Optimizing lab design for rapidly evolving science

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Exterior rendering of the Jackson Laboratory for Genomic Medicine in Farmington, Conn. Image: Tsoi/Kobus & Associates

The Jackson Laboratory (JAX), based in Bar Harbor, Maine, operates at the forefront of genomic research. Tsoi/Kobus & Associates (TK&A)'s challenge as co-designer of The Jackson Laboratory for Genomic Medicine (JAX GM) in Farmington, Conn., was to ensure that the research environment can respond quickly to shifts in research focus that are necessary to support these advances in personalized medicine.

"The JAX GM is a cornerstone of the State of Connecticut's Bioscience initiative, to become a global leader in personalized medicine. The location and design of the this building were carefully considered to symbolize JAX's fundamental role in this public-private partnership," says Jim Childress, FAIA, Partner at Centerbrook Architects. Located at the front door of the Univ. of Connecticut Health Center, Childress notes that "even the

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exterior of the lab was designed to be distinct, to illustrate the global reach of the world-class research done inside. The place is special."

The new facility represents JAX's commitment to human genomic research, expanding on the organization's historical business and research emphasis on the mouse as a model for investigating human disease. Because of this new investigation shift, the majority of the institution's key researchers and principal investigators (PIs) would be recruited after the design for the building had been completed. This unknown user group with an evolving research focus became a crucial focal point of the design process, as well as JAX GM's value proposition.

A moving target

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Rendering of collaboration corridor with informal gathering spaces and view of dry lab zones. Image: Neoscape

JAX's vision for successful research endeavors is "fail fast, fail cheap". This mantra suggests a heavy focus on dry, or computational science, as an integral partner to traditional wet bench science. This became the basis for assuming a 50/50 wet-to-dry ratio of PI programs for the lab. Initial expectations of 30 total PIs were increased to 34 at the start of construction. Yu-Hui Rogers, site director at JAX GM and member of the Human Genome Project research group, notes that classifying researchers as "wet" or "dry" is already outdated. "Most scientists today perform both types of research and some have heavier focuses on one area over the other," says Rogers.

Jeff Schantz, AIA, Principal at Jacobs Consultancy, sees an industry trend toward dry research, "The ratio of wet to moist to dry space is rapidly changing. In an era of big data, interdisciplinary research teams include bioinformaticists working alongside wet bench researchers. The goal is to design research environments that can withstand the paradigm shifts as the science evolves."

While the pace of dry lab growth relative to wet lab growth can be debated, the more fundamental need was to create a space that can accommodate a wide range of scenarios: early wet-heavy hiring trends, technology and workflow changes and a potentially dry-heavy future environment. Finally, each of these scenarios must also be compatible with JAX's emphasis on collaboration across all research platforms.

Design for the unknown

Unknown end users and rapidly evolving science creates both a short- and long-term planning challenge. One of JAX GM's fundamental goals was to serve as a recruiting tool for top-tier research talent and, as such, the building is expected to be fully populated shortly after construction completion, however not in a timeframe that would allow users to participate in the design process. Designing for these challenges requires:

- An experienced team of national lab planning experts.
- An advisory committee to establish the guiding principles.
- Flexible lab environments at multiple levels.

A strong knowledge base can also allow a hidden benefit to emerge from the problem of unknown users. The design process isn't inhibited by users' pre-existing notions of what their space should look like based on their current research environments. It takes courage and sound reasoning to manage expectations and sometimes justifiably deny the requests of extremely high-level, bright research scientists when discussing their space needs. Designers then listen and respond with solutions that meet the needs of many. The result is a more cost-effective, collaborative environment that's planned for longevity and a variety of users, rather than tailored to the needs of a few specific users.

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Rendering of wet lab with view to dry lab and collaboration corridor.

Image: Neoscape

National experts

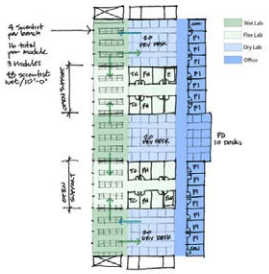
Working with design firms that have experience across the country provides owners with a broad base of knowledge and perspective that can be crucial in helping to shape the vision into reality. Alongside performing the most important task—listening—experienced designers and planners can facilitate:

- Benchmarking.
- Visioning.
- Design of collaborative environments.
- Determining appropriate balance of cost and flexibility.
- An environment that prioritizes culture and people.

Advisory committee

An advisory committee that's consistently engaged from the very early stages of a project is critical to the ultimate success of the design. The group ideally should:

- Provide a wide range of experiences and viewpoints with an international perspective.
- Set standards and benchmarks for success.
- Commit to long-term perspectives.



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Wet-to-dry-lab ratio studies based on estimated research team numbers and ease of convertibility. Image: Tsoi/Kobus & Associates

Flexible lab environments

Flexibility is at the forefront of lab design. It has earned some negative connotations recently, as it can be seen as synonymous with expense. It also may seem overly simplistic to suggest that a space that can “do anything” is the answer to planning for the unknown. In reality, effective flexibility is ultimately a quest for simplicity. For the last 15 years, Apple has dedicated itself to the concept that simple solutions are the most elegant, sophisticated and difficult to accomplish compared to complex ones. Flexibility and simplicity in lab design is no different.

To further understand flexibility and determine its appropriate usage, it’s often useful to think in terms of scale. This suggests three separate definitions: convertible, adaptable and adjustable. Convertible labs in the largest-scale sense can change their entire program—from wet to damp or dry or vice versa. An adaptable lab is one in which the program remains the same, but the workflow and bench configurations can be modified to suit the needs of the research or researchers. Adjustable environments are ones in which the benches, shelving or other systems can be tweaked to accommodate new equipment or workstyles. Each scale of flexibility has a corresponding up-front cost impact. Determining the right usage requires a full lifecycle cost analysis that weighs future modification costs alongside initial investments.

TK&A worked extensively with JAX during the early project phases to understand the organization’s priorities, mission and expectations before beginning the process of designing the lab environment. By recognizing JAX’s commitment to collaborative environments and convertibility, the design team was able create a series of metrics to validate each design decision.

Design process

Labs today contain many of the same broad programmatic elements regardless of institution: traditional wet lab space, hard-wall support rooms and offices for researchers. Most institutions include dry computational space as a complement to

the wet environment. Some prefer to locate the computational areas on a separate floor, or even a separate facility, since the mechanical needs for this space are more similar to office environments. Additionally, some institutions dedicate a portion of the space for less formal collaboration areas, which can take many different forms depending on need and level of emphasis. To fulfill JAX's mission of a highly collaborative environment, it was desirable to locate both the dry labs and informal collaboration spaces directly adjacent to the wet labs. This became the focal point for the initial lab organization concepts.

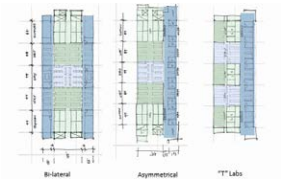
Each of the three layouts, shown at the bottom right, solves the adjacency and convertibility requirements, but not all are equal relative to flexibility and collaboration. Pros and cons of each configuration are:

Bi-lateral layout

- Highly efficient.
- Potential for isolation of PIs.
- Limits spontaneous collaboration opportunities due to office and support zone locations.
- Large hard-wall support zones prevent expansion of the lab environment.

Asymmetrical layout

- Reduces PI isolation by shifting offices to one side.
- Allows more natural light into the lab.
- Similar support zone and expansion issues.



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Early lab configuration studies.
Image: Tsoi/Kobus & Associates

"T" layout

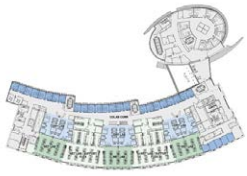
- Breaks up the hard-wall support areas into smaller pieces.
- Maintains reasonable travel distances to support zones.
- Improved linear expansion capability along the exterior edges.

Ultimately JAX decided that the "T" layout met the needs of the institution most effectively.

A major impediment to large flexible areas is often the support rooms. Two considerations for these areas help to alleviate this pressure: challenge the traditional wet-to-support ratios, and make the support rooms themselves flexible. At JAX GM, the design team reduced the area of hard-wall support rooms and replaced it with an adaptable support zone—one that could

serve as either wet lab or support space depending on the researchers' needs. The remaining hard-wall spaces were designed as "flexible support rooms," or FSRs. The FSRs contained basic fixed elements, such as a sink, but provided a variety of configuration options and MEP system connections to support different functions: fume hood room, tissue culture, microscopy and more.

The final project design incorporating all other site, building and systems considerations satisfies the need for easy modification at all scales within the context of a highly collaborative environment. Wet and dry lab areas, pictured above, are convertible depending on JAX GM's growth; each lab area is fully adaptable to a myriad of workflow needs, and the lab casework is adjustable. Other small-scale considerations that contributed to the overall flexibility are:



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Final building layout, as a result of conceptual studies and advisory committee findings. Image: Tsoi/Kobus & Associates

- Location of hard monuments (sinks, fume hoods, etc.).
- Soffits designed to accept relocated partitions.
- MEP infrastructure for wet lab space built in to dry lab areas.
- Shared support resources—reduces individual scientist's space needs.
- Floor-to-floor height optimization.
- Location of core resources.
- Distribution of lab gases.
- Component-based lab benches and systems.

Theory to reality

A successful design can only truly be measured by its ability to function in the way the clients intended. To date, JAX has recruited 14 PIs mostly focused on wet science, representing 40% of their overall target. This wet-heavy hiring trend is likely to continue and will serve as the lab's first significant test of its pliability. John Fitzpatrick, senior director of facilities services at JAX, is confident that the lab will respond as planned both through densification and potential conversion of dry lab space. Fitzpatrick also noted that a big reason for JAX's focus on flexibility was the de novo nature of the facility.

The Jackson Laboratory is still at the very beginning of its new mission. JAX GM will officially open in October 2014, and users will quickly relocate from their temporary facilities on the adjacent UConn medical campus to their permanent new home.

Project team:
Prime Architect: Centerbrook Architects
Design Architect: Tsoi/Kobus & Associates
Lab Consultant: Jacobs Consultancy
Civil/Structural Engineer: BVH
MEP Engineer: BR+A Consulting Engineers|BVH Integrated Services
Landscape: Stephen Stimson
Construction Firm: Whiting Turner Contracting Company
Program Manager: Gilbane

Richard L. Kobus is a founding principal at TK&A with almost 40 years of experience in designing lab environments. Steve Palumbo is an associate at TK&A with over 10 years of experience with lab projects.

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