Reducing the Energy Appetite of a Chemistry Building

Harley Ellis Devereaux — WAYNE STATE UNIVERSITY
A. Paul Schaap Chemistry Building and Lecture Hall

Chemistry and other science buildings probably consume more energy per square foot than any building on a university or college campus. Much of the cost is because of the need to draw in, heat, and cool outside air before it is blown into laboratories and returned outside as it is sucked out through fume hood exhaust— without any re-circulating back into the research/learning space. When considering remodeling, it is good to remember that a science building with 100 older fume hoods will consume energy as would a building with 100 open doors.

So the challenge facing the planning team at Wayne State University was formidable: to transform a four-story, 1960's chemistry building designed for general science classroom/laboratories into one that gave new generations of Ph.D. candidates exposure to chemistry as it is done today, preparing them as leading 21st century practitioners in chemistry research.

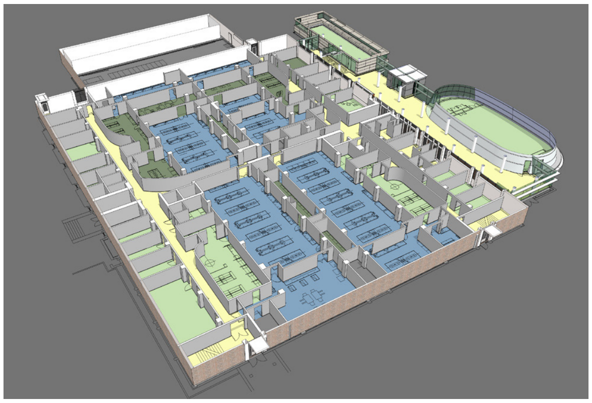
As with many similar buildings, the mechanical and electrical systems were beyond their life expectancy and did not support the kind of research in the chemical sciences being conducted at Wayne State. Thus, valuable research was at risk of being exposed to an unexpected infrastructure failure. David M. Coleman, Associate Chair of Chemistry Department at Wayne State and one of the many users involved throughout the project, states the challenge clearly:

> *Safety throughout the labs was a very critical component. Efficiency and use by today's standards was also important. The existing configuration of 2,000 sf of labs provided either too much space or not enough. Some labs had only three fume hoods where we required twenty. We needed modern flexible spaces that would be attractive to students and researchers and that would relate to current needs and enable future programmatic change as our research programs advance.*

The approach to addressing these dual challenges began like this:

- Detailed evaluations were made of the building's electrical and mechanical systems.
- Intensive meetings were held with lab planners, faculty, and staff to develop a program and to test fit drawings for a two-phase building renovation.
- The decision was made to undertake a two-phase renovation. 10 – 18 interconnected labs of different sizes are replacing the current eight classrooms/labs on each floor. This allows optimal space utilization, matching research program sizes to lab sizes, enabling smaller/larger spaces by closing/opening doors as appropriate.
    - On the lower floors are organic and inorganic labs, dealing with higher quantities of hazardous or flammable liquids, which thus require more fume hoods. Those with lower hazards are on upper floors.
    - On the lower level, the 48 existing hoods were replaced with 163 hoods, 32 exhaust connections for glove box work, and 32 snorkel locations. This was an essential, but energy-intensive, nearly fourfold increase in the 'under-the-hood' chemistry research space.
    - On the third floor, which accommodates biochemistry and analytical chemistry, 24 existing fume hoods were replaced by 54 hoods. Large areas with overhead service carriers and movable benches increase flexibility, also serving future research needs as needed.
    - On the fourth floor, which houses bio-chemistry, 18 hoods were replaced by 15. New bio-safety cabinets and tissue culture rooms are located outside of the overall space devoted to labs, adding to the flexibility for accommodating future change without disruption to main labs.

Since fume hoods are central to a productive chemistry lab, everyone (faculty, lab planners, architects, and engineers) worked together to reach several decisions relevant to fume hood design and use in order to optimize safety and minimize energy use, serving institutional goals for the renovation.



The pre-renovated building had 101 constant-air-volume (CAV) fume hoods, a "one size fits most" lab design, and hood-related energy costs of $1,428,000. The renovated space will have 249 fume hoods, 40 snorkel locations, and numerous connection points for glove boxes, etc. A similar approach to fume hood design and use during the renovation would have raised annual building energy cost to $3,000,000 post-renovation.

Decisions addressed:

- Placement of fume hoods— away from doors and out of pedestrian traffic, to optimize research productivity and safety by reducing distractions.
- Configuration of hood face— a large sash to improve visibility; sash panels configured to reduce the open area during operation (half the openings on discarded hoods), reducing exposure to danger in the hood and, significantly, the amount of air needed for fume capture.
- Sizing of supply air louvers— to lower supply velocities and turbulence.
- Location of supply louvers— to turn the ceiling into a continuous low velocity air supply louver by locating supply louvers away from the hood face and above an egg crate ceiling; this confines turbulence and stabilizes the airflow before it enters the space.

With renovated labs in operation, the design team and WSU's Environmental Health and Safety officers successfully experimented with a 20% lower hood face velocity to test its affect on fume hood performance. Testing of all hoods confirmed that such velocity was still high enough to overcome all but the most severe challenges to fume capture.

Thus, even after increasing the number of fume hoods from 101 to 249, WSU will reduce the maximum fume hood exhaust volume by over 25% and cut their annual energy bill by about $380,000.

Those of you familiar with the ASHRAE 110 test know there is a deeper story here, but key lessons learned are the value of piloting various options for placement of air louvers and fume hoods and for selection of their components, and to do so working collaboratively with all members of the planning team. ■