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Advancing lab design, applying lessons learned

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As the design of laboratory buildings undergoes incremental evolution, designers learn from each other what works and why, and respond to emerging technologies and variations in the client culture. This article explores several recent laboratory buildings and examines the progression of the architects' thinking over time.

LAB FLOOR PLANNING AND NEIGHBORHOODS

The fundamental building block of a successful lab community is the lab neighborhood, typically comprising laboratory spaces, lab support and interaction areas. While lab planners might disagree amongst themselves about the minimum programmatic ingredients that constitute

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The 4515 McKinley Research Building, Washington University School of Medicine. Image: © Robert Benson Photography

Evolution of airflow control technology

THE ADVANTAGES OF AN INTEGRATED SYSTEM FOR CRITICAL ENVIRONMENTS

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Phoenix Controls

Critical environment control systems can be challenging for building owners to fully understand. Because they can seem complex and difficult to maintain, these systems are often installed with limited data interface in the design phase in an effort to make operations and maintenance easier. As a result, facility managers often sacrifice efficiency to maintain safety in order to manage the overall system.

There is an alternative. New integrated systems that combine high performance products such as venturi-valve controllers, network integration hardware, room level monitors and front-end displays, allow owners to take a more simplified approach to designing and implementing advanced control systems without sacrificing energy efficiency, quality or safety for complex applications.

Hood 1 Data	
Hood Flow	691 cfm
Sash Opening	55,0%
Face Velocity	80,3 ft/min
Face Velocity Setpt	79,9 ft/min
Hood Occupancy	Occupied
Optimal Hood Flow	227 cfm
Wasted Hood Flow	0 cfm

Hood 2 Data	
Hood Flow	691 cfm
Sash Opening	99,7%
Face Velocity	103,7 ft/min
Face Velocity Setpt	100,0 ft/min
Hood Occupancy	Occupied
Optimal Hood Flow	691 cfm
Wasted Hood Flow	0 cfm

Hood 4 Energy	
Hood Flow	200 cfm
Wasted Flow	46cfm
Current Flow	246cfm
Annual Flow Cost	100,0 ft/min

Fume Hood Data: Optimal hood flow is determined by occupancy status. If the hood is occupied, it is assumed that the hood flow is optimal; if the fume hood is unoccupied, then the optimal airflow is the minimum scheduled flow set point of the fume hood valve; the difference between the fume hood scheduled minimum flow and the current airflow is the wasted cfm.

NOTHING VENTURED, NOTHING GAINED

Critical spaces seen in laboratories and healthcare spaces are highly energy-intensive, consuming three to 10 times the energy of a typical office building. In laboratories and other critical environment spaces, room pressure monitoring and accurate airflow control are key—but they must be balanced against energy use and the ability to control the environment.

For facility managers of these settings, there are three main risks that limit per-

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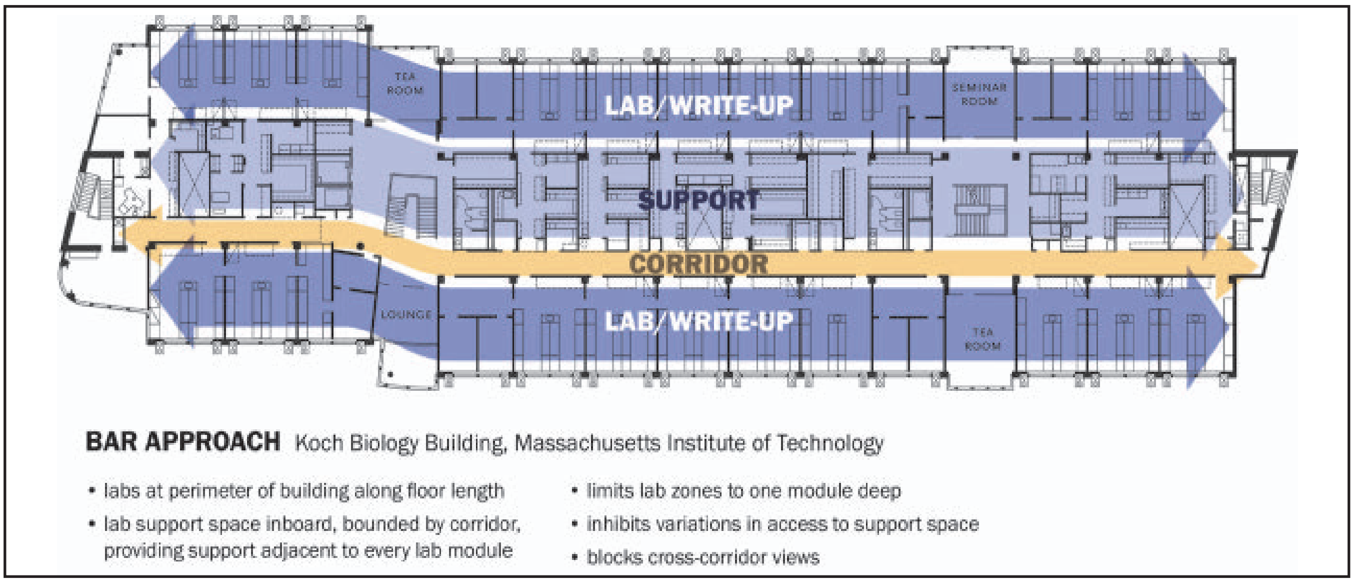
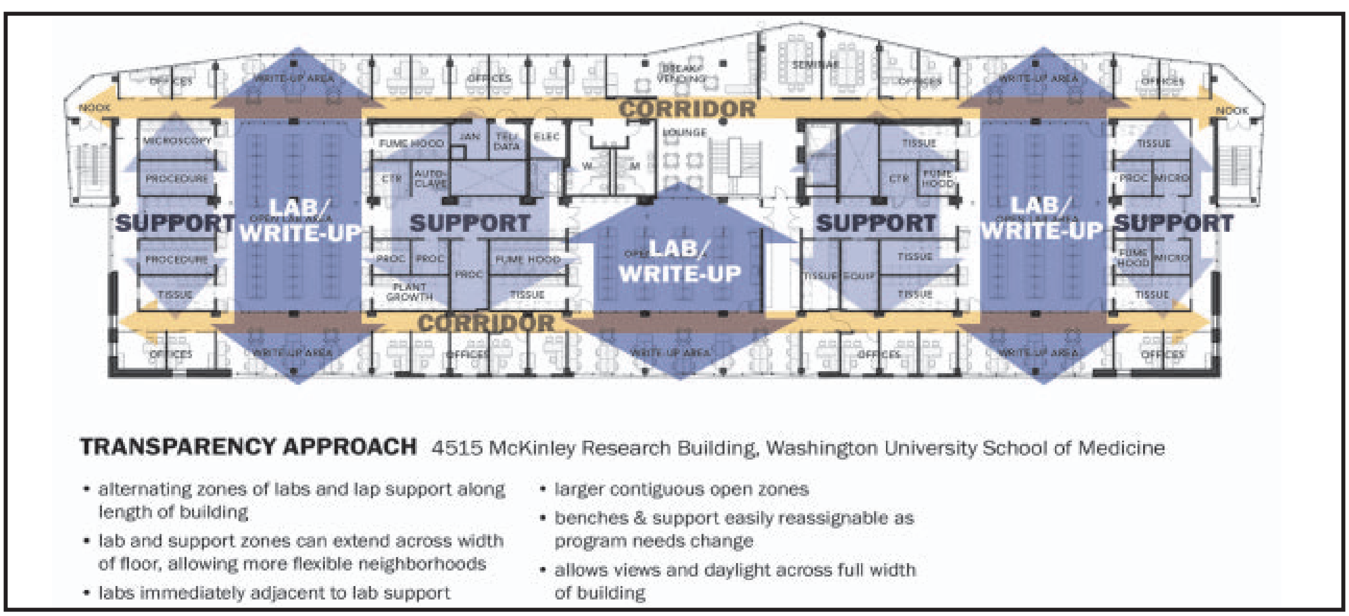
a neighborhood, we will focus instead on the configuration of a neighborhood for science or engineering labs, and the aggregation of two or more neighborhoods to form a lab floor.

One of the more conventional patterns of arranging a lab neighborhood and a lab floor has been the "strip" or "bar" approach, in which the labs are arrayed along the perimeter of the building, typically along the long dimension of the floor. A lab support zone parallel to the lab "bar" is the next layer inboard, bounded by a corridor in the middle of the building's width. While this has the advantage of locating lab support spaces immediately adjacent to every lab module, it limits the lab zone to being one module deep, inhibits variations in access to support space that might evolve over time, and essentially blocks any cross-building views. The neighborhood in this case might only be on one side of the corridor, or it can extend across the building to the other side.

An alternative approach gaining more widespread implementation arranges alternating zones of labs and lab support down the length of the building, in what is sometimes called the "transparency" model. The lab and support zones can extend across the width of the building, allowing more flexible, adaptable neighborhoods. This configuration, in contrast to the "bar" approach, results in larger contiguous open lab zones in both directions with dedicated benches and support that can be easily re-assigned as program needs change. This also and quite significantly enhances quality of life for researchers, in that it allows views and daylight across the full width of the building. Proximity to lab support is not compromised; in fact, the larger contiguous support zones have better long-term flexibility for reconfiguration and for adjacency between bench and specialized support space such as tissue culture, imaging, or instrumentation.



This biology research building is organized in a "bar" concept, with a continuous lab-support zone between the labs and the corridor. Image: Goody Clancy



This new building alternates full-width zones of labs and lab support to permit views and daylight across the full width of the building. Image: Goody Clancy

FUME HOODS AND LAB EQUIPMENT

The chemical fume hood continues to be one of the most common pieces of research equipment in the lab. Given the broad range of scientific disciplines, as well as the differences between research labs and teaching labs, and the associated variations in required hood density, size and features, it would be unreasonable to generalize about a "best approach." Nevertheless, we have seen a marked shift in thinking about where the hood in a science research lab should be located.

For many years, if a lab required a hood, it was often placed in the lab proper, at a bench and frequently at the end of an aisle near the outside wall. While this had the advantage of making the hood less subject to airflow disturbances from nearby walking traffic, they ended up occupying what is often a premium location, blocking access to daylight and creating what many clients came to see as creating an inherently unsafe "dead-end" condition. In recent projects, we have been migrating the hoods out of the labs and into lab-support alcoves or rooms: nearby, but separate from the labs. This approach has several benefits: increased safety due to segregation of hazardous materials requiring hoods; improved flexibility since the remainder of the neighborhood can now be rearranged without affecting the hood; and, finally, the location of the hood near other fixed elements such as the building core shortens ductwork connecting the hood to exhaust systems.

LOCATIONS AND TYPES OF COLLABORATIVE SPACES

Through observing patterns of building occupant behavior, and supported by client-led surveys of researcher satisfaction, we are seeing a more nuanced approach emerge for providing spaces for interaction. In the past, architects would often locate a desired break room or lounge at the end of a corridor, theorizing that its relatively quiet, secluded location would make it more appealing. While that approach has worked in some instances, we have concluded that such remote spaces cannot, by themselves, meet the full range of needs found within a science community. User surveys show that long distances to a break room are unacceptable and result in the proliferation of nearby informal break spaces. Users are very clear that these break spaces should instead be designed for smaller groups of two or three people and located near the neighborhood.

We have also found that shared lounge or interaction spaces are most successful when they are near a communicating stair so people see each other while they travel through the building during the course of the day. Lounges/interaction spaces also require writing surfaces and, ideally, a kitchenette located

Views from a write-up area on one side of the building are continuous through the lab zone to the opposite side. Image: © Robert Benson Photography

somewhere close by. As most of us do at parties, people tend to congregate in the kitchen—for lab group meetings, impromptu "creative collisions"—or simply to have a snack !

HOW BUILDINGS CAN CONTRIBUTE TO THE LARGER SCIENCE COMMUNITY ON CAMPUS

When programming a science building on a college or university campus, one would typically take into consideration where related programs are in other buildings. This points toward context-dependent programming decisions to avoid redundant facilities to the extent possible. It has been instructive for us, as architects, to see how this issue plays out across different campuses and how it influences the nature of the research that takes place in these new buildings.

At the new 4515 McKinley research building at Washington University School of Medicine (St. Louis, Mo.), the primary program uses are Genetics, Developmental Biology, Genomics and Imaging. Yet there is no vivarium—instead, the building includes a direct basement-level connection that provides secure access to adjacent vivaria and research facilities, thus avoiding the need for an animal facility in the new building.

In addition to research labs, the design of the new Integrated Sciences Complex (ISC) at the University of Massachusetts Boston included 80 faculty offices across five departments. However, since most of the teaching labs for those disciplines are located elsewhere on campus, the client decided to keep the departmental headquarters closer to these teaching labs. What this meant for the ISC was that research-focused faculty from the ISC would need to walk to other buildings to interact with some of their teaching-focused colleagues and to meet with HQ staff. This is not necessarily a disadvantage, but it will be interesting to observe how the dynamic of faculty interaction is affected by this configuration.

Finally, the phenomenon of adding new research space to an existing science building brings its own challenges and opportunities. The Neuroscience Research Building at SUNY Upstate Medical University (Syracuse, N.Y.) is an addition to a major facility, the Institute for Human Research, configured such that the two are joined by a 300-foot-long, two-story, linear skylit atrium, or "zipper." The architects placed all of the shared social and collaborative spaces such as break rooms, conference rooms and lounges along this atrium. Part of the project involved breaking through the former outside wall of the original building to connect new and old and to facilitate the interactions of scientists from both buildings to share those social spaces. The strategy is working: the addition has stimulated more collaboration.

ADVANCING SUSTAINABLE LAB DESIGN

Given the fact that laboratories are inherently large consumers of energy (a typical fume hood uses as much energy in one year as a house), we as designers have an obligation to use every mechanism possible to reduce the energy demand of the labs we design. While institutional attitudes toward sustainability vary from one owner to another, the desire to use less energy is consistent; the variations come with the comfort level each has with certain strategies.

At a minimum, during programming, we encourage our clients to be realistic about how many fume hoods—one of the primary "energy hogs" in a lab—they really need. We simultaneously examine their willingness to consider so-called low-flow hoods, from a safety and usability standpoint. Increasingly, we are considering filtering hoods as an option even as more manufacturers of this technology have entered the market. Such decisions are intimately tied to the precise program (research vs. teaching, low chemical use vs. intense use) and to the stance of the institution's environmental health and safety (EH&S) staff.

Finally, having reduced the demand for air, we typically deploy one of several energy-recovery strategies to scavenge energy from the outgoing airstream or to cascade already conditioned air from office zones into the labs as make-up air. Again, the choice is related to first cost, long-term payback, and system efficiency. While enthalpy wheels have been in use for many years, some owners are not comfortable with the apparent risk of cross-contamination in such systems.

Another significant contributor to a lab's energy-use profile is lighting. Best practice now includes the incorporation of daylight harvesting, with sensors controlling the dimming of artificial lighting. And after many decades of working with the "recommended" universal levels of 80- to 100-ft. candles on the bench, the industry has finally moved to a more sensible energy saving approach, understanding that most tasks are compatible with 50- to 60-ft. candles of ambient lighting from a ceiling-mounted fixture with the option to use higher-intensity task lighting where needed for critical visual tasks. The rapid proliferation of LED lamping and fixture options, in response to more stringent energy codes, has accelerated the move toward much lower lighting power density in labs. In our experience, lab occupants have embraced these trends and appreciate having the flexibility.

CONCLUSIONS

The future lab appears to be migrating to ever greater use of sophisticated analytical equipment that is small and adaptable to benchtop use rather than in isolated support space—essentially shifting to "bring your own device" analytical spaces at researcher benches. This requires careful consideration of benchtop utility requirements, since these locations might otherwise be considered to have unremarkable power needs.

Another trend is towards computation space and high-speed connectivity to remote data servers. The computation groups are an integral component of research groups—their work happens in what are essentially dry labs, which are efficient, smaller spaces requiring half as much support space as wet lab research requires. It is important to remember, however, that these computation labs must nevertheless be integrated into the lab neighborhood, not isolated from it.

While some of these trends may seem only to be only incremental, the aggregate result is moving us toward the design of labs that will have longer useful lives, more ability to adapt easily and cost-effectively to the inevitable changes in research priorities and greater sustainability.

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