

Early Sustainability Planning in Research Laboratory Design



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The early phases of the design process, such as programming and planning efforts, are typically exercises to get the entire team on the same page concerning programmatic priorities and budget limitations. Additionally, these early phases should also be approached through a lens of sustainability.

If done correctly, the process will focus on the benefits of program efficiency (avoiding overbuilding), creating functional adjacencies (shared spaces), planning for efficient systems (sustainable and green), and getting the best long-term value as well as setting standards for materials, equipment, and the environment.

ABOVE RIGHT & COVER | *Miami University*

OPPOSITE RIGHT | *Purdue University: Centrally located support labs maximized efficiencies and lowered the carbon footprint.*

Do Not Overbuild

It has been said before: “lean is green;” and “avoid overbuilding.” The benefits of program efficiency for a research space include energy savings and material savings that can be applied to upgrade lab spaces.

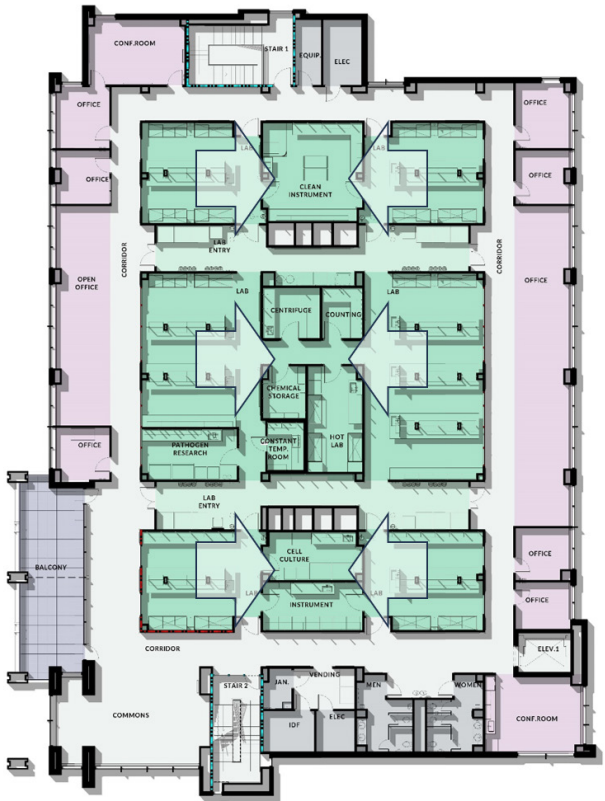
Right sizing a building, managing needs, wants, and the budget, can be emotional. There is a delicate but necessary balance between diplomacy and planning backed by evidence. Utilization studies should inform the basis of occupants’ space requirements, both today’s needs and future needs. Lab planning professionals account for planning standards, class schedules, research grants and focuses, and projections of growth, or retraction. Any gap analysis part of a utilization study will reveal areas of underutilization and crowding.

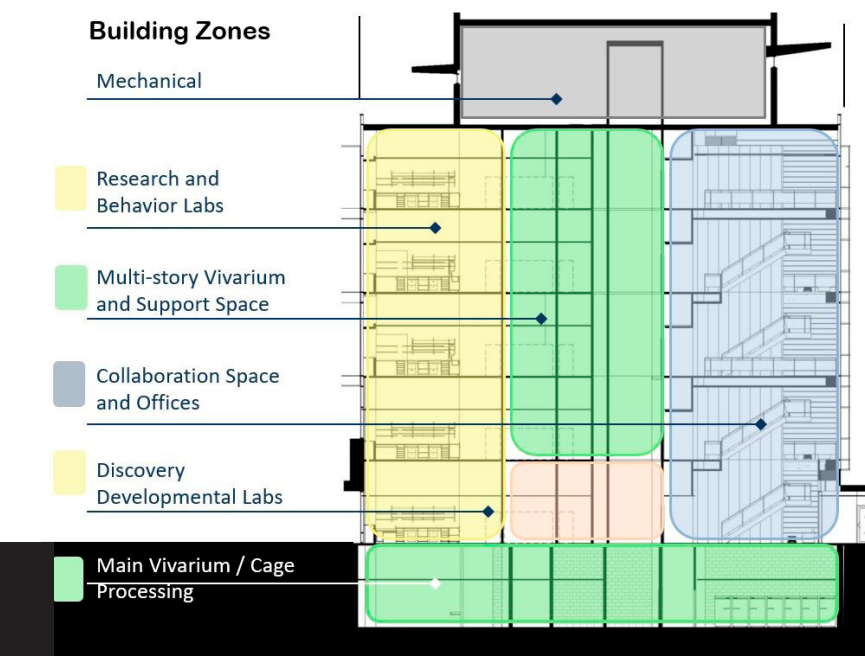
At Miami University in Ohio, space planners were

able to right-size research and other areas by applying utilization data. The resulting cost savings allowed for linoleum flooring to be specified in the research labs. The linoleum is not only sustainable, but also wears better and can help researchers be more productive by preventing fatigue from being on their feet for most of the day.

Creating Functional Adjacencies

The necessities of designing shared spaces can lead designers to opportunities to also right-size space allocations and reduce redundancies. At the Institute for Drug Discovery on the campus of Purdue University, shared support facilities were designed in the center of the floorplate to maximize the adjacencies for the most-frequent users. Reducing square footage lowers the carbon footprint, kept additional materials out of





ABOVE LEFT | Study areas located next to faculty offices promote interaction and allow daylight deep into the building's interior.

BELOW | The vertical vivarium at the Stark Neurosciences Research Institute resulted in energy efficiencies.

the landfill during construction, creating more green space on the campus and created lean processes in the research environment.

In a similar fashion, the shared core facilities at Purdue's new engineering complex, Lambertus and Dudley Halls, led to optimal plan configurations for both efficiency, daylight capturing, and collaboration. Study areas were located next to faculty offices and allowed natural light to be delivered deep into the building to circulation areas. This space-planning model influenced the design of the floorplan throughout the building.

Adjacencies can also be vertical. At the Stark Neurosciences Research Institute, vertical zoning is manifested in the "vertical vivarium." Vertical adjacencies allow for animal holding rooms to be located adjacent to the laboratories and main supporting spaces. Researchers have immediate access to animals without leaving their lab area. The mechanical system's vertical configuration is extremely efficient, saving on operational costs.

Setting standards for materials, equipment, and the environment.

Establishing room design criteria is also a vital facet of the early phases of design. Room criteria set the stage for selecting sustainable materials and finishes and for meeting mechanical, electrical and plumbing requirements. Although standards and codes must be followed, they sometimes allow for interpretation. For example, when choosing between epoxy flooring and rubber flooring, rubber offers sustainability. It is renewable, low volatile organic compounds (VOCs), anti-slip, bacteriostatic, and is washable with water rather than chemicals. However, rubber is not always appropriate or allowable in all cases.

Remember the Building Systems

Research and Development (R&D) facilities often require reconfiguration to keep pace with changing research. At a Fortune 500 corporation's R&D facility, reconfiguring 42 lab arrangements over three years cost

a whopping \$2.7 million. At the firm's new innovation development center, preassembled modules were designed to provide all major MEP infrastructure throughout the labs. The modules were the MEP infrastructure "fingers" throughout the space, providing water and lab gasses, electrical bus duct, telecom cables, and exhaust ductwork.

Technicians can quickly connect hood ventilation lines in a variety of locations. Ten percent of the hoods were reconfigured within 18 months. It would have cost \$750,000 if this new facility had the design of the previous one, and this estimate does not include the considerable design, demolition, and reconstruction cost that would have been necessary. Modular design allowed these configurations to occur in a matter of days, at no additional cost. Prefabrication also accelerated the construction schedule, reducing costs by more than \$70,000 and saving more than 3000 on-site labor hours.

ABOVE RIGHT | A modular approach to mechanical design resulted in an annual savings of nearly \$1 million in reconfiguration costs.

Case Study: McCourtney Hall

McCourtney Hall at the University of Notre Dame exemplifies how early planning helped establish a high-profile, flexible, and collaborative lab space.

The building houses combined labs for the colleges of science and engineering, and supports analytical sciences and engineering, chemical and biomolecular engineering, and drug discovery. This building is meant as a high-profile home for advanced research. It encourages collaboration between different fields and inspires novel research while providing a foundation for original research that might not have occurred in a more traditional, siloed setting.

McCourtney Hall is approximately 18,580 m2 (200,000 sf), one-half of which consists of open lab and team spaces. It has a collaborative core for offices and informal interaction. Forty percent of the building was initially reserved as shell space but is now almost entirely built out. The project cost \$56 million to build, or about \$280 per gross square foot. The building occupies four floors with a basement level and a mechanical penthouse on top.

Interdisciplinary design made this project possible. From its beginning, there were four major goals: architectural impact, Leadership in Energy and Environmental Design (LEED) certification, systems flexibility, and energy conservation. For architectural impact, the idea was to make a statement on campus while establishing a modern laboratory presence. The project initially had a minimum target of LEED Silver. The systems needed to support a broad range of cutting-edge research and adapt to research needs over the next 50 to 100 years. Conserving energy was essential for this high-energy usage building type, which was achieved by focusing on responsive controls that deliver energy and services when and where they are needed.

Early planning and architectural drivers help support those project goals. McCourtney Hall is a foundational building in establishing a presence in a newly developed area of campus, as part of the master plan. One idea was to blend the exterior design with the campus' style, which is akin to Collegiate Gothic. The building needed to provide a program to meet the needs of two different schools, while encouraging cross pollination and collaboration in research between them. It also needed to make a statement to help put Notre Dame on the

map and attract top research talent. McCourtney Hall is the cornerstone of what Notre Dame envisions as a new research and development quad. Early on, engineers helped establish the new campus utility distribution loop to this quad, one that uses the campus' geothermal development.

From an exterior architecture standpoint, the university challenged the design team to create a building that looked like it has been around for 100 years, then renovated to become a modern lab. The design team adapted this Collegiate Gothic style to accommodate the modern laboratory program. They installed gables to conceal the fans and hide the heavy HVAC equipment needed to support the lab.

Shape Collaboration

Early in the design process, the team created a concept of "neighborhoods" to support collaboration between engineers and scientists from Notre Dame's various schools. These "neighborhoods" consist of shared space and core labs, and dedicated spaces. The neighborhood concept also incorporates labs as modules that can be easily slotted into any shell space and reconfigured as

needed, allowing researchers to plug and play.

This plan was furthered by developing the 'L' shape of the building and its "knuckle." The knuckle became a unifying design feature and as a collaboration destination. The knuckle includes a public zone where researchers can gather, offices for graduate students, and where conference rooms are located. The building's wings serve as non-public zones, except for the first floor. Labs closest to the knuckle are more standardized for the sharing of space and equipment; labs further from the knuckle are specialized. This space planning served as a project roadmap for initial design and construction as well as future lab module buildouts of the shell space. A small atrium within the second-floor knuckle connects the second and third floors.

The design of the MEP systems in McCourtney Hall optimize flexibility and efficiency while supporting the neighborhood design theme. Early collaboration between engineers, architects, and planners made this possible. Ductwork, for example, has a manifolded distribution scheme to allow supply and exhaust flexibility anywhere in the building. This approach required interdisciplinary collaboration to provide the



LEFT | McCourtney Hall, University of Notre Dame

RIGHT | MEP Systems, McCourtney Hall, University of Notre Dame

required space for larger than normal ductwork mains throughout the building. The flexible approach allowed for a maximum number of connected fume hoods for the entire building which could be located anywhere.

The team conducted a wind study early on to help locate and size the exhaust stacks for safe exhaust of hazardous chemicals. Variable frequency drives allow operation along many operating points for all air handling unit fans, exhaust fans, and pumps. Low-pressure drop coils and filters help reduce fan power and energy use. The use of mechanical controls creates a highly responsive system, using energy and air only when and where it is needed. For example, variable volume fume hood exhaust and an occupancy setback for the fume hoods save energy by only exhausting when fume hoods are in use.

The plumbing infrastructure uses centralized systems to allow easier maintenance and enable easier relocation of services as lab needs change. One of the central design features allowing for this laboratory flexibility are the ceiling interface panels (CIPs). The services are provided at easy connection points in the ceiling for quick connection and relocation. The flexibility is also supported by typical locations for emergency stations and sinks. Sustainable features abound here as well. Localized vacuum systems and variable-speed air compressors conserve energy, while low-flow water fixtures and metering on a nitrogen tank measured by a central monitoring system reduce use of resources.

On the electrical side, the design of McCourtney Hall allows moving and relocating pieces of equipment to accommodate changes in laboratory equipment needs. Additionally, it enables plug and play functionality

and improves maintainability through a main-tie-main service. It also draws out switchgear and the use of raceway ceiling interface panels and busway within labs. There is also an emergency system to provide resiliency to support critical research. An emergency generator and redundant electrical system provide power reliability for critical experiments.

The building's lighting system is entirely light-emitting diode (LED), with 40 percent less energy use than code at the time the project was built. Daylight and occupancy sensors carefully control energy usage, while allowing users to override the controls as needed.

LEED with Pre-Planning

How did early planning affect LEED? The project achieved LEED Gold versus its initial target of LEED Silver. The project achieved resource savings of 26 percent for energy and 30 percent for water. Given this project's focus on control and verification, there are a number of credits that were important to achieve, including the lighting and thermal comfort credits and outdoor air delivery monitoring. Enhanced commissioning, measurement and verification to make sure those systems are functioning well after constructed, and as designed, was critical.

Lean is green, and green in early design is essential. Early planning that brings designers, engineers, contractors, and owners to the same table can result in energy and material savings that translate into upgraded lab spaces equipped to serve researchers today and in the future.

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