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**FEFPA**

Florida Educational Facilities Planners' Association

**UNIVERSITY STEM FACILITIES**

July 2<sup>nd</sup> , 2025

Boca Raton, FL

**Royal 1-5:**

**Latest Trends and Metrics:**

**Building Next-Gen STEM Facilities for  
Long-Term Viability**

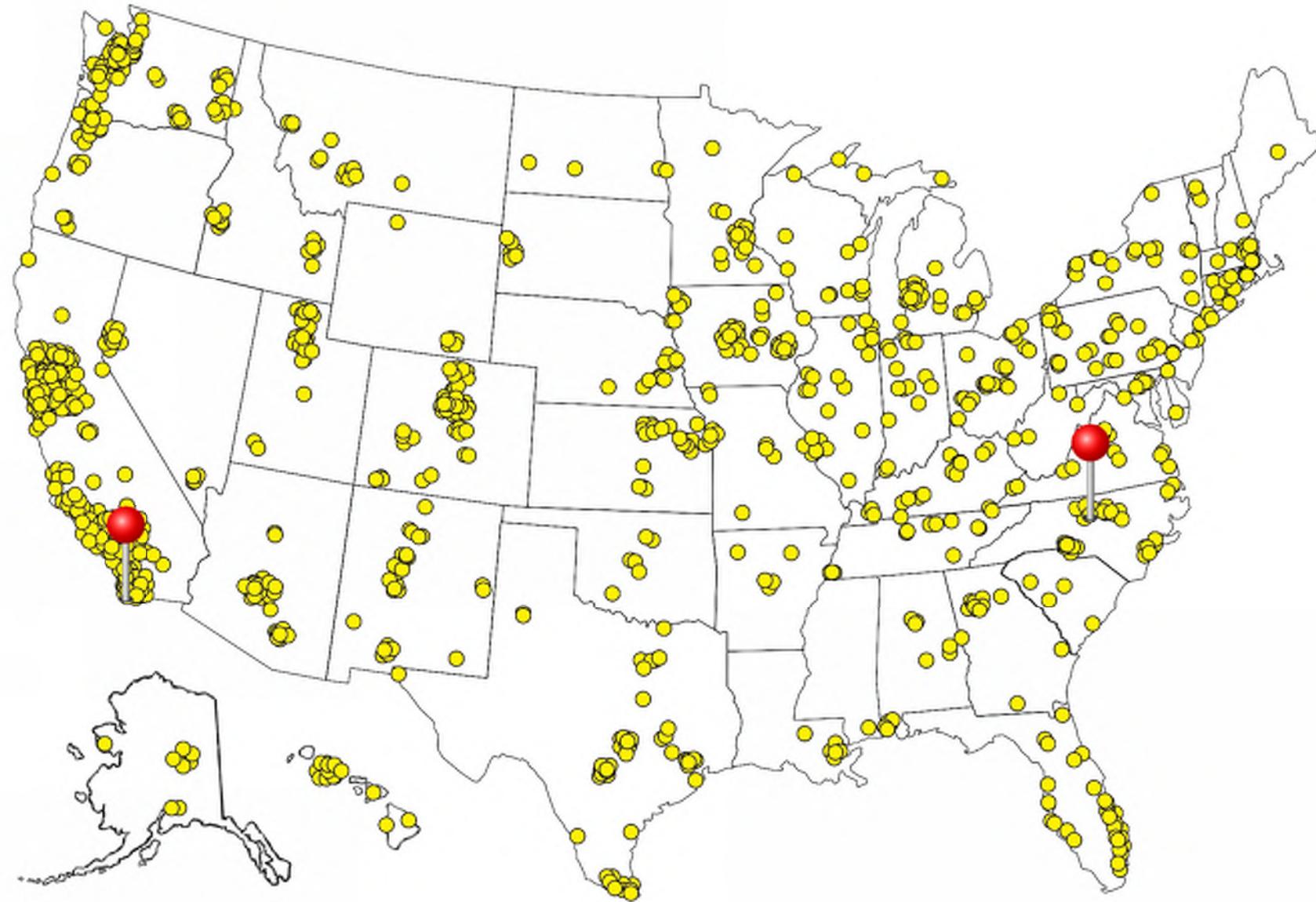
**MICHAEL DAVISON, AIA, NCARB, LEED AP**  
Associate

1 AIA / HSW Credit

**RESEARCH FACILITIES DESIGN**

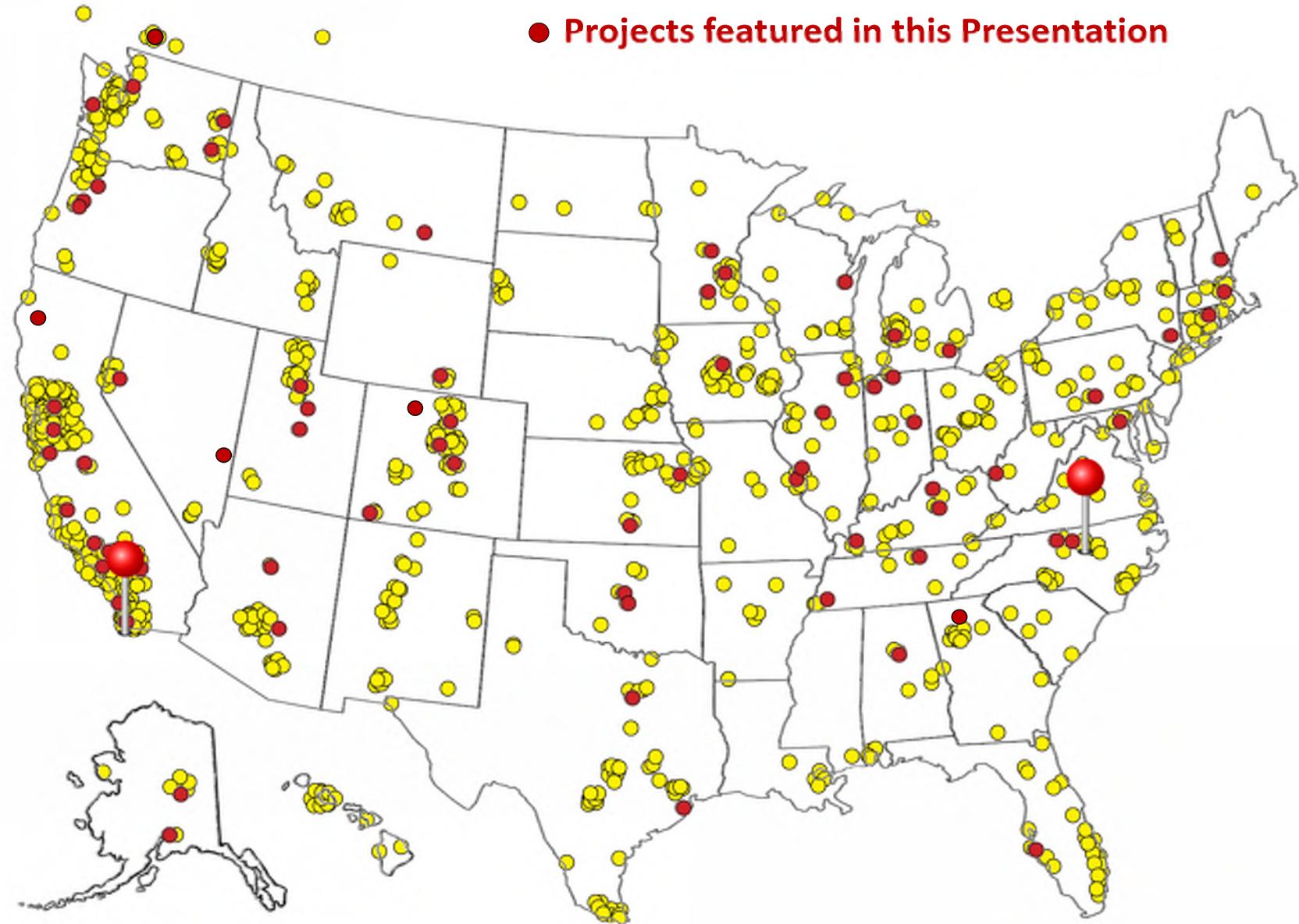
## Laboratory Programming & Design Consultants

- Architects, Engineers, Designers, & Technical Support Staff
- **Focused 100% on Planning & Design of Laboratories**
- Collaborated with more than 500 Architectural Firms
- More than 1,300 Projects in 50 states throughout the U.S., Canada, Australia, United Kingdom, Asia & Middle East
- 470 College and University Clients
- 100 Million GSF of Building Space
- \$30+ Billion Construction Value



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# What is our perspective?

**As Laboratory Design Consultants, RFD has Collaborated with more than 500 Architectural Design Partners in our 40+ year practice.**

**Architects for Projects Featured in this Presentation include:**

- AC Martin
- Acton Ostry
- Anderson Mason Dale
- Architekton
- Ballinger
- Bolin Cywinski Jackson
- BSA Life Structures
- Cooper Carry Architects
- Dekker Perich Sabatini
- Dewberry Architects
- Ennead Architects
- Farnsworth Group
- Grimshaw Architects
- GBBN
- H+K Architects
- Harvard Jolly
- Hacker
- Hanbury
- Hastings & Chivetta
- HGA
- Hord Coplan Macht
- Kieran Timberlake
- Lake Flato Architects
- Lionakis
- LMN Architects
- Mahlum Architects
- Miller Hull
- Moore Ruble & Yudell
- Morphosis
- OPN Architects
- Perspectus
- PGAL
- RATIO Architects
- Revery Architecture
- RDG
- Richard + Bauer
- Shepley Bulfinch
- SmithGroup JJR
- SOM
- SRG Partnership
- Steinberg Hart
- Upland Design Group
- VCBO Architecture
- ZGF Architects



- 1) Attendees will be able to identify which STEM programs have the need for laboratory space and how to program for them.
- 2) Attendees will learn how the laboratory designs can respond to the different Pedagogies
- 3) Attendees will learn about current trends in laboratory design and how they can be applied to benefit the faculty and student experience
- 4) Attendees will learn the latest metrics in STEM Building
- 5) Attendees will learn about recent Building Code changes towards the management of hazardous material (Maximum Allowable Quantities MAQ's, and control areas CA) and laboratory ventilation requirements in Teaching Facilities and how to apply them to laboratory buildings.

# Presentation Outline

## 1) Considerations for Science & Technology Facilities

- 1) The STEM Programs
- 2) Developing Communities
- 3) Recruitment & Retention
- 4) Engaged, Active & Applied Learning- Changing Pedagogy
- 5) Transparency, Connections & Extended Learning

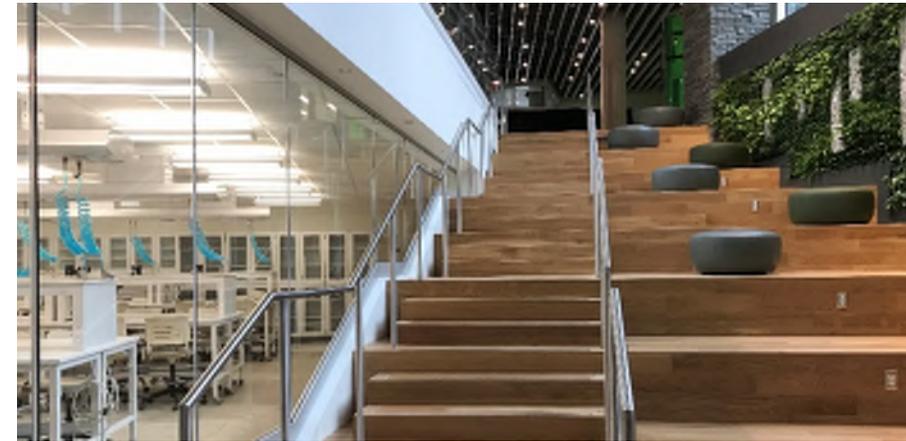
## 2) Planning Trends for Science & Technology

- 1) Building Planning Considerations
- 2) Science and Engineering Learning Laboratories
- 3) Environments for Discovery

## 3) Programming Tools - Benchmarking & Metrics

## 4) Case Studies

## 5) The Take Aways



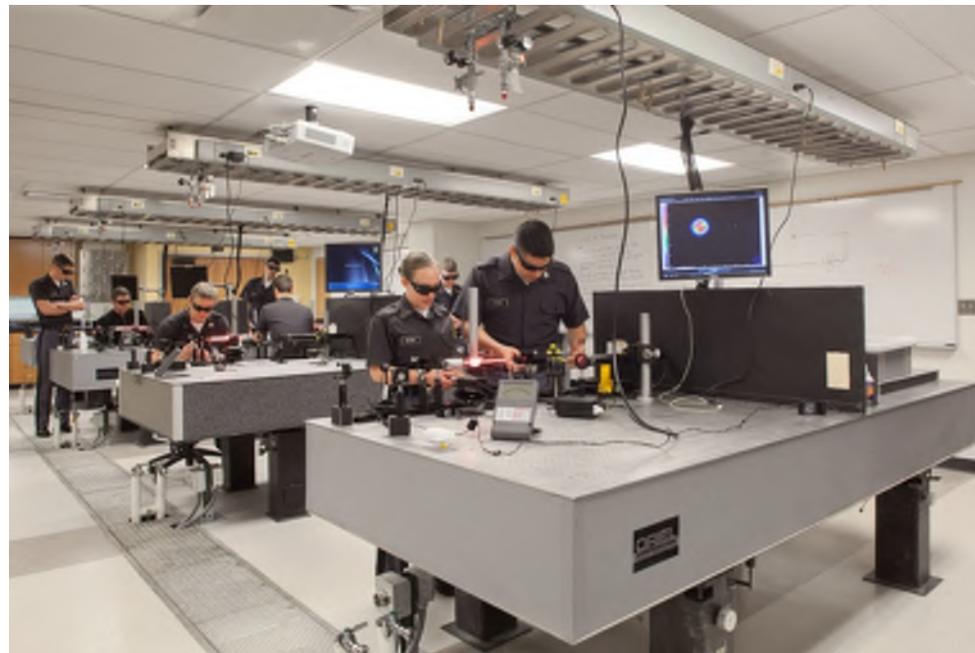
# The STEM Programs

# The Programs – Basic Sciences

**Chemistry**



**Physics**



**Biology**



**Earth Sciences**



# The STEM Programs

# The Programs – Engineering

**Electrical Engineering**



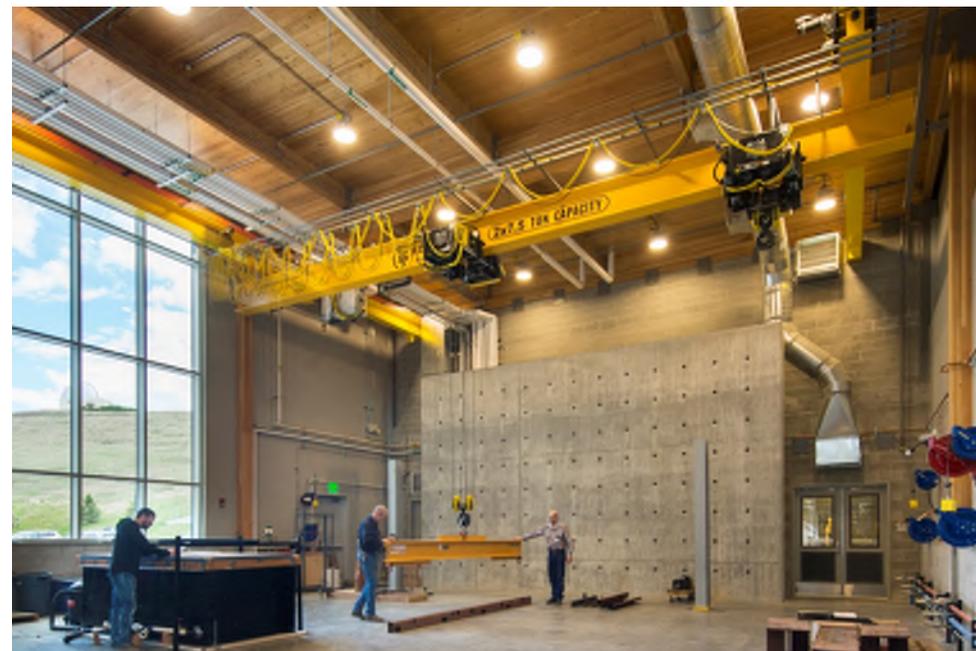
**Bio - Engineering**



**Mechanical Engineering**



**Civil Engineering**



# The STEM Programs

# The Programs – Other STEM Disciplines

Allied Health



Robotics



Environmental Sciences



Computer Science





# Developing Communities for STEM

- ✓ **PLACES** for extended learning
- ✓ **PEOPLE** that broaden your community
- ✓ **PARTNERSHIPS** that build industry connections

# Developing Communities

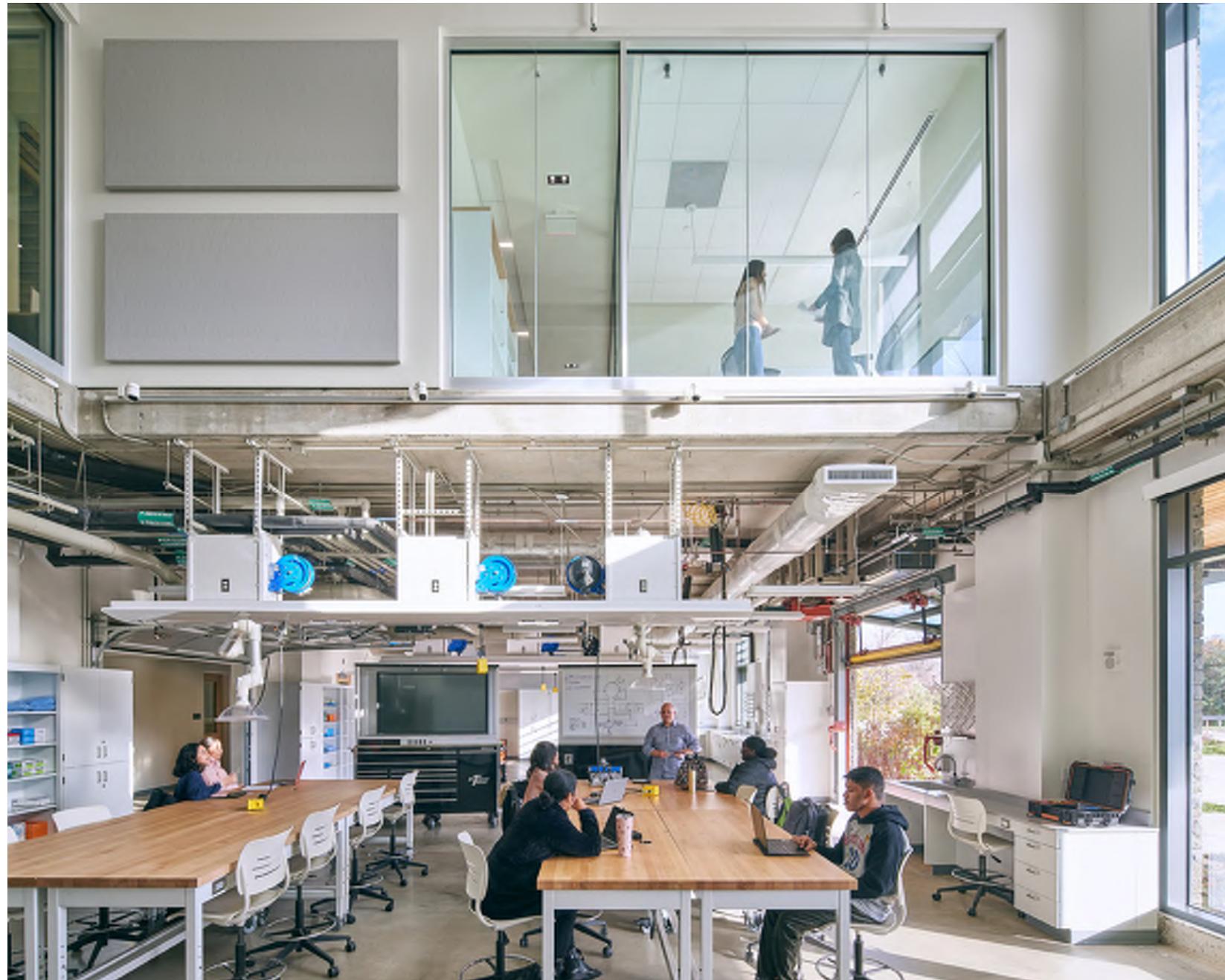
# The Places – Formal & Informal





## Developing Communities

## The People – Students, Faculty, Staff



# Developing Communities

# The Partnerships, Outreach





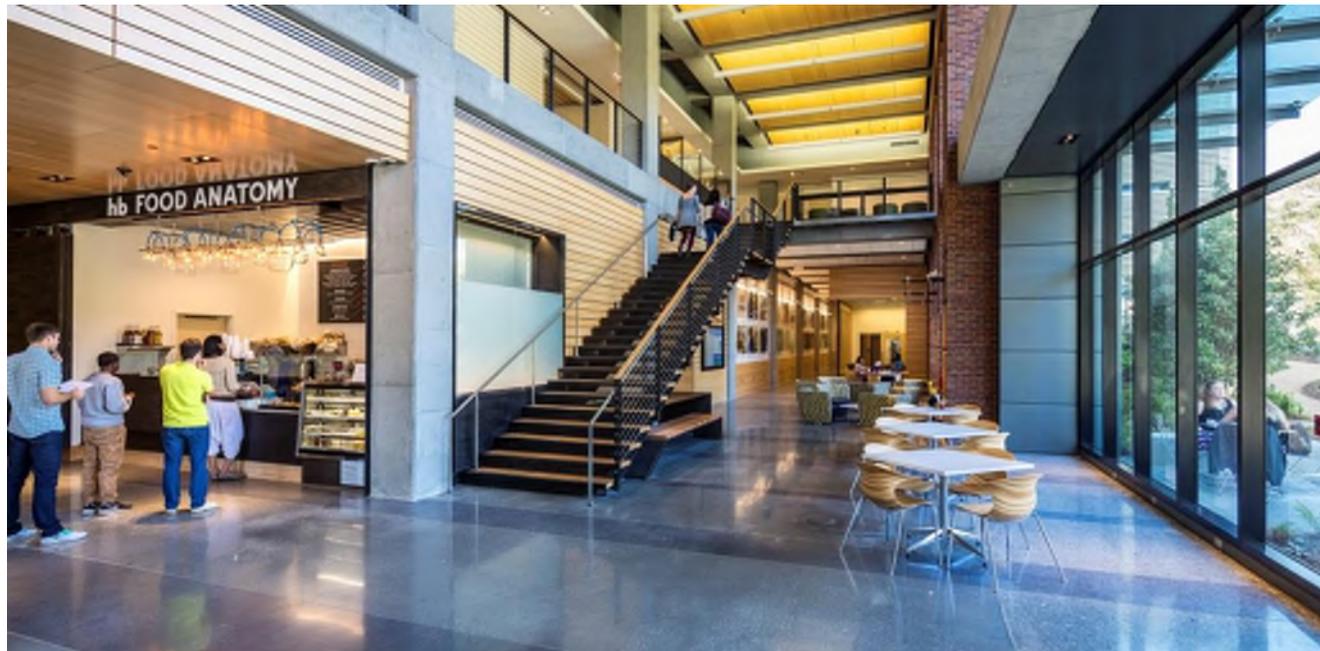
## Recruitment & Retention

## Importance of 'Curb Appeal' – Renovations



# Recruitment & Retention

# Student Life Amenities - Food, Caffeine, Daylight & Wi-Fi

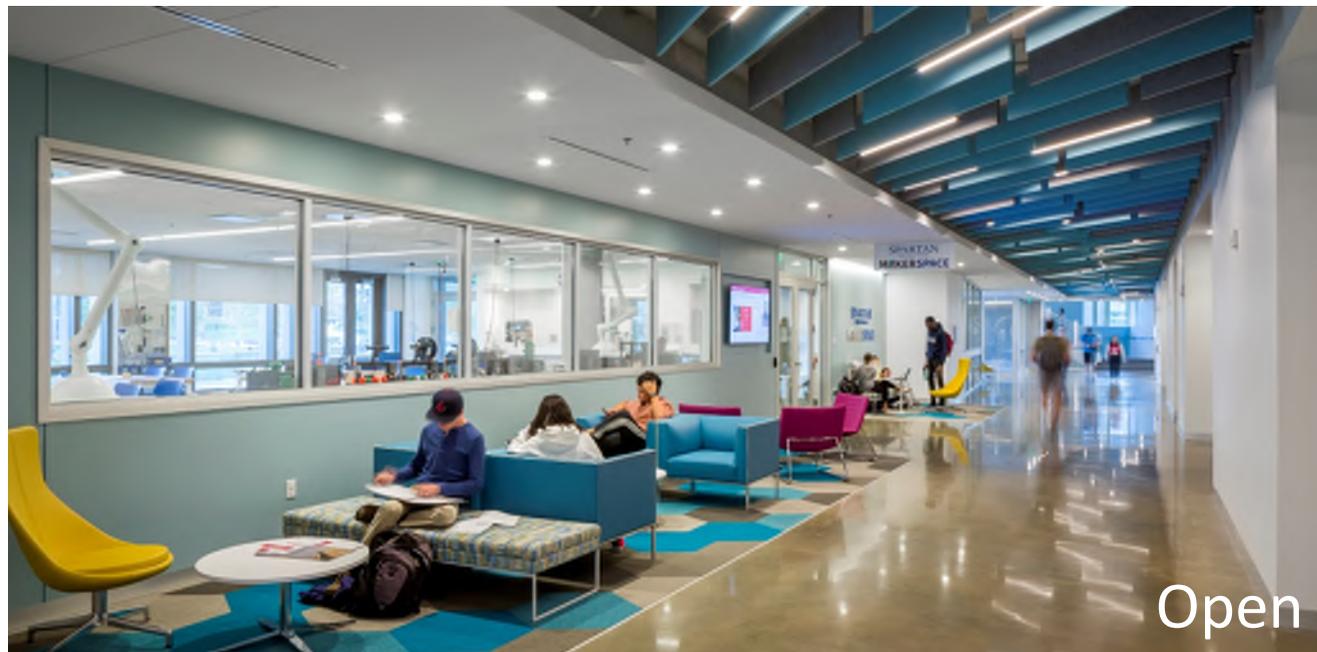


# Engaged, Active & Applied Learning

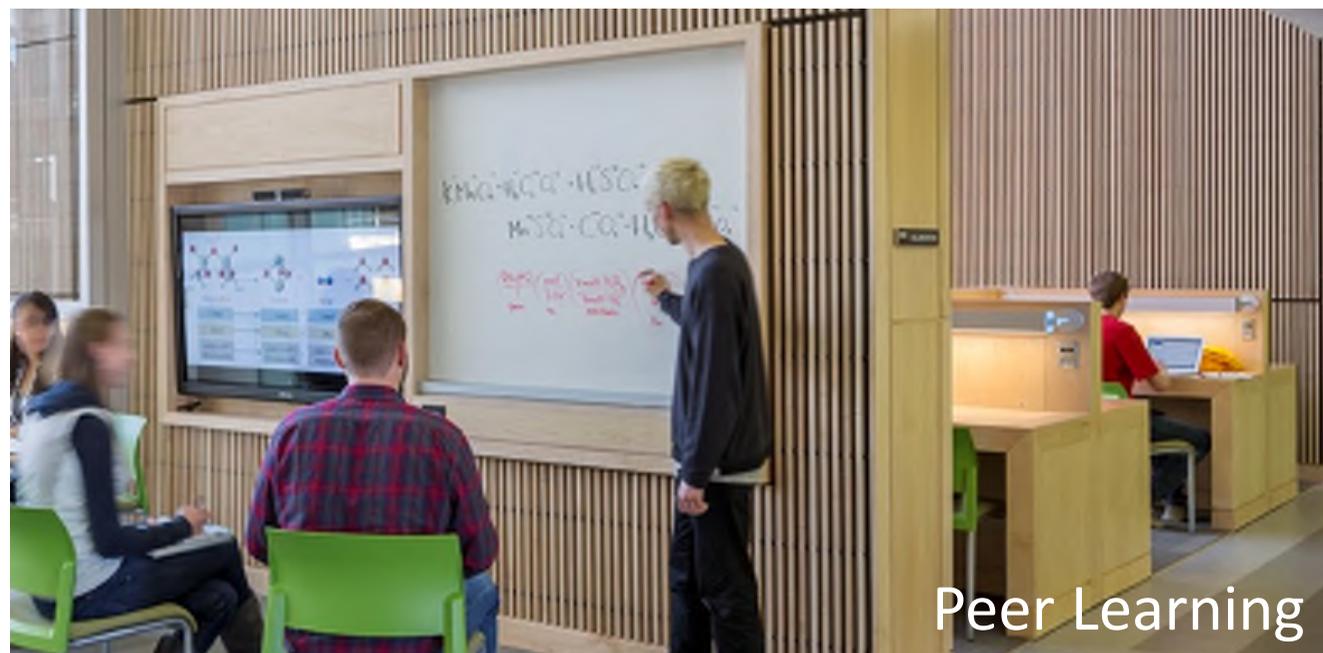
# Entire Building as a Learning Environment



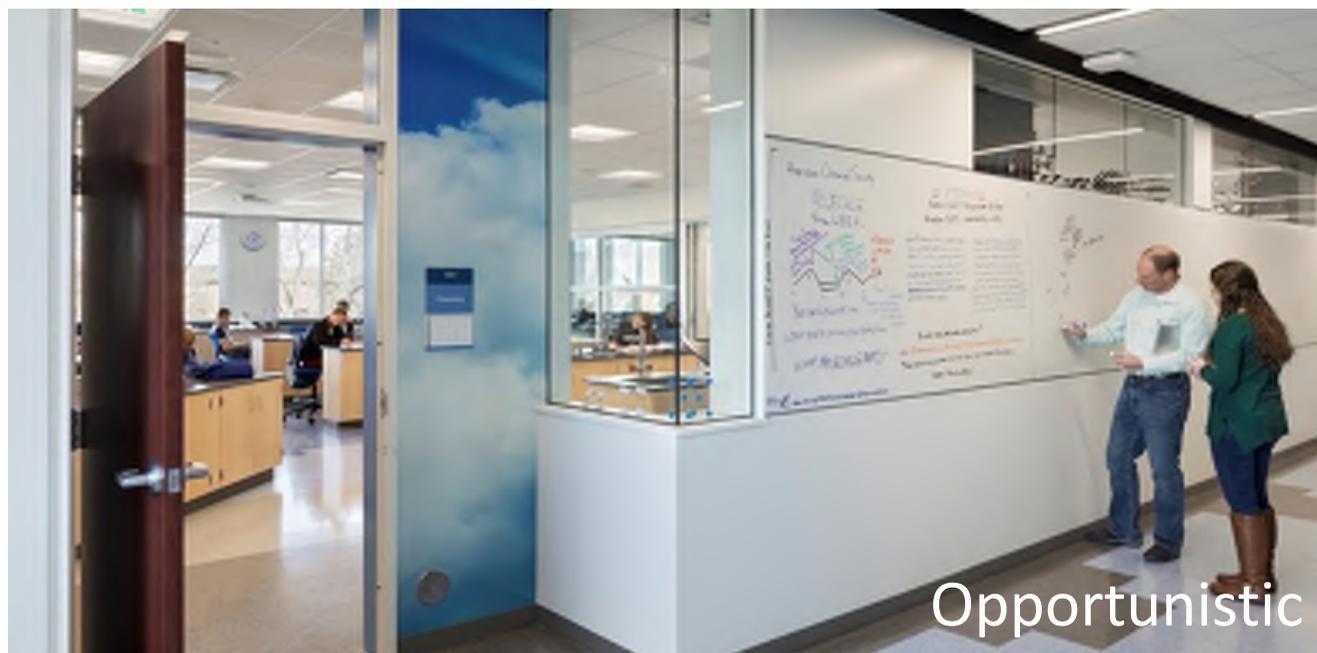
Quiet



Open



Peer Learning



Opportunistic

Engaged, Active & Applied Learning

Entire Building as a Learning Environment – Flexible



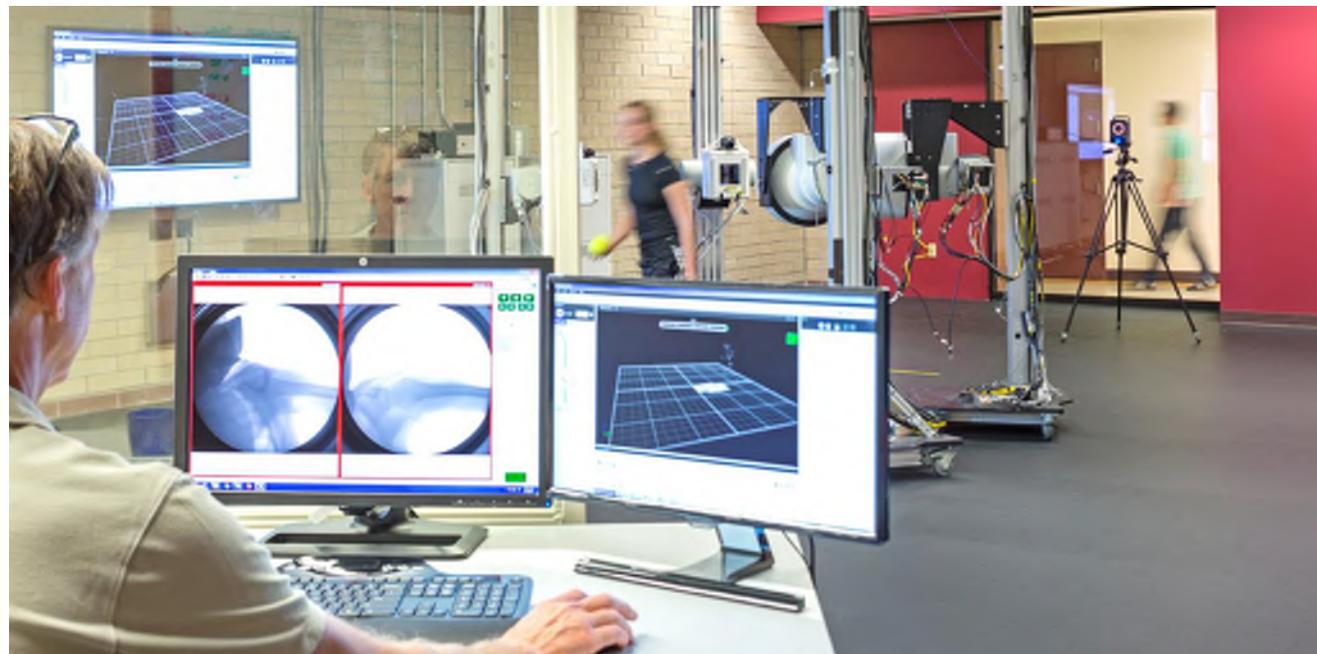
Engaged, Active & Applied Learning

Active Learning in Labs – Discovery & Problem Solving



# Engaged, Active & Applied Learning

# Applied Learning in Labs – Projects & Research



Transparency, Connections & Extended Learning

Transparency – to Exterior



- Daylighting
- Connections to the Environment
- Well-being



# Transparency, Connections & Extended Learning

# Transparency – from Corridors



Transparency, Connections & Extended Learning

Transparency – Between Spaces



Transparency, Connections & Extended Learning

Transparency – Between Spaces



# Transparency, Connections & Extended Learning

# Transparency – Between Floors



Transparency, Connections & Extended Learning

Connections – Hub of Activity



# Transparency, Connections & Extended Learning

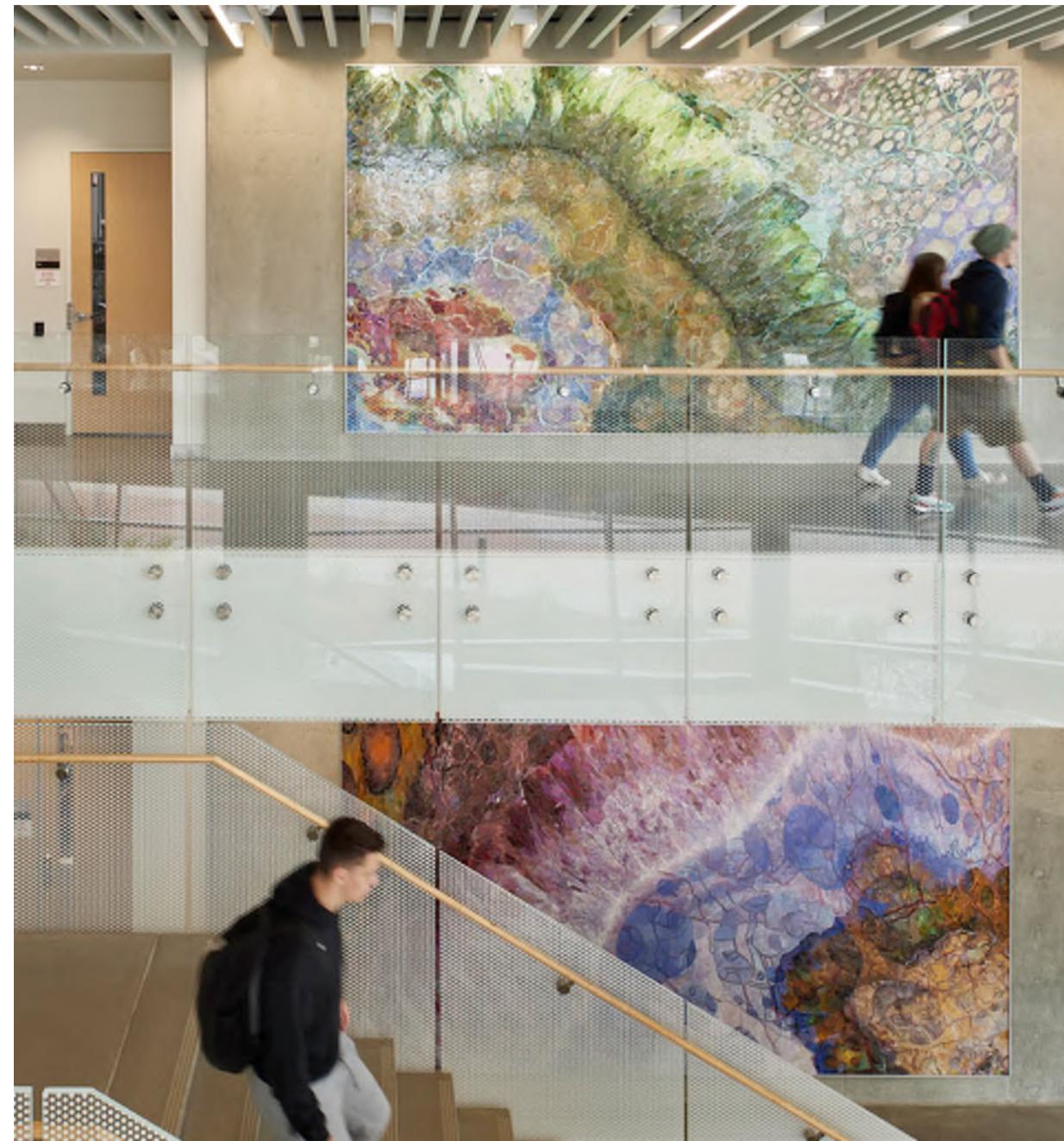
# Extended Learning – STEM on Display





# Transparency, Connections & Extended Learning

# Extended Learning – Scientific Art





# Transparency, Connections & Extended Learning

# Extended Learning – Donor Art



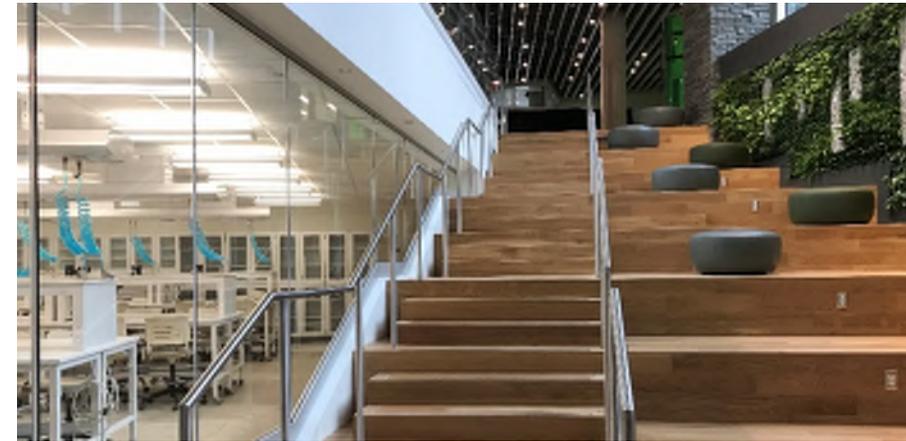
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## 2) Planning Trends for Science & Technology

- 1) Building Planning Considerations
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- ## 3) Programming Tools - Benchmarking & Metrics
- 4) Case Studies
  - 5) The Take Aways



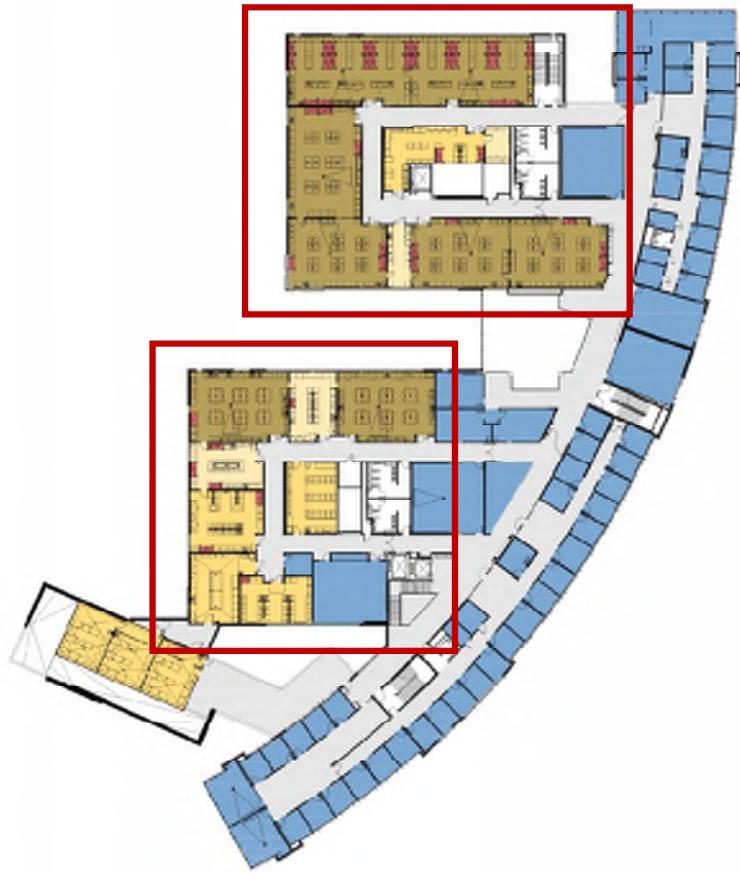
# Building Planning Considerations

# Organized by Building Systems

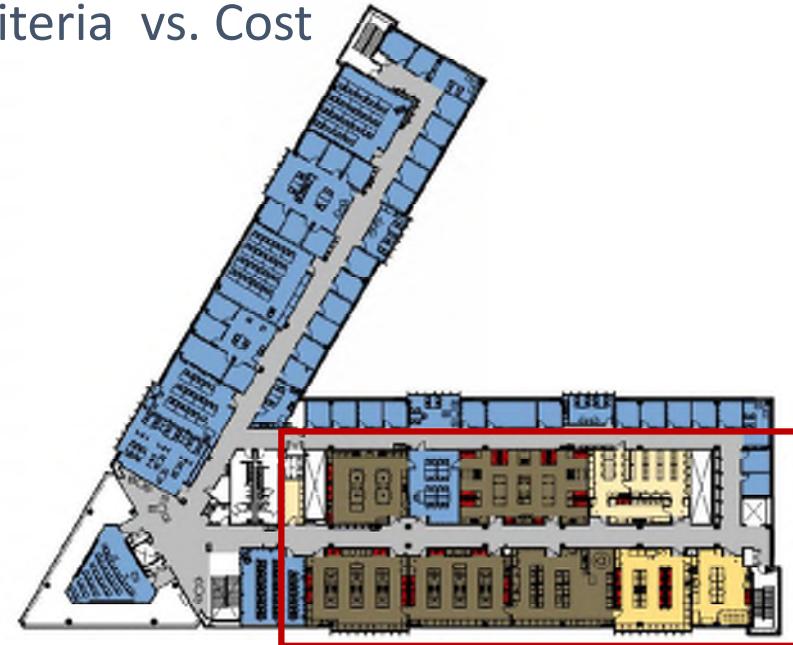
## Energy Efficiency Planning Overlay

- HVAC – 100% Exhaust vs. Recirculated Air / Natural Ventilation
- Structural System – Vibration Criteria vs. Cost
- Piped Service Distribution

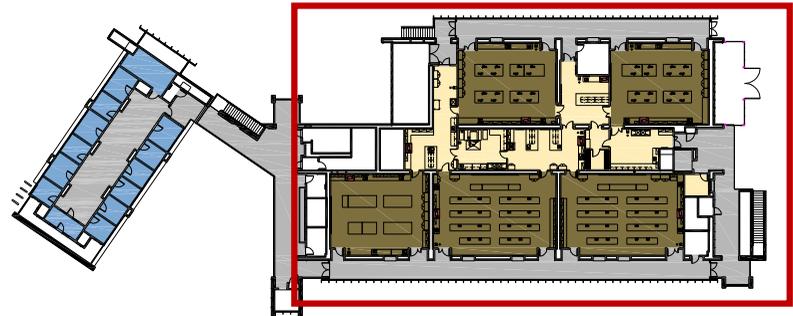
	Teaching Labs
	Research Labs
	Support Labs
	Office / Classroom



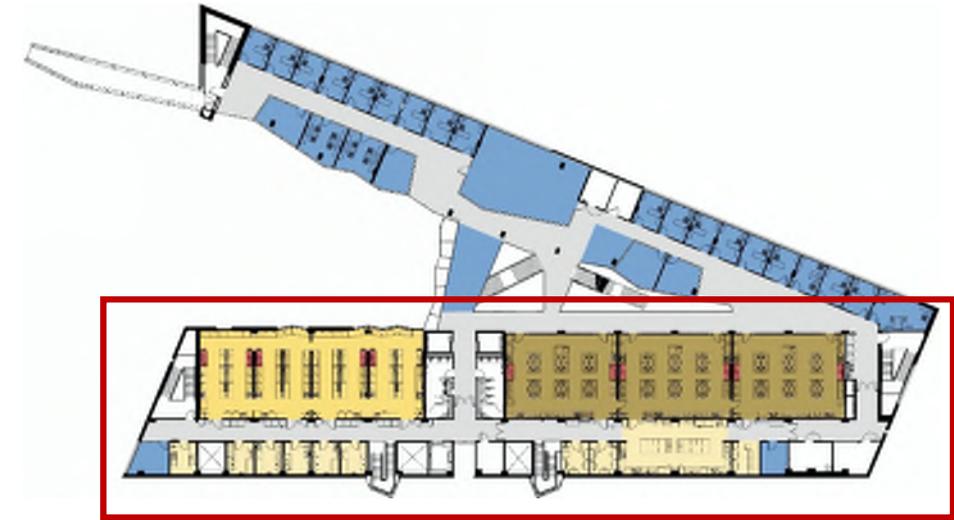
Weber State University



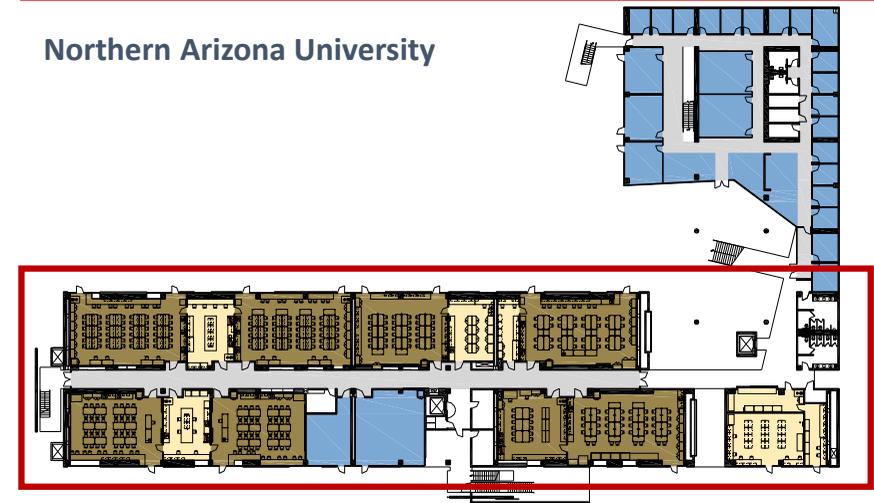
Augsburg College



Crafton Hills College



Northern Arizona University



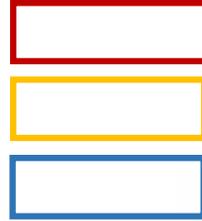
LA Valley College

# Building Planning Considerations

# Organized by Program Function

## Zoned by Space Type

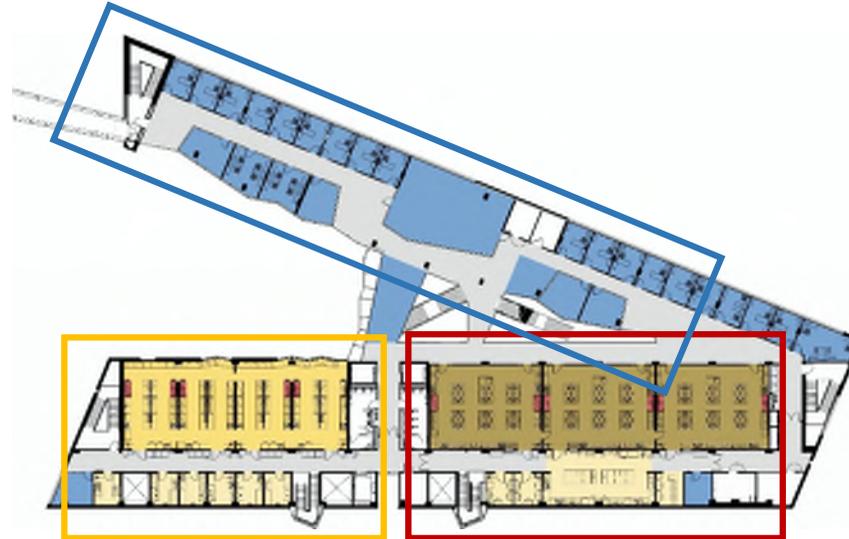
- Teaching Laboratories
- Research Laboratories
- Offices / Classrooms



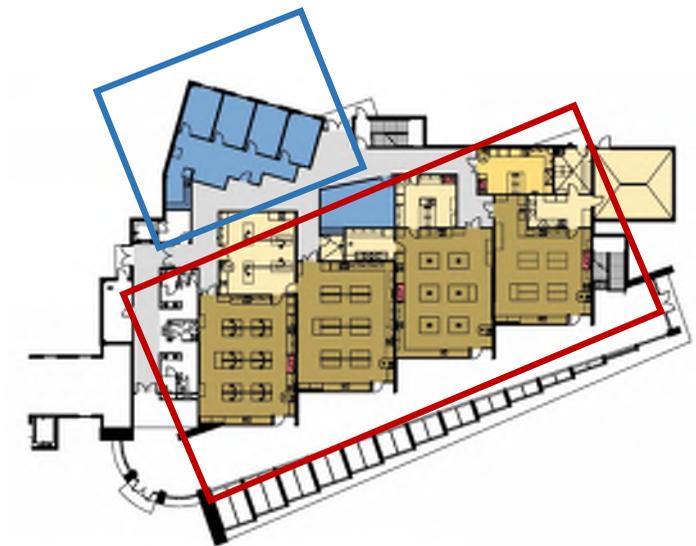
Valparaiso University



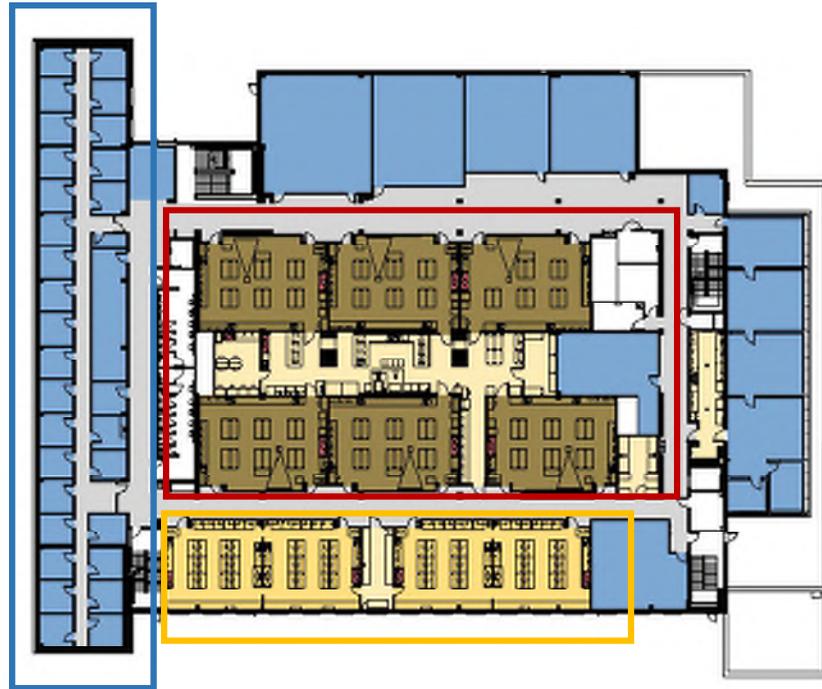
University of Washington - Bothell



Northern Arizona University



Southern Nazarene University



Grand Valley State University

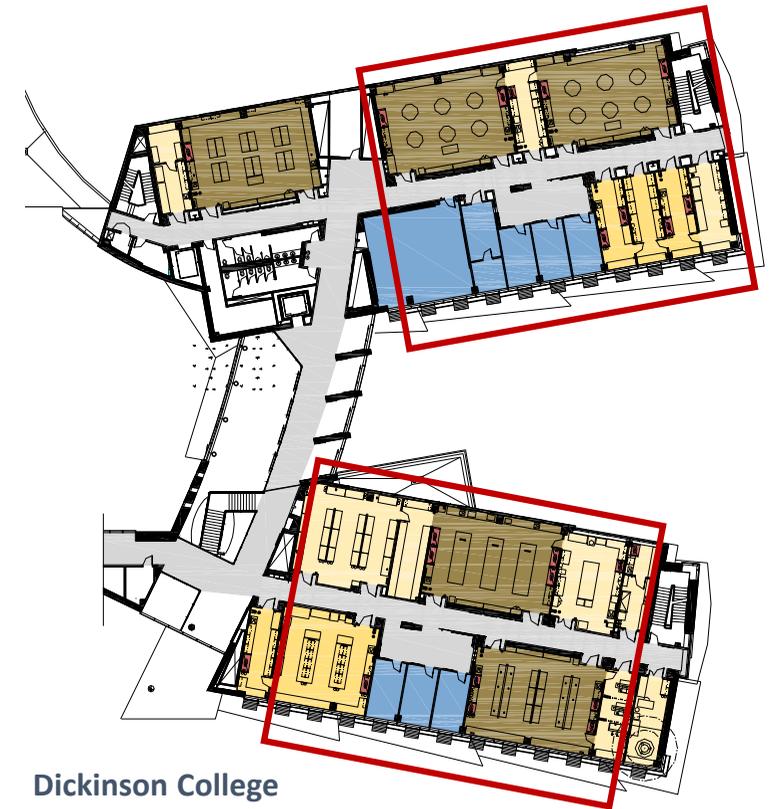
# Building Planning Considerations

# Organized by Neighborhoods

- Neighborhoods of Teaching Labs, Research Labs, and Offices
- Shared use of Lab Support by Teaching and Research
- “Soft” Learning Spaces



Gustavus Adolphus College



Dickinson College

# Building Planning Considerations

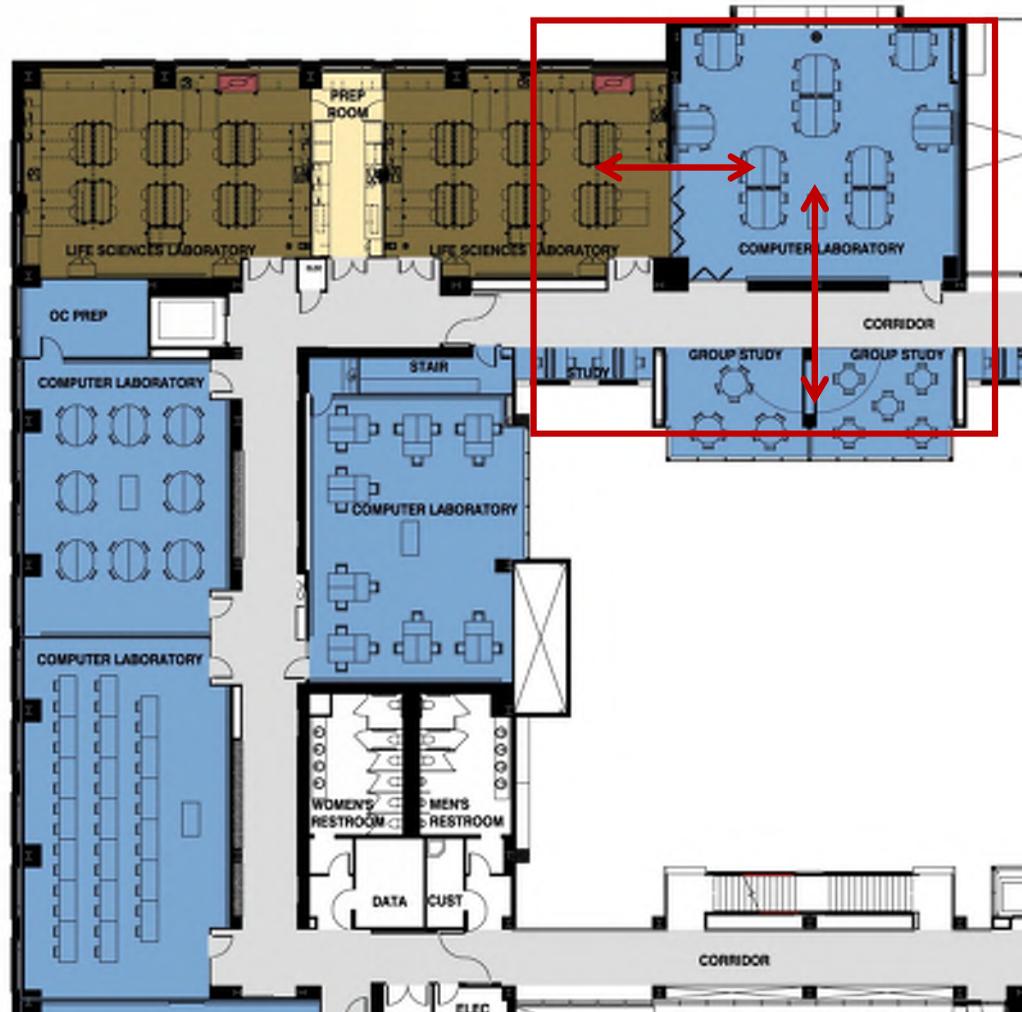
# Organized by Neighborhoods



# Building Planning Considerations

# Organized by Neighborhoods

- Teaching Labs
- Technology Access
- Informal Collaboration



## Building Planning Considerations

## Mass Timber / CLT Considerations



# Building Planning Considerations

# Structure, Floor Heights & Vibration

- Steel vs. Concrete Frame – Floor Assembly Depth
- Floor to Floor Heights – MEP Distribution
- Trend Toward Flat Slab Concrete

	Steel	Concrete	Timber
Community College	93%	7%	0%
4-Year Public/Private	52%	44%	4%
R-1 Research	32%	62%	6%

**SUSTAINABLE ENERGY AND ENVIRONMENTAL ENGINEERING BUILDING**  
 Simon Fraser University  
 Steel Frame/Braced Frame  
 Floor to Floor Heights: Level 1: 16'-4"  
 Level 2 - R: 16'-4"



**HENRY A. AND ELVIRA H. JUBEL HALL**  
 Washington University in St. Louis  
 Concrete Frame/Shear Wall  
 Floor to Floor Heights: Level 1: 16'-0"  
 Level 2 - R: 16'-0"



**ENGINEERING & INTERDISCIPLINARY SCIENCE COMPLEX**  
 San Diego State University  
 Concrete Frame/Shear Wall  
 Floor to Floor Heights: Level 1: 16'-0"  
 Level 2 - R: 16'-0"



**HEALTH SCIENCE BIOMED RESEARCH BLDG 2**  
 University of California, San Diego  
 Concrete Frame/Shear Wall  
 Floor to Floor Heights: Level B: 21'-0"  
 Level 1: 17'-0"  
 Level 2 - R: 17'-0"



**AMY GUTMANN HALL FOR DATA SCIENCE**  
 University of Pennsylvania  
 Mass Timber  
 Floor to Floor Heights: Level 1: 16'-0"  
 Level 2 - R: 15'-0"



**PACCAR ENVIRONMENTAL TECH BLDG**  
 Washington State University  
 Concrete Frame/Shear Wall - Laboratories  
 Cross Laminated Timber - High Bay / Lobby  
 Floor to Floor Heights: Level 1: 16'-0"  
 Level 2 - R: 16'-0"



**SCIENCE & ENGINEERING BUILDING 2**  
 University of California, Merced  
 Steel Frame/Braced Frame  
 Floor to Floor Heights: Level B: 18'-0"  
 Level 1 - R: 15'-0"



**INTERDISC SCIENCE & TECH BLDG (ISTB7)**  
 Arizona State University  
 Concrete Frame/Shear Wall  
 Floor to Floor Heights: Level B - 1: 18'-0"  
 Level 2 - R: 15'-6"



**MULTIDISCIPLINARY BUILDING (MDB)**  
 Cornell University  
 Steel Frame - Laboratories  
 Mass Timber/CLT - Offices / Classrooms  
 Floor to Floor Heights: Level 1: 15'-0"  
 Level 2 - R: 15'-0"

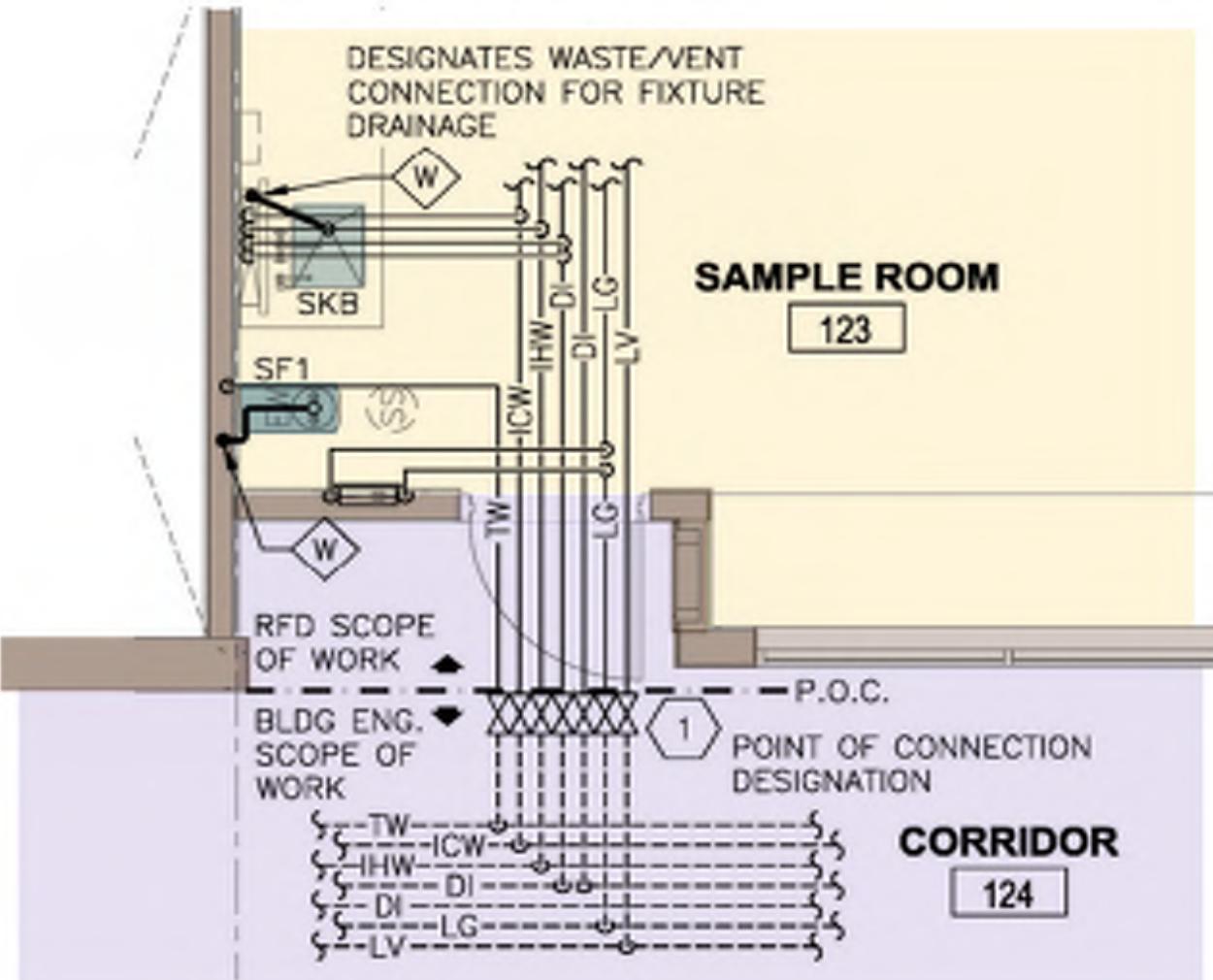


**SISKIYOU II SCIENCE REPLACEMENT BUILDING**  
 California State University, Chico  
 Steel Frame/Braced Frame  
 Floor to Floor Heights: Level 1: 16'-0"  
 Level 2 - R: 16'-0"



## Concrete Frame + Flat Slab

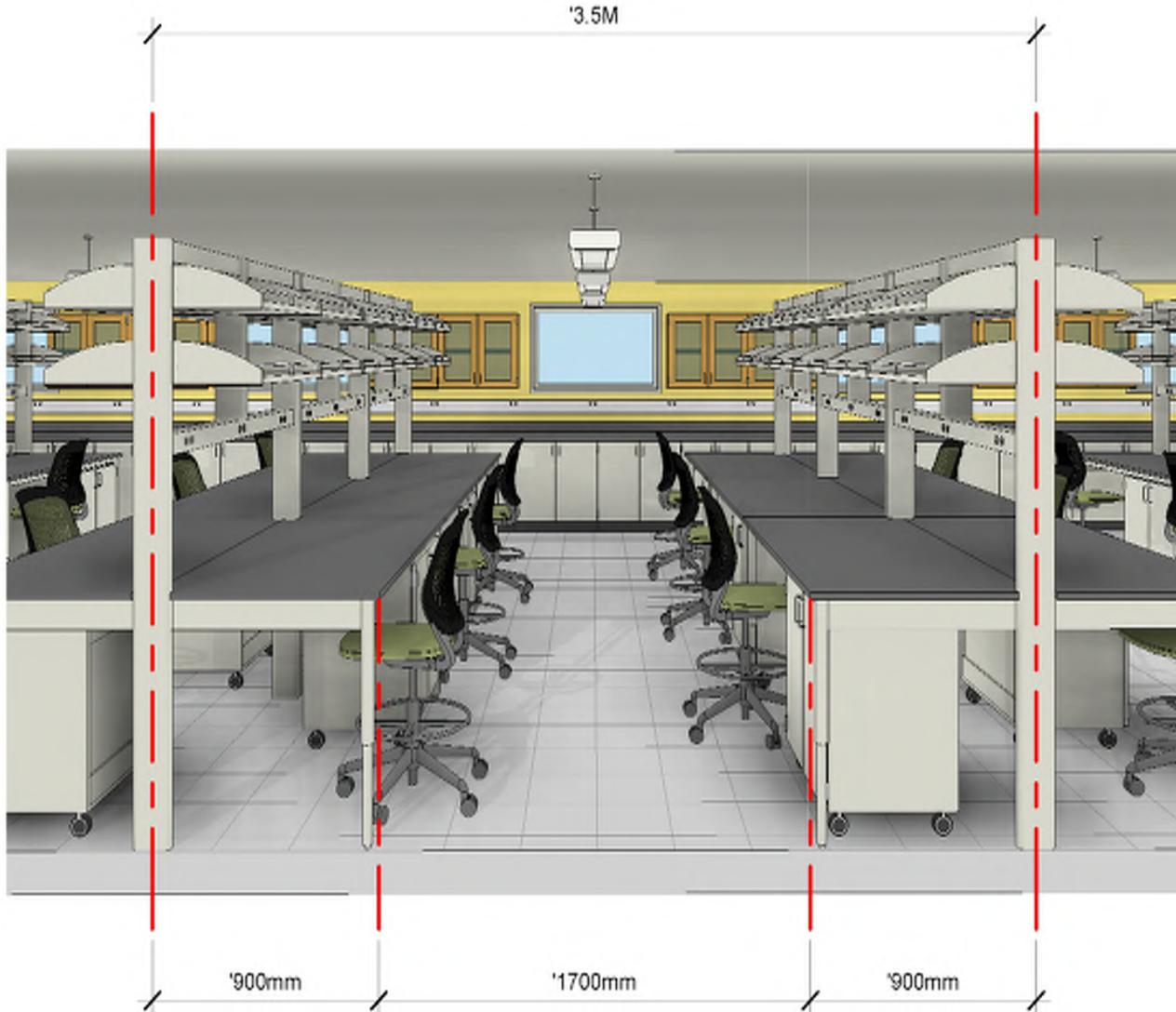
- Reduced Floor to Floor Heights
- Economy of Installation
- Ease of Renovations



# Building Planning Considerations

# Laboratory Planning Module

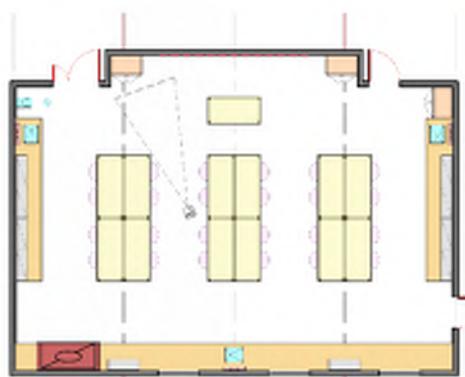
- Basic Planning Module Getting Deeper – 30’ to 33’ Deep
- Two Way Module
- Engineering Labs Benefit from Wider Modules



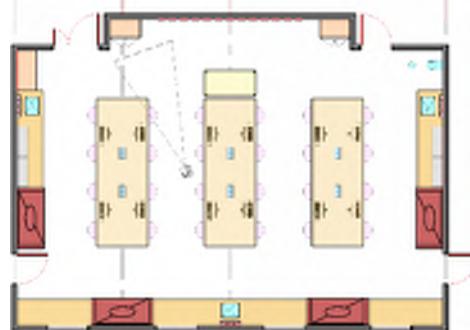
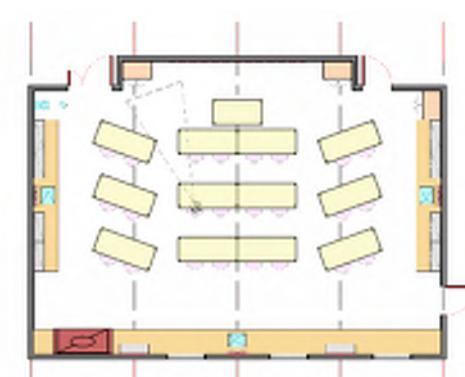
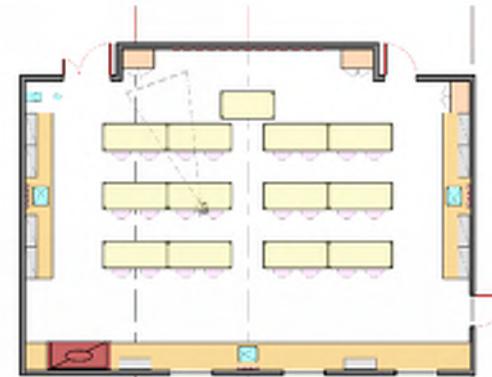
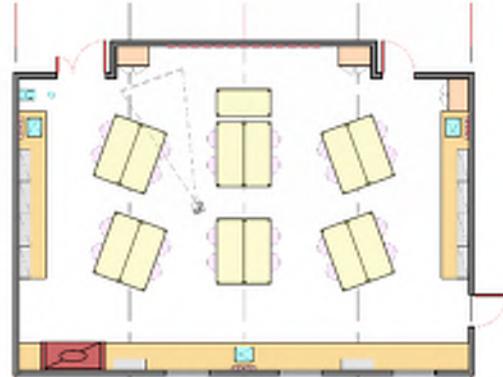
2015 – 2019	Private	2020 – Beyond
20%	10'-0"	5%
0%	10'-4"	0%
<b>50%</b>	<b>10'-6"</b>	<b>50%</b>
<b>30%</b>	10'-8"	20%
0%	<b>11'-0"</b>	<b>25%</b>

2015 – 2019	Public	2020 – Beyond
0%	10'-0"	0%
17%	10'-4"	0%
<b>75%</b>	<b>10'-6"</b>	<b>82%</b>
0%	10'-8"	9%
8%	11'-0"	9%

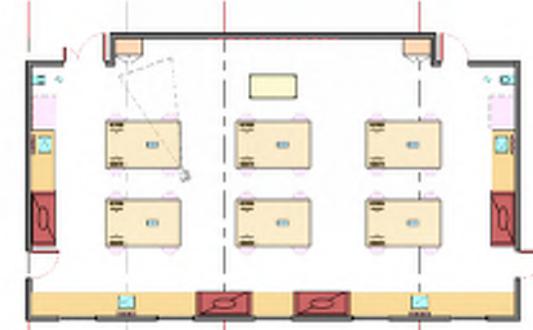
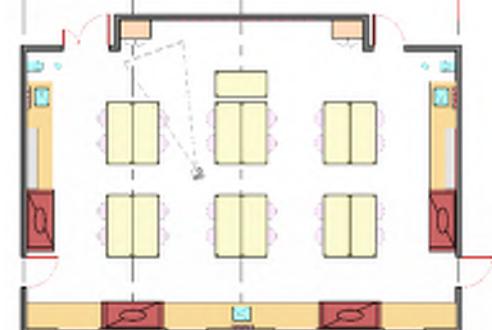
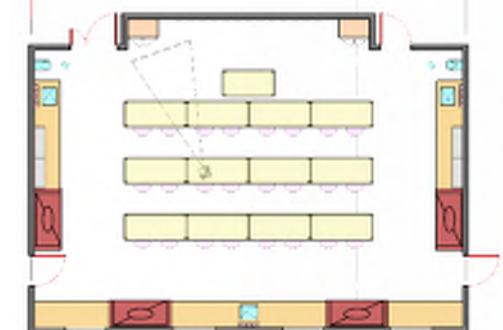
2015 – 2019	Comm. College	2020 – Beyond
30%	10'-0"	0%
0%	10'-4"	0%
<b>60%</b>	<b>10'-6"</b>	<b>81%</b>
0%	10'-8"	6%
10%	11'-0"	13%



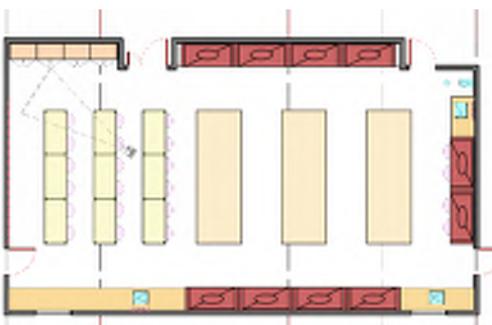
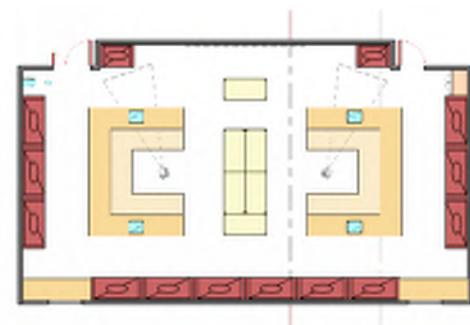
Earth Science - Physics - Engineering

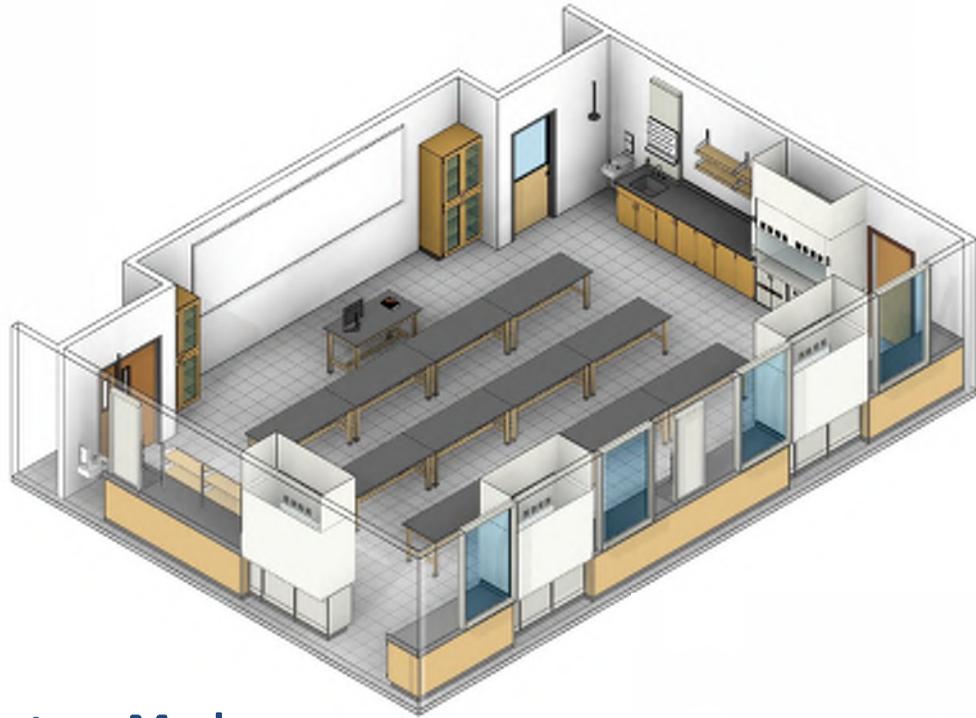


Biology - Microbiology - Plant Sciences - Zoology



General Chemistry - Organic Chemistry

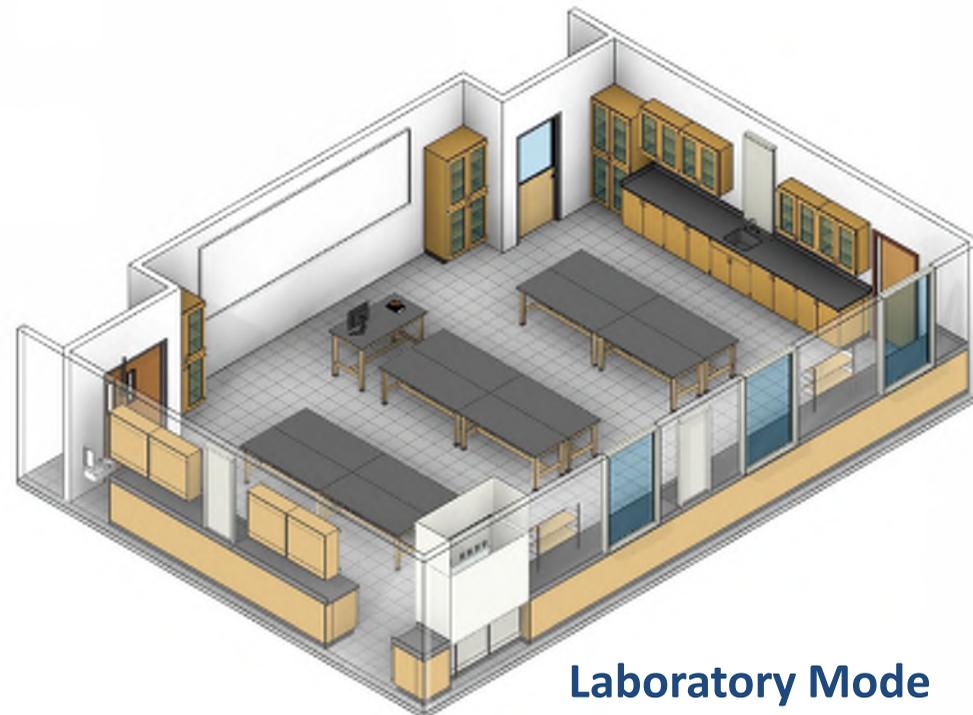




Lecture Mode



Workshop Mode



Laboratory Mode



# Building Planning Considerations

# Laboratory Flexibility and Capability



Revised Laboratory Utility Matrix  
Version 1.2

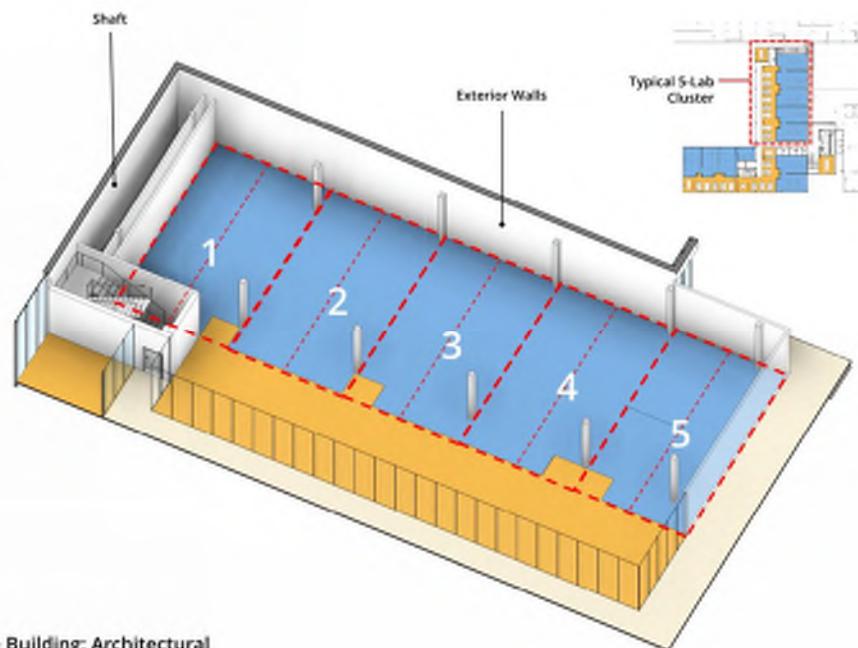
System	Total Points of Use/ Connection	Room Scale Diversity	Building Scale Diversity	Design Load for Simultaneous Usage (Per Room U.N.O.)
100% Outside Air	1600 CFM = (2) 6' Fume Hoods at 18" Open and 100 FPM	N/A	55%	880 CFM (Building) = (1) 6' Fume Hood at 18" Open and 100 FPM = 1 CFM/Square Foot = 6 ACH
Heat Load Removal (Air Side including Chilled-Water Fan Coils)	5.0 Watts/Square Foot	N/A	75%	3.75 Watts/Square Foot (Building)
Industrial Hot Water	7 Outlets	25%	7BD	1.5 GPM
Industrial Cold Water	9 Outlets	25%	7BD	2.0 GPM
Purified Water	2 Outlets	50%	7BD	1.0 GPM 4 Gallons/Day
Process Chilled Water	4 Drops	50%	7BD	4.0 GPM of 1.0 Degree Delta T = 20,000 BTU
Gaseous Nitrogen	8 Fittings	30%	33%	2.4 SCFM (Room)/ 0.8 SCFM (Building)
Compressed Dry Air	8 Fittings	30%	7BD	2.4 SCFM
Laboratory Vacuum	8 Fittings	30%	7BD	2.4 SCFM
Electricity (Grid)	200 Amp Panel. (This can provide 120V, 208V Single-Phase, and 208V Three-Phase circuits). See note below for specialized power.	50%	7BD	100 Amps
Electricity (Standby)	(2) 208V 30 Amp 1 Ph & (2) 120V 20 Amp 1 Ph	50%	7BD	8,640 Watts (8.64 kVA)
Wired Data Ports	8 Ports	N/A	N/A	8 Ports

Notes:

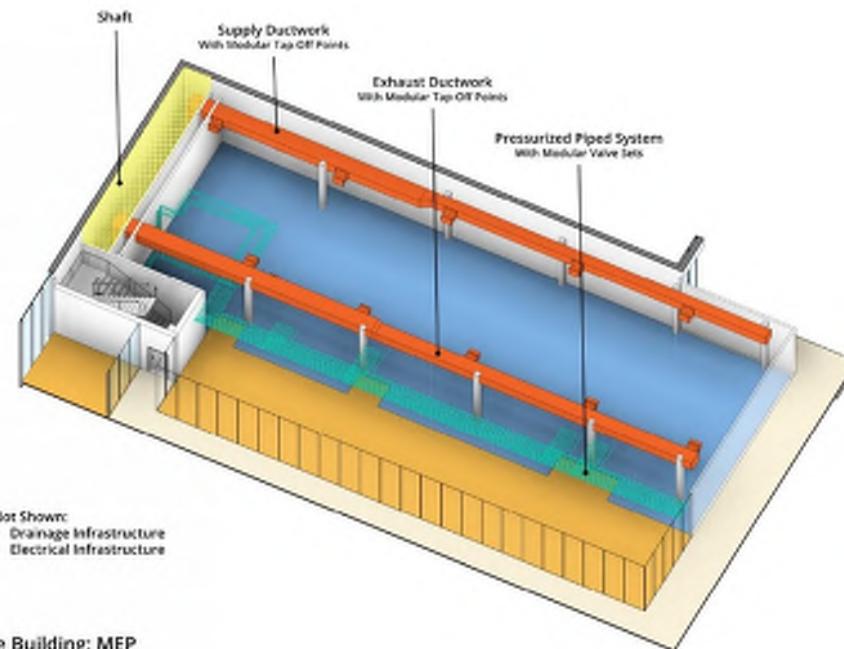
- Purified water is proposed to be ASTM Type II. Where needed Type I water would be created by local Owner-Furnished polishers.
- Where needed, Uninterruptible Power (UPS) would be Owner Furnished within each lab.
- Standby power may be consolidated into specific areas.
- One 480V, 3-Phase, 400 Amp panel should be provided per floor for high-power and specialized needs.

# Building Planning Considerations

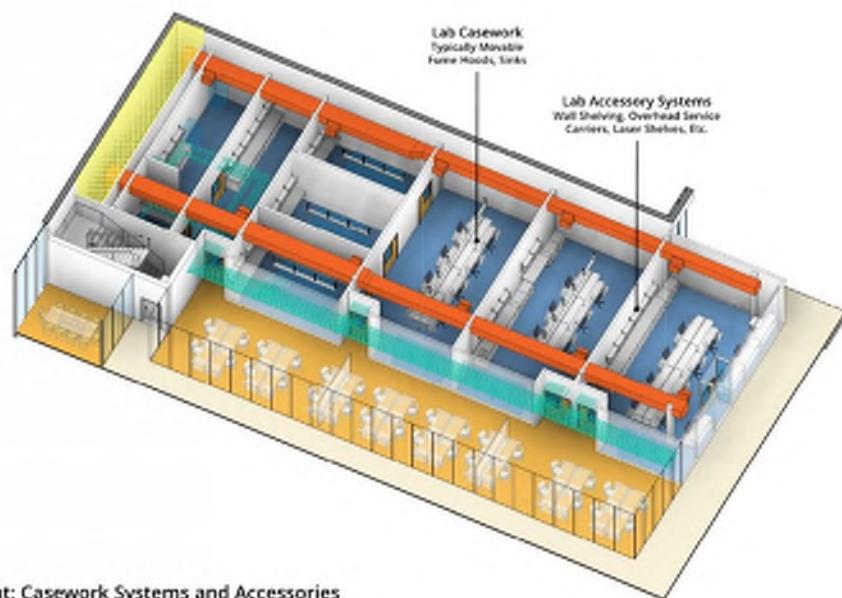
# Laboratory Flexibility and Capability



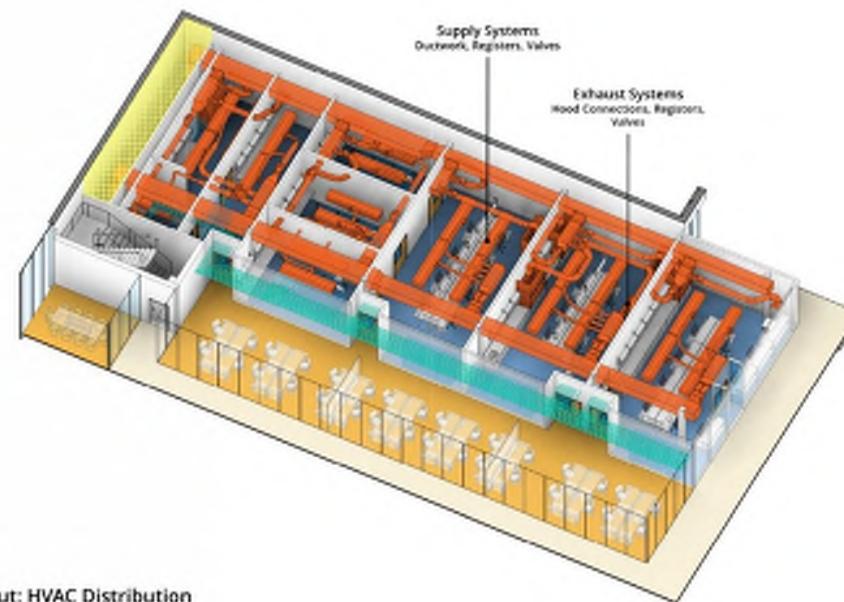
Base Building: Architectural



Base Building: MEP



Fitout: Casework Systems and Accessories



Fitout: HVAC Distribution

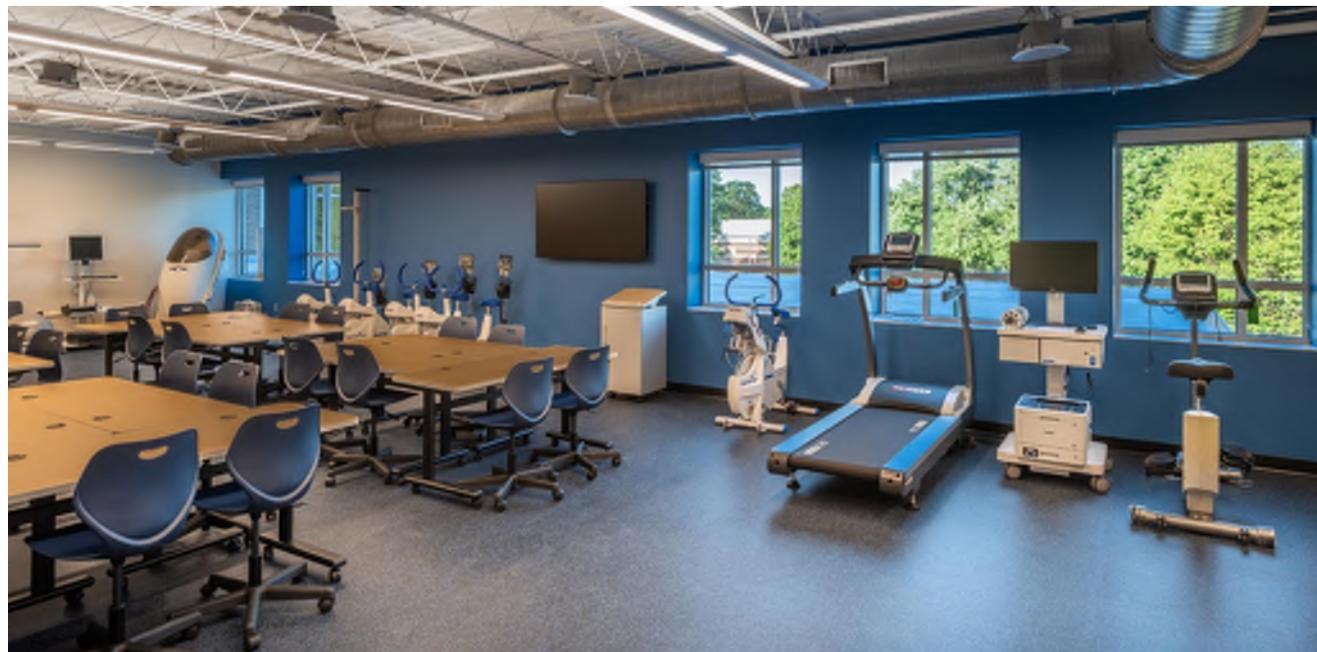
## Building Planning Considerations

## Laboratory Flexibility and Capability



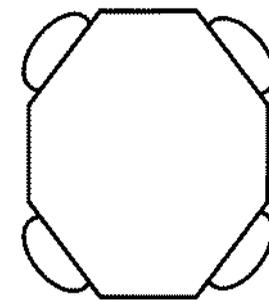
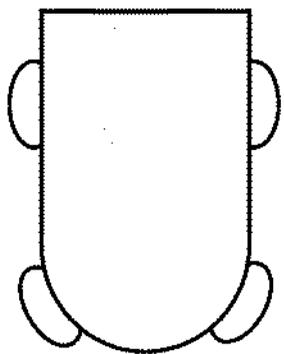
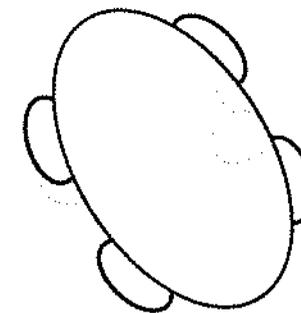
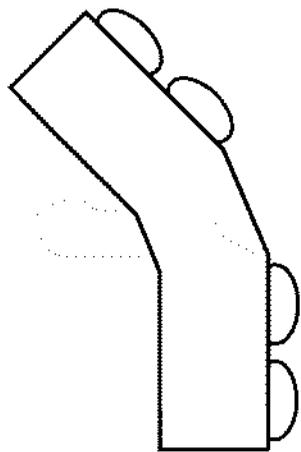
# Science Learning Laboratories

# Laboratory Design Trends – Greater Flexibility



# Science Learning Laboratories

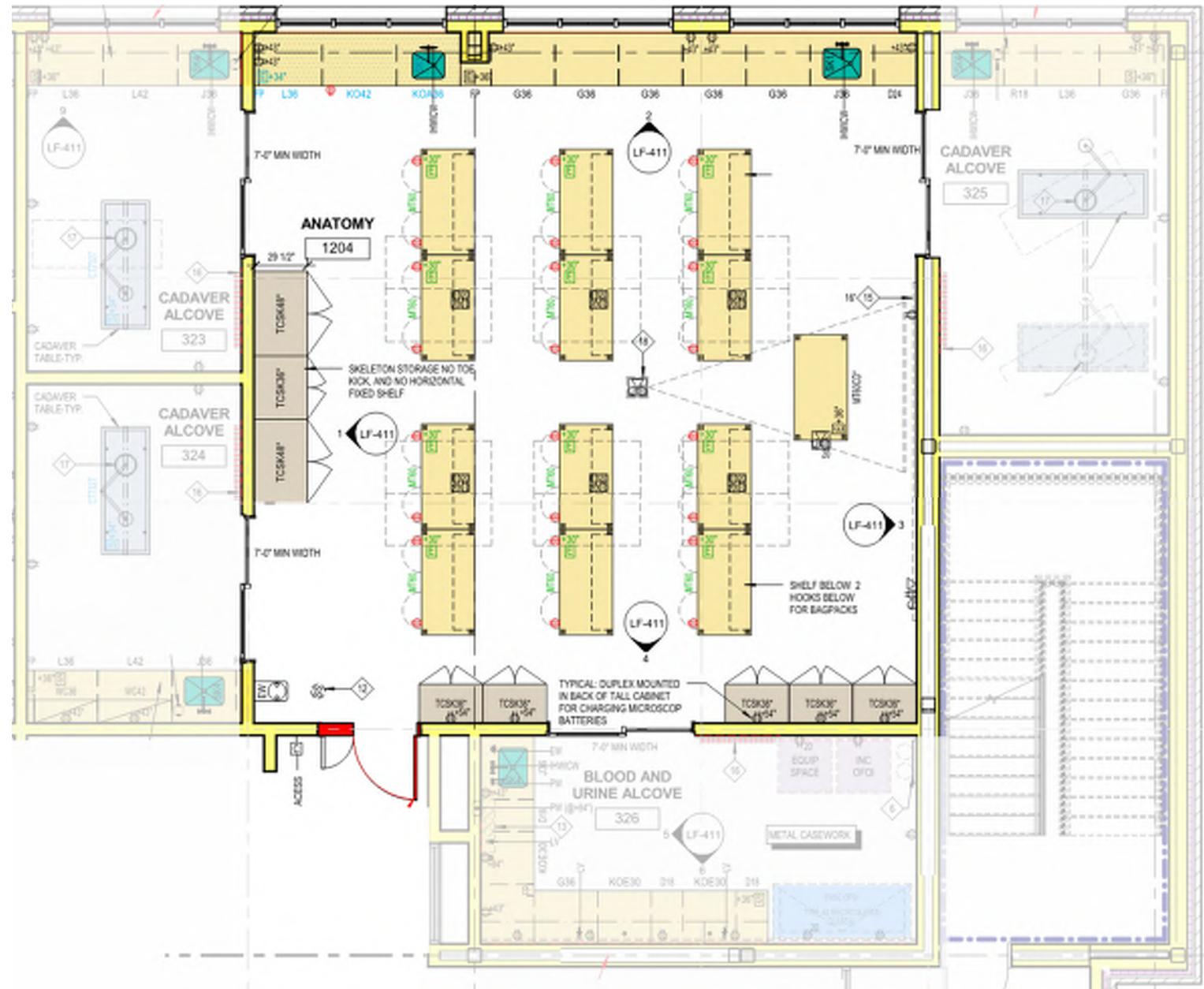
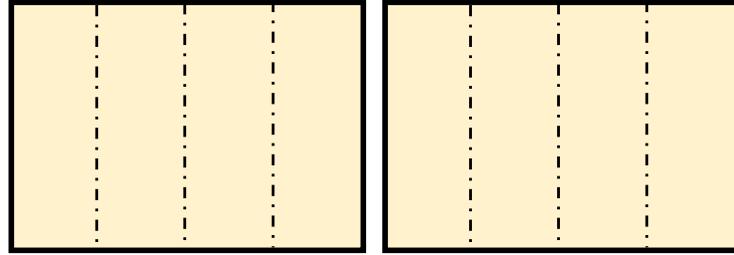
# Team Learning / Shaped Benches







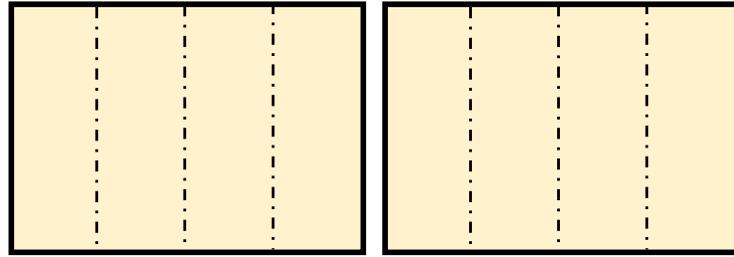
- 2 labs at 1,320 nsf each = 2,640 nsf



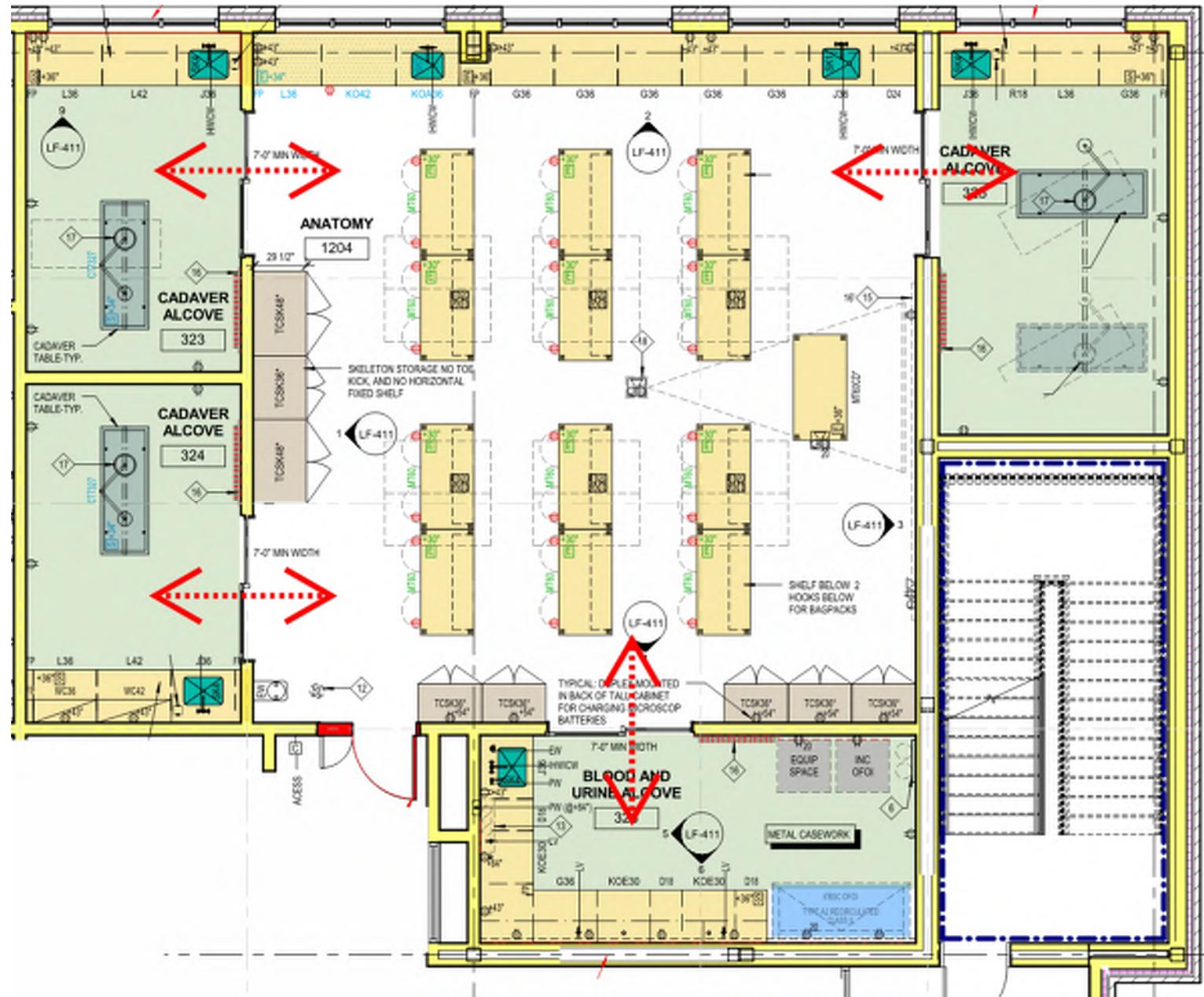
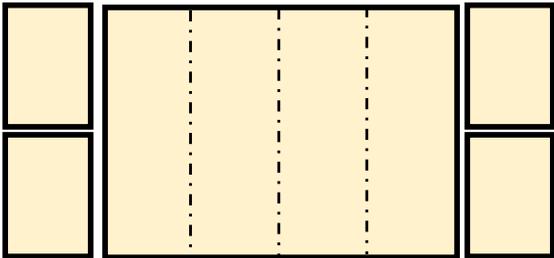
# Science Learning Laboratories

# Lab Design Trends – Multi-Use Teaching Laboratories

- 2 labs at 1,320 nsf each = 2,640 nsf



- Single Lab = 1,320 nsf + Alcoves = 660 nsf
- Total Area = 1,980 nsf







- Isolate Dangerous Equipment
- Keyed Lockouts on Equipment
- Cameras & Displays for Demo



# Engineering Learning Laboratories

## Lab Design Trends – Engineering Fluids Lab Example

- Equipment Scale Lab Sizing
- Metrics Less Useful
- Teaching Zone Variable



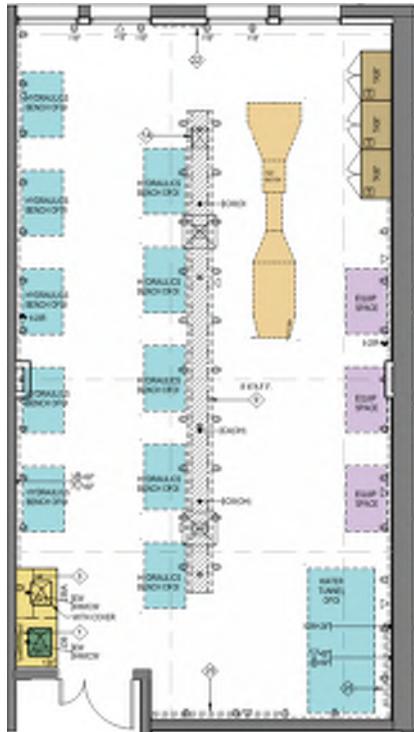
# Engineering Learning Laboratories

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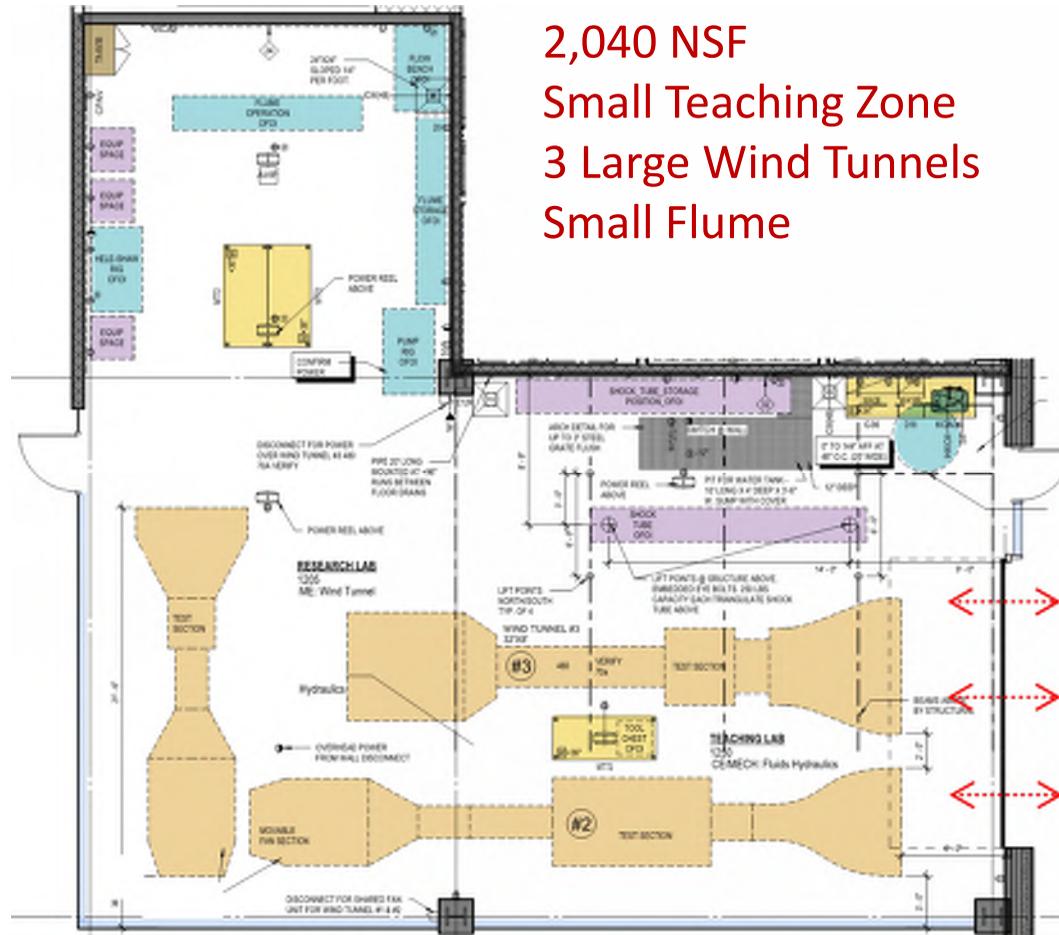
850 NSF

No Teaching Zone  
No Large Wind Tunnels  
No Large Flumes



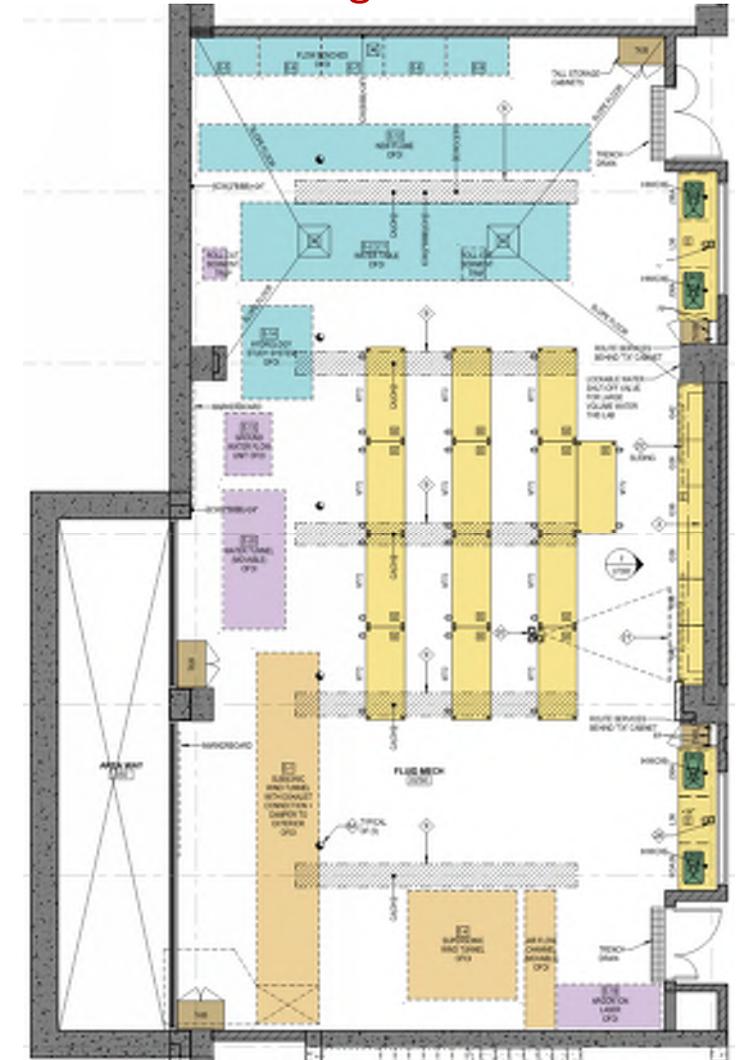
2,040 NSF

Small Teaching Zone  
3 Large Wind Tunnels  
Small Flume



1,920 NSF

Large Teaching Zone  
2 Wind Tunnels  
2 Large Flumes



# Engineering Learning Laboratories

# Lab Design Trends – Engineering Fluids Lab Example

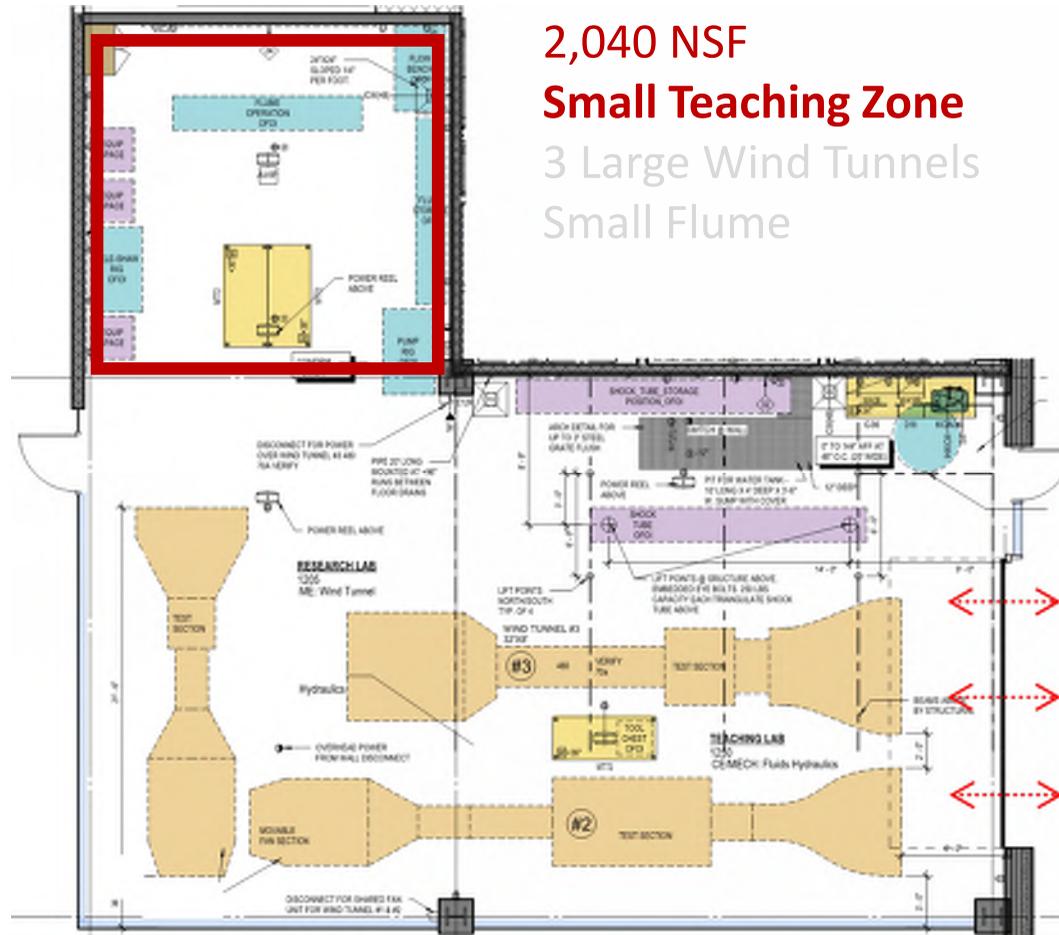
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850 NSF  
No Teaching Zone

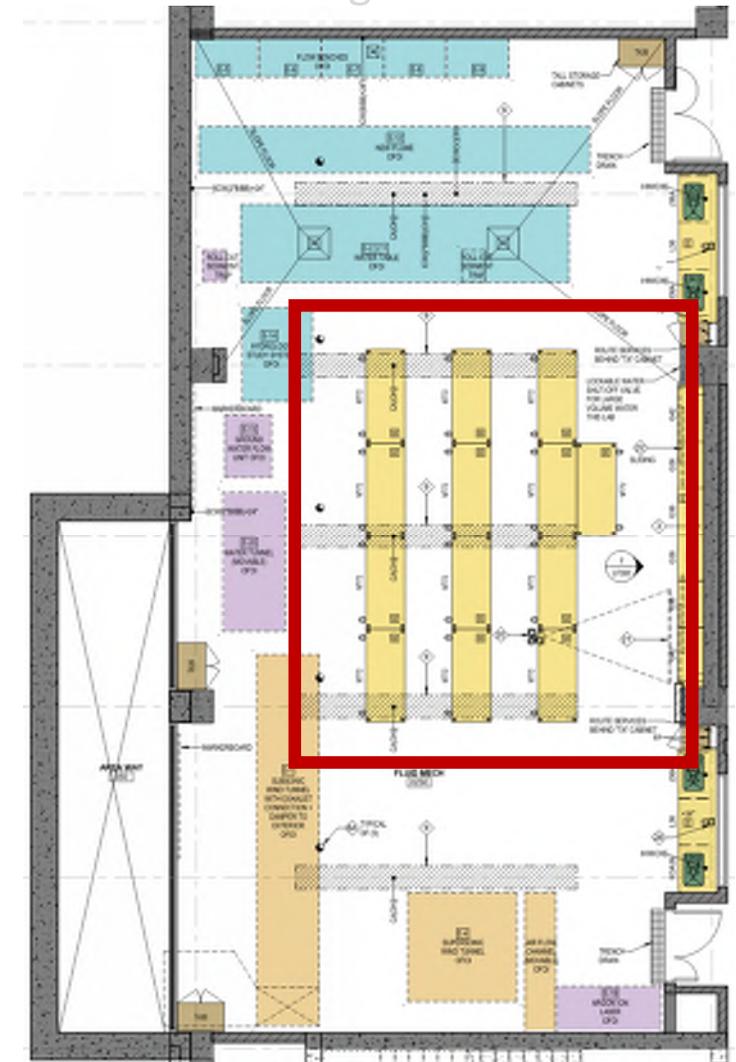
No Large Wind Tunnels  
No Large Flumes



2,040 NSF  
Small Teaching Zone  
3 Large Wind Tunnels  
Small Flume



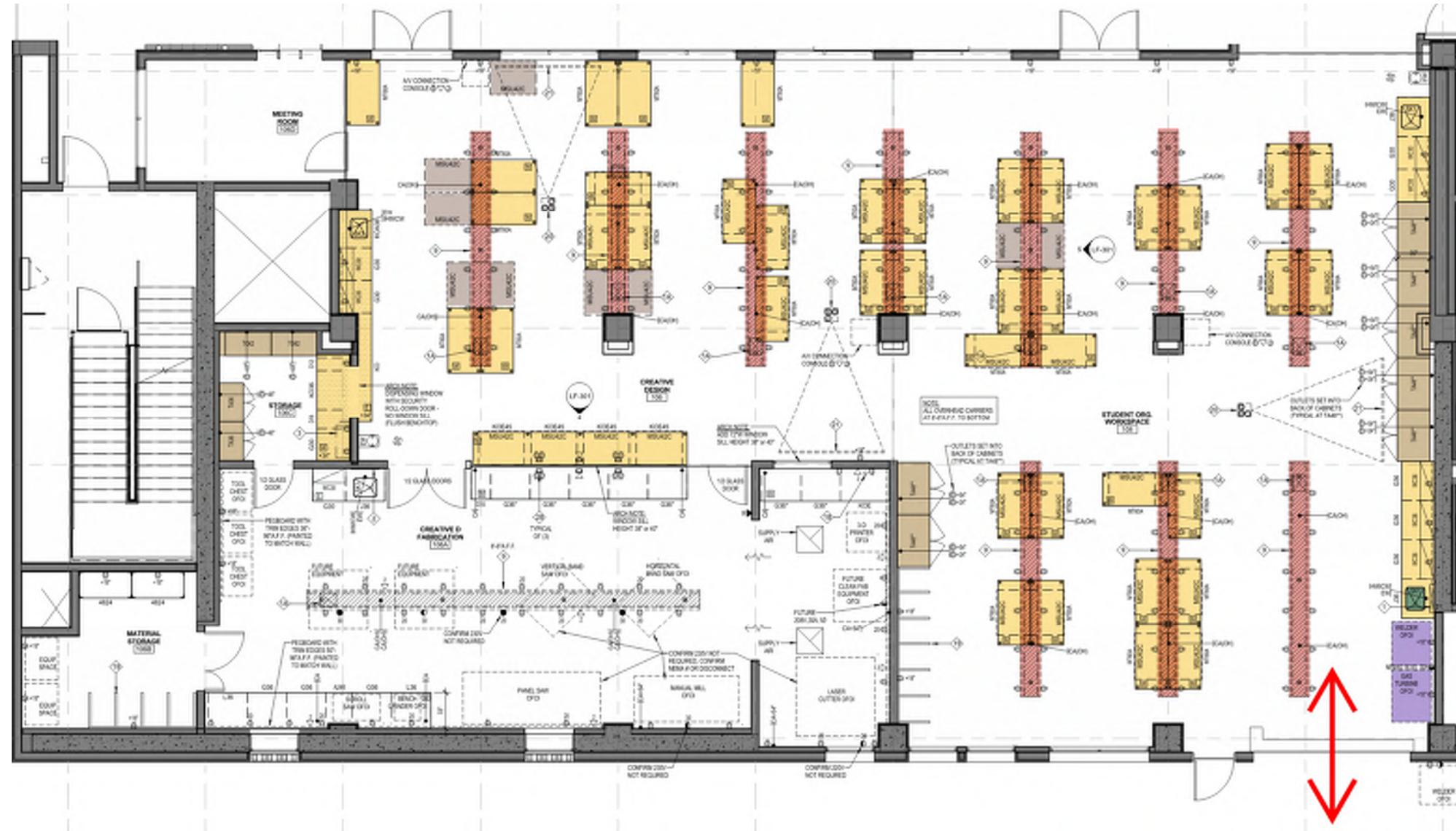
1,920 NSF  
Large Teaching Zone  
2 Wind Tunnels  
2 Large Flumes



# Engineering Learning Laboratories

# Lab Design Trends – Engineering Project Labs

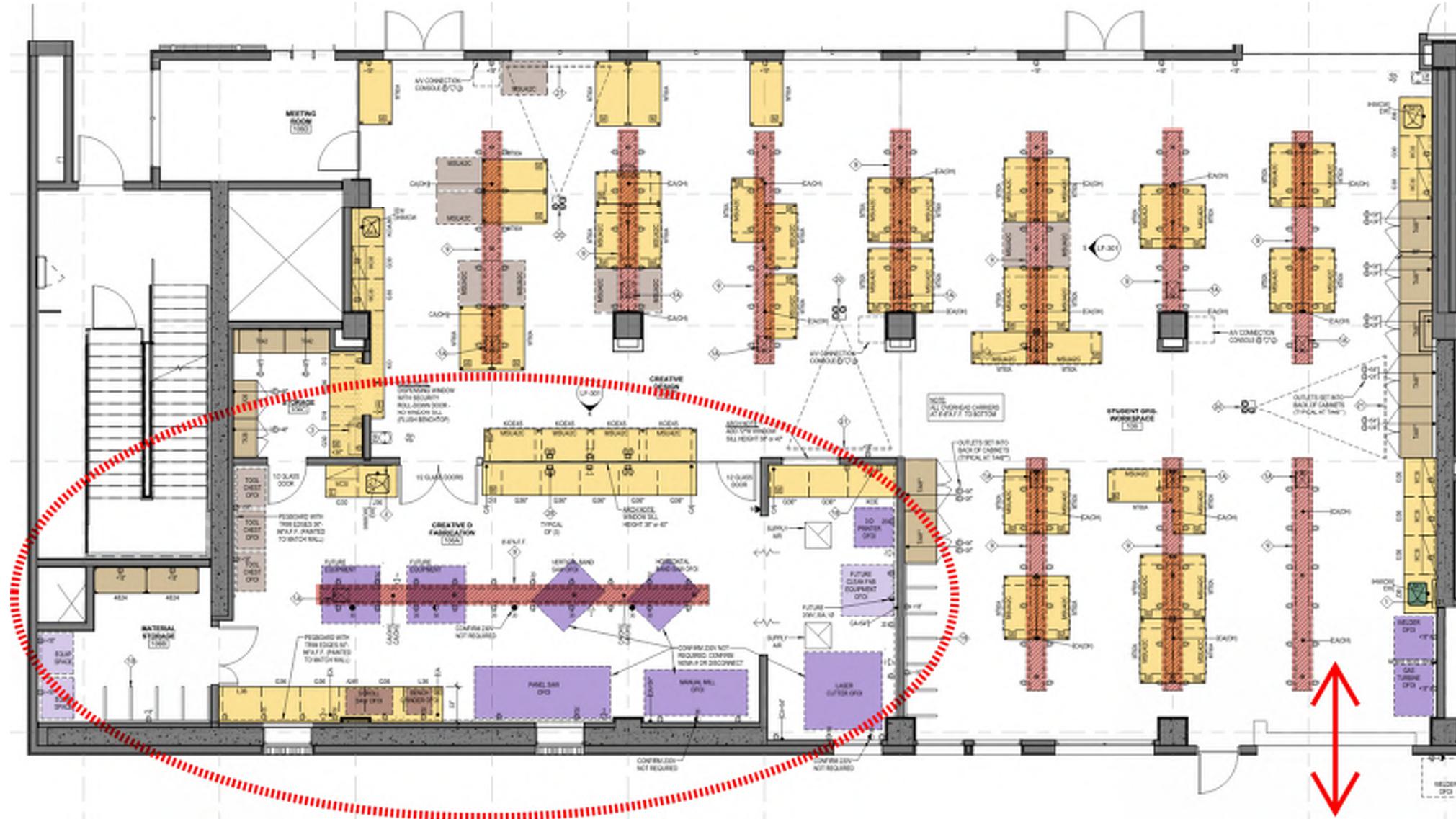
- Equipment & Assembly Type Labs
- Assigned Home for Student Teams
- Metrics Less Useful
- Strategic Adjacencies



# Engineering Learning Laboratories

# Lab Design Trends – Engineering Project Labs

- Equipment & Assembly Type Labs
- Assigned Home for Student Teams
- Metrics Less Useful
- Strategic Adjacencies





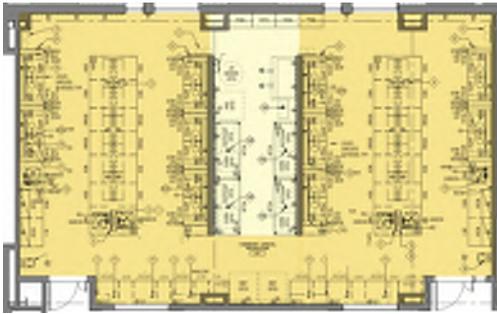


# Environments for Discovery

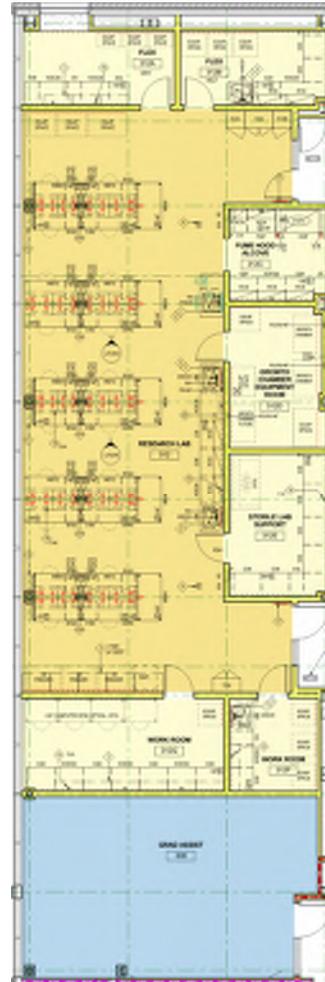
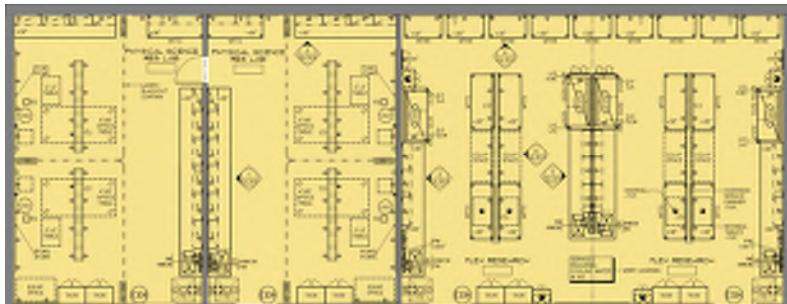
# Research Accommodations

- Evolution away from Individual Faculty Labs to Shared Suites
- Small Research Labs based on Function not Ownership
- Research Themed Lab Suites

Chico State – Small Labs  
3 to 4 Faculty Each  
**= 400 nsf Allocation**



Northern Arizona U – Medium Labs  
**= 630 nsf Allocation**

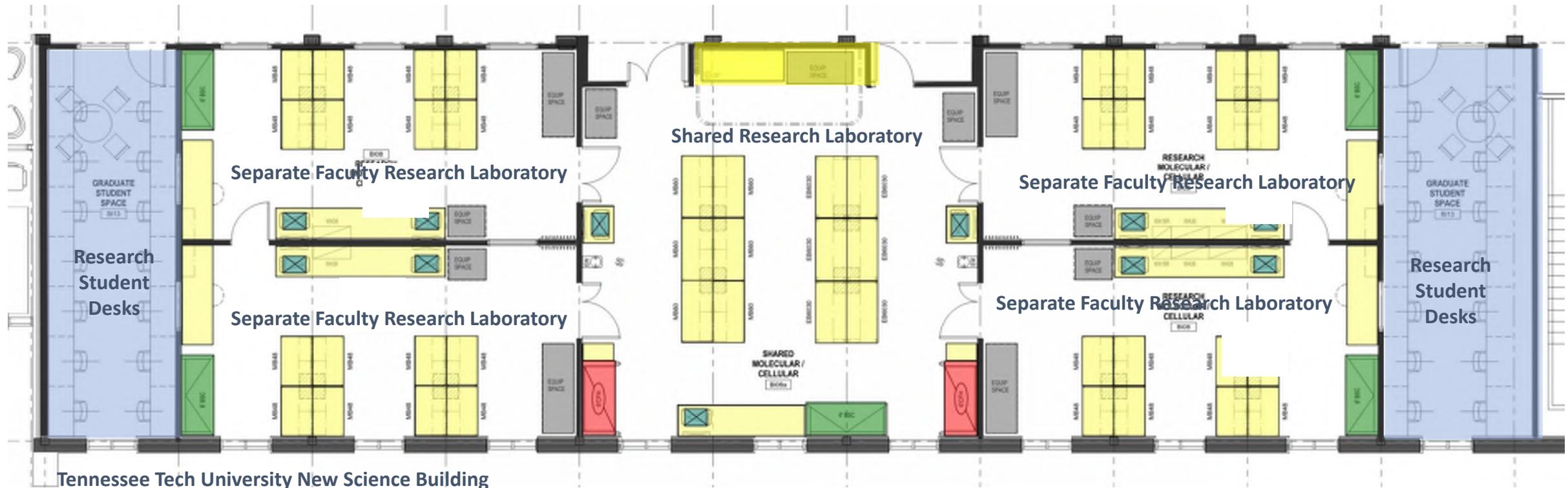


Cal Poly SATRC  
Lab suites for  
3 Faculty Each  
**= 600 nsf Allocation**

Utah State – Lab Suites for  
4 Faculty Each  
**= 580 nsf Allocation**



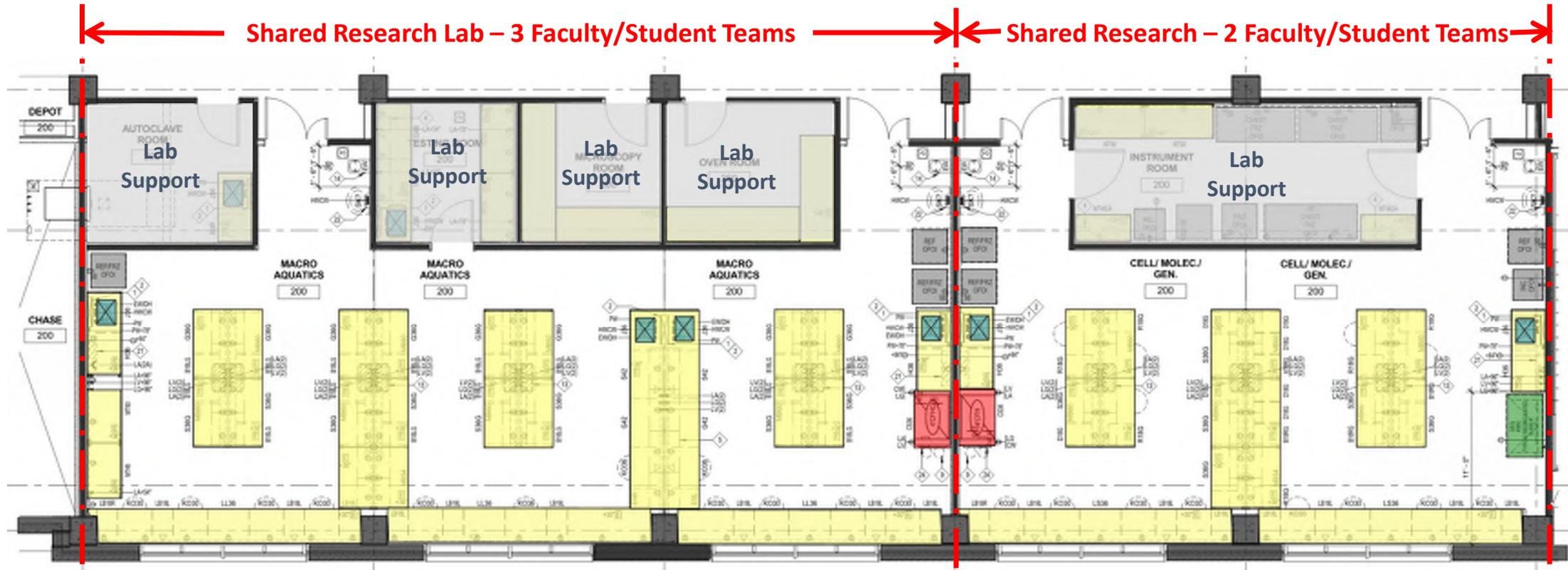
- Suite of 4 Faculty Research Laboratories
- Separate Lab per Faculty @ 480 nsf each
- Shared Laboratory @ 960 nsf for Overflow and Shared Equipment / Instrumentation
- Shared Student Desk Spaces per Pair of Faculty Research Laboratories



# Environments for Discovery

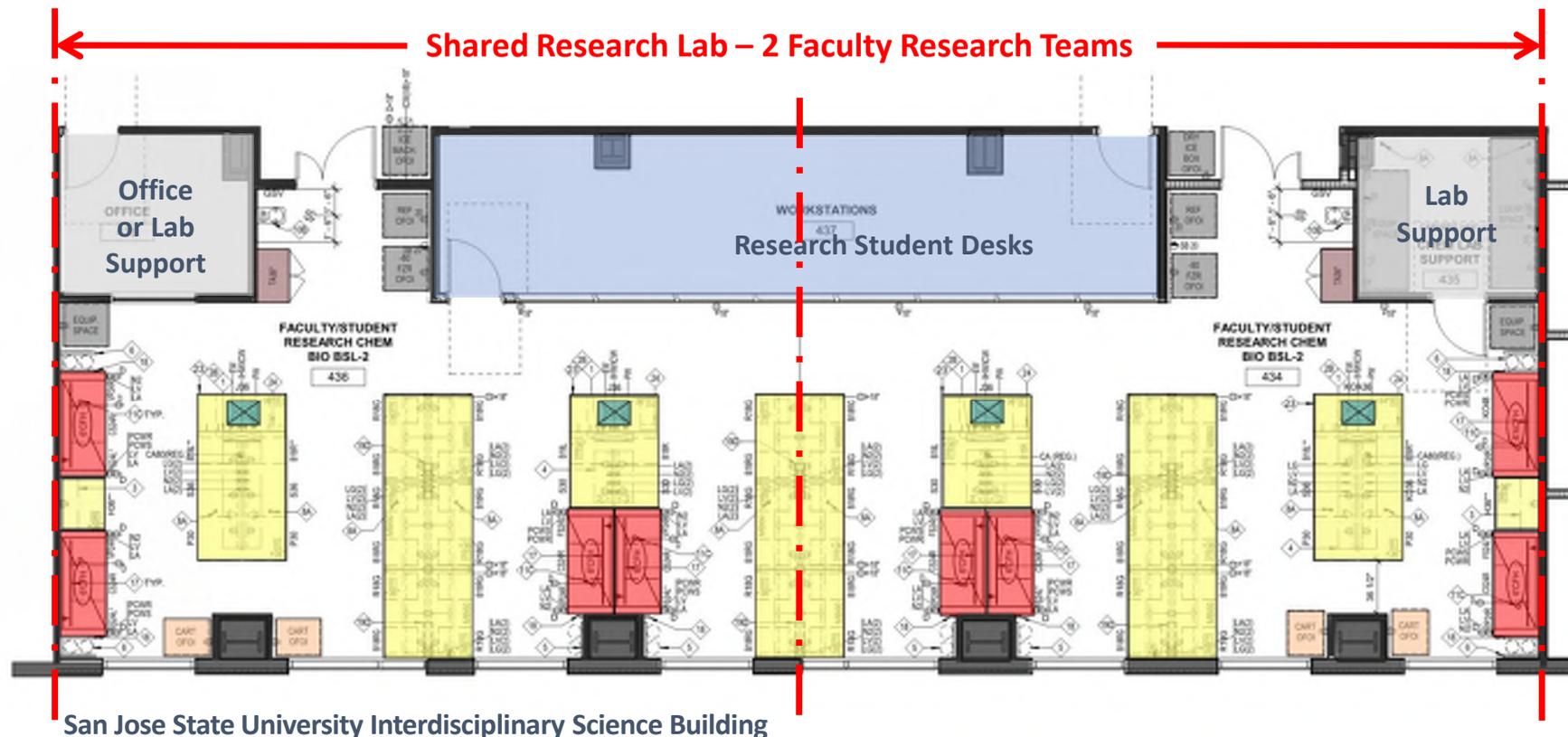
# Research Accommodations – Shared Labs

- Faculty Research Labs for 2 to 4 Faculty teams
- Shared Lab for 2 Faculty Teams = 1,050 NSF
- Shared Lab for 3 Faculty Teams = 1,530 NSF
- Shared Lab for 4 Faculty Teams = 2,060 NSF
- Lab Support Zone along Corridor

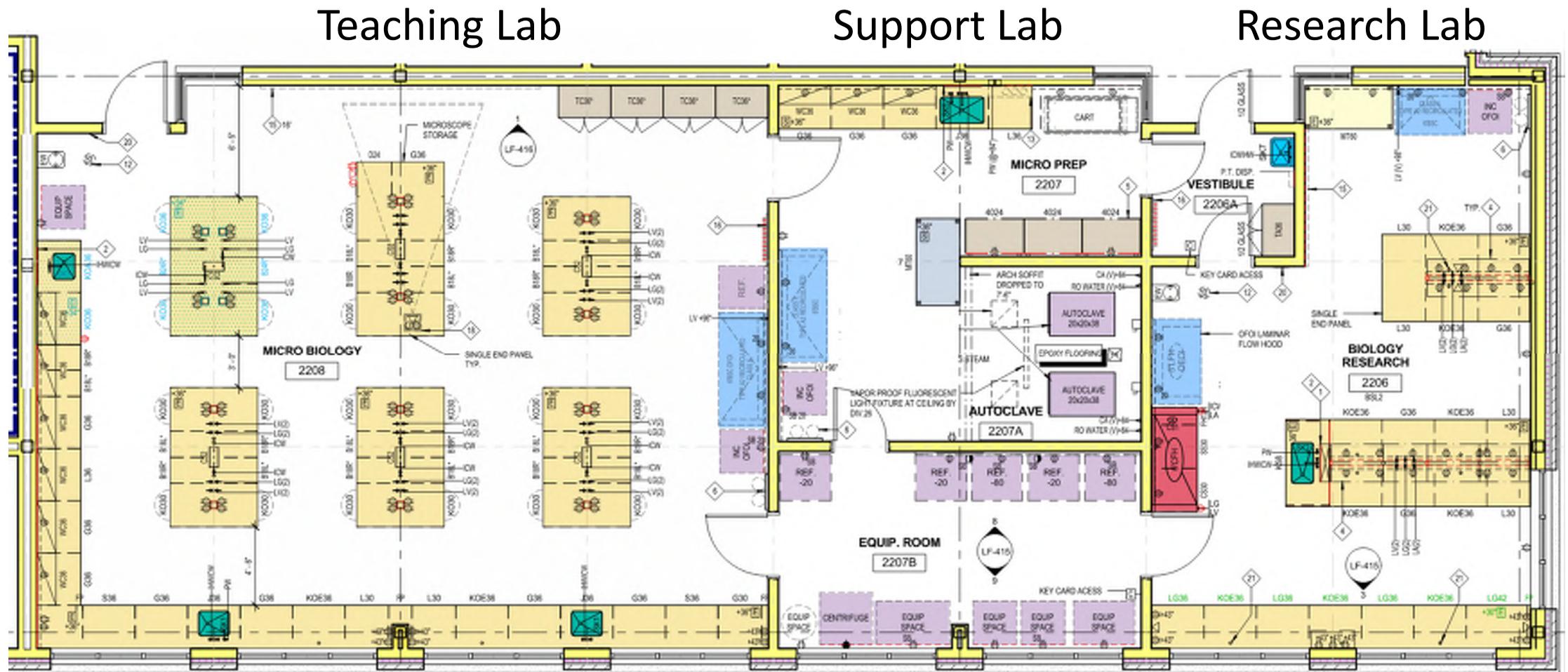


Ball State University Foundational Sciences Building

- Faculty/Student Research Labs - 2 to 4 teams
- Shared Lab for 2 Research Teams = 1,890 NSF
- Shared Lab for 4 Research Teams = 3,780 NSF
- Lab Support Rooms along Corridor
- **Research Student Desk space adjacent to Labs for ease of monitoring**

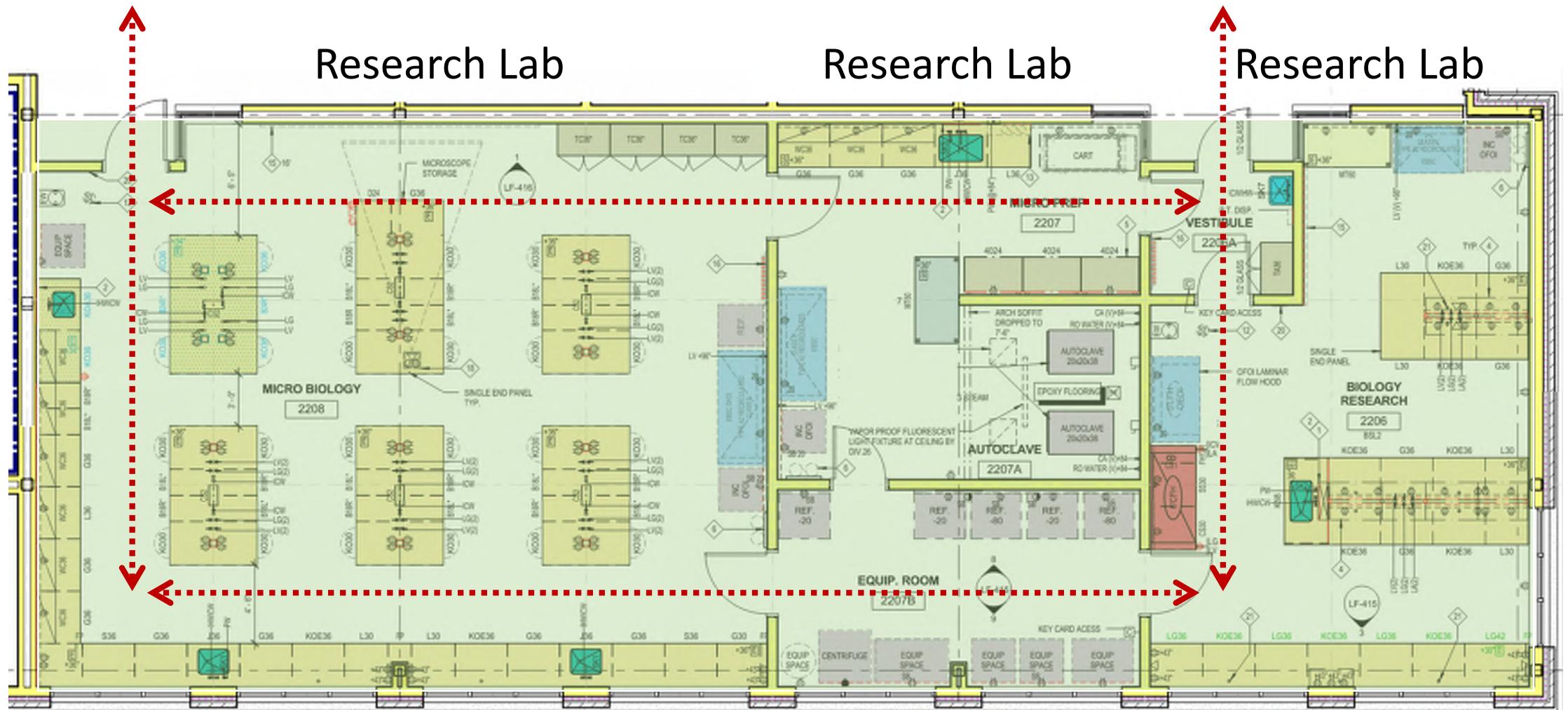


- Modest dedicated Research allocation during the academic year
- Coupled with Teaching Laboratory for extended use during the summer
- Shared Laboratory Support Space in between





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- Shared Laboratory Support Space in between





# Environments for Discovery

# Flexibility in Research Laboratories - Flexible Benching



# Environments for Discovery

# Flexibility in Research Laboratories – Separated Write-up



# Presentation Outline

## 1) Considerations for Science & Technology Facilities

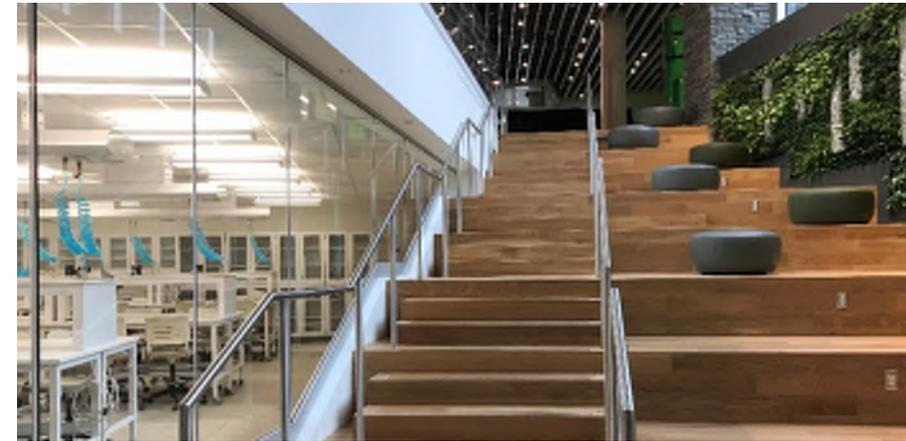
- 1) The STEM Programs
- 2) Developing Communities
- 3) Recruitment & Retention
- 4) Engaged, Active & Applied Learning- Changing Pedagogy
- 5) Transparency, Connections & Extended Learning

## 2) Planning Trends for Science & Technology

- 1) Building Planning Considerations
- 2) Science and Engineering Learning Laboratories
- 3) Environments for Discovery

## 3) Programming Tools - Benchmarking & Metrics

- 4) Case Studies
- 5) The Take Aways

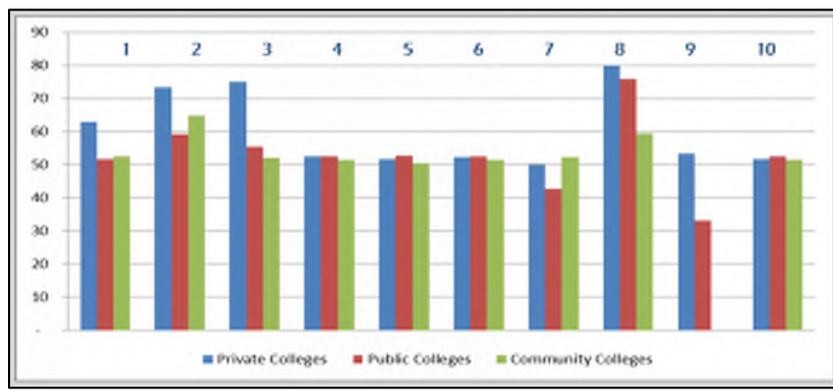
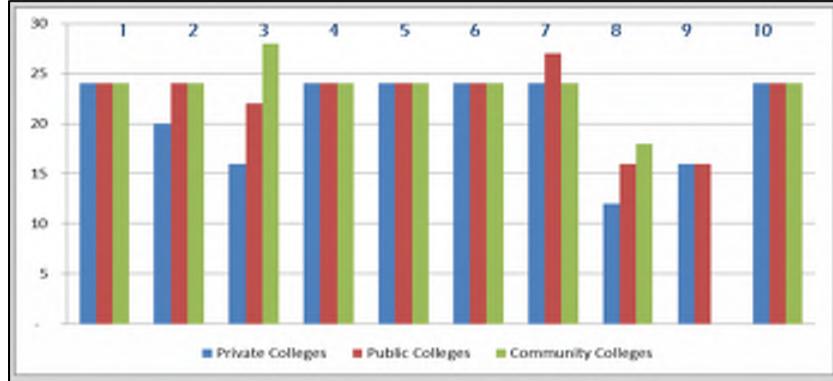
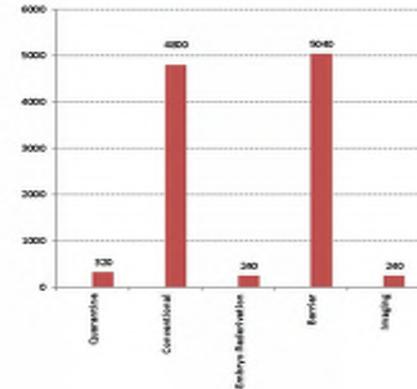


# Programming Tools

# Benchmarking Database

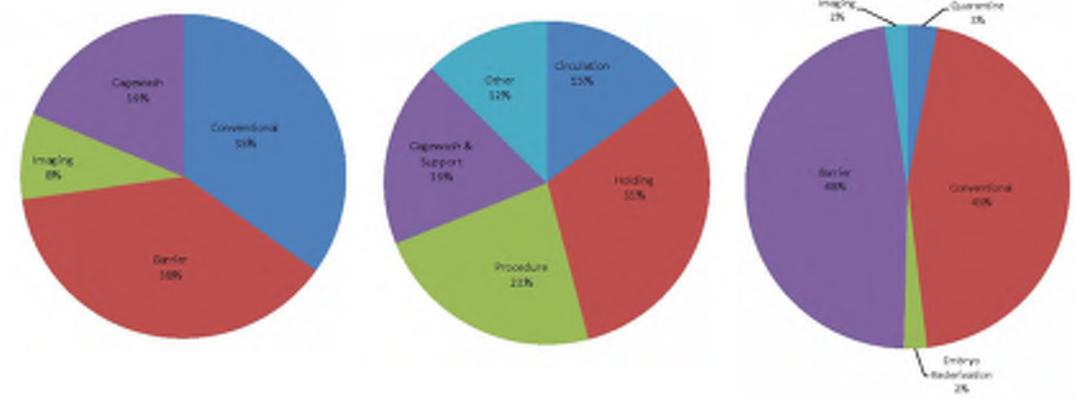
## Benchmarking Application to Your Project

- Use as a 'Guide' not a 'Predictor'
- Align with Similar Projects
- Checks and Balances



## ROOM LIST / SPACE TABULATION

Overall Space Summary						Uj													
Department	Option "A" - Reduce Pfs				March 27, 2012 Total	Delta	Option "B" - Reduce All				March 27, 2012 Total	Delta							
	Lab	Support	Office	Other			Lab	Support	Office	Other									
1 College of Science	13,740 15 108	8,400 38%	13,390	2,050	37,580	-13,360	20,310 23 152	12,390 38%	15,990	2,250	50,940	0							
2 College of Engineering	12,690 15 108	7,665 38%	8,550	1,600	30,505	-12,035	19,260 23 152	11,130 37%	10,350	1,800	42,540	0							
3 Core Facilities	0	4,830	0	0	4,830	0	0	4,830	0	0	4,830	0							
4 Vivarium	0	31,350	0	0	31,350	0	0	31,350	0	0	31,350	0							
5 Building Facilities	0	3,150	0	6,800	9,950	0	0	3,150	0	6,800	9,950	0							
<b>Total ASF</b>	<b>26,676</b>	<b>55,395</b>	<b>21,940</b>	<b>10,450</b>	<b>114,462</b>	<b>-25,395</b>	<b>39,940</b>	<b>62,851</b>	<b>26,340</b>	<b>10,850</b>	<b>139,981</b>	<b>0</b>							
Assumed Net/Gross Ratio					<b>0.57</b>					<b>0.57</b>									
Estimated Total Building Area					<b>200,810</b>					<b>245,580</b>									
Construction Cost/GSF by Type of Space						Construction Cost/GSF by Type of Space													
Laboratory + Support		Core Functions		Vivarium		Office/Admin - Conference		Laboratory + Support		Core Functions		Vivarium		Office/Admin - Conference					
\$400		\$400		\$500		\$225		\$400		\$400		\$500		\$225					
Estimated Construction Cost						<b>\$366</b>	<b>\$73,496,053</b>						<b>\$366</b>	<b>\$89,643,421</b>					

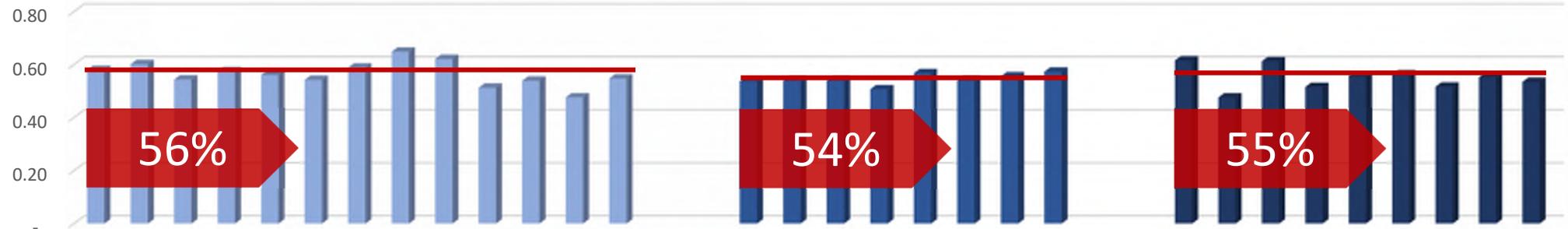


2010 - 2014

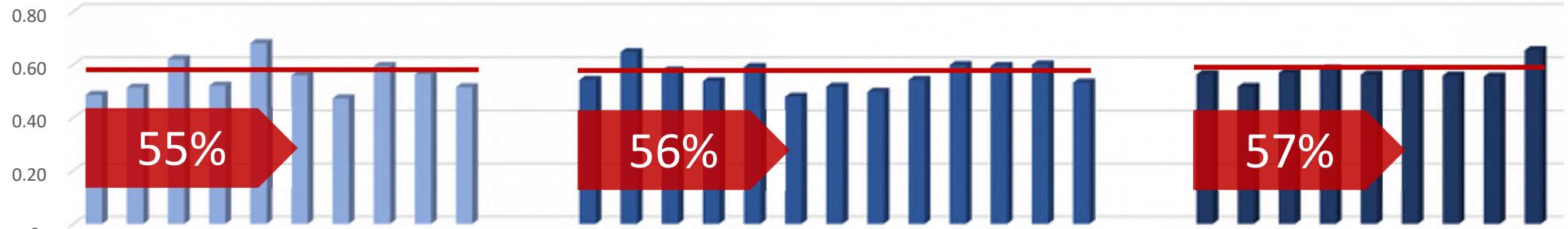
2015 - 2019

2020 - Beyond

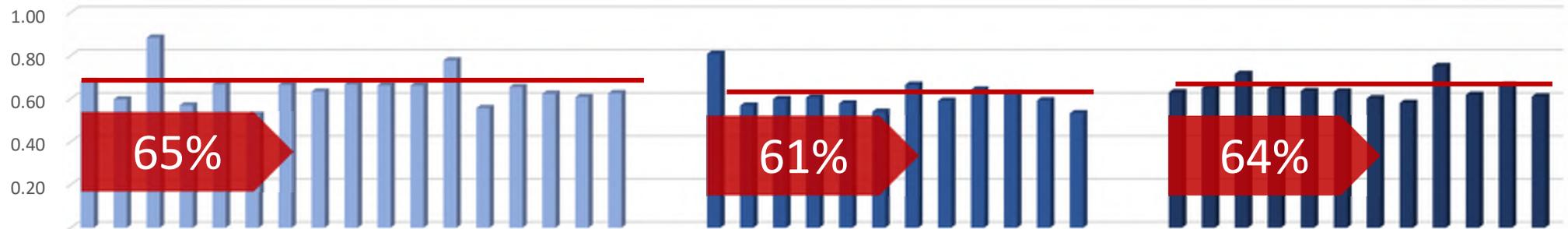
Private  
College



Public  
University

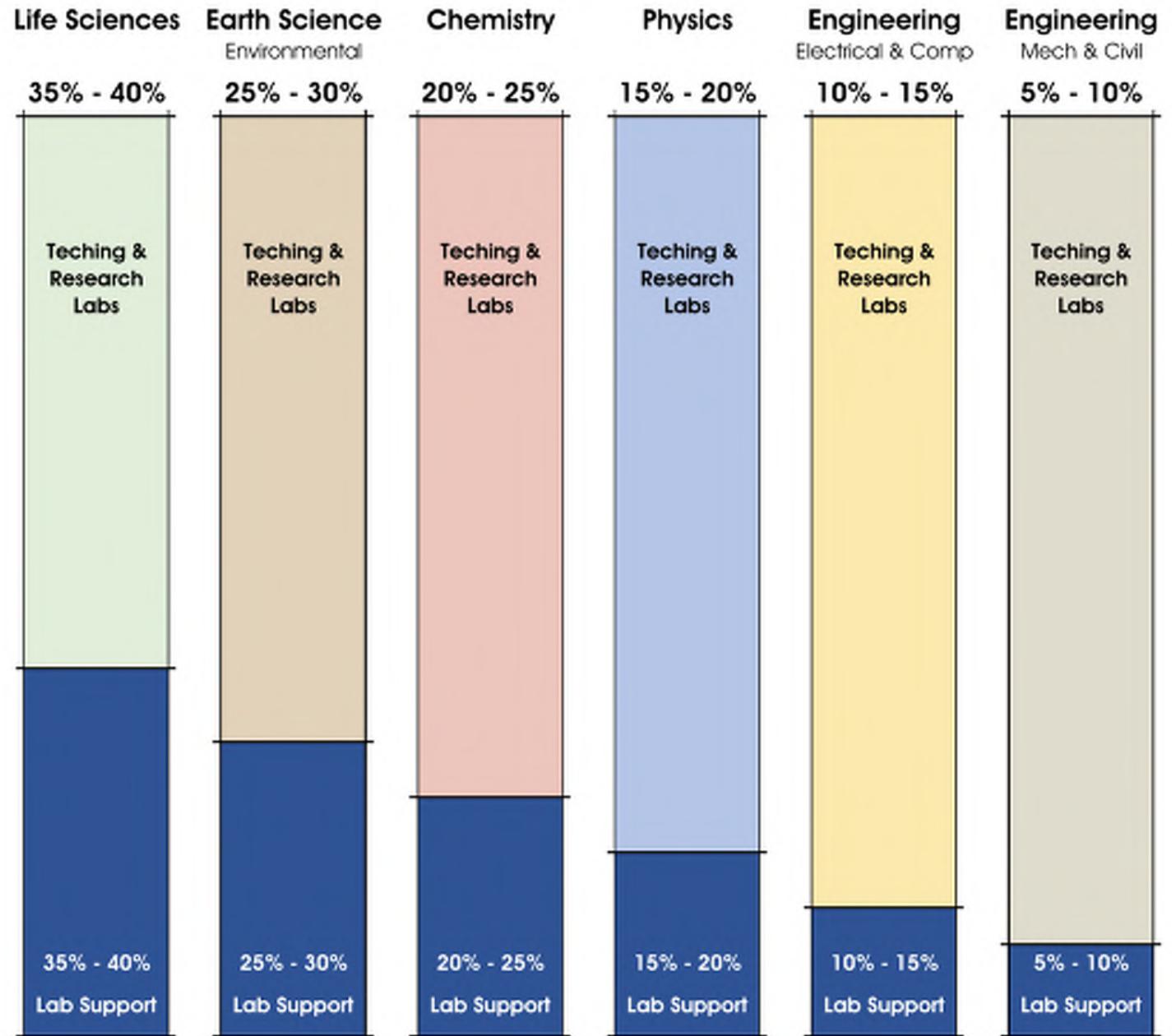


Community  
College



## Lab Support / Lab + Lab Support

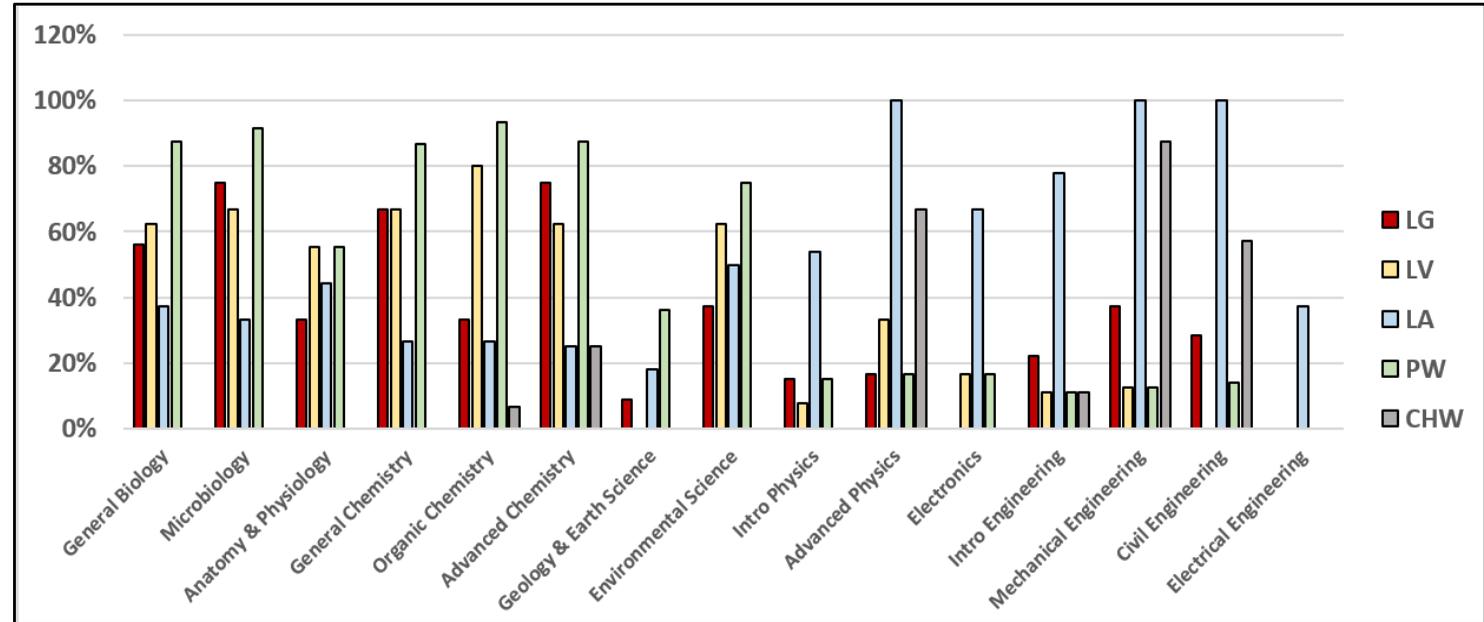
- Lab Support Ratios vary significantly by Discipline
- Life Sciences have much higher Lab Support Ratios with spaces such as:
  - Animal Facilities
  - Greenhouse / Headhouse
  - Glasswash / Autoclave
  - Media Prep
  - Controlled Environment Rooms
  - Tissue Culture
  - Equipment Rooms, etc.
- Engineering facilities have much lower Lab Support Ratios – large shared equipment tends to be located within the Teaching and/or Research Laboratories



- Overall decreasing density of piped services
- Purified Water and Lab Vacuum are still common in Biology and Chemistry
- High density of Compressed Air in Engineering Labs – much less in other disciplines
- Reduction in use of Natural Gas for Sustainability, Safety and Cost Reasons

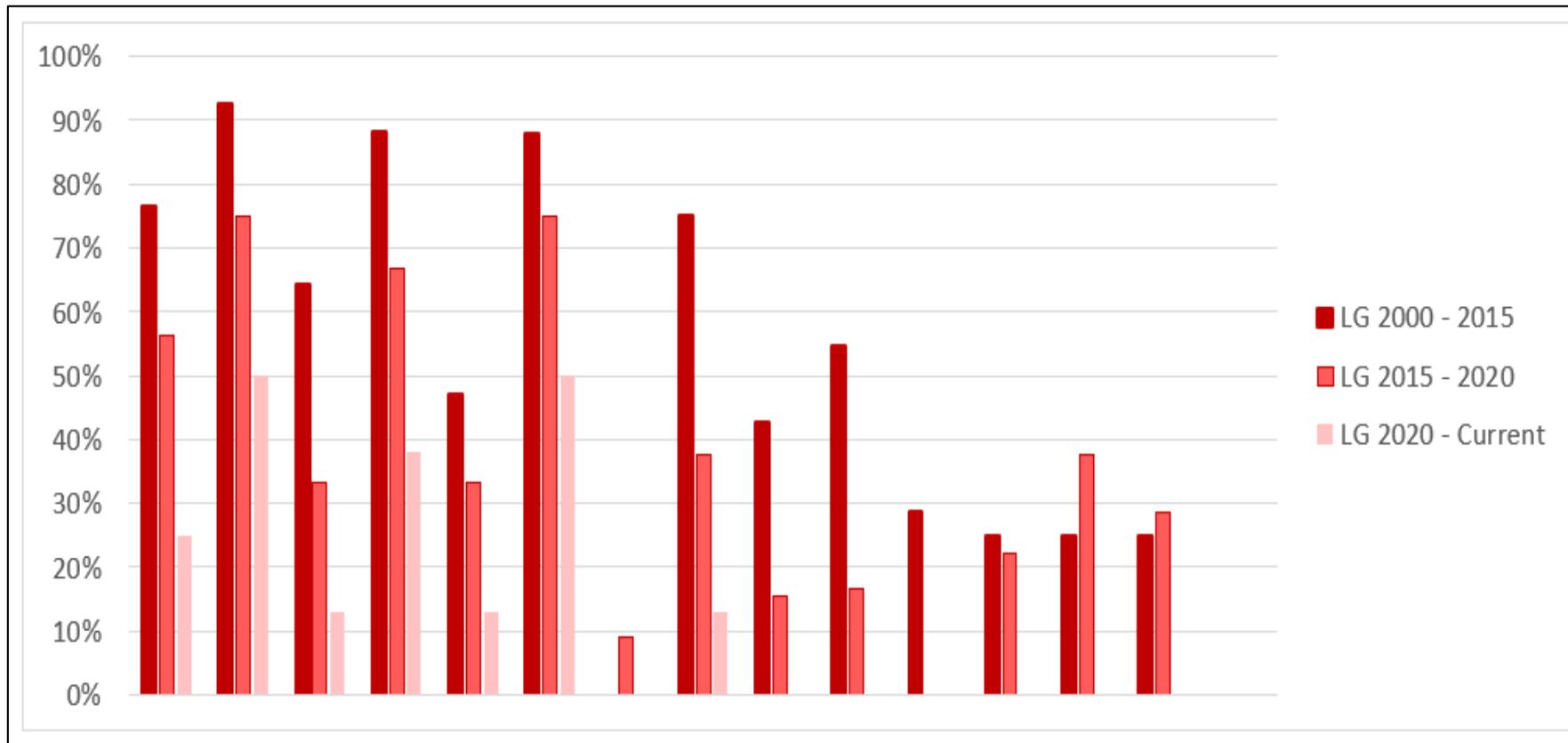
## 2015 - Current Piped Services Distribution

2015 - Current	LG	LV	LA	PW	CHW
General Biology	56%	63%	38%	88%	0%
Microbiology	75%	67%	33%	92%	0%
Anatomy & Physiology	33%	56%	44%	56%	0%
General Chemistry	67%	67%	27%	87%	0%
Organic Chemistry	33%	80%	27%	93%	7%
Advanced Chemistry	75%	63%	25%	88%	25%
Geology & Earth Science	9%	0%	18%	36%	0%
Environmental Science	38%	63%	50%	75%	0%
Intro Physics	15%	8%	54%	15%	0%
Advanced Physics	17%	33%	100%	17%	67%
Electronics	0%	17%	67%	17%	0%
Intro Engineering	22%	11%	78%	11%	11%
Mechanical Engineering	38%	13%	100%	13%	88%
Civil Engineering	29%	0%	100%	14%	57%
Electrical Engineering	0%	0%	38%	0%	0%



- Overall decreasing density of piped services
- Purified Water and Lab Vacuum are still common in Biology and Chemistry
- High density of Compressed Air in Engineering Labs – much less in other disciplines
- **Reduction in use of Natural Gas for Sustainability, Safety and Cost Reasons**

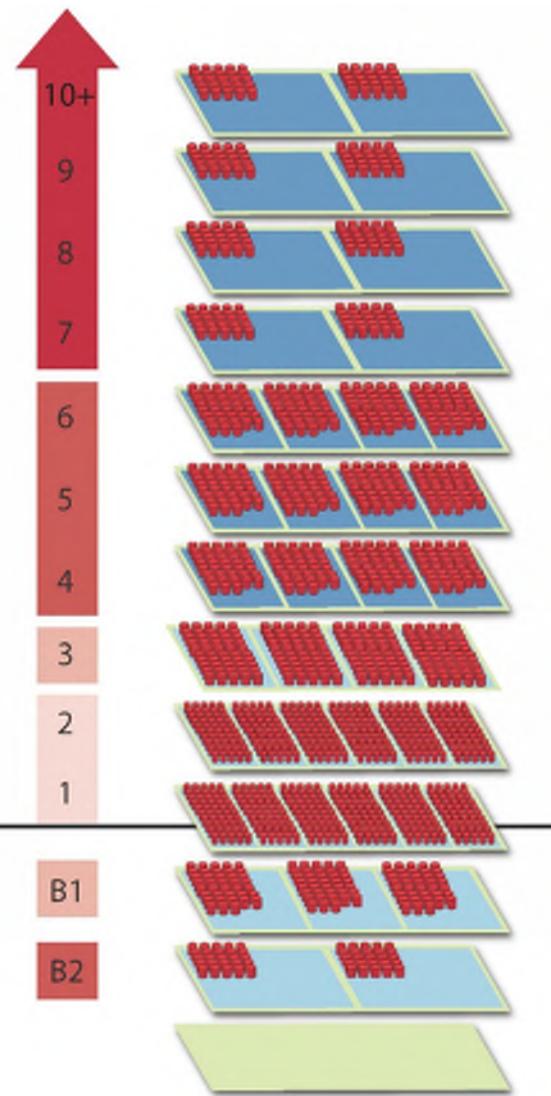
## Comparison - Natural Gas Reductions in Teaching Labs



**Higher Ed Lab Exception:** Laboratory Suites → more materials allowed & more zones allowed

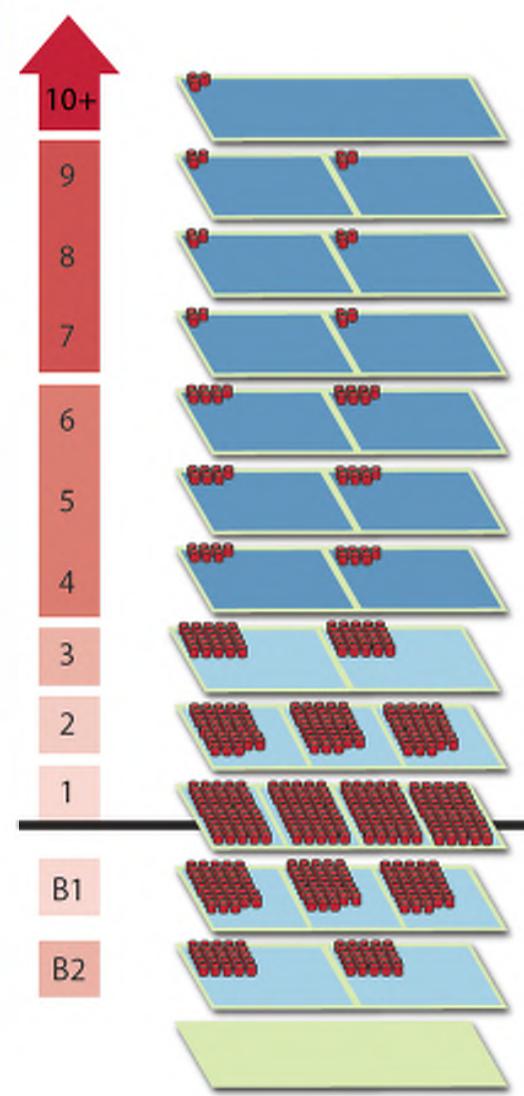
2018 IBC - Table 428.3  
**LABORATORY SUITES** Allowed as "B" Occ. in a Building  
 & Percentage of Maximum Allowable Quantites per Control Area  
 Higher Education Laboratories

Floor	Maximum # of Lab Suites per Floor	Percentage of Maximum Allowable Quantity per Lab Suite			
10	1	50%	50%		
9	2	50%	50%		
8	2	50%	50%		
7	2	50%	50%		
6	2	75%	75%	75%	75%
5	2	75%	75%	75%	75%
4	2	75%	75%	75%	75%
3	2	100%	100%	100%	100%
2	3	100%	100%	100%	100%
1	4	100%	100%	100%	100%
B1	3	75%	75%	75%	75%
B2	2	50%	50%		
B3	0	0%			



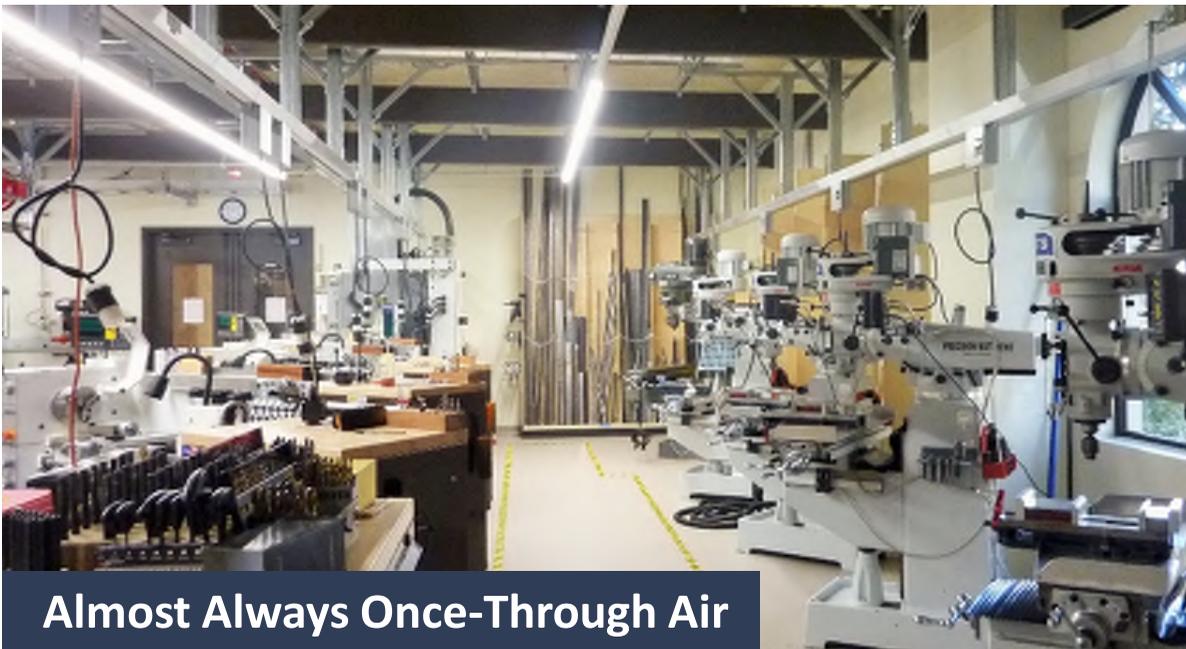
2021 IBC - Table 414.2.2  
**CONTROL AREAS** Allowed within a Building  
 & Percentage of Maximum Allowable Quantites per Control Area

Floor	Maximum # of Control Areas per Floor	Percentage of Maximum Allowable Quantity per Control Area	
10+	1	5%	
9	2	5%	5%
8	2	5%	5%
7	2	5%	5%
6	2	12.5%	12.5%
5	2	12.5%	12.5%
4	2	12.5%	12.5%
3	2	50%	50%
2	3	75%	75%
1	4	100%	100%
B1	3	75%	75%
B2	2	50%	50%
B3	0	0%	



# Programming Tools

# Laboratory Ventilation Air



## Recirculating Air:

- Computer Sciences
- AR/VR
- Astronomy



## Sometimes Recirculating Air:

- Physics
- Engineering
- Geology
- Earth Science



## Always Once - Through Air (Minimum Make-up Air)

- Maker Spaces
- Shops
- Mechanical & Civil Engineering



## Always Once - Through Air

(Required Elevated Air Change Rates)

- Chemistry
- Organic Chemistry
- Anatomy & Physiology
- Biology



# Presentation Outline

## 1) Considerations for Science & Technology Facilities

- 1) The STEM Programs
- 2) Developing Communities
- 3) Recruitment & Retention
- 4) Engaged, Active & Applied Learning- Changing Pedagogy
- 5) Transparency, Connections & Extended Learning

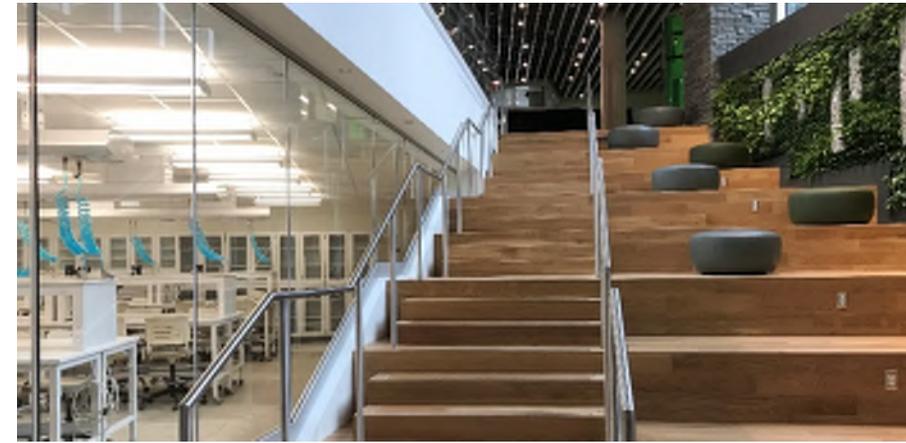
## 2) Planning Trends for Science & Technology

- 1) Building Planning Considerations
- 2) Science and Engineering Learning Laboratories
- 3) Environments for Discovery

## 3) Programming Tools - Benchmarking & Metrics

## 4) Case Studies

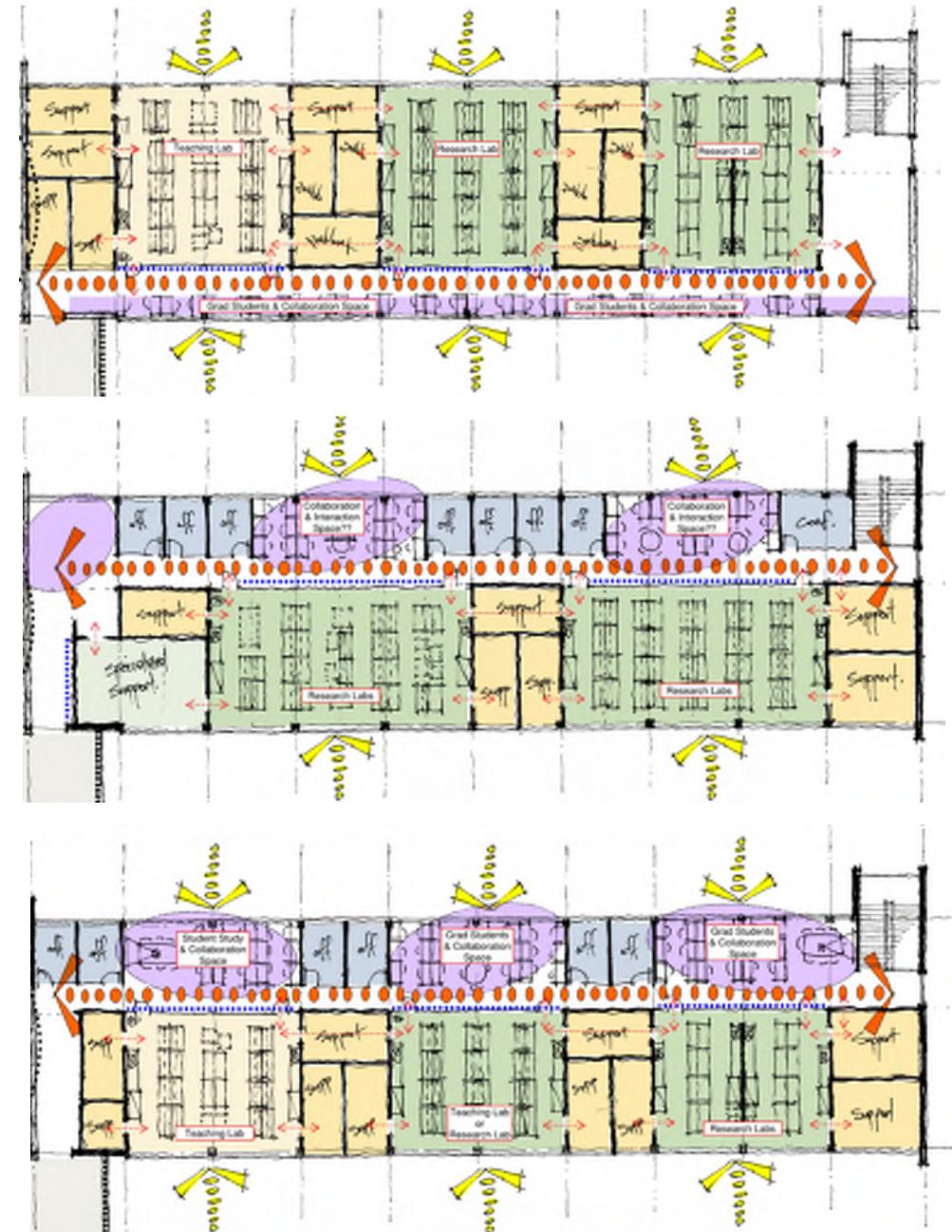
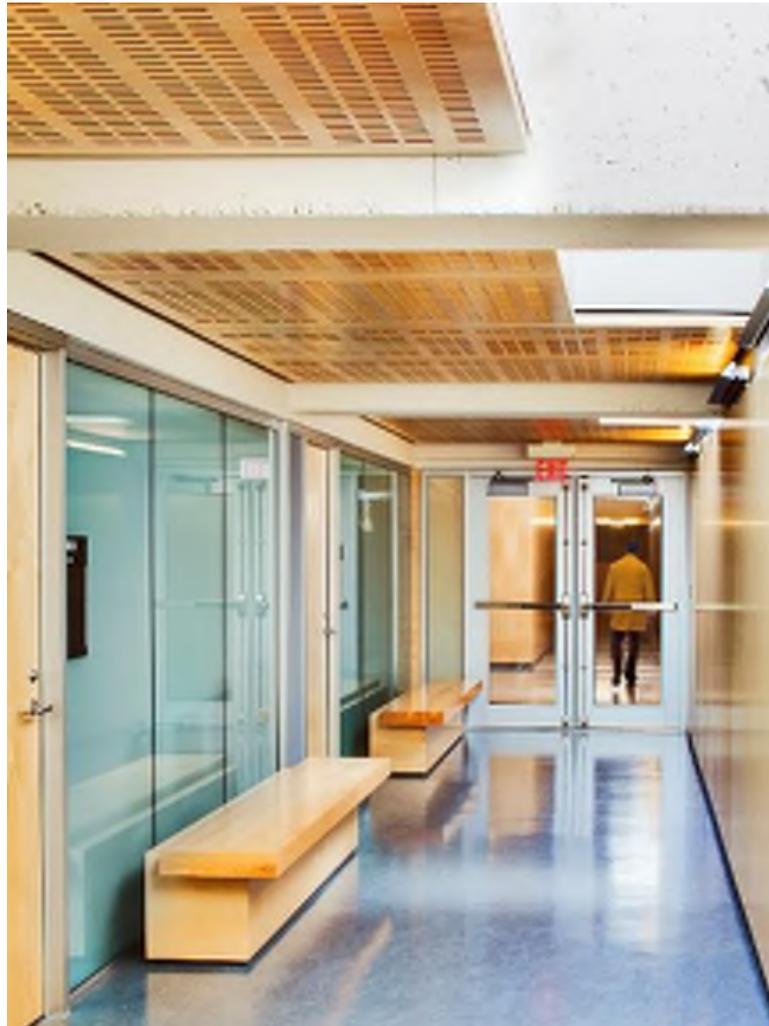
## 5) The Take Aways



# Case Study

# Utah State Renovating for Research – Big Moves

- Transform Spaces for Modern Research Labs
- Consider Shifting Circulation Patterns to Achieve Flexibility
- Activate and Daylight Corridors

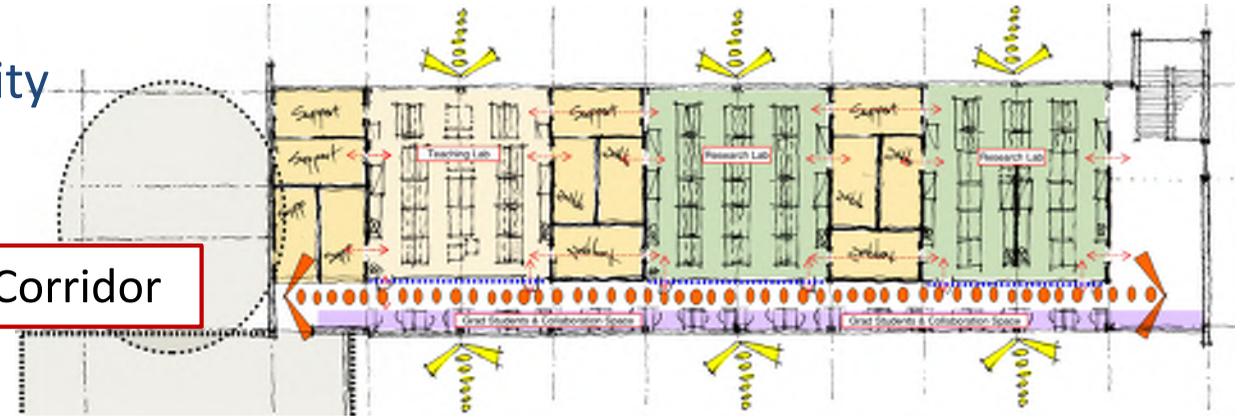


## Case Study

## Utah State Renovating for Research – Big Moves

- Transform Spaces for Modern Research Labs
- Consider Shifting Circulation Patterns to Achieve Flexibility
- Activate and Daylight Corridors

Offset Corridor



## Case Study

## Arizona State University, ISTB7



### Rob and Melani Walton Center for Planetary Health

- 228,300 GSF
- Research (“wet”): 19,000 nsfl
- Lab Support: 18,800 nsfl
- Net/Gross: 63%
- Lab Support/Total Lab Area: 48%
- Laboratory Types:
  - Interdisciplinary Science
  - Engineering Design & Fabrication
  - Institute of Human Origins (IHO)
  - Atmospheric Studies
  - Advanced Energy
  - Engineering High Bay
  - Computational



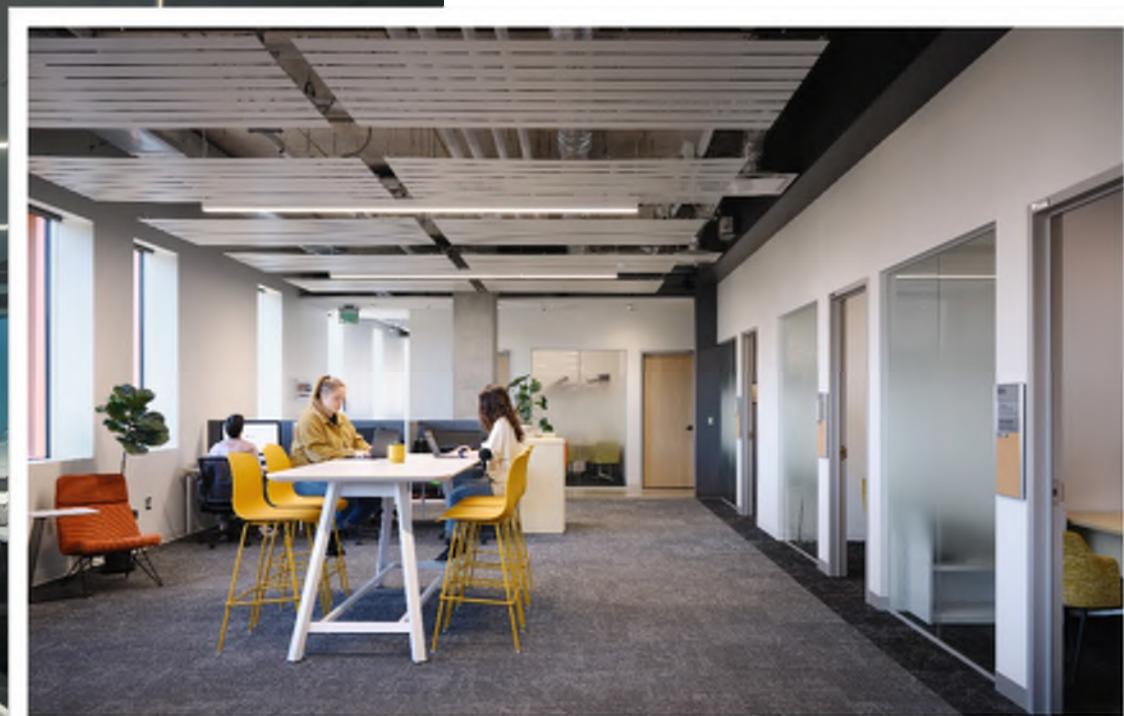
## Case Study

## Arizona State University, ISTB7



# Case Study

# Arizona State University, ISTB7

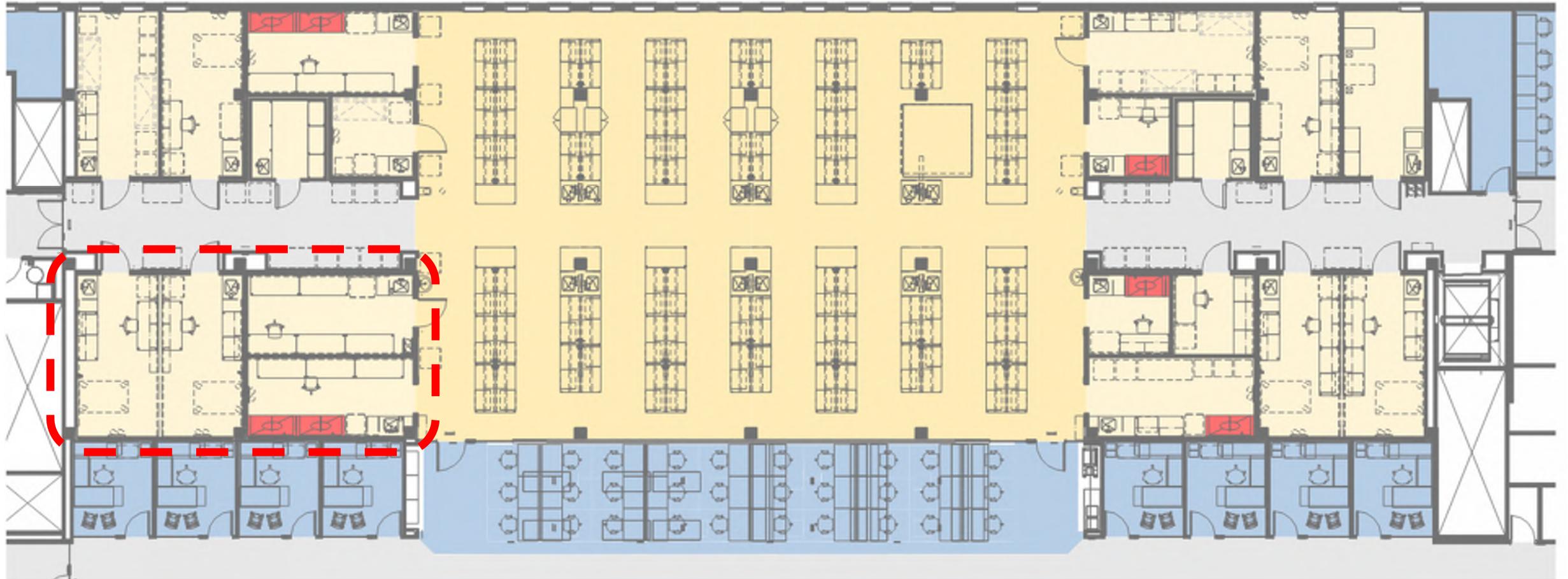




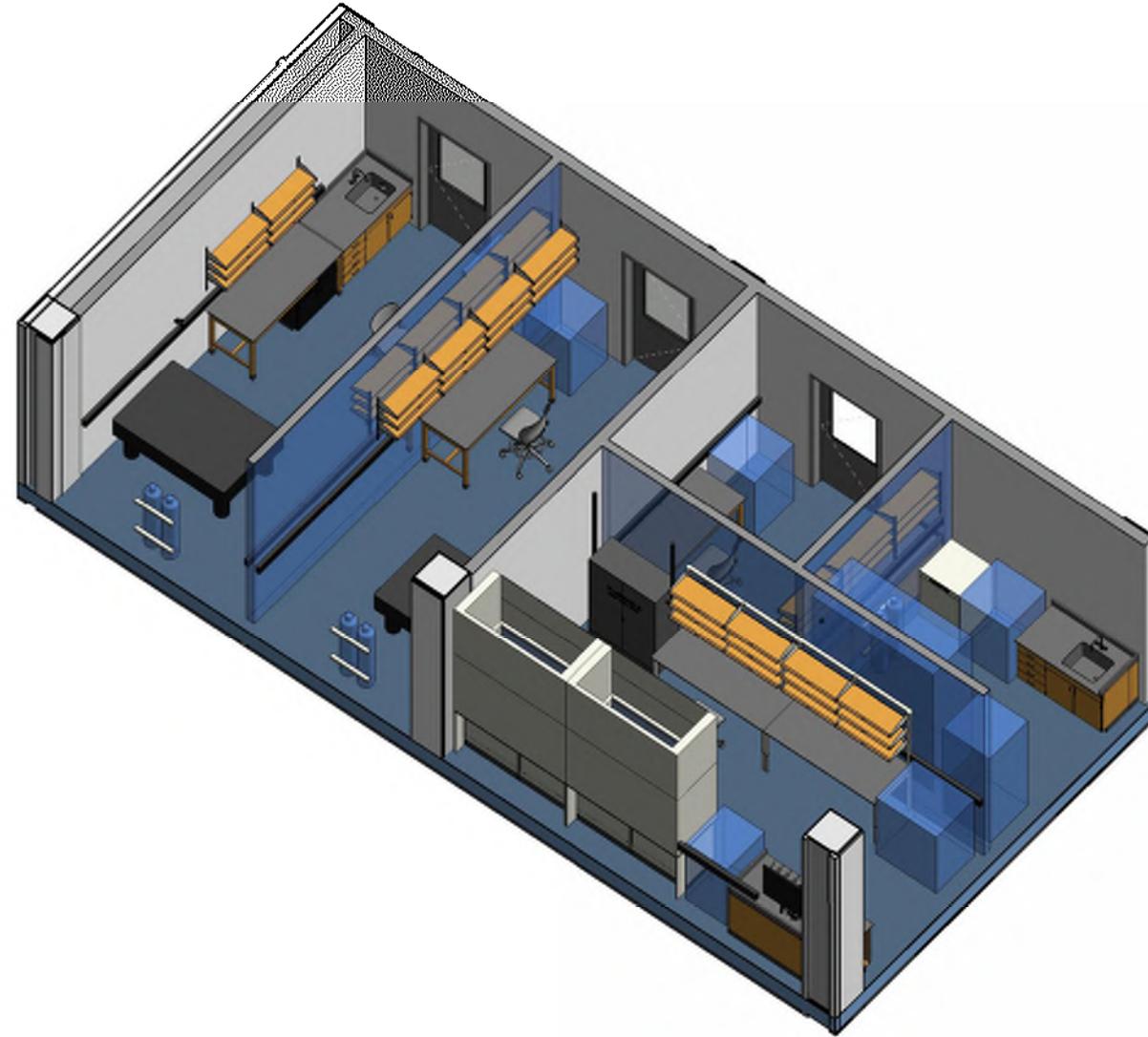
ISTB7 - ARIZONA STATE UNIVERSITY

## Case Study

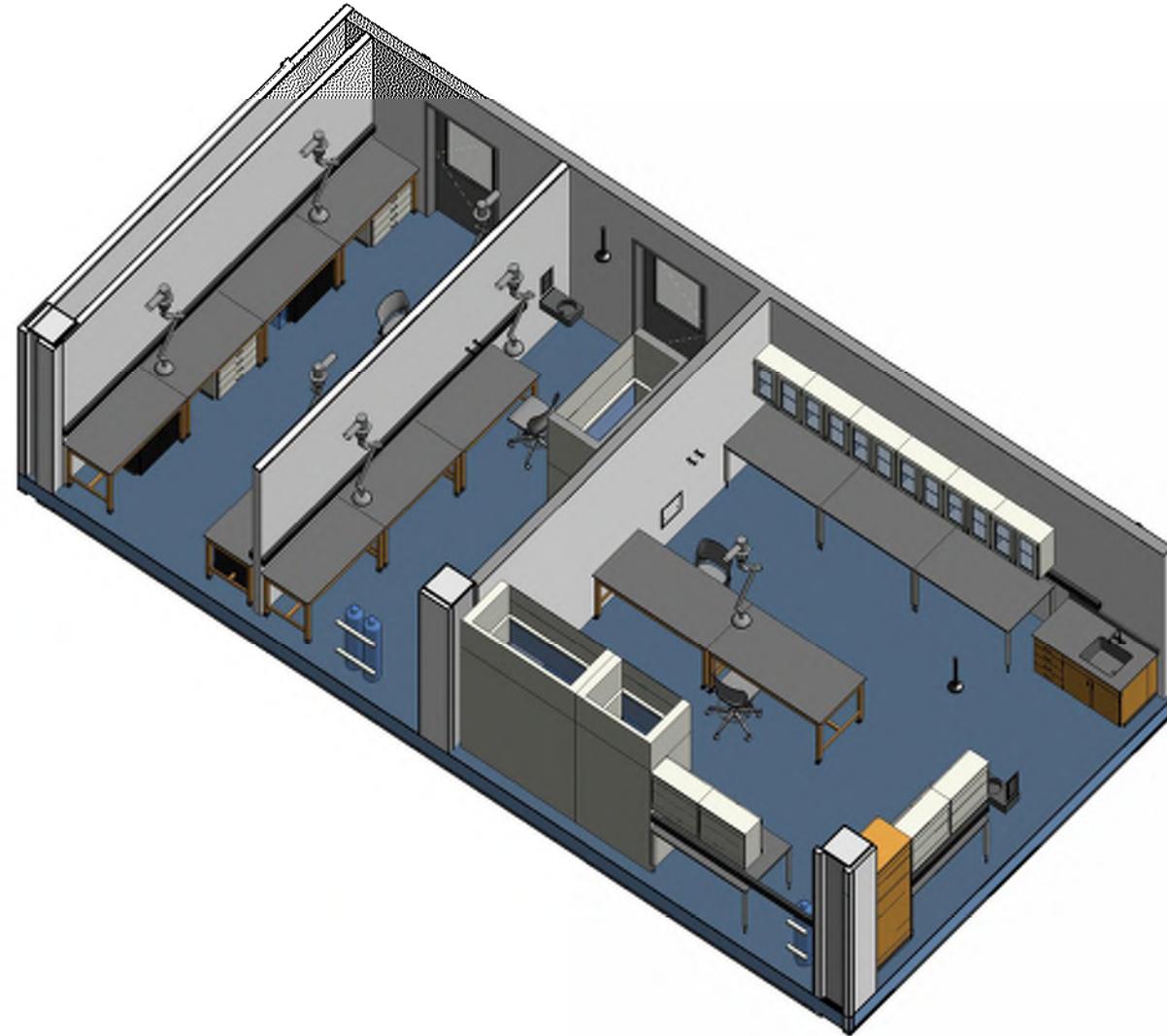
## Arizona State University, ISTB7











## Case Study

## Arizona State University, ISTB7



## Case Study

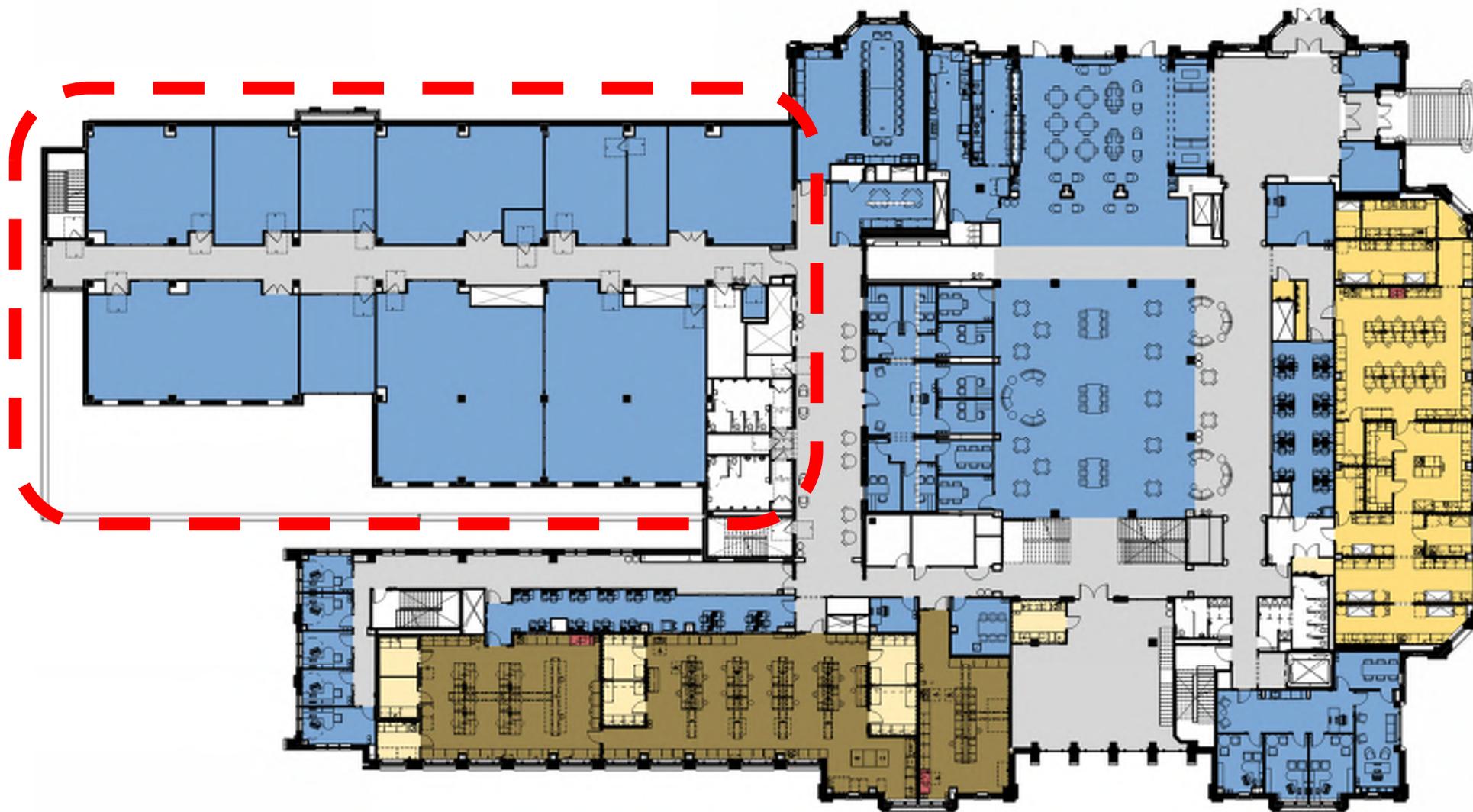
## Villanova University Drosdick Hall



### Lab Support / Lab + Lab Support

- 150,000 GSF
- Research: 31,000 nsfl
- Teaching: 11,000 nsfl
- Support: 6,400 nsfl
- Net/Gross: 60%
- Lab Support/Total Lab Area: 13%
- Laboratory Types:
  - Engineering
  - Advanced Energy
  - Materials
  - Water Research Laboratory
  - Soil Research
  - Biomaterials
  - Robotics
  - Shop





LEVEL 1 FLOOR PLAN

- COLOR DIAGRAM**
- RESEARCH
  - TEACHING
  - SUPPORT
  - OFFICE
  - CORRIDOR
  - FUME HOOD

## Case Study

## Villanova University Drosdick Hall



## Case Study

## Villanova University Drosdick Hall



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# Case Study

# Villanova University Drosdick Hall



# Case Study

# Villanova University Drosdick Hall



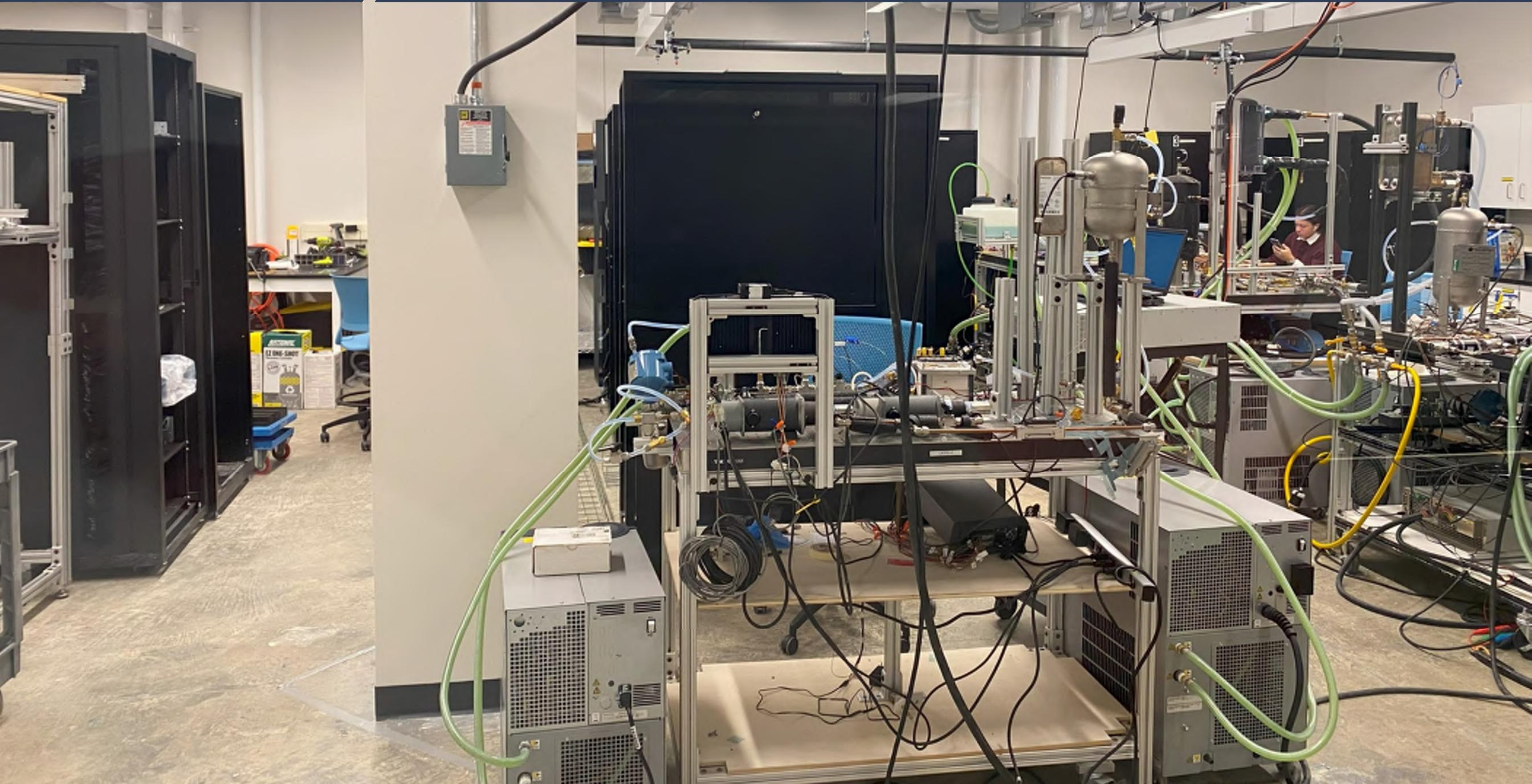
# Case Study

## Villanova University Drosdick Hall



## Case Study

## Villanova University Drosdick Hall



## Case Study

## Villanova University Drosdick Hall



## The Take Aways

- 1. Extend your Learning Environments whenever possible.**
- 2. Teaching Laboratories have changed to match current Pedagogy**
- 3. Determine what are the Critical Design considerations for your Laboratories**
- 4. The next major renovation for your new facility may be 50 years away. Plan for adaptability and flexibility to extend the life of the facility.**



Please Sign In

# RESEARCH FACILITIES DESIGN

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