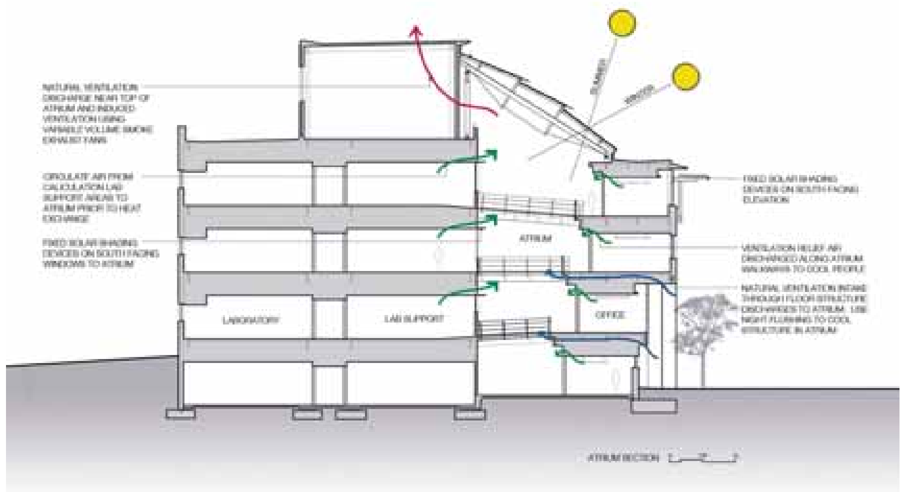
- LOW-POLLUTING MATERIALS, ADVANCED LABORATORY CONTROLS AND HEAT RECOVERY CREATE A HEALTHY, ENERGY-EFFICIENT ENVIRONMENT.
- THE FACILITY IS10 PERCENT MORE EFFICIENT THAN ASHRAE STANDARD 90.1-2001.
- BUILDING MATERIALS HAVE HIGH RECYCLED CONTENT AND HIGH DURABILITY.
- THE BUILDING HAS NATURALLY VENTILATED AND PASSIVELY CONDITIONED INTERACTION SPACE.
- THERE IS A SINGLE HVAC SYSTEM FOR LAB AND ADMINISTRATIVE SPACES.
- THE BUILDING IS NATURALLY DAYLIT.

STRATEGY: CAREFUL DESIGN & CAREFUL MODELING

Burt Hill was able to use the natural buoyancy, or stack effect, through the atrium to create natural ventilation of the building. Natural ventilation to cool the atrium is possible with the use of operable windows in lower-level offices and through the floor structure. Cooler air is drawn into the atrium and rises through the atrium before being exhausted at the high point. An additional strategy is to route the exhaust air discharged from the office and lab support spaces through the atrium, providing a tempering effect. Finally, spot heating and cooling were applied at the entrances and pre-function spaces of the atrium that are adjacent to the conference areas, where more sedentary activity is likely. The design team used Computational Fluid Dynamics to model this thermal behavior and was able to maintain the atrium temperature remain within five degrees Fahrenheit of the conditioned spaces surrounding it year-round without the addition of any primary energy into the atrium itself.

By eliminating the requirement for primary mechanical cooling and heating systems in the atrium, the capacity of the mechanical equipment was reduced by 250 tons of refrigeration, saving over $1 million in construction cost and eliminating the energy use that would be needed to operate the space conditioning systems.





PIONEERING SUSTAINABLE DESIGN: REFRIGERANT-BASED HEAT RECOVERY SYSTEM

One of the most impactful sustainable features of the Center for Biotechnology and Interdisciplinary Studies at RPI is the refrigerant-based heat recovery system pioneered by Burt Hill. Due to safety requirements, laboratories require vast quantities of air for ventilation. While most codes require that this air be 100 percent exhausted, it doesn't mean heat must be ejected with the air. Over the years, most A/Es have tried a variety of heat recovery methods, such as heat wheels, heat pipes, and run-around systems to recover this heat (and to a limited extent, cooling). Since the heat wheels and heat pipes require that the supply air and exhaust air be in proximity to perform properly, these technologies are infrequently used in lab design to avoid cross contamination of the air streams. Thus the run-around system is most frequently used. Traditionally, this has been achieved with a glycol-based system, which is economically marginal in most parts of the United States.

Burt Hill has been among the first to use a pumped refrigerant-based heat recovery system, which is designed into the Center for Biotechnology and Interdisciplinary Studies at Rensselaer. A zero ozone-depleting refrigerant (HFC 134a) is used to transfer heat through the latent heat of vaporization instead of the sensible mechanism of heat transfer of the glycol. A few specifics allow for a sense of value of the refrigerant over the glycol:

- In a single 65,000-CFM air handler, a glycol system will require 6" diameter piping and two 20-HP pumps. With a 10-degree temperature difference and typical system efficiencies, one pound of liquid will transfer about 3 BTUs.
- In the same 65,000-CFM air handler, a refrigerant system will require 1-5/8" diameter piping and two much smaller pumps. Due to the increased effectiveness of the latent heat process, one pound of refrigerant will transfer about 50 BTUs.
- Since the pipe and pump sizes are much smaller, the first cost of the refrigerant-based system is typically less and the operating energy requirements are substantially reduced.
- This system provides useful heat recovery for nearly twice the annual hours of operation as the glycol system.

The Center for Biotechnology and Interdisciplinary Studies was designed by Burt Hill and Bohlin Cywinski Jackson. The firms collaborated on the architectural and laboratory design. Burt Hill also provided engineering design and led the integration of sustainable features.

David Linamen is the principal and director of engineering serving not only Burt Hill, but other architectural practices as well. An innovator who applies strategic planning and technology to solve unprecedented problems, he started his career at Burt Hill in the energy and engineering department, and is now widely recognized as an expert in energy-conscious design for healthcare, labs, and higher education.

Harry Gordon is chairman and chief operating officer of Burt Hill (www.burthill.com). In his 34 years with the firm, he has become a nationally recognized expert in green building design and a leader in promoting sustainable design within the building industry. He was a founding member and past chair of the National AIA Committee on the Environment and has served on the board of the US Green Building Council.