building for breakthrough science

OPTIMIZING ROI IN R&D FACILITIES

OLSON PHOTOGRAPHIC

The Yale School of Medicine West Campus, WB-24 Laboratory, New Haven, Conn., a renovation project that resulted in the delivery of a "prestige lab," especially notable for attractive and welcoming interior spaces. Such amenities are vital to the recruitment of top research and academic talent.

LEARNING OBJECTIVES

After reading this article, you should be able to:

+ DISCUSS the lab project planning phase, including inputs related to site selection, occupancy, and codes and standards as they related to sustainable design.
+ EXPLAIN the requirements for green building and LEED as they apply to laboratory and research facilities.
+ LIST approaches to improve energy efficiency, daylighting, and the use of sustainable building products in labs.
+ DESCRIBE ways to make laboratory indoor environmental quality comfortable, healthful, productive, and inspiring, with positive effects on occupant health.

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Whether in the corporate sector or in the academic realm, scientific research is a complex and highly competitive field. Because decisions of where and how to direct research funding can be decided at the margins, even small factors can make the difference, and the built space within which research is conducted is, in fact, no small factor at all.

Laboratory facilities and associated support spaces that are built to best practices have a significant impact on the return on research-related investment. Yet traditional, one-size-fits-all modes of design and construction are still frequently employed for both corporate and institutional end-users, to the detriment of their research and of scientific advancement more broadly.

The reason given for operating within a traditional and arguably outmoded framework of research facility design is usually related to initial cost. Without factoring ROI into facility-related decision-making, however, the research team and its benefactors risk realizing less than desired, or even zero, results.

More and more, stakeholders in the research science sector are moving toward a more holistic approach to the built space. The reasons for this trend are manifold, but all relate to the notion that every aspect of the facility can impact the occupants, who are performing or supporting research. A holistic approach to designing the space can leverage improvements in occupant health, morale, and productivity in a way that positively impacts research outcomes; moreover, such an approach will avoid the negative impacts of one-size-fits-all laboratory designs on highly specialized research.

This holistic approach will also frequently include attention to the laboratory and its support spaces as a “home for research” and, equally, a home for researchers. De-industrializing the research facility and making the space agreeable to the human occupants to the greatest extent possible should have a positive impact on researchers and their work.

Properly planned and designed facilities can foster a productive collaboration within and among various research teams and cultivate a sense of community. What’s more, they can also realize cost savings and cost-effectiveness by effectively managing operations, maintenance, and energy use. Finally, the highly effective research facility contributes to the advancement of science itself, providing a space wherein the research team can work optimally and produce breakthrough results.

EARLY CONSIDERATIONS IN LAB DESIGN

Stakeholders engaged in the design of research facilities already face a specialized task, since the considerations involved are highly specific compared to those of most commercial project types. In some cases, particularly unusual areas of research can further complicate this task with narrow parameters and atypical equipment types.

Consider a facility that houses transgenic butterflies for study. Unlike many other vivaria, this facility will require secure ventilation and points of entry to prevent specimens from escaping and contaminating the outside environment; it will also need a daylighting strategy that supports the natural procreative activities of the mutated butterflies. Or consider what might be required to produce an anechoic chamber for audiological studies, or a noncorrosive environment for delicate geological research. Whatever the case, the solution is to begin anticipating and resolving the design issues as early as possible.

The Pre-Planning/Visioning Phase. Because of the array of highly specialized lab typologies, few design firms are likely to have experience with a particular uncommon lab type. But AEC firms that specializes in laboratory design and construction should employ a course of action that begins with “visioning”—to establish a description of the desired outcome—followed by a careful and thorough cataloging of the requirements for achieving the outcome.

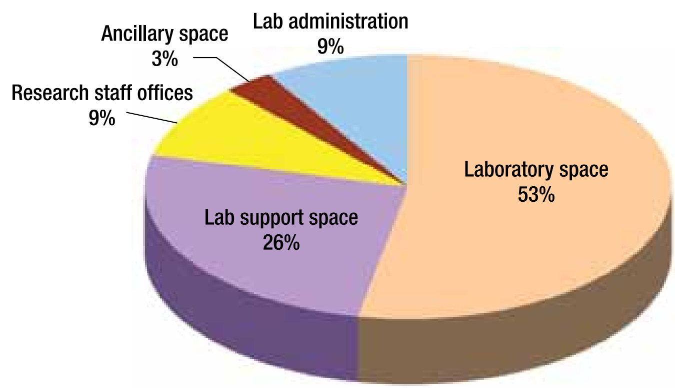
Such a process will engage stakeholders who might otherwise be disinterested or separated from the design process, including the research staff themselves, human resources staff, and the marketing team (for corporate clients). While the research staff will obviously flesh out project prerequisites, the marketing professionals can propose branding elements, while human resources can bring the design team’s attention to wellness issues and collaborative workspace. One design methodology, Phusion, which was developed by our firm, addresses this process. Some important aspects of the methodology for include:

• **Checking project alignment.** Elucidation of immediate and long-term goals will impact site selection and develop the lab program by adding detail. Addressing core assumptions, the research organization avoids the risks of an inappropriately sized and outfitted facility, such as making it too large to be cost-effective, too small to house the research, or lacking basic or specialized infrastructure, etc.

• **Documenting the required R&D program.** The lab design team must guide the research organization in comprehensively recording all program requirements and goals, whether pre-existing or realized through visioning.

Organizing and benchmarking. Attention to organizing the facility properly forms a crucial pillar of the planning phase. Doing so will

CHART 1. ALLOCATION OF SPACE IN A TYPICAL R&D FACILITY



Laboratory functions take up the majority of space (53%) in the typical R&D facility, but support functions and administrative, office, and ancillary space have to be accounted for in the design process.

Source: NIH Office of Research Facilities, “Biomedical and Animal Research Facilities Design Policies and Guidelines” require creativity within the parameters of industry standards, some of which are flexible, some quite rigid. There are many applicable standards deriving from a number of sources, notably the National Institutes of Health, Office of Research Facilities; the Centers for Disease Control; the Occupational Safety and Health Administration; ASHRAE; and the National Fire Protection Association.

State and local building codes must be taken into consideration as well. The NIH Office of Research Facilities (ORF) document *Biomedical and Animal Research Facilities Design Policies and Guidelines* is a useful reference tool, although it is important to understand which of its components are policies and which are merely guidelines or suggestions. For instance, ORF's guidelines for space utilization—33.67 sm, or 362.4 sf for a single module—is suggestive, not required.

However, ORF's allotments for support, administrative, and office spaces (as opposed to laboratory space) may not apply in the case of a highest-ROI facility. In fact, the accepted definitions of support or administrative space may not apply as Building Teams strive to build research facilities that optimize collaboration and occupant health and morale.

On the other hand, ORF guidelines for lab modules and spacing will apply more frequently. Equipment and casework manufacturers build to these specifications; without a budget for custom furnishings, the design team will have to adhere somewhat to these constraints.

Building Teams will find that significant lab design experience, combined with thorough visioning and planning that includes the future occupants, is crucial to managing the many codes and standards in play. For instance, the points of intersection and overlap between occupant safety and energy management present enormous challenges.

For example, control systems for HVAC equipment must be chosen to serve the needs of the expected research program, striking a balance between safety and efficiency. Strategically grouping the spaces with the heaviest ventilation load into a single, concentrated zone, perhaps away from the core and closer to the building exterior, offers the opportunity to manage HVAC energy consumption based on the needs of specific user types while delivering draw and exhaust rapidly and efficiently. This strategy tackles one of the largest energy concerns for a research facility, by combining what is gleaned from visioning with creative solutions for organizing spaces.

The importance of the visioning and pre-planning phases cannot be overstressed. Opportunities for problem solving and achieving best practices, plus future ROI, increase by an order of magnitude when early planning is thorough. The process cannot begin with just a floor plan.

Green certification and LEED. The client organization may or may not be interested in the goal of achieving green building certification, but the design team must be aware of the possibilities and the pitfalls. The first and most important consideration is the fact that there is no "LEED for Labs." The proposed "LEED Application Guide for Labs" (LEED-AGL), is not yet a formal alternative to LEED-NC and LEED-CI standards for research facilities, but it does serve well as a general guide for the design team aiming for certification. Lab environments and equipment, being so specialized, will often strain to

WOODRUFF BROWN PHOTOGRAPHY

The renovation of Yale's Sterling Hall of Medicine featured aggressive energy-efficiency measures. A related project, the School's Department of Neurobiology, was the first lab in the U.S. to earn LEED-CI certification.

fit within the parameters for commercial green certification standards. Here are some examples of how the specifics of lab design make qualifying for specific green-building certifications much more difficult:

- **Ventilation requirements for safety** make energy-reduction targets harder to reach.
- **Water for cooling equipment** may not be used "once-through," and process water requirements may be significant, making water-efficiency goals more difficult to achieve.
- **IEQ and IAQ requirements** present would-be LEED labs with onerous challenges, especially since finishes and materials must be chosen or compatibility with the research, not just occupant health.

LEED, Green Globes, Energy Star, or Greenguard certification may not always be a good fit for research facilities. Stakeholders must agree early as to whether such certification is essential or, alternatively, whether such green-building standards could be surpassed.

Should the stakeholders opt out of certification, they should not throw in the towel on green design. Because sustainable design principles so often dovetail with other goals, such as occupant health and energy efficiency, the Building Team and the client must build according to best practices for sustainability. In fact, eschewing certification can free the stakeholders to experiment with new green building techniques not yet recognized under accepted standards.

Collaboration and creativity. Optimal ROI will not be achieved without incorporating humanistic considerations into the design strategy. These considerations must not be limited to providing for occupant health and safety; achieving best-case research outcomes requires that, at the least, the research team and support staff find the facility an enjoyable place to occupy.

There is evidence that creating a "home for research" opens a project to dramatically improved outcomes, not least because researchers generally spend long hours in the labs or offices, so they must be comfortable and supportive of the mission. Research has shown that workplace design elements such as natural illumination, exterior views, natural (read: biophilic) materials and finishes, and even artwork contribute to reduced absenteeism and improved productivity. These principles apply should be leveraged in the research lab.

Stakeholders should consider this a baseline as they move through the early planning phase. Beyond making the work environment pleasant, the client and Building Team should also look for opportunities to foster interaction and collaborative discussion. Workplace design has moved toward open office plans and other configurations engineered to increase interaction and potential for collaboration. The underlying notion of this new paradigm is groupthink, the principle that the value of collective endeavor is greater than the sum of the individual efforts.

From this perspective, stakeholders must assign a greater value, on a per-square-foot basis and on the basis of percent of usable area, to what had been considered *support space*. A break room is no longer merely a place to take a break; it is a valuable space in which interaction can take place that could lead to important new

Artwork, as in this common area at New Haven's Albertus Magnus College, can inspire breakthrough science and, combined with exterior views and natural daylight, also increase researchers' productivity.

ideas and even scientific breakthroughs. While a lab is not a typical workplace, what happens in the in-between spaces can push boundaries and generate a competitive edge.

CHOOSING THE RIGHT SITE

Having engaged all stakeholders in a comprehensive pre-planning dialogue, the Building Team is now ready to move ahead to site selection. The chief considerations for selecting the most appropriate site, whether for new construction, renovations, or long-term tenancy, should be relatively easy to determine in light of what has been uncovered through the visioning process.

Renting vs. owning. This decision, while usually budget-driven, may not be as it appears on the surface. To maximize ROI, consideration must be given not only to cost, but to cost-effectiveness as well. Leasing space for research usually means a lower upfront investment and the possibility of reduced time required for start-up. In some markets, the supply of available space is increasing, making rents more affordable and even encouraging landlords to add amenities that make their properties more competitive.

Caution: Lease agreements must be carefully crafted to address the special demands of research science, including provisions for ongoing changes in funding, activities, and program footprint.

In purchasing a site for new construction or an existing facility to build out, stakeholders must consider any financial incentives, environmental concerns, or sustainability issues and whether the existing infrastructure is adequate to support the range of desired goals for the program. As a rule of thumb, the cost of constructing research space construction may be double or triple that for retail or other more common commercial typologies. That's why proper site selection must be the first, most important step toward minimizing costly mistakes. Correct site selection—one that meets the research organization's culture perfectly—will not only motivate the existing staff, but may attract talented scientists looking for a home for their research.

Location. Research organizations with existing locations may do well to seek a site for new facilities in close proximity to their current operations, possibly even within a driving distance of 15 minutes or less. Proximity to research facilities conducting similar activities may offer synergy through opportunities for shared services and a potential source of research and technical staff for future expansion or replacement needs. Facility size is also an important factor, and determining whether the selected site is of an appropriate, manageable size for the functional program should follow from criteria as defined in the pre-planning phase.

Infrastructure. Depending on the type of research, power, data, waste disposal, and related utilities must be at a level that serves the lab facility's specialized demands. Roads, traffic and parking considerations, and access to transportation hubs and quality-of-life amenities may not bear directly on facility operations or the research program, but indirectly may affect the research team and support staff, either creating or eliminating worries and distractions that could interfere with performing breakthrough-level science.

CASE STUDY 1
Site Selection: Transgenic Butterfly Lab

In need of a lepidopteran lab for study of a mutated butterfly group, Yale's Department of Molecular, Cellular and Developmental Biology could not afford to drift far afield from the existing campus. In consultation with our firm, the university decided to convert an old carriage house into a secure lab for sensitive research.

This choice of site carried with it the requirements to meet the stringent USDA guidelines for the containment of transgenic species. To prevent an escaped specimen from contaminating the environment, the facility would have to support security redundancies, air curtains, and vestibules. Penetrations of walls for light fixtures, MEP equipment, and the like required gaskets and other sealing details, both to control moisture and prevent specimens from escaping. Incorporation natural daylighting into the illumination scheme provided natural environmental cues for the butterfly breeding cycle while promoting researcher health and work satisfaction.

Utilizing the basic structural elements of the carriage house saved the project the cost of acquiring a site and building new—and important environmental benefit—while making sure that the research would be conducted in an appropriate space.

Support. Access to support organizations in business and government can be crucial for success. Site selection should incorporate an appropriate measure of attention to the location of economic development companies and state departments of commerce. These organizations are instrumental in navigating legal and regulatory requirements, and can offer help in identifying available financial incentives.

Sustainability. On the subject of incentives, brownfield redevelopment, as well as land and water use strategies such as stormwater retention/reuse, can contribute to LEED certification. If the site under consideration is not in a research complex or industrial park developed and zoned for research use, consideration should be given to an environmentally and locally friendly plan for waste removal, HVAC exhaust, exterior lighting, and other elements that could impact commercial or residential neighbors' quality of life.

LAB INTERIORS: BEST PRACTICES

Floor plans, furnishings, and other elements of interiors for research space were once rather predictable and drab. More recent attention to sustainable design and energy efficiency has led some lab design projects to shoehorn various strategies, techniques, and products into traditional configurations and approaches, with mixed results.

Again, for optimal ROI, a holistic approach that begins with a workshop/visioning phase involving all of the stakeholders' input yields the best results for medium and long-term occupancies. Whether for new construction or a complete shell rehab, the interior design and architecture should be planned accordingly to leverage opportunities for sustainability, energy efficiency, and occupant comfort and enjoyment.

Energy-efficiency demands. Research science is energy-intensive. According to Daniel Watch of Perkins + Will, writing for the *Whole Building Design Guide*, "A typical laboratory currently uses five times as much energy and water per square foot as a typical office building." This vast difference in energy use is due to several factors:

- The many required containment and exhaust devices
- Abundant heat-generating equipment
- The need for researchers to have 24-hour access
- Rigorous ventilation requirements

Finally, says Watch, "Irreplaceable experiments require fail-safe redundant backup systems and uninterrupted power supply (UPS) or emergency power."

One important consideration with respect to energy use is *user habit*. The best energy-saving equipment and design are meaningless if the occupants are unfamiliar with their proper operation.

The best time to address this problem is during the workshop phase. If the facilities department finds, for example, that building to green specifications requires more controls—and therefore more monitoring—the likely user-occupants can be instructed as to how technicians and staff members should function in the space and how to operate the equipment, such as water supply shut-offs and fume hood closures, to ensure that all systems are working at optimal efficiency levels.

This type of discussion should, in fact, continue throughout all project phases and into occupancy. The workshop process also presents an opportunity for the owner-stakeholder to become acquainted with the benefits of a potentially greater upfront investment; knowing that ROI will come at a desirable speed can make the client more amenable to aggressive approaches to efficiency and sustainable design. The payoffs during occupancy benefit all stakeholders: owners enjoy long-term cost savings; researchers and support staff have a healthier, more comfortable workplace; and facility managers have fewer callbacks.

An efficient lab design may require commissioning, although the visioning and workshop processes may suffice. Where the interiors are concerned, certain computer modeling technologies should be considered carefully, as the findings may radically alter the design approach. Computational fluid dynamics (CFD), for example, creates a digital model that tracks airflow from supply through the built space to the exhaust points.

Accurate CFD modeling locates areas where air will pocket and identifies tendencies toward stratifying, information the engineering team can use to recommend arrangements and supply diffusers that make the lab not only more efficient to heat and cool, but safer as well, since airborne toxins and contaminants will be directed successfully to exhaust. Targets suggested by CFD can be accomplished with lower air exchange rates, another energy-saver.

Perhaps the last thing to consider in the pursuit of efficiency is installing the latest high-tech equipment. Sometimes traditional equipment will be the best choice, when measured against the criteria set forth in the planning phase; this will be determined by the projected needs of the research team weighed carefully against the specifications of the equipment under consideration. In the case of fume hoods, for example, low-flow technology may seem appealing, and it certainly can outperform conventional constant- or variable-volume hoods in terms of energy savings. But safety, being paramount, should trump efficiency in this instance. Careful specification coordinated with data from the proposed ductwork and HVAC may suggest:

1. Low-flow hoods will underperform (compromising safety)
2. Low-flow fume hoods will be sufficient, or
3. The ROI does not merit the expenditure because the traditional system performs equally well (or well enough) with a smaller upfront investment.

Research goals, likely user behavior, and interaction with systems and controls must all be considered, not only for fume hoods but for any element that impacts initial investment and ROI: lighting, electrical, water fixtures, security systems, etc. The latest and greatest technology may serve a project poorly if it is not measured against interacting elements.

Sustainable building products. Specifying sustainable materials and systems for the lab interior not only accrues to the facility the primary benefits to the "triple-bottom line"—reduced impact on the environment, a healthier workplace for occupants, and increased cost-effectiveness for the owner—but secondary benefits as well. Recruiting top talent is easier for research organizations with prestige labs; for members of the scientific community, a fully realized green-built lab is uniquely prestigious.

But achieving that prestige is accomplished by focusing on the primary benefits, continuing the holistic approach in order to balance green goals and certification with those of safety and occupant comfort.

Finish materials need to be low-VOC emitting. Rubber flooring is a common choice; often containing recycled/recyclable materials, sheet rubber and tiles are low-VOC, minimize static electricity (which can contaminate some research), prevent slipping and absorb shock.

Where possible, floors should be composed of renewable wood or other biophilic materials that contribute to occupant enjoyment and relaxation, especially in offices, support spaces, and corridors and rooms intended to promote collaboration and interaction. Bamboo may be an option, though there may be maintenance needs when it is used as high-traffic flooring or for high-use casework.

Casework and other furnishings should also be composed from renewable and recyclable materials, especially those that tend toward the biophilic. Casework is a major portion of the investment in a lab interior and will have the greatest impact on the overall sustainability of the interior design. If metal casework is to be specified, the design team should consider casework with recycled content.

Wood casework can be sourced locally, at a cost similar to metal; the materials are more rapidly renewable, not to mention biophilic. Several Yale Medical School projects use casework made from a composite derived of wheat, and panels of FSC-certified maple veneer. Bamboo or eucalyptus may be an option, depending on use and performance needs.

Ceiling systems must be specified to achieve acoustic goals. Dampening can offer some privacy while creating a more pleasant environment free of harsh echoes or ambient chatter from neighboring researchers; this is especially important in open-plan labs. Coatings and other finish materials (such as adhesives for flooring) should be low-VOC for occupant health and for conducting contaminant-free research science.

Lighting and daylighting. The importance of maximizing natural illumination cannot be overstated. The two most frequently referenced studies, by the consulting firm Heschong-Mahone, found that natural daylighting increased productivity, reduced absenteeism and positively impacted occupant health and satisfaction one in the workplace and in schools.

When properly balanced to mitigate solar heat gain, using daylight for illumination can dramatically reduce the amount of energy consumed in operation. Though it will not always be possible, research space should incorporate daylighting and exterior views; support space, offices, and interaction/collaborative areas should all be placed where they can enjoy the full benefit of available daylight. By combining large windows with partial dividing walls, or reflective materials and coatings in conjunction with clerestory windows, it is possible to bring natural daylight into 90% or more of a facility's discrete spaces, as was accomplished in the Yale Medical School interior renovation.

The visioning and workshop processes should indicate what

WOODRUFF BROWN PHOTOGRAPHY

The renovation of the Yale School of Medicine included outfitting much of the august Sterling Hall of Medicine with state-of-the-art equipment and furnishings, while delivering a healthy, sustainable workplace for researchers that incorporates natural illumination and natural wood finishes.

lighting fixtures and techniques will serve best: where task lighting will be needed, what spaces have strict requirements for safety lighting, where low-wattage LED and CF lamps will satisfy, etc. If the floor planning allowed for a zone-by-zone strategy (as discussed earlier in reference to ventilation), controls for lighting can be linked by zone to further save energy and reduce responsibilities for facility management.

Other interior considerations. Workshopping, at its best, should reveal research needs and work habits that influence specification of workstations, seating, storage, and more. Clients may reveal that they will need to optimize the facility for flexibility, while research organizations may have goals, techniques, or even an institutional or corporate culture that translated into demands on the space and its components.

CASE STUDY 2 — Interiors: WB-24 Labs

In 2007, Yale University acquired the former Bayer Pharmaceutical complex to add to its growing West Campus, with an eye toward creating a research hub for leading scientists, PhDs, and principal investigators. As a prestige project, the selected site would have to accommodate cutting-edge DNA-sequencing technology, microscopy suites, and cold rooms. The project would also have to make an outmoded facility into a high-profile, world-class research center.

With a laboratory infrastructure already in place, the Building Team must focus on delivering a fresh, sunny look that would feel inviting to future occupants. In addition to bringing natural daylighting as far into the core as possible, designers outfitted the space to maximize adaptability. Flexible casework, plug-and-play MEP access, and rolling cabinets make the facility responsive to the changing needs of research science. As a uniquely sustainable solution, existing fixed benches are used as counters and lab benches where possible, and existing fume hoods have been refurbished.

The results reduced costs by as much as 50%, yet this frugal, three-story, 60,000-sf facility has been vital to recruitment of institute directors and principal investigators. Brightly colored walls, lightweight furnishings, ample wood and wood-grain surfaces, and glass partitions and doors—many with fritted patterns suggesting cellular or molecular patterns—contribute to the "prestige project."

Where possible, consider cost-effective ergonomic systems, but make sure the research team is on board. Adjusting to a radically new environment, even a strange chair, can hamper an individual's research efforts, so specify seating, workstations, benches, and storage in close consultation with the client.

Computer workstations have become an integral component of laboratory design, of course, and manufacturers have responded with an array of choices. Make certain the infrastructure is in place and then consult with the clients through workshopping to determine the best furnishings and arrangements for digital workstations.

THE BREAKTHROUGH LAB: LEVERAGING THE INTANGIBLES

This course has stressed the early-planning phase for a number of reasons, all of which bear on the bottom line: what is best for the research, and the researchers, will translate into a better return on investment. Taking this thinking to its logical conclusion, it becomes the task of the Building Team to seek out the qualities of the client and research stakeholders that are not easily translatable into design elements. It is the integration of these intangibles into the design that set apart the high-ROI "breakthrough" lab from the typical one.

Unique research challenges. Designing for unusual fields of research can further complicate an already highly specialized task. The most cost-effective approach to solving for these challenges is the one that delivers optimal research results—and therefore, best ROI—and that begins with thorough visioning and workshop programs.

As noted in the first case study, the workshop process opens the door to synergy among various project goals: only with a sufficient understanding the behavior of butterflies, as detailed by the researchers themselves, could the design team realize a natural daylighting strategy that serves both the researchers and their study specimens. As a result, the transgenic lepidopteran lab is not only producing successful research, but the synergy also allowed for some cost cutting in construction and operations.

The same process led to the development of a solution for a geological lab. This particular facility needed to be built entirely from nonferrous materials, to avoid corrosion and contamination of samples from metal particulates. In the end, the non-ferrous environment, being generally less caustic, also avoided corroding standard systems and equipment, which would have brought research to a standstill. This synergy of goals was the direct result of a thorough dialogue among the Building Team, the researchers, and facility management stakeholders.

Amenities and aesthetics. In our second case study, the client (Yale University) clearly wished to invest not just in a functional lab, but also in a world-class molecular biology research facility that would project an image of prestige. One of the goals for many such facilities is generating interest among potential PIs and research directors, so as to be able to recruit top-tier talent: prestige begets prestige. But efforts to create the image of prestige align and synergize with other goals, such as sustainability and employee health and satisfaction; such elements will fall into one of two categories, amenities or aesthetics.

Amenities include prime location, interior spaces for interaction and relaxation, flexible lab arrangements, ergonomic furnishings, etc. But the visioning phase may reveal other amenities that could be included to further boost the facility profile. Some may opt for workout facilities and showers, or even sleeping space sleep for those who spend long hours in research. Larger facilities will probably support a cafeteria. Corporate or high-profile institutional clients may want such amenities as a lecture hall, a boardroom, and high-tech smartboards and videoconferencing.

Even if the client and occupant stakeholders do not mention it in workshop, the Building Team should raise the issue of aesthetics. Recall that WB-24, in our second case study, enjoys an image of prestige in no small part due to abundant natural daylight and exterior views; the same can also be said of that facility's furnishings, which tend toward wood and natural finishes as much as possible, so as to elicit a subtle biophilic response in the occupants. For this reason the stakeholders would do well to consider whether exterior areas could be cultivated and landscaped to augment this choice, such as garden areas, water features, and green roofing solutions that incorporate vegetation or walkable decks.

For corporate projects, the preference may be to brand the space with elements and color choices drawn from associated logos and iconography. Elements such as these can even be used in artwork for exteriors and occupied interior spaces. Image crafting and branding will be especially important for clients who plan to offer tours, conferences, and the like to shareholders or potential investors.

Home for Research. There are clients who may resist the notion of artwork in the facility, deeming it a low priority. But artwork can contribute greatly to the overall success of a new or renovated facility, improving ROI at a relatively low cost. The "home for research" is not itself an intangible quality; researchers and support staff in successful and attractive research facilities themselves report higher job satisfaction and better ability to focus on work. And pride in one's workplace, while not measurable, is nevertheless quite real.

Even on the institutional level, where it might seem less important to direct resources toward image, the effect of an art installation can be powerful; the butterfly-wing evoked by the artfully designed front doors of the lepidopteran lab makes it impression upon passersby, upon potential benefactors, and most assuredly upon the building's regular occupants, especially the researchers. If the researchers enjoy the facility, they will be there more often, and studies show that their work likely will improve, too.

CASE STUDY 3 — Intangibles: PepsiCo Nutrition Lab

One of PepsiCo's newest R&D labs opened recently in New Haven, Conn., with the goal of developing healthier, more nutritious products through advanced biological research. The design team's mission was to design a premium research facility that reflects the beverage-and-snack company's culture and focus on health, while incorporating high-performing sustainable design and providing optimal working conditions that support the research scientists, thereby boosting their productivity and effectiveness.

The construction had to be done on an accelerated timetable, as Pepsico had recently hired a raft of new researchers who would need new workspaces as quickly as possible. The project team was given loose requirements for the various departments, and a goal of providing wet labs (with filtered water piped in), dry benches, and office space for 80 employees. The new research facility, a complete renovation of an entire research floor, went from documents to occupancy in roughly eight months, thanks in part to the design team's familiarity with more obscure aspects of the type of research in question, such as specific equipment needs ranging from specialized mixers to industrial bottle crushers.

PepsiCo also entrusted the team with the task of branding the interior, in particular, the common area and break space. Located at the joint of the L-shaped floor plan, the space integrates reception and security with a lounge and small bar. Product-related artwork and decor contribute to the sense of mission and corporate culture while creating an oasis of relaxation for employees and visitors alike.

FLEXIBLE LABS: PLANNING FOR CHANGE

Traditional floor plans for laboratory interiors can create problems for research organizations and facility owners alike, notably when a new tenant moves in or when the needs or goals of an occupant group's research change. Built-in-place fixed systems require a construction crew to replace or exchange modules, since the module cores themselves must be excised. Happily, there is a "flexibility spectrum" with varying degrees of adaptability that can be incorporated into research facilities using currently available technology.

The most flexible options eliminate the fixed core in favor of, for example, plug-and-play pods installed in the ceiling or floor. The adapted infrastructure may have a higher upfront cost and will require freely accessed floor and ceiling systems. But no construction crew is needed should the room requirements change; occupancy and project start-up can begin sooner, at a minimal cost.

If properly designed, the flexible lab can provide a highly adaptable space without the casework and furnishings feeling flimsy or underperforming. Not every interior needs to be extraordinarily flexible: wasted flexibility is wasted effort and cost, but an appropriately flexible lab benefits all stakeholders. Some strategies to consider:

- Benches and equipment still tend to fit a 10-foot module standard; using this as a guideline assists in design for flexibility.
- Not all core elements will be needed at every station; at this time, casework systems with flexible water and drain connections are not widely available. Keep most benches dry and on the perimeter, with sinks and wet benches inboard near support areas.
- Limit the supply of vacuum and gases to save on construction and operating costs.
- Establish benchmarks. This means revisiting projects and tenancies from time to time, to discover how many hoods, benches, or sinks went unused, for example. The data can help establish points of reference for future lab design projects.
- Consider the durability of casework and furnishings. Certain products may seem ideal for the goal of flexibility, but may need to be replaced all too soon. As an example, ceramic or state-of-the-art epoxy/glass countertops may be preferable to traditional epoxy. Also, open shelving may be preferable to cabinet doors that can slow down researchers, or break.
- Adjustable height countertops may assist with projects using bigger-than-normal equipment.

> EDITOR'S NOTE

This completes the reading for this course!
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