THE POWER OF THE LAB BENCH

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Perkins&Will

Executive Summary

Our Innovation Incubator project purpose:

1. Gain a better understanding how the lab bench is used on a daily basis.
2. See how today's research may inform space planning and laboratory casework in the future.

Most new lab projects are designed around conversations between architects and lab planners talking with department heads, facility groups, and principal investigators (PI). As a result, the laboratory design and layout is mainly derived from benchmarking, standards, and best practices.

At first look this makes sense; why get input from the entry-level scientist or PhD student when by the time the laboratory is built, most of these folks will have changed jobs. However, these are the roles that are required to use the lab and lab bench. They are performing the experiments, using the equipment, and collaborating with each other. So we took this opportunity to speak with these scientists themselves and simply asked "how do you work in the lab?"

With this as our mission, we began reaching out to people we knew who worked in a lab or people we knew that could connect us with someone who did. While the sample size of 9 is smaller than we had hoped, we still received valuable feedback and began seeing some commonalities. Most interviews were conducted via a 15-minute video call, but we were able to arrange a 2-hour visit with the Director of Scientific Facilities Operations at Albert Einstein College of Medicine to conduct some interviews with researchers at their actual benches. We also reached out to casework manufacturers to find out what they are seeing and to ask about casework pricing.

While the lab bench may be considered the 'main attraction' in the lab, we know that there are other components to a laboratory. Most scientists don't stand in front of a lab bench all day. They are moving from the lab bench to equipment and other elements in the laboratory, such as biosafety cabinets (BSC), fume hoods, freezers, sinks, and write-up stations. They are also moving in and out of the laboratory to office spaces, such as their desk/office, conference rooms, and pantries.

Ultimately, the recurring themes we heard were:

1. The importance of flow between the lab bench and other elements.
2. The growing reliance of other laboratory spaces beyond the lab bench.

It wasn't our intention to upend the casework industry with this research project, but several of our conversations with the scientists left us thinking about the importance of resource management and operational costs. This suggests that the 'flexibility' and 'future proofing' mentality may give way to something more responsible and targeted. On a casework level, if benches can be moved around, do all the benches need to be the same? And on a laboratory level, if we layout a laboratory with a focus on flow and function, can that result in a more efficient footprint?

The next few pages provide more detail of the interview process, takeaways from what we heard, and some thoughts on how the laboratory bench and laboratory design/buildings can evolve to accommodate scientific research in the future.

Photo taken during the October 3, 2023 site visit at Albert Einstein College of Medicine

Hudson Research Center, Architect: Perkins&Will

Interviews: Questions and Process

Our initial goal was to be methodical with our interviews. Similar to the scientific process, eliminating variables can reduce error and experimenter bias. Despite all of our participants working within the molecular biology field, they all have a different 'typical day'. Even people within the same lab have a different 'typical day'. For example, a research scientist and lab manager have varying responsibilities that influence their day. We therefore pivoted the conversation to the individual. When talking with a participant that "only spent a few minutes at their lab bench a day," we talked about the tissue culture room they spent 50% of their day in instead.

With that said, we did ask the same questions listed below about their 'day in the life' and their lab bench usage. The responses from the interviews can be found on the next page.

Day in the Life

1.1 - Company Work and What do you do?
1.2 - How do you move within the lab and office (see Image 1)

1.3 - Typical Day
- % of the day in the lab
  versus the office environment
- % of the time spent in the lab at your bench
  versus a specialized lab - ie: tissue culture

1.4 - How much linear feet of bench is assigned to you?

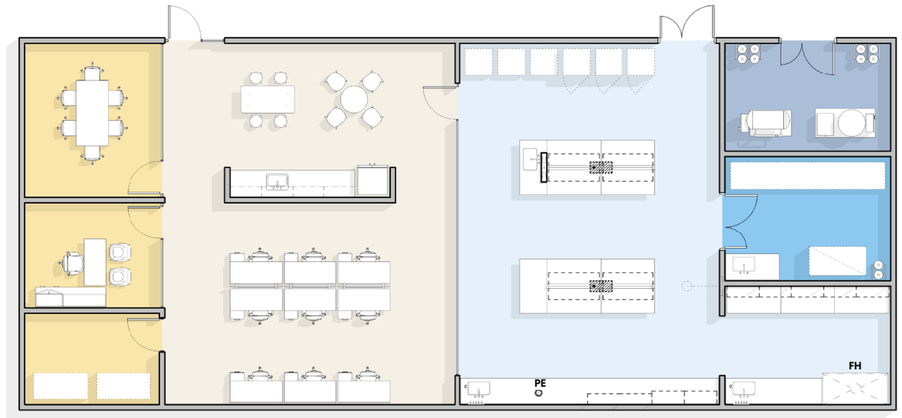


Image 1 - Presented during Day in the Life question series

The Lab Bench

2.1 - Which image better aligns with your bench (see Image 2)
- What is on your shelves?
- What is on your bench?
- What is under your bench/storage?

2.2 - What services do you USE at your bench?
- Electrical: Normal, Standby/Emergency
- Data: Cat 6/6A
- Plumbing Services: Air, Vac, CO2, Nitrogen

2.3 - What do you wish was different about the lab bench?

Image 2 - Presented during The Lab bench question series

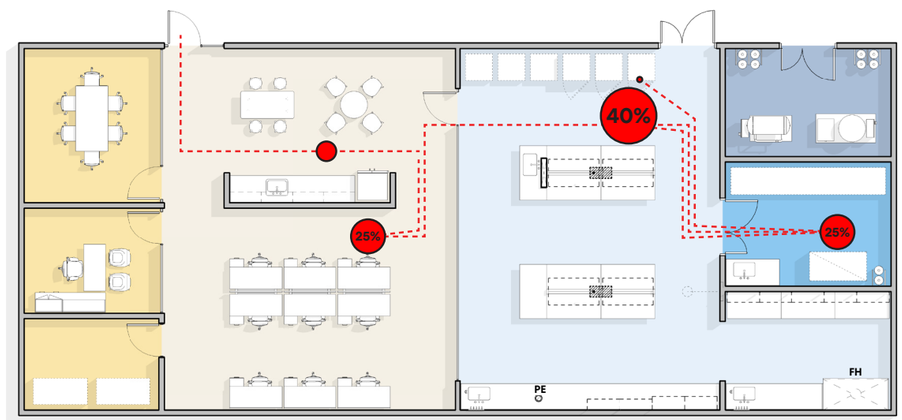
Interviews: The Data

Company	Evergreen Theragnostics	Hyfe	Lawrence J. Elison Insitute for Transformative Medicine	Lime Therapeutics	Albert Einstern College of Medicine	Albert Einstern College of Medicine	Albert Einstern College of Medicine	Interactome BIO	Alebund Biotech
Title	Scientist (Drug Discovery)	Research Scientist	Lab Manager	Research Scientist	Post Doctoral Research Fellow	Lab and Facitilities Manger	Assistant Professor	Research Scientist	Research Scientist
Type of Work	Cell Biology	Biomanufacturing, feed stocks (upcycling wastewater)	Cancer Biology Research and Clinical	Molecular biology	Cell Biology and Hemato-Oncology	Hematopoietic Stem Cell	Prostate cancer microenvironments	Cell culture and Culture Media	Kidney disease therapy, protein development
Typical Day	Coffee, email, then proceed to lab bench. Non-sterile tasks at the bench. Sterile tasks at BSC in TC room	Lab in converted warehouse. Too much travelling back and forth from lab to office, so just stayed in lab	Manage a team now. More time at office desk and less time in the lab. Spends time travelling to multiple labs	First to the desk (drop in things off). Then bring laptop, headphone and phone into the lab	Non-sterile benchwork. Then, walking samples to and from TC room, core facilities, shared equipment	Move throughout the lab. Manages shared equipment, so moves between lab and shared equipment rooms	Oversees researcher's work. Move from office to lab bench to BSC and FH alcoves	To my desk, then 2 minutes at lab bench and in TC room for the rest of the day. Back and forth from bench to TC room	Somedays in the lab has to monitor experiments. Other days mostly doing papework at my desk
Assigned Bench	Yes. 6'-0"	Yes. 6'-0"	Yes. 6'-0"	Yes. 15'-0"	Yes. 10'-0"	Yes. 8'-0"	Yes. 10'-0"	Yes. 6'-0"	Yes. 6'-0"
Lab Support Uses	TC room. First come, First serve system. FH for cell culture	No lab support in facility	Reserve TC space	TC room. Shared equipment at communal lab bench	TC room, core facilities, shared equipment	TC room, shared equipment	None. Lab as own BSC and FH alcoves	TC room	-
% of time spent in the lab	0 Office 35 % Bench 65 Lab 65 50	0 Office 30 % Bench 100 Lab 70 50	0 Office 50 % Bench 50 Lab 50 50	0 Office 50 % Bench 20 Lab 50 50	0 Office 0 % Bench 80 Lab 100 50	0 Office 80 % Bench 100 Lab 20 50	0 Office 50 % Bench 50 Lab 50 50	0 Office 50 % Bench 2 Lab 50 50	0 Office 50 % Bench 95 Lab 50 50
What's on your lab bench shelves	Day-to-day, non-sterilize, reagents (use in high volume), glassware, conical tubes, gradualate cylinders	Things for immediate use	Things they used all the time ('easy grab'). Pipette tips, conocals	...	Tip boxes, reagent bottles, reagent kits, gloves	Alcohol and media bottles	Storage, reagents	Nothing in the TC rooms	Pipette tips, eppendorf tubes, filters, chemicals, reagents, 15ml tubes
What's on your lab bench	Micro-centrifugure, water bath, pipettes	Pipetter, laminer flow hood	Bench centrifuge, vortex machine, pipette box/tips, vacuum trap	Western and DNA gels, note pad, glove box, electrical bunset burner	...	Pipettes, tips gloves	Equipment, pipettes, microscopes, waterbath	-	Equipment, DI water, heating plate
What's under you lab bench	Items in lab that aren't used very frequency. Storage, tube racks, pens, labels	For things to get out of the way. Storage, chiller	Thing that aren't daily uses. Storage, aseiptator for vacuum trap	Shared refrigerator. Drawers have pens, binder sheets, tape, calculator	Pipettes, slides, paper towels, boxes, misc stuff, cleaning supplies (under-sink cabinets), first aid, stationery	Drawer unit built in on either side with and nook for a chair	Refrigerator, red bin	-	50ml tubers, large pipettes, gel knife, tape
What services do you use at your lab bench	VAC	VAC	VAC	VAC	VAC	VAC	VAC	VAC	
What do you wish was different about the lab bench	Make it easier to adjust the shelving (height). Bench requires specialized tools	More shelving. More mobilility. Move tables versus having to rearrange and setup experiments.	Collaboration areas within the lab, by the entrance. Not sure everyone needs there own bench. Reassign bench space for more core lab. Move desk out of the lab	Fixed casework with base cabinets is difficult to stand in front. More shelving. More under bench storage	Raised or height adjustable countertop. Individual lighting controls. Larger shelves to fit notebooks	Shelving and drawers should not be made of wood-like material (too porous)	Some benches should be deeper for larger equipment	Shelving in TC room, so don't have to take supplies back and forth. Even if it is shared. No complaints about the bench, it's good.	It gets the job done, but could use more storage

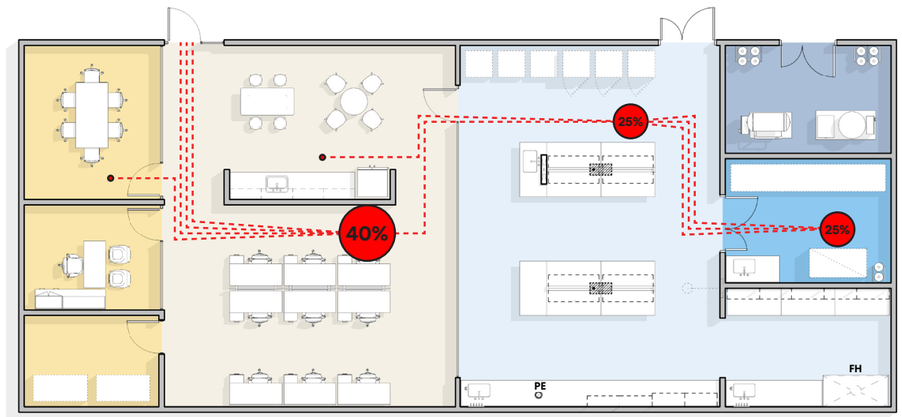
Interviews were conducted between August 17, 2023 and October 9, 2023

Interviews: The Workflows

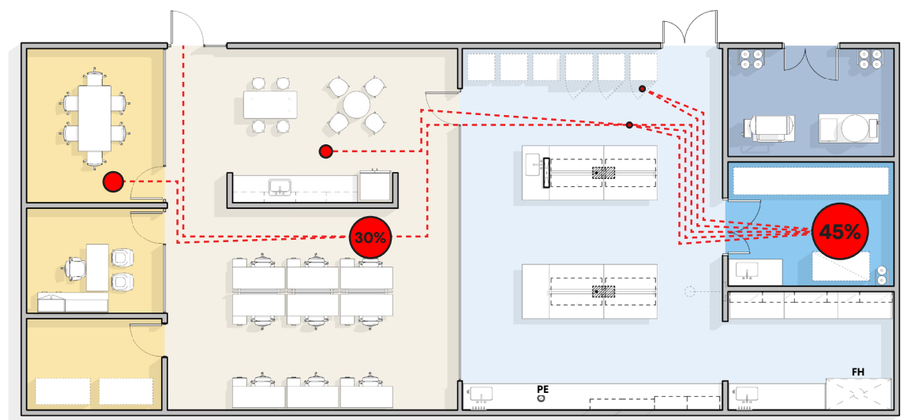
Whether a post-doc or lab manager, there is one thing in common: people who work in labs are on the move! While the lab bench is the common denominator and is a place to perform tasks such as pipetting and Western Blot, it appears that it is becoming more of a touchpoint for some scientists. More and more, day-to-day tasks are not or cannot happen at the lab bench. Sterile tasks need to happen in a controlled environment (ie: in a tissue culture or cold room), equipment allows for experiments to be monitored from a remote location, and emailing/meetings are taking place in the office environment. Does this mean that lab benches will just be needed for equipment to sit on? that benches in the open lab will be replaced with more specialized lab rooms? or that less lab space will be required? Below are the workflows from four interviewees. Note the similarities and differences.



Research Scientist #1: I start my day with coffee and emails, then proceed to the lab bench for the day. My typical experiment day means non-sterile tasks at the lab bench and sterile cell culture tasks at biosafety cabinet (BSC).



Lab Manager: I spend more of my time at my desk than I did as a researcher. I spend a lot of time walking from lab to lab.



Research Scientist #2: I spend 2 minutes at the bench. It would be great to have everything in the tissue culture (TC) room, so I don't have to go back and forth to my bench just to get supplies. It's difficult to open the TC door when I'm carrying things.

Post-Doc: My desk is in the lab. I sometimes have to go across the street for certain shared equipment with samples in an ice bucket.

Influence on Planning: Blocking Plans

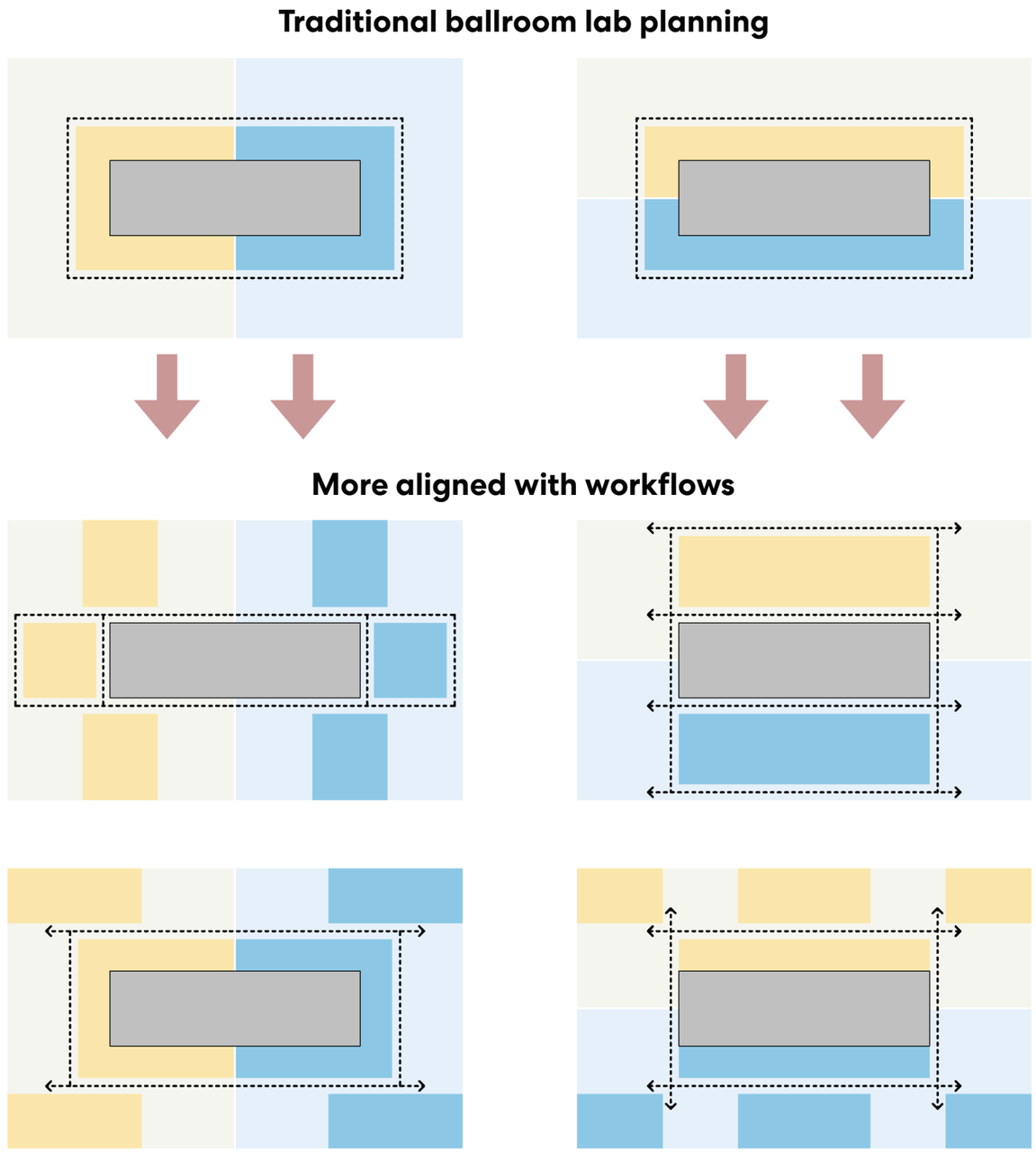
Let's think about how much the lab has changed over the past couple of decades. Individualized, segregated labs comprised of fixed casework have been replaced with big, open labs filled with modular workstations and overhead services. Write-up stations are no longer required to be within the laboratory environment. This shift is a result of wanting to create more collaborative, flexible, and safer environments that can better respond to the faster pace and collaborative type of research that is happening today.

The 'ballroom' bench planning parti, with rows and rows of lab benches along the exterior windows and specialized/support labs internal to the open lab, has become ubiquitous with today's laboratory design and the tried and true go-to layout. It makes sense; bring daylight into the lab because as it is widely stated, "scientists are people too." But this style was developed when write-up stations were *in* the lab and when scientists were spending most of their day in the lab at their lab bench or write-up station.

This is not always the case anymore. Some of the people we interviewed for this study spent very little time at their lab bench, as they are spending more time at their desk in the office environment or in a controlled, sterile environment, such as a tissue culture room.

This feedback suggests that the specialized labs, which are mostly shared spaces, should be more centrally located. Given that some scientists are spending 25-50% of their day in these spaces, it makes sense to locate these rooms off the exterior windows so the scientists aren't confined to an internal windowless room.

The diagrams to the right show how lab planning for a typical centralized core building could evolve so that the specialized labs are more centrally located. This may result in the one big lab becoming more compartmentalized, but the open lab can remain connected. It would be more akin to neighborhoods - where the shared spaces are at the intersections of circulation paths.



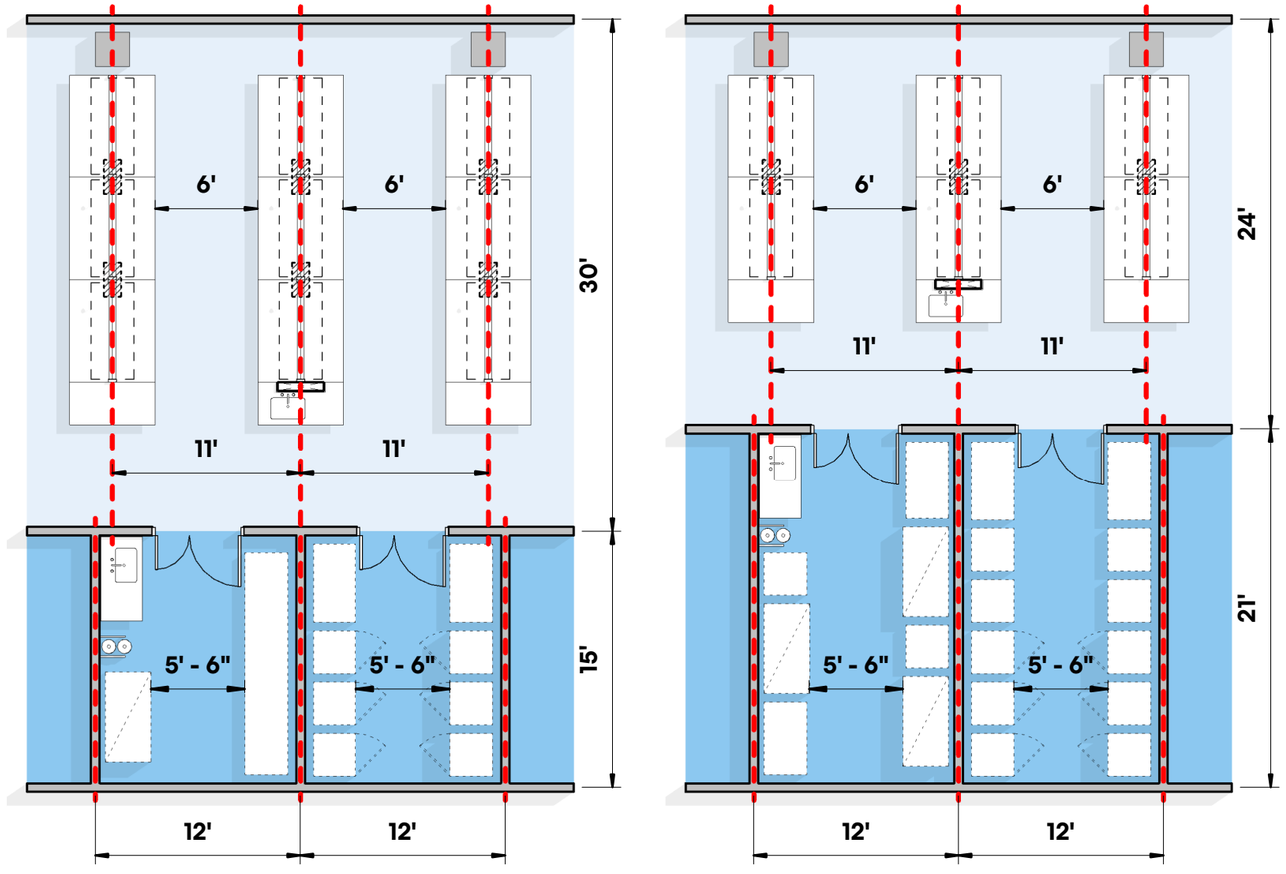
Influence on Planning: Lab Module

While some academic institutions space out lab benching and rooms on the 10’-0”, or 10’-6” module, the common practice for laboratory building design is to work off of a 11’-0’ module. In addition to the lab bench spacing, the 11’-0” module dictates column spacing, core to window depth, and the size and shape of the entire building. If there is a shift to reduce lab benches in the open lab to more specialized lab rooms, it is worth re-examining the 11’-0” module.

This is because with specialized lab room, you need to factor in the thickness of the wall and consider that biosafety cabinets, fume hoods, and -80 freezers are deeper than the typical 30” deep lab bench (especially when you factor in the necessary gap between the equipment and the wall). Therefore, the 6’-0” wide aisle that is achieved in the open lab with benches on the 11’-0” module is reduced to 4’-0 - 4’-6” in the specialized lab room. These rooms, ideally should be between 12’-0” and 14’-0” wide, to allow for the 6’-0” aisle spacing.

Does this mean lab buildings should be designed with a wider module? Not necessarily. But it would be worth investigating the impacts when you consider that more space in the lab is being dedicated to these specialized rooms and that it is best practice to space rows of office workstations more than 11’-0” on center.

>> Square footage shift to more specialized lab >>



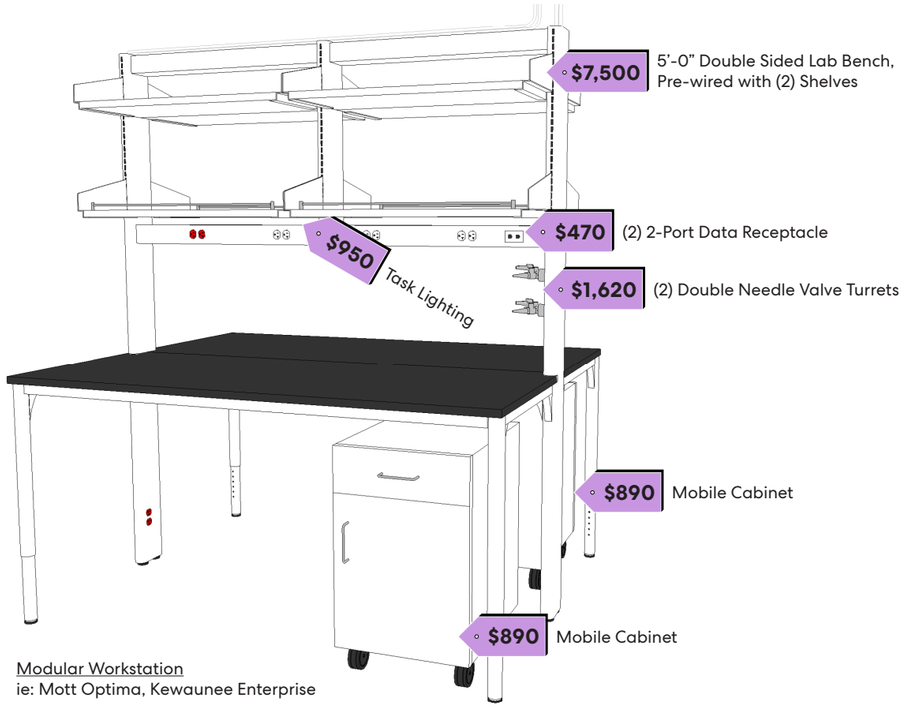
Influence on Planning: Lab Casework Costs

We reached out to casework manufacturers to find out what they are seeing and to ask them about casework prices. The cost of a lab bench isn't limited to the initial purchase price of a bench or sink station (which can cost up to $1,500/LF) or a fume hood (which can cost up to $3,000/LF). You also have to factor in the long-term infrastructure and power/water consumption associated with the casework and the rentable square footage (RSF) cost associated with the footprint of the casework. For example, with most laboratory fitouts running between 250-300 SF per person, the footprint of 5'-0" wide bench and working area (about 55 SF) represents about 20% of a scientist's square footage (SF). When combined with the 30-40% associated with circulation and corridors, reexamining the number of required benches and flow between spaces can potentially yield more efficient and effective designs.

While our research didn't yield anything that would disrupt the casework industry, we made some observations which can have localized impacts. For example, most of the scientists we interviewed had compressed air at their bench, but either didn't use it or more importantly didn't know why they would ever need it. This is contrary to nearly all the labs we have worked on in the last few years that had compressed air at each lab bench. Reexamining the configuration for individual lab benches can yield efficiencies and cost savings.

Initial Purchase Price

$1,200/LF to **$1,500/LF**



Modular Workstation
ie: Mott Optima, Kewaunee Enterprise

$80-120/RSF Per Year

5'-0" Office Workstation	10'-0" LF Lab Bench	5'-0" Biosafety Cabinet
$2,400 to **$3,600**	**$4,400** to **$6,600**	**$3,200** to **$4,800**