MISSOURI
S&T

Manufacture Missouri Ecosystem

Manufacturing Complex for Science, Technology and Prototype Development

Facility Program Study March 2021

MACKEY MITCHELL ARCHITECTS

Missouri University of Science & Technology

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Key Functions of the MME

Integrate

Collaborate

Network

Accelerate

De-Risk

Enable

2. Executive Summary

Vision Statement

The MME will be headquarters for a statewide ecosystem, where experts, innovators, small and large businesses, entrepreneurs, educators, and policy-makers develop and adopt the technologies needed to create and sustain manufacturing jobs in Missouri.

Summary

A reflection of the statewide ecosystem of manufacturing and technology it serves, the MME is conceived as a place where industry and academia come together to research new materials and methods, prototype and test new manufacturing processes, and solve multi-discipline problems required to bring integrated cyber-physical manufacturing systems into practical use.

The collaborative work for which this new facility is intended requires flexibility to move back and forth between suites of traditional lab, office, and conference spaces, and large, secure, well-appointed high-bay manufacturing lab spaces. Placing these dual work environments adjacent to one another in each discipline will allow fluidity of movement required for rapid prototyping, as well as visual transparency to improve communication, coordination of the work, and safety for all occupants.

The first new building of the MME campus is organized around the four fundamental disciplines of the manufacturing ecosystem itself:

Materials, Manufacturing & Methods
Pre-Production Testing & Development
The Forge – Steel and Advanced Metallurgy
Cyber-Physical Systems Security, Testing & Development

Each of these individual discipline areas is characterized by and will be designed around current and evolving needs for both space and equipment in both the office/lab suites and high-bay research and production facilities, with a loose-fit flexibility to accommodate the continual evolution of the work, the technology, and the relationships.

To maximize interdisciplinary collaboration and facilitate communication required to leverage ideas from prototype to production, the building arranges these four discipline areas around a bright, open, and energetic central core of shared circulation, conference, and amenity spaces. Ample glazing on the interior and exterior of all levels allows the new facility to communicate both its purpose and its processes.

Executive Summary Cont'd

Materials, Manufacturing, & Methods

Work in this discipline area focuses on new approaches and technologies for advanced material fabrication, including both additive and subtractive processes. In collaboration with research and academic staff from Missouri S&T, material suppliers, fabricators, and manufacturers will combine computer modeling, material science, and high-technology fabrication equipment to create innovative new materials, resolving complex fabrication problems that would otherwise prevent them from practical use in manufacturing.

Pre-Production Testing & Development

In this discipline area, established manufacturing companies will work with Mechanical Engineering, Manufacturing Engineering, and Robotics specialists from Missouri S&T to improve the functioning, precision, and efficiency of existing automated manufacturing equipment, from individual machines and processes to entire production lines. By designing generous height, area, and technological infrastructure into this discipline's high-bay space, companies will be able to prototype, test, and perfect entire new systems without interrupting the operation of their existing manufacturing facilities.

Spaces and features within this center are expected to include:

- Loading docks (to move equipment in/out of the building as equipment will be moved out in order to setup new projects)
- General machine shop (welding, precision cutting, grinding, polishing, manual machining, lathe, EDM, etc.)
- Robotic assembly/disassembly center
- 3D scanning/Reverse engineering center (needs to be dust free)
- Raw material production center: Powder maker, wire maker, etc.
- Additive manufacturing center: with 4 to 5 major AM processes
- CNC machining center: with 3 to 4 processes (Lathe, mill, turn, etc.)
- Quality inspection center (needs to be dust free)
- Automated material handling vehicles: automated guided vehicles between major manufacturing cells.

Executive Summary Cont'd

"The Forge" – Steel and Metals

The Forge will be a one-stop shop where you can design materials from atom up and then put it through the pilot processing facility. In this discipline area, materials engineers and research scientists from Missouri S&T will use advanced, large-scale infrastructure and machinery to explore new methods for producing, analyzing, testing, and machining ferrous and non-ferrous metals. The ability to more rapidly create and test a wider variety of ne w alloys will expand Missouri manufacturers' toolkit of available materials for use in structural, industrial, and aerospace applications.

Processes in this program area will include:

- Melting
- Casting
- Hot Roll Milling
- Quenching
- Processing of materials such as steel, titanium and aluminum and allowys
- Testing using spectrometers, OES, LECO, XRF and cryogenic using portable chillers

Processes under consideration to be included:

- HIPping (Hot Isostatic Processing)
- Forging
- 3D Sand printing molds

Cyber-Physical Security Testing & Development

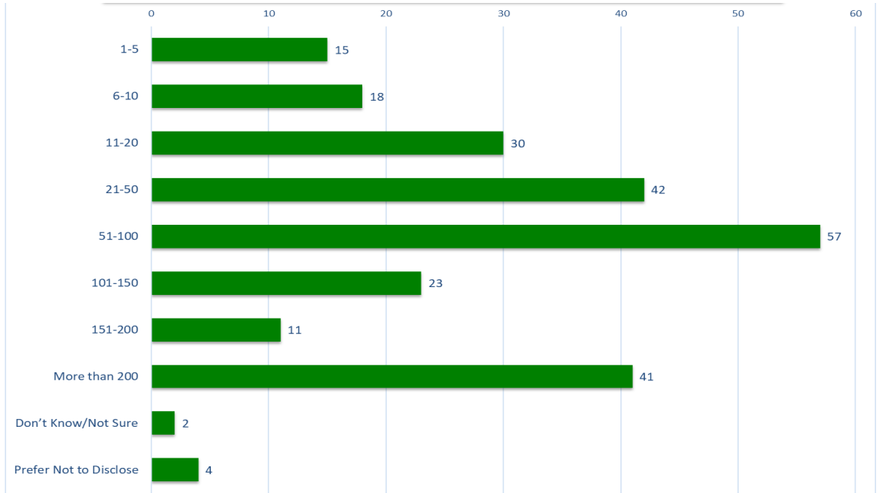
Essential to Industry 4.0 manufacturing and production, Cyber-Physical systems require multi-disciplinary coordination to design, implement, operate, and maintain. To cultivate the mix of software, wireless communications, and hardware expertise necessary to service and collaborate with all other discipline areas, the Cyber-Physical discipline group is both self-contained and itinerant.

This group will have its own lab space to continually innovate, test, and refine new automation systems and controls, and to investigate and help solve discreet problems for manufacturers already employing cyber-physical systems. Its location within the new building should reflect the itinerant, embedded consulting relationship they are likely to have on multiple projects throughout the facility and the State.

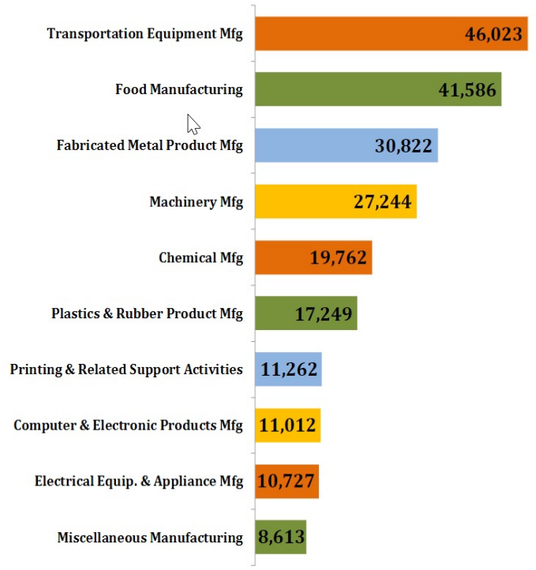
Executive Summary Cont'd

Missouri Enterprise October 2020 Manufacturing Policy Survey

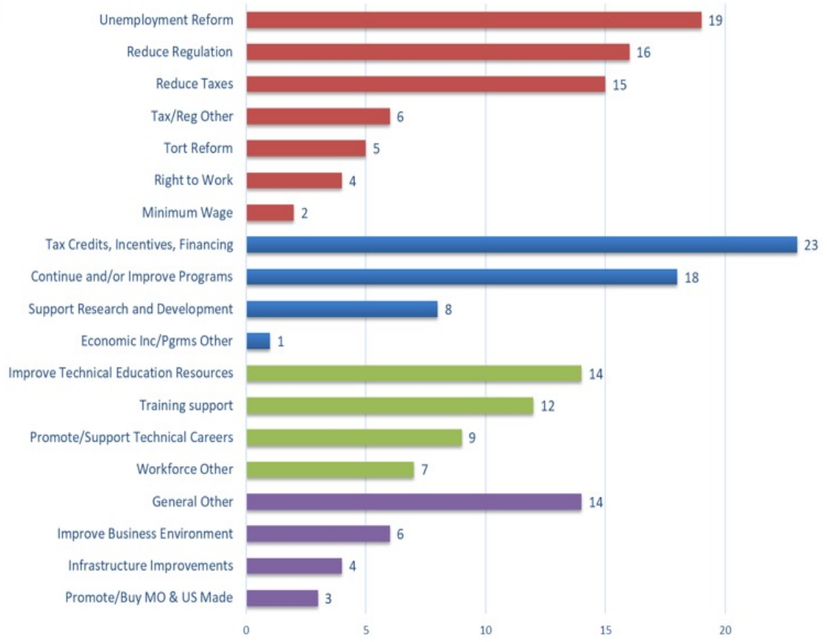
Q22 How many people does your company employ in Missouri?



Top Ten Manufacturing Industries in the State by Direct Employment



Q20 What can the State of Missouri do to help manufacturers grow?



Q5 Is there any specific manufacturing business issue you've sought help with but had difficulty finding a useful resource to assist you?

Workforce issues

"Labor resources and attracting talent. Need 14 new employees since March 2020. Still need 14 September 2020."

"Finding new employees with the required basic skills is difficult. We also have a difficult time finding temporary, or contract, resources with the skills needed to be effective in our environment."

"How to minimize turnover"

"Employee soft skills"

"Local trade school has not had the needed curriculum or level of instruction needed for transferable skills."

Other issues

"Compliance issues with conflict minerals, RoHs, etc."

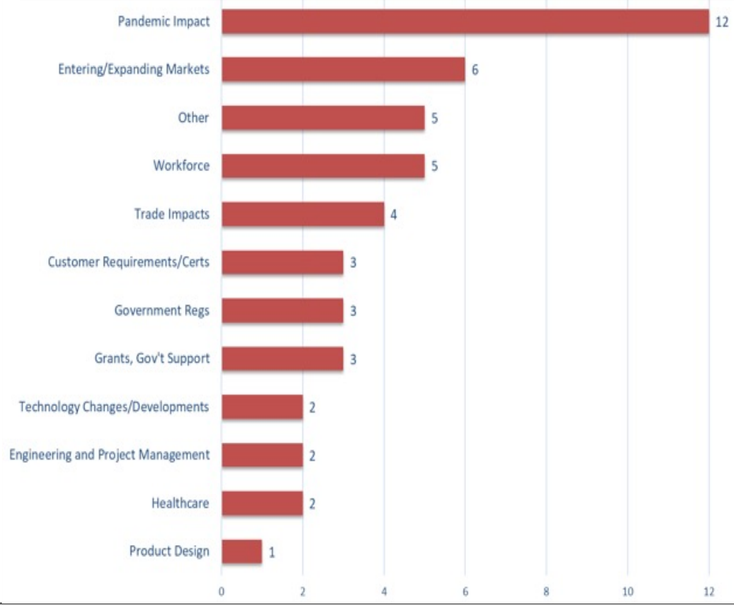
"New DOD Cyber Security Requirements"

"I run a business that uses high speed resistance welding and we have sought out expertise on electrodes, entrons, and integration of robotix, but there are few experts in the field."

"We have tried for many years to identify new sourcing for a key raw material, but we have had no luck."

"Automation integration, IIOT and mfg. 4.0"

Q13 Are you concerned about any specific manufacturing business topics that give you a strong feeling of "I don't know what I don't know"?



Context

2020 Campus Master Plan

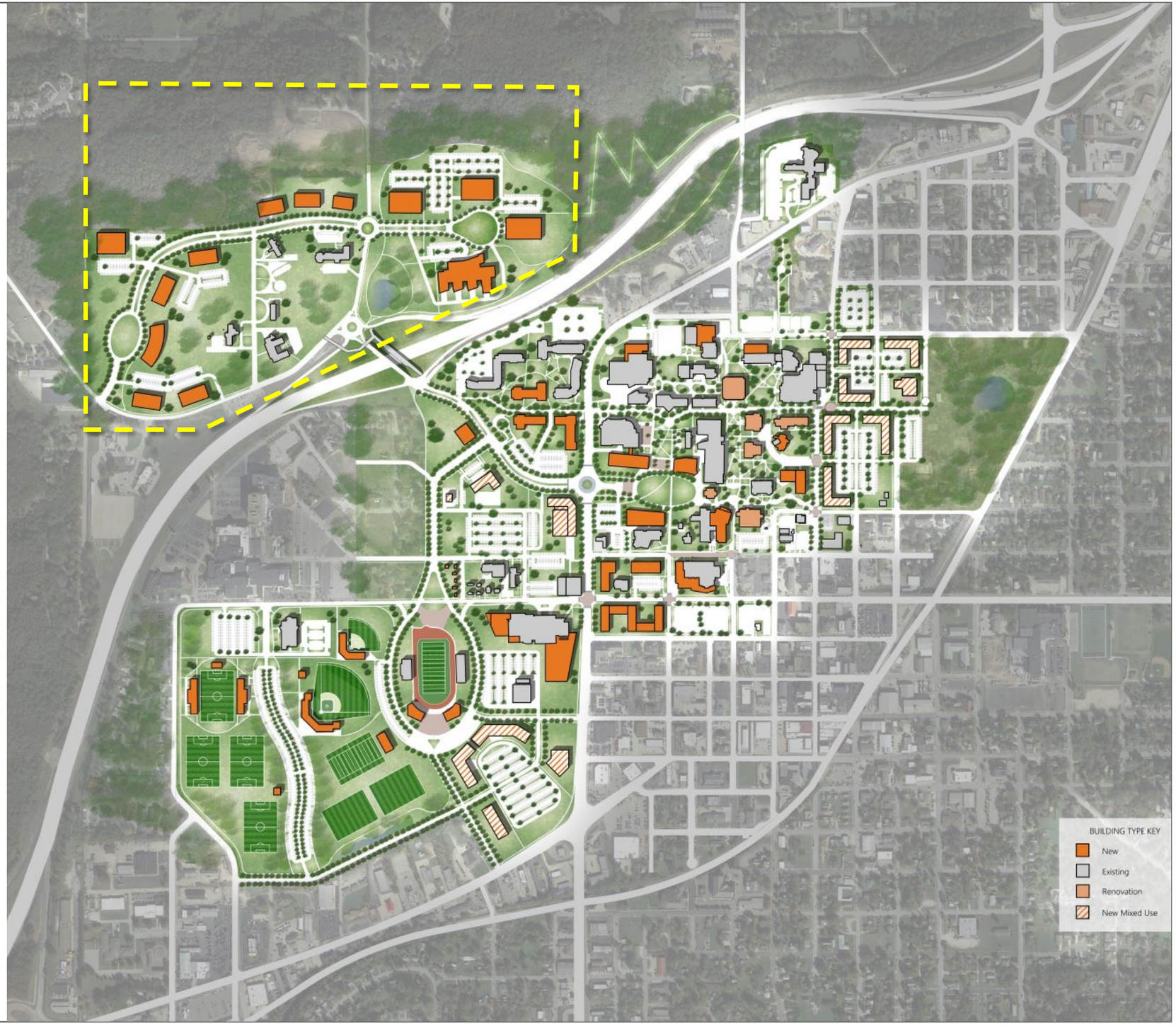
Missouri S&T's recently completed Campus Master Plan created several development areas on campus for strategic partnerships of different types. These development areas are oriented toward three key strategic priorities for Missouri S&T :

- Recruitment and Retention
- Research, Innovation and Entrepreneurial Thinking
- Regional Economic Development

As a catalytic component of the planned R&D Park, the new MME Facility will serve to support all three of those strategic priorities. As a national model for manufacturing research and development, the MME will improve the University's status and increase applied research and experiential learning opportunities for undergraduate, graduate and post-doc students.

In creating this ecosystem, established and emerging companies can cross disciplines and combine intellectual horsepower to work on complex problems leading to innovative solutions and techniques. The increased applied research activity will help lead S&T to its aspirational Carnegie Research 1 classification.

The new facility will enable the State's manufacturers to work with S&T's research talent and top companies (often their customers) to develop new knowledge, techniques and processes. This will allow Missouri's manufacturers to be more competitive and better equipped to respond to changes in industry.



Context

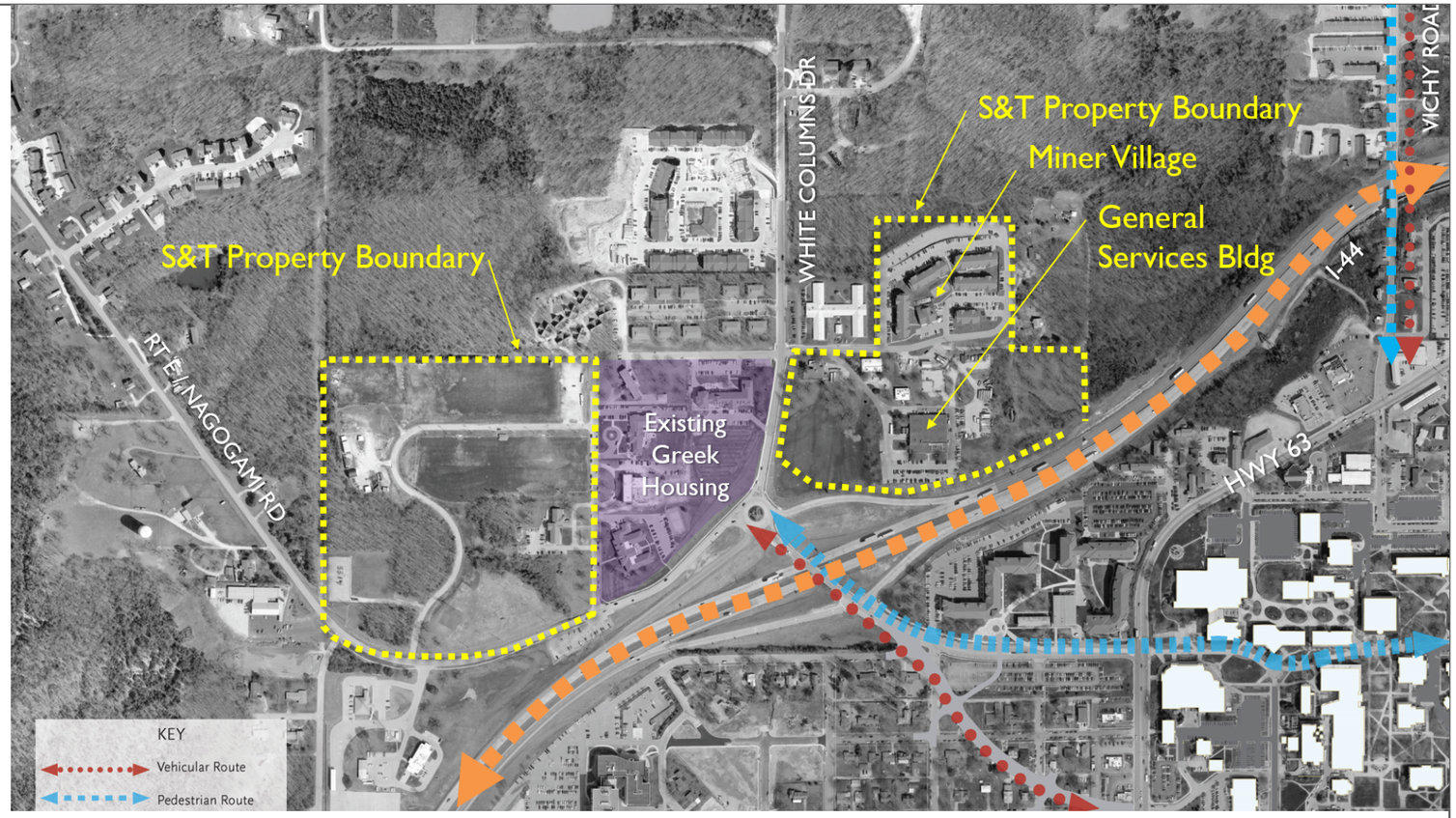
2020 Campus Master Plan Cont'd

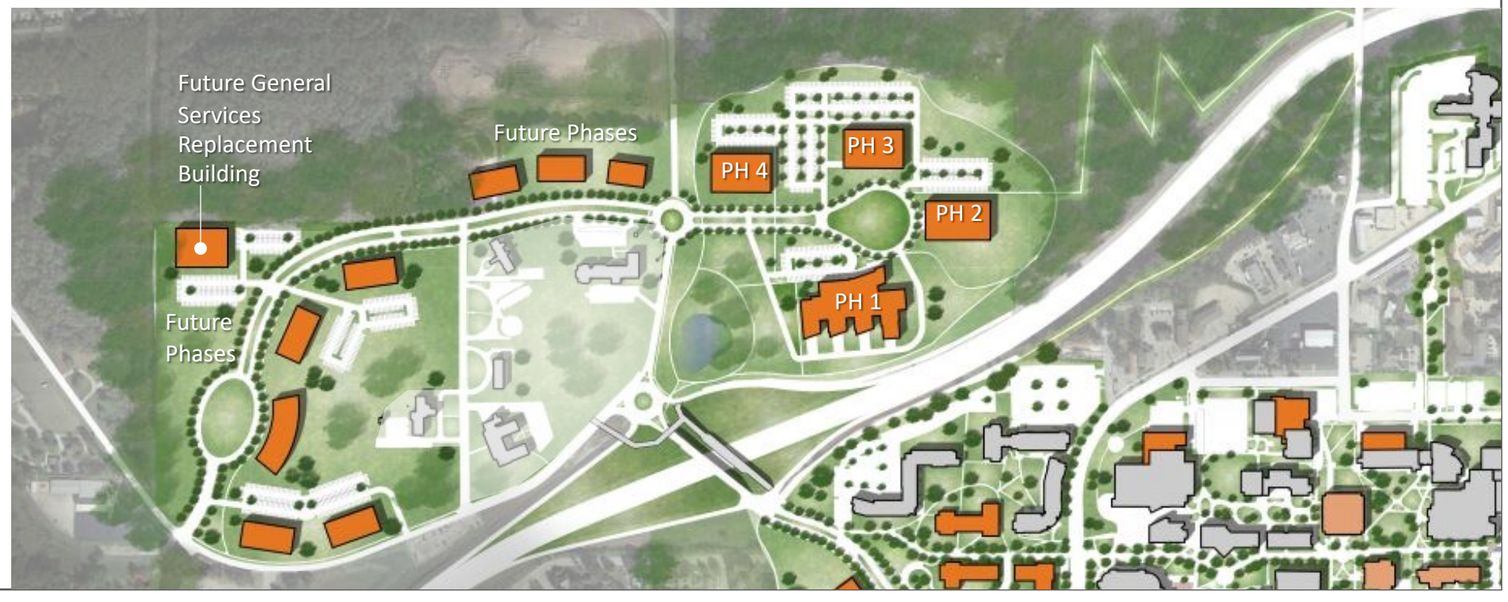
The Campus Master Plan advances the 2014 and 2017 Master Plan proposals for an R&D/Corporate Partnership zone north of I-44. This use type makes good sense for this area of campus as it is separated from the academic campus by I-44 which will serve to identify the R&D Park as a more professional environment versus an academic environment. The recently connected pedestrian bridge serves to provide a safer and more attractive connection to this part of campus.

The proposed site for the new facility is the current location of the General Services Building. Adjacent to the GSB are a mix of small buildings housing programs/functions that will need to replaced prior to construction of a new facility. In addition to General Services, other impacted programs/functions include the Compressible Flow Laboratory, The E3 Commons and the Dangerous Materials Storage Facility. Replacement facilities will be required for General Services as well as Dangerous Materials Storage.

The Campus Master Plan identifies potential future growth of the R&D Park beyond the first phase. Future growth east of White Columns Drive will be impacted by adjacent properties which S&T may or may not yet own. Sites east and north of the Phase 1 site include wooded ravine areas which will require careful study for future development.

The area west of the Greek residential area is primarily available however, these sites will require moving intramural and rugby fields. The Campus Master Plan identifies consolidation of athletic and rec functions to an Athletics and Mixed-Use district at southwest corner of 10th and Hwy 63/Bishop Ave.





Context

View of site from south end of new pedestrian bridge over I-44

Program Summary

High Bay	80,256 SF
Lab Space	32,000 SF
Workspace	28,523 SF
Meeting	38,031 SF
Admin	11,212 SF
Support	33,740 SF
Total	223,762 SF

4. Programming and Analysis

Program

There are five main program areas for the new facility in support of the facility's vision and desired functionality. Important to all of them is long term flexibility and their ability, once organized, to foster an environment of creative professional exchange and knowledge sharing.

High Bay Spaces

Large (~20,000 SF) High Bay Spaces are required for three program themes – Manufacturing, Materials and Methods, Pre-Production and Testing and Steel/Metals (aka 'The Forge'). Cyber-Physical Security and Testing will require a smaller high bay space to house testing chambers and perform immunity tests. Access to high bay spaces will be restricted based on the security required for specific projects. At the overall building level, the high bay spaces will be viewable to visitors from second floor gallery spaces along the perimeters leaving the ground floor operations focused.

Each high bay/theme will need more focused program development related to equipment locations, process/flow between stations and other operational considerations.

Lab Spaces

Each high bay will be supported by adjacent lab/specialized spaces for conducting testing and research associated with their respective program theme. Lab spaces

Workspace

Much of the work performed in the building will be team based and require easy access to the high bay and lab spaces where processes and testing are occurring. Flexible, open workspace is required to support teams which will range in size and which will come and go based on projects. Teams may be made up of corporate/industry partners, personnel from local manufacturers, faculty and student workers. As open workspace, can be problematic where proprietary information is involved, small office suites and private offices are also included. Integrated into the open office environments will be lounge seating and movable whiteboards to facilitate impromptu collaborative sessions.

Meeting Space

Because the projects are primarily team based, it is important to have ample space for teams to meet in small and larger groups. Meetings will run the gamut of half hour to full day and should each include writable walls and be tech enabled. Meeting spaces should be easily accessible to the open work areas allowing for conversations to be easily carried to proximate meeting spaces. A large 100 seat meeting room and exhibit space will offer the ability to host symposia, workshops and small conferences.

Meeting spaces also include the building's cafeteria which will be a place of culture reinforcing collisions and connections. The cafeteria can be the social hub of the facility offering flexibility to host after hours events and social recreation such as table tennis and gaming.

Admin Space

The building will have two types of administrative spaces. Center directors will have private offices and embed with their respective program/themes. There will also be an administrative suite dedicated to managing the building and day to day operations.

Tabular Program

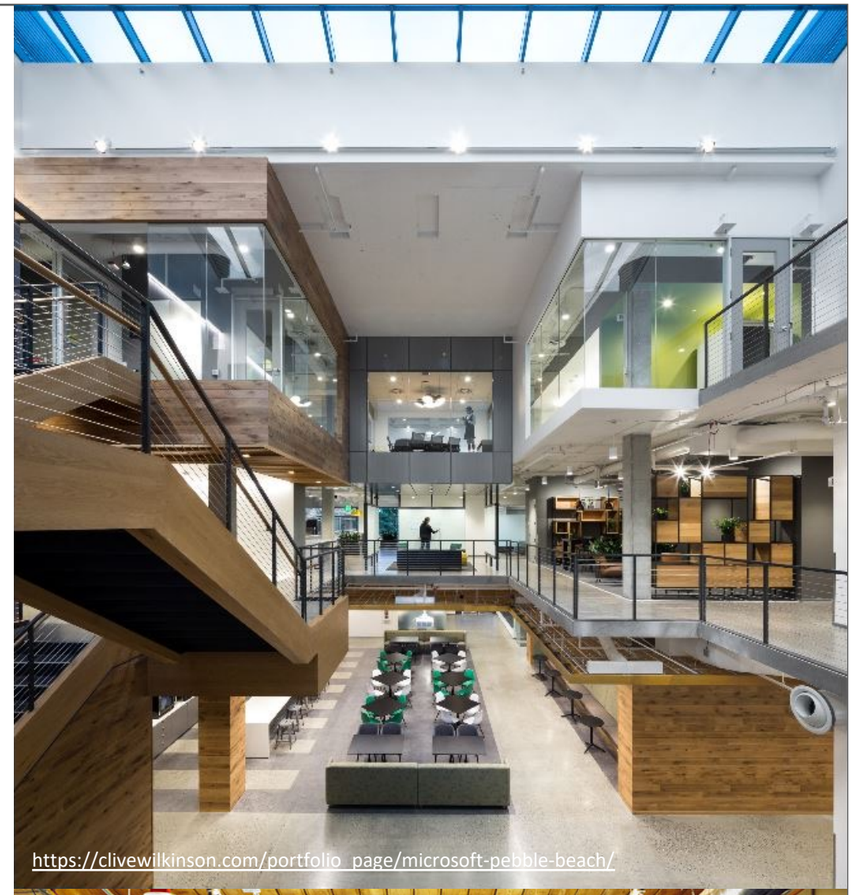
SPACES		MASTER PLAN PROGRAM # OF	SF/EA	SF	NOTES
1 HIGHBAY SPACE					
a	Material, Manufacturing, Methods	2	10,000	20,000	75'X130'
b	Pre- Production Testing & Prototype Development	2	10,000	20,000	65'X130'
c	The Forge	2	10,000	20,000	75'X130'
d	Cyber Security	1	2,600	2,600	40'X65'
	SUBTOTAL			62,600	
	Net to Gross Factor	EFFICIENCY		78%	
		TOTAL		**80,256**	
2 MEETING SPACE					
a	Large Meeting Room	1	2,500	2,500	100 people, 50% with table, dividable
b	Community Kitchen	1	1,000	1,000	includes catering kitchen
c	Community Dining/Social Hub	1	5,200	5,200	
d	Furniture Storage	2	400	800	adjacent to large meeting room
e	Meeting Rooms	9	480	4,320	18-20 people
f	Small Meeting Rooms	10	350	3,500	4-6 people
g	Flex Lounge Space	1	2,400	2,400	
h	Exhibition Hall	1	5,000	5,000	
	SUBTOTAL			24,720	
	Net to Gross Factor	EFFICIENCY		65%	
		TOTAL		**38,031**	

https://www.hdrinc.com/portfolio/carbon-neutral-energy-solutions-laboratory

https://clivewilkinson.com/portfolio_page/microsoft-pebble-beach/

Tabular Program

3	**WORKSPACE**				
	Material, Manufacturing, Methods				
a	Center Director Office		1	180	180
b	Faculty Offices		6	120	720
c	Partner Offices		2	120	240
d	Open Work Stations		45	85	3,825
		SUBTOTAL			4,965
	Pre- Production Testing & Prototype Development				
a	Center Director Office		0	180	0
b	Faculty Offices		6	120	720
c	Partner Offices		2	120	240
d	Open Work Stations		45	85	3,825
		SUBTOTAL			4,785
	The Forge				
a	Center Director Office		0	180	0
b	Faculty Offices		6	120	720
c	Partner Offices		2	120	240
d	Open Work Stations		45	85	3,825
		SUBTOTAL			4,785
	EMC, Cyber Physical Systems, and Security				
a	Center Director Office		1	180	180
b	Faculty Offices		6	120	720
c	Partner Offices		2	120	240
d	Open Work Stations		45	85	3,825
		SUBTOTAL			4,965
			TOTAL		18,540
	Net to Gross Factor		EFFICIENCY		65%
			TOTAL		**28,523**
4	**LAB SPACES**				
	Material, Manufacturing, Methods				
a	Lab		4	800	3,200
		SUBTOTAL			3,200
	Pre- Production Testing & Prototype Development				
a	Lab		4	800	3,200
		SUBTOTAL			3,200
	The Forge				
a	Lab		4	800	3,200
		SUBTOTAL			3,200
	EMC and Cyber Physical Systems and Security				
a	Lab		4	3,600	14,400
		SUBTOTAL			14,400
			TOTAL		24,000
	Net to Gross Factor		EFFICIENCY		75%
			TOTAL		**32,000**



https://clivewilkinson.com/portfolio_page/microsoft-pebble-beach/

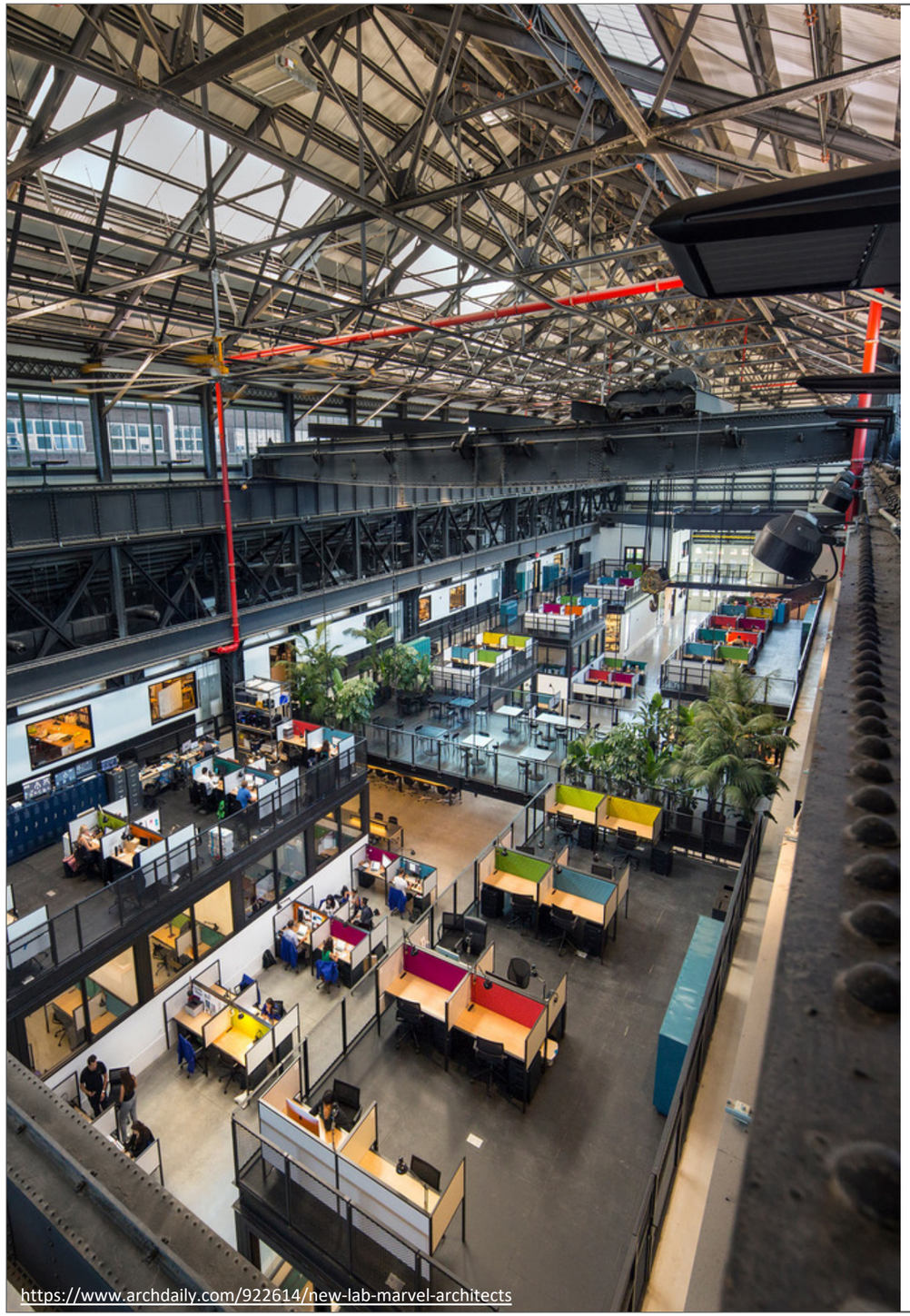
https://entrepreneurquarterly.com/feature-a-tale-of-two-districts/

Tabular Program

5	**CENTRAL ADMINISTRATIVE SPACE**				
a	Administrative Office Area		1	2,400	2,400
b	Lobby/Reception		1	5,000	5,000
		SUBTOTAL			7,400
			TOTAL		7,400
	Net to Gross Factor		EFFICIENCY		66%
			TOTAL		**11,212**
6	**HIGHBAY/LAB SUPPORT**				
a	Loading		4	800	3,200
b	Mechanical Room Allowance		4	6,400	25,600
c	Enginering Analysis and Design (EA&D) Shop		1	1,500	1,500
d	Lab Storage		16	215	3,440
		SUBTOTAL			33,740
			TOTAL		33,740
			EFFICIENCY		100%
			TOTAL		**33,740**
7	**WITHIN GROSSING FACTOR**				
a	Mechanical (also in Highbay Support)				
b	Custodial				
c	Public Toilets				
d	Hallways				
e	Wall Thickness/ Chases				

https://zenoot.com/articles/new-smart-factory-test-bed-facility-opens-at-amrc-in-sheffield/

https://www.airlinereporter.com/wp-content/uploads/2012/03/factory-tour-500x333.jpg



https://www.archdaily.com/922614/new-lab-marvel-architects

5. Program Diagrams and Floor Plans

Interior Organization

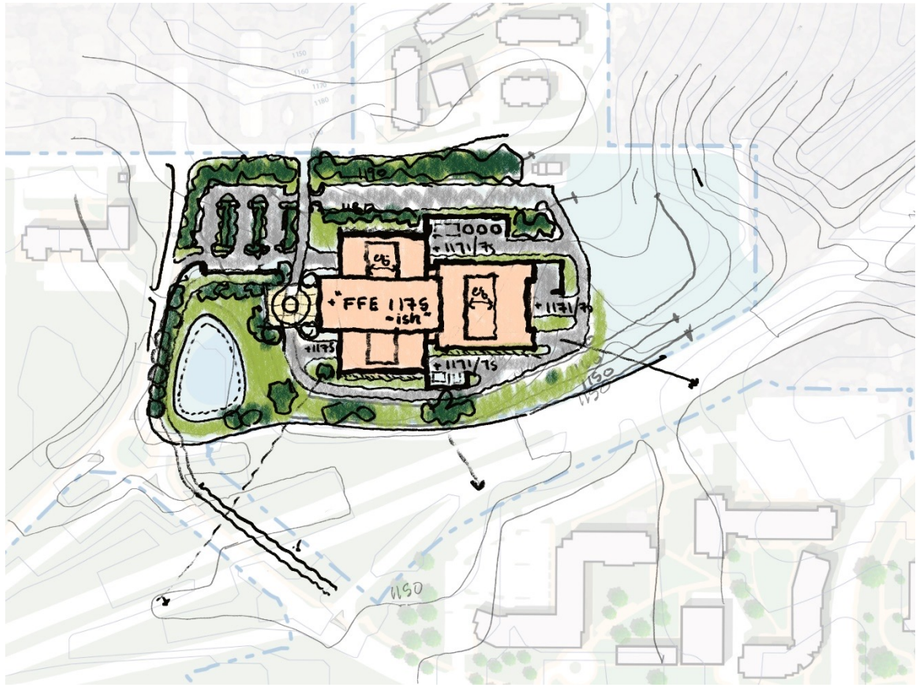
The proposed plan concept organizes space into a series of clear, yet porous and transparent layers allowing for an abundance of transparency and connectivity in service to creativity and innovation.

The central layer unifies the entire setting providing a 3-story “main street” in which a mix of lab, work, and meeting spaces are organized. The spaces are organized to encourage movement and creative collisions between different disciplines. The setting is choreographed to showcase the range of activities being pursued within the facility.

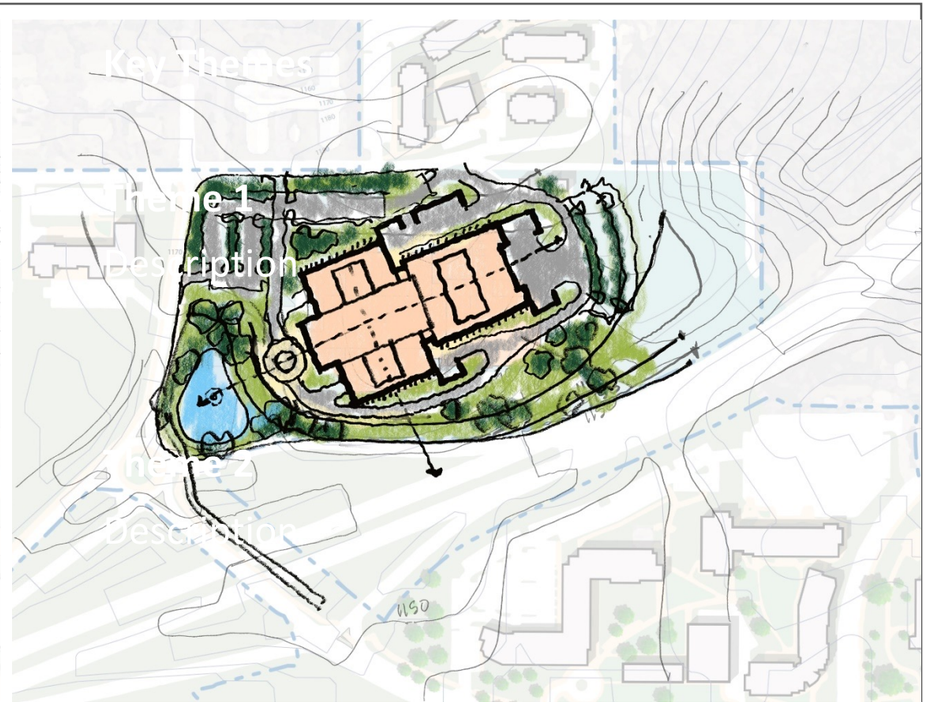
Externally the building sits as the central focal point for the new R&D Park. As such, visibility along one of the states primary thoroughfares, I-44, is leveraged to showcase the vital work and pursuits being undertaken here.

The exterior concept design celebrates S&T’s mining heritage, harkening to the cracks, rifts, and crevices one might observe in geologic formations. The resulting openings dramatically frame the activity going on within the building and provide an inspiring presence for the building from motorists along the I-44 corridor. All told the ensemble communicates a shift in Missouri’s status as the Show-Me State, to being the Show-Them State

Concept Studies

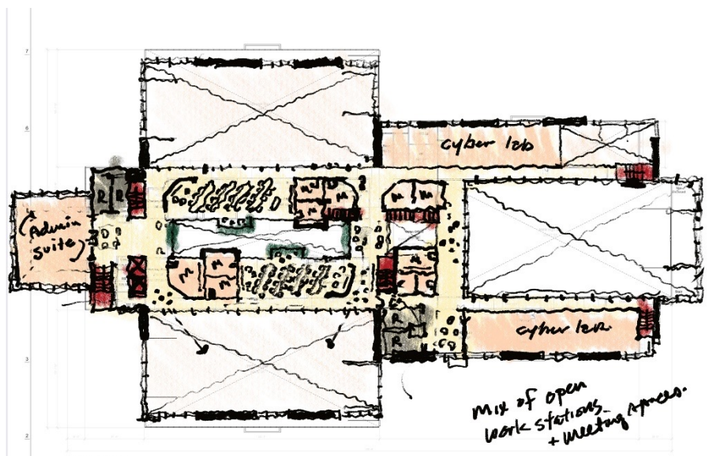


Site Study

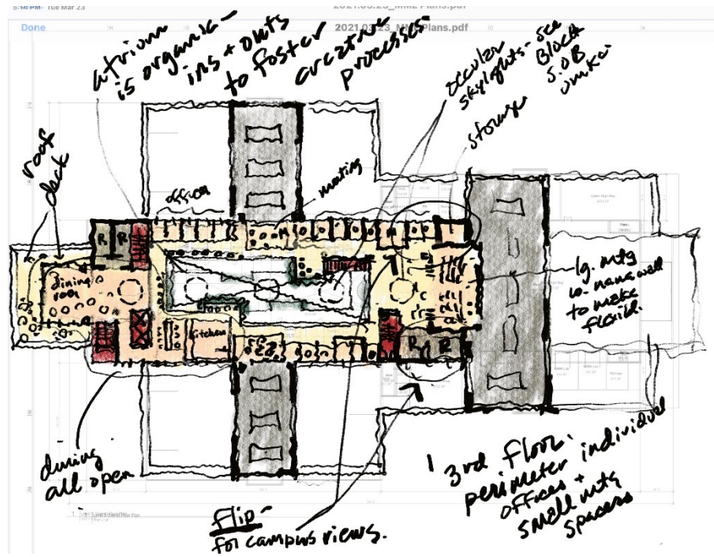


Site Study

First Floor Concept Study

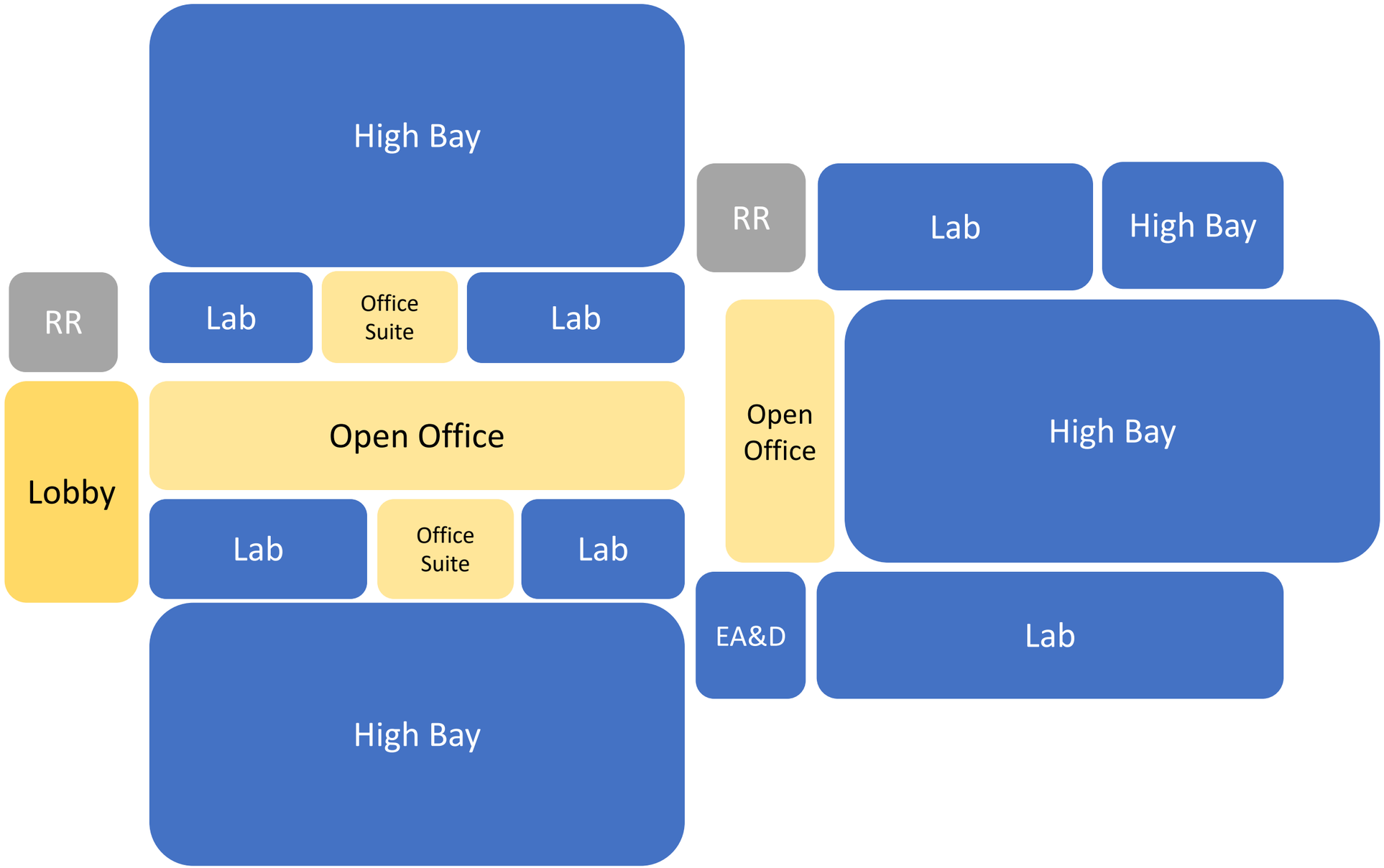


Second Floor Concept Study

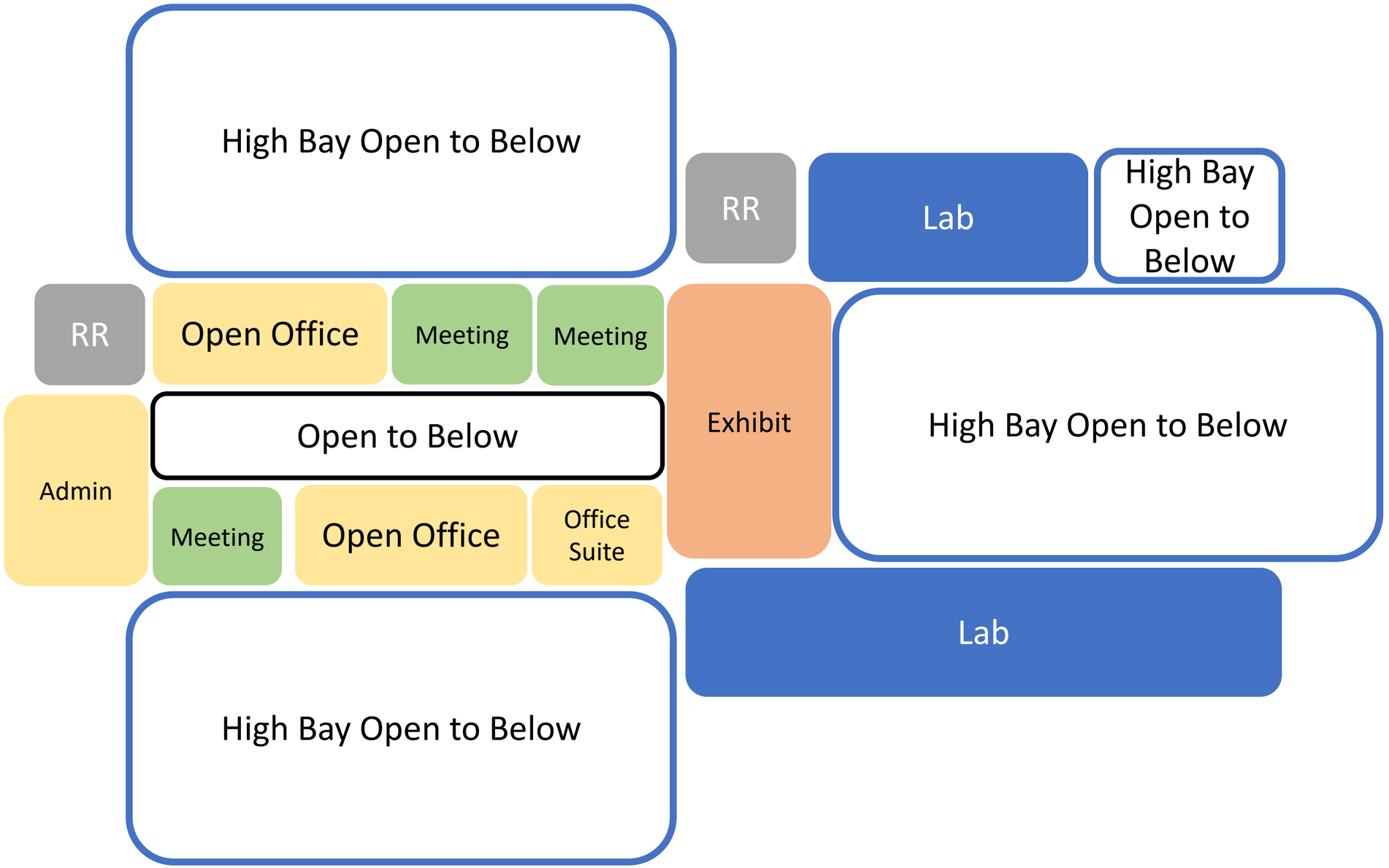


Third Floor Concept Study

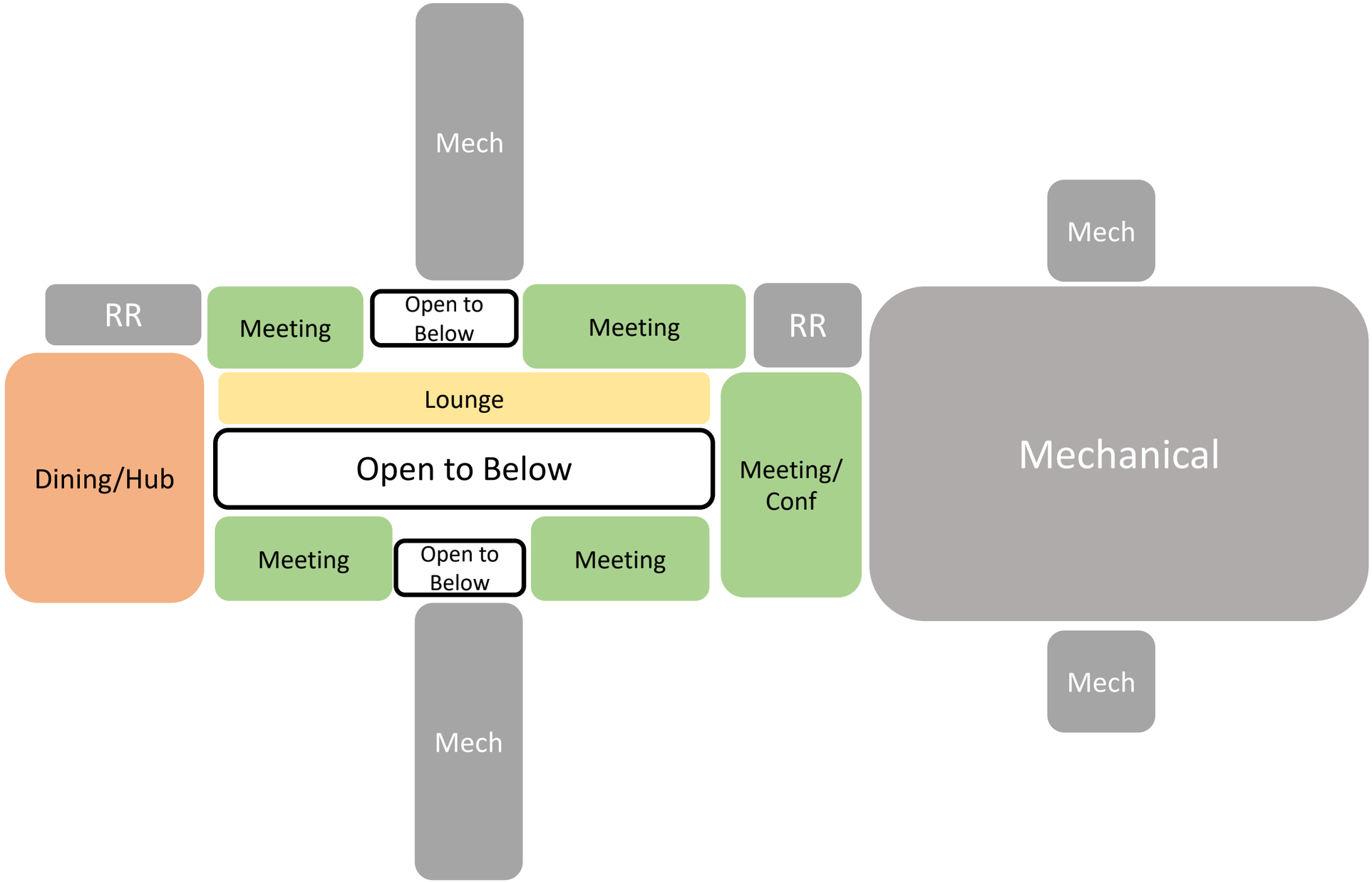
First Floor Program



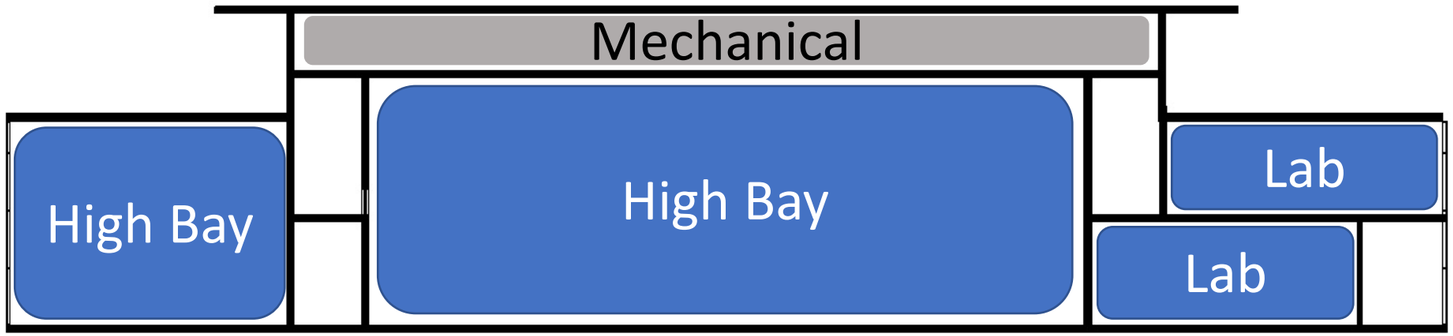
Second Floor Program



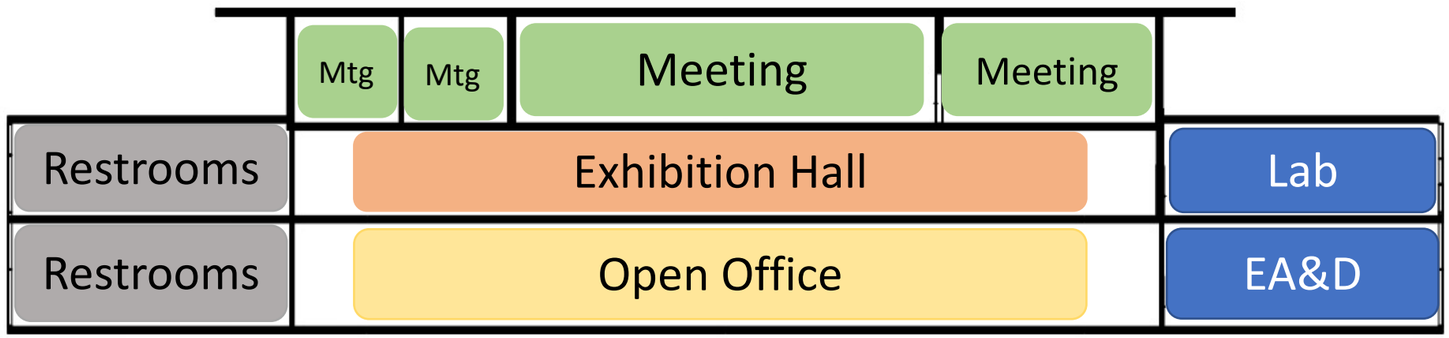
Third Floor Plan Program



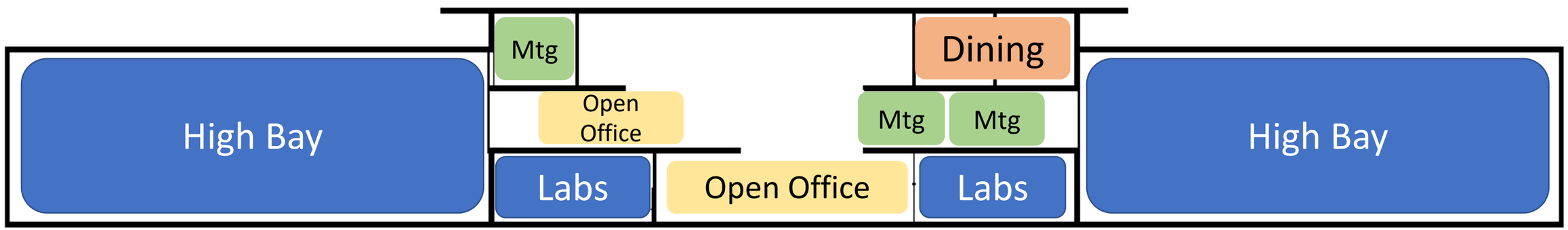
Section Diagrams



East Section

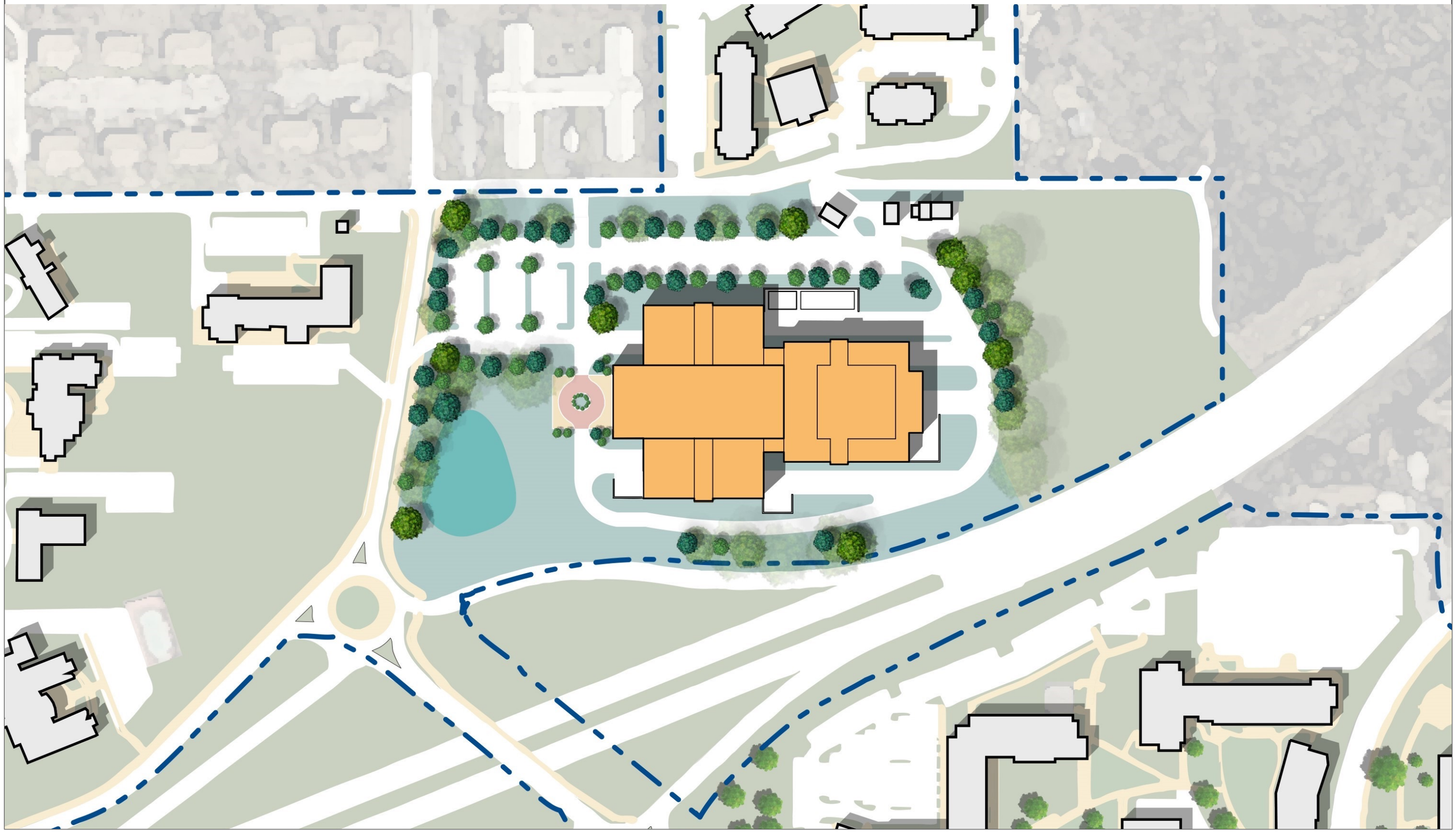


Center Section

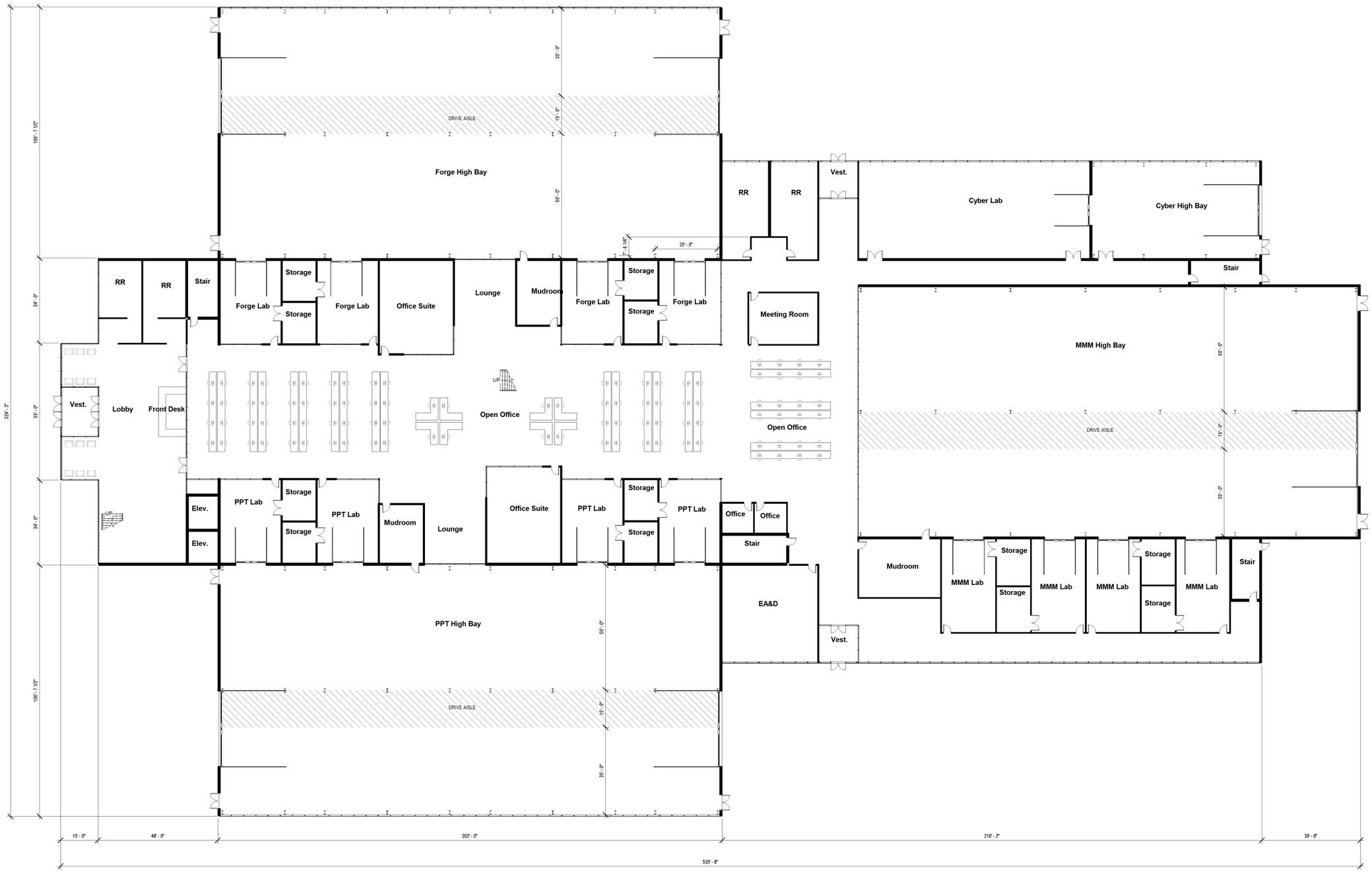


West Section

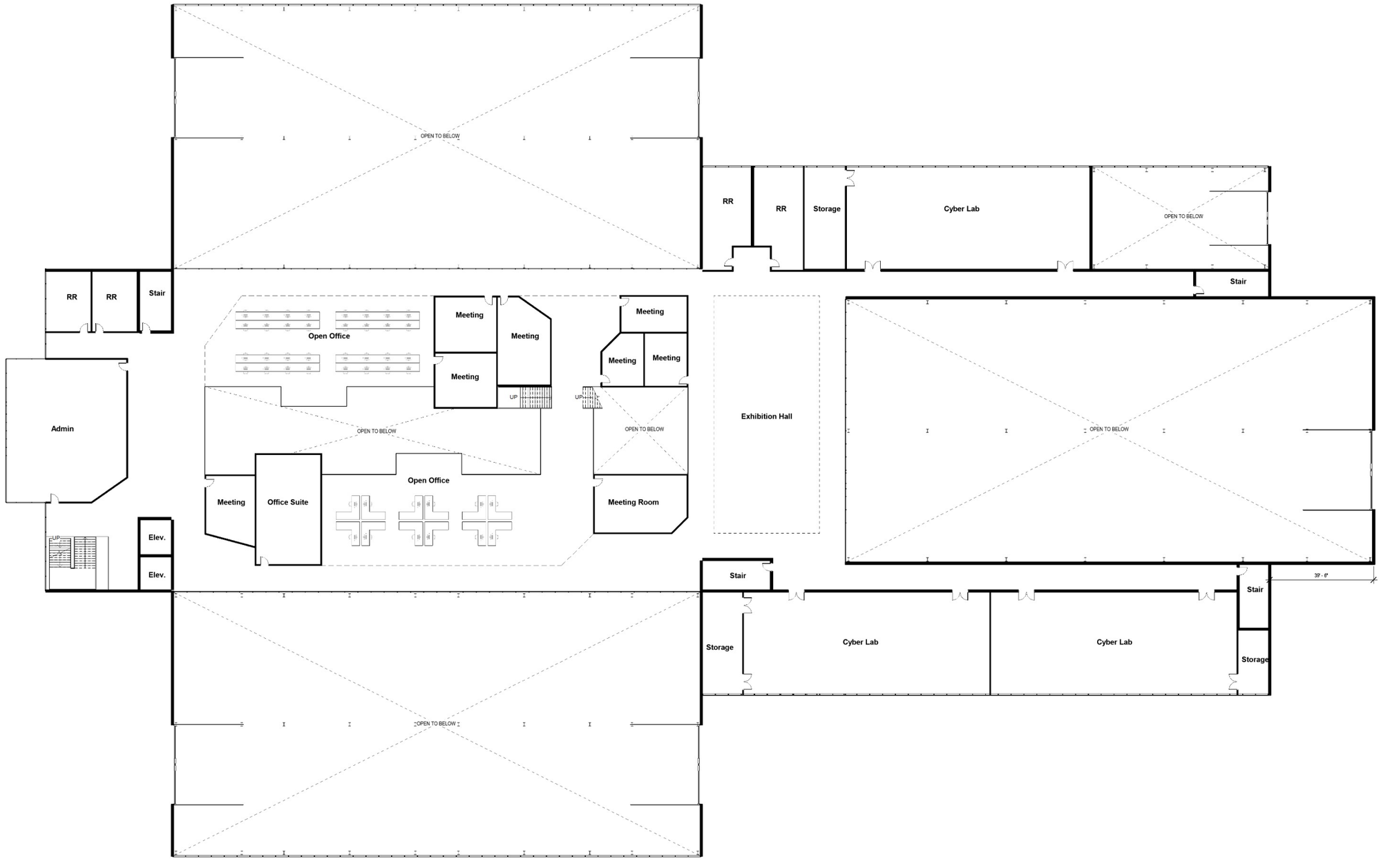
Site Plan



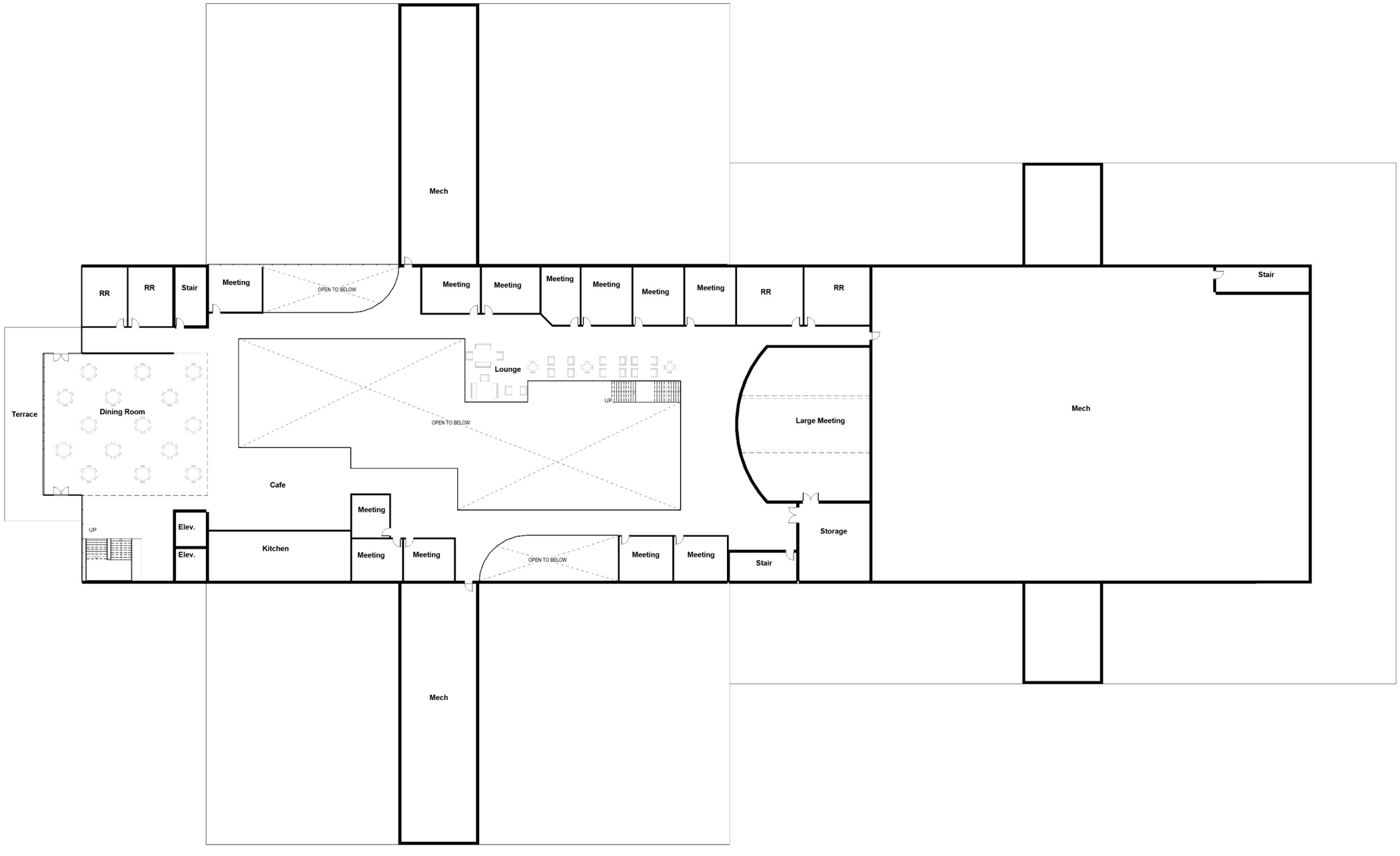
First Floor Plan

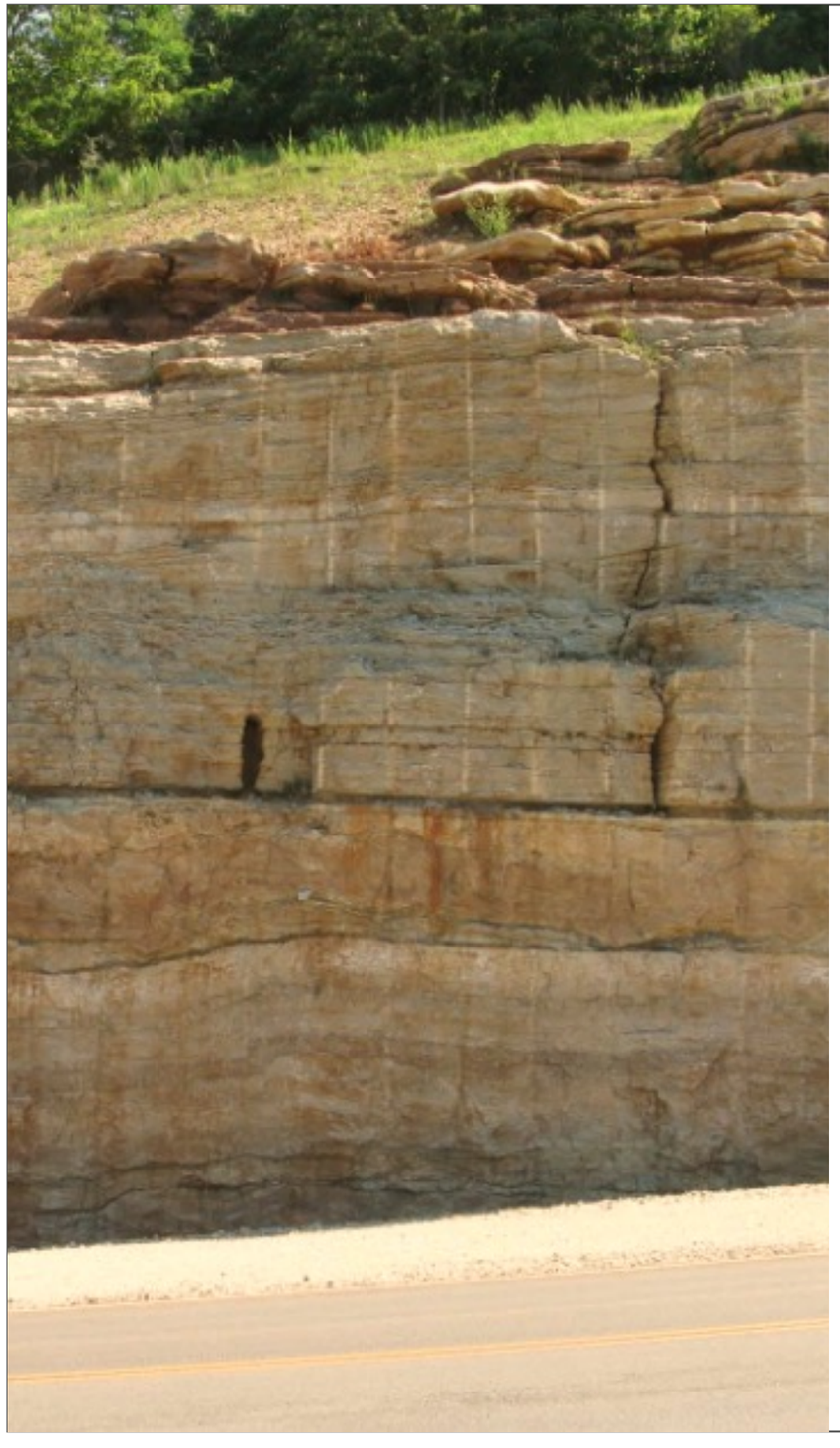


Second Floor Plan



Third Floor Plan





6. Concept Renderings

Exterior Design Concept

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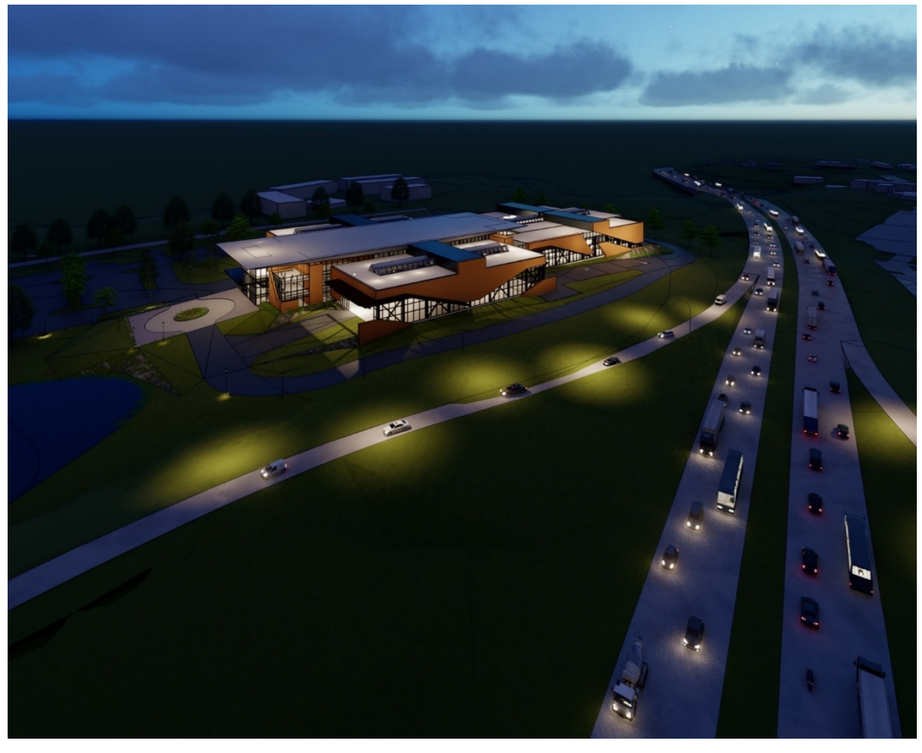
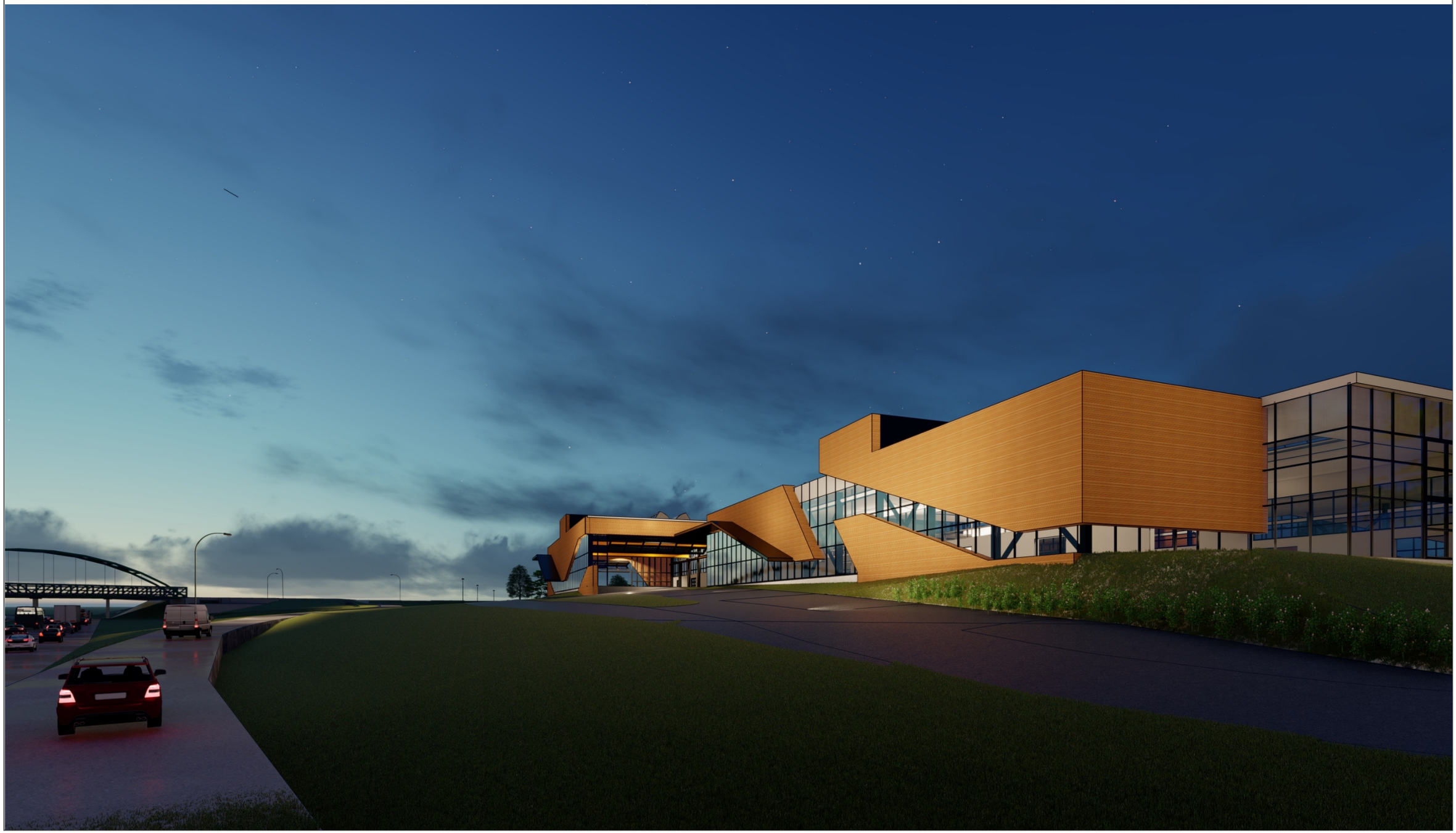
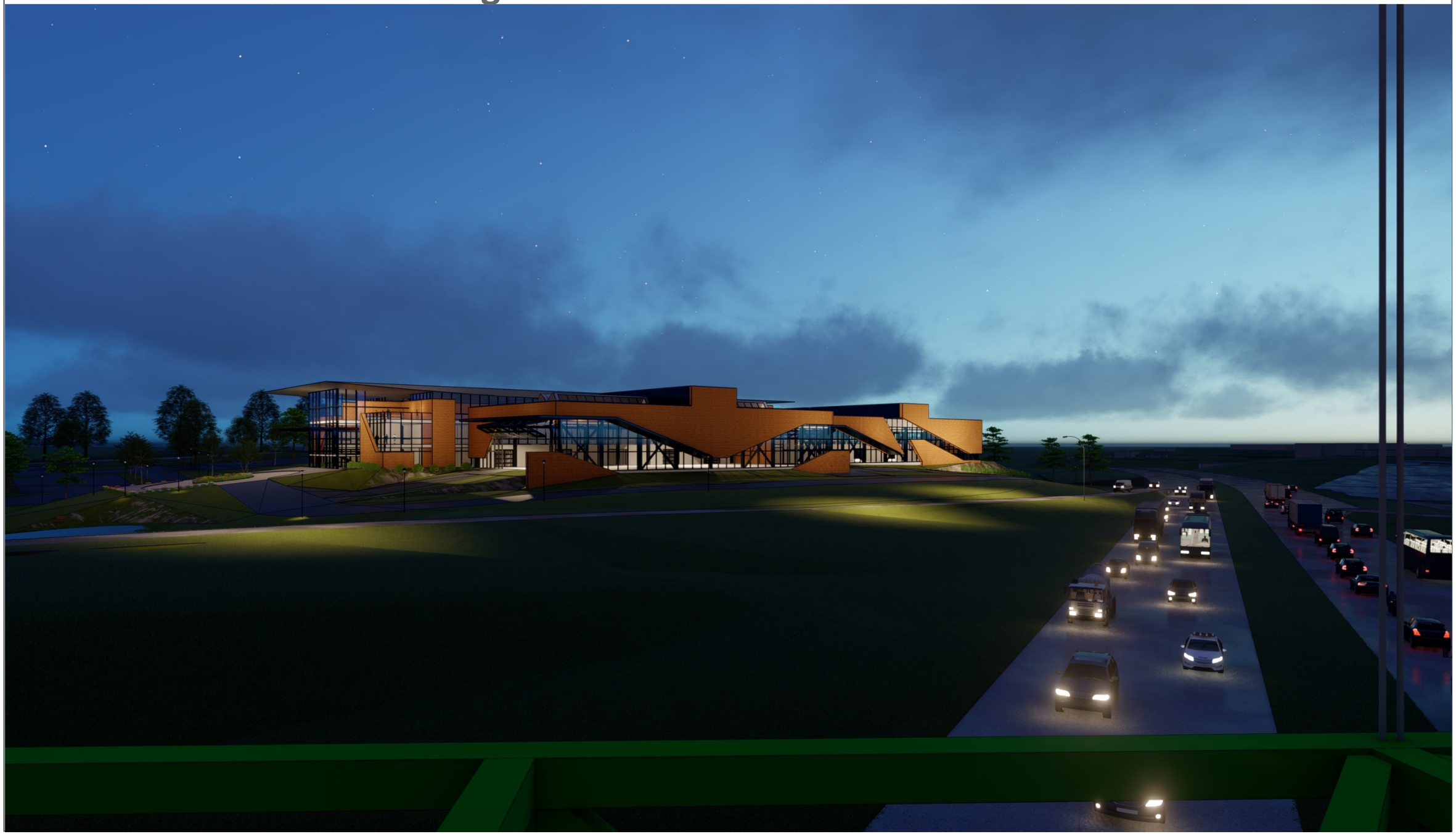


View from I-44

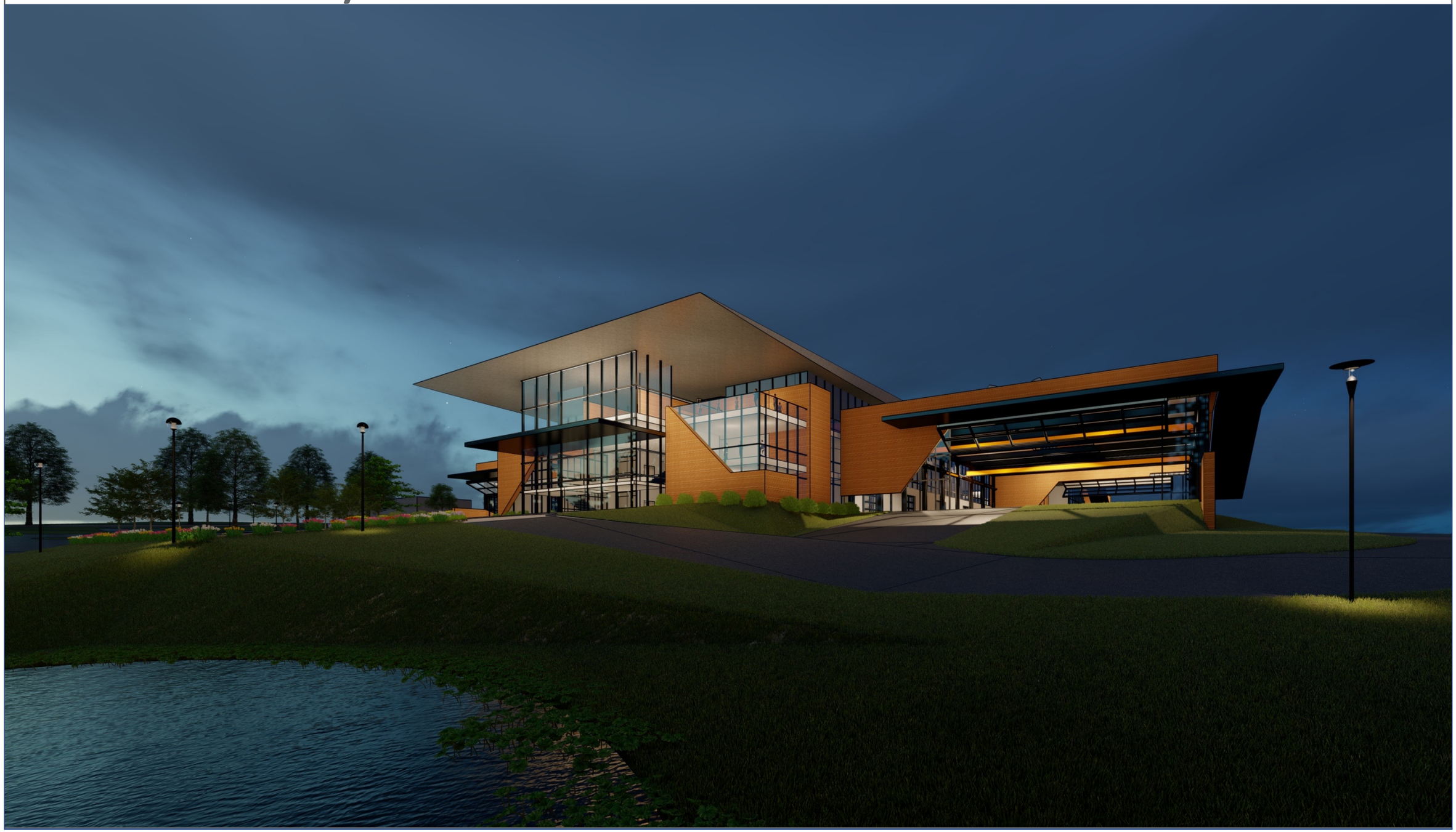


View from I-44

View from Pedestrian Bridge



View of West Entry



The Show

The Show - Visitor Experience

7. Systems Narratives

MEPFP Summary

The building's Mechanical, Electrical, Plumbing and Fire Protection systems are designed with pilot plant flexibility to facilitate research and production needs. A centralized chilled and heating water plant will service the complex and provide personal comfort and limited process cooling. The high bay lab areas will be divided between two power transformers for isolation of "dirty" and "clean" power consumers. The HVAC system will be on a separate power transformer. A generator will be provided to provide emergency backup as well as standby power for limited process and data retention needs. Spare medium voltage switches and distribution panel breakers will allow expansion and flexibility. The MEPFP systems are designed for future integration with geothermal HVAC and solar electrical power.

Special considerations are required for lab spaces. "Dirty" lab areas such as The Forge will require grease/solid separator in the sanitary line serving the floor drains in the lab. Other labs such as Material, Manufacturing and Methods find benefit is a dry type pre-action sprinkler with nitrogen generator will be provided to minimize water contamination with fabrication process.

Division 21 – Fire Protection

- Dedicated fire service water supply.
- Wet pipe sprinkler system throughout building.
- Schedule 40 steel grooved connection sprinkler piping.
- Class I standpipe in stairwells.
- Fire Department connection at building entrance.
- Dry type sprinkler system with nitrogen generator for MMM lab.

Systems Narratives

Division 22 – Plumbing

- Centralized domestic water system.
- N+1 domestic gas fired water heaters.
- Building hot water recirculation system.
- Safety showers with tempering valves in lab spaces.
- Wall mounted 1.6 GPF battery/sensor operated water closets.
- Battery/sensor operated lavatories.
- Sanitary and Storm schedule 40 PVC below grade, cast iron no hub above grade.
- Type L copper for domestic distribution piping.
- Grease and solid separator for The Forge lab.
- Natural gas service to serve domestic and process loads.

Division 23 – HVAC

Plant Utilities

- Chilled water will be supplied by four (4) 225-ton variable speed water-cooled screw chillers.
    - Chillers piped in primary secondary configuration.
    - Four cell stainless steel cooling towers.
- Four (4) 3,000 MBH natural gas condensing boilers will supply heating water.
- Heating coils will be designed for 120-degree heating water.
- A duplex water softener will condition heating water, domestic heating water and provide softened water to the labs.
- Labs will be supported by centralized pressure independent of lab exhaust system providing general exhaust and fume hood exhaust capability.
- Large ceiling fans in high bay lab areas to provide circulation.
- The Forge lab will not be air conditioned when forging and milling operations are occurring. Outside ventilation shall be utilized at those times.

Suite Specific Utilities

- The building will be served by VAV (variable air volume) air handlers with hydronic reheat pressure independent terminal units.
- A DOAS (Dedicated Outside Air) air handler will condition ventilation air.
- Occupancy sensors and CO2 sensors connected to the BMS system for demand control ventilation.
- Space will be allocated in suite mechanical rooms for project specific utilities, (vacuum, compressed air, gas, etc.).

Division 26 – Electrical

Electrical Power Service and Distribution

- New Rolla Municipal Utility feed at 15kV.
- The building shall be primary metered at 15kV with a spare switch to feed future medium voltage loads.
- Three (3) 1000 kVA transformers shall provide 480/277V, three (3) phase, four (4) wire which will feed lab power, pumps, air handling units, and miscellaneous mechanical equipment in the additional mechanical space, as well as the additional lighting.
- Each of the four (4) high bay labs will be served by a 1200-amp 480/277V distribution panel with 50% spare buss capacity located in the penthouse to facilitate ease of adding equipment. A 1200-amp 480/277V distribution panel will also feed the office, commons, and HVAC equipment.
- The 208/120V three (3) phase, four (4) wire separately derived systems will be fed from the 480Y/277V panels and will be used to serve the building convenience power and miscellaneous mechanical equipment.
- Digital customer metering will be included to submeter each lab module.
- Circuit breakers and copper buss will be used for panelboards and switchgear, feeding lighting and convenience loads.
- Switchboards and panelboards may be located in either mechanical or electrical rooms as necessary.
- Branch panelboards will be located in dedicated electrical rooms/closets or mechanical spaces not readily available to the general public.
- Aluminum cable will not be used.
- Transient Voltage Surge Suppression (TVSS) will be provided at each 1200-amp distribution panel and at panels serving high electronic equipment loads.
- Variable Frequency Drives (VFD's) will be by Toshiba, ABB, Yaskawa or Danfoss.

Systems Narratives

Division 26 – Electrical cont'd

Lighting

- Campus standard LED 2x2's, 2x4's, and downlights will be used for offices and corridors.
- High bay fixtures may be utilized in the high bay lab spaces.
- Target light levels will be in accordance with IES recommendations for maintained foot-candles.
- Ease of maintenance will be considered in the selection and placement of light fixtures.
- Generally, preliminary light fixture selections will be made by the Architect. The Engineer will make every effort to achieve proper quality of light with these or comparable fixtures and will work with the Architect to explore other options when required.
- Exit lighting will be accomplished with LED lamp exit lights.
- Emergency/Egress lighting will be by emergency generator backed-up fixtures. These fixtures will also serve as night light fixtures where necessary.
- Emergency lighting will be included outside of every building emergency egress/exit point.
- A light fixture and receptacle will be furnished in any plumbing chases.
- Lighting control in public areas and corridors will be accomplished with the use of a digital, programmable lighting control system. The system will allow additional switches/control points/zones to be added over the years as the building operations philosophy changes both upon initial use of the building and in the future.
- The system will initially be setup to provide separate zones of control for areas such as: public spaces, private spaces, site, and classrooms. Control stations will be provided for manual control of the system while occupancy sensing will be integrated as necessary to meet energy code requirements. Daylight harvesting and plug load controls will be discussed as the final design is developed.
- ASHRAE 90.1-2016 (or later) Energy Standard for Buildings requirements will be complied with as a minimum.
- Parking lot lighting per campus standard.
- The building will have exterior lighting to draw attention to it from Highway 44 and provide welcoming approach for visitors and tenants.

Wiring Devices

- All wiring devices will be specification grade and will be Leviton or Hubbell.
- No quick-disconnect receptacles will be permitted.
- Occupancy sensors will be considered for use in offices, toilets, storage rooms, and similar spaces.
- Digital count-down timers will be considered for use in mechanical rooms.

Division 26 – Electrical cont'd

Wiring Methods

- It is preferred that conduit not be installed in concrete slabs.
- All above-grade exposed, and concealed wiring will be installed in EMT conduit.
- Below-grade wiring will be installed in PVC conduit.
- All wiring will be copper. #12 and #10 wire shall be stranded.
- Low voltage systems will be installed as open-type plenum rated cables.

Electric Vehicle Charging stations

- 1 - Level 2 charging station.
- 1 - Level 3 fast charging station.
- Allow infrastructure and space to add four more Level 3 stations in the future.

Snowmelt Systems

- Snow melt systems will not be provided.

Lightning Protection

- Lightning protection will be provided.

Emergency and Standby Power

- Emergency lighting will be feed off generator.
- Each lab will have a dedicated panel with circuits routed to a standby power panel.
- The standby panels will be routed to transfer switches in each lab module area.
- A 750 kW diesel generator and associated standby distribution panel will distribute 100 kW to each lab module.

Systems Narratives

Division 27 –Communications

Telephone and Data Systems

- Communications cabling will be Category 6 plenum rated cabling. Rough-ins will be included, and two (2) cables furnished and terminated at all locations.
- The building will be wired for secured wireless network. The backbone wire will be separated in to four lab spaces and public/outdoor gathering areas to allow future isolation of the wireless network by tenants.

Audio and Video (AV) Systems

- Rough-in including power and network data for video monitors with a local video signal input plate shall be in all meeting rooms, group study, active learning classroom, maker workshop, and lobby.

Division 28 – Electrical Safety & Security

Access Control

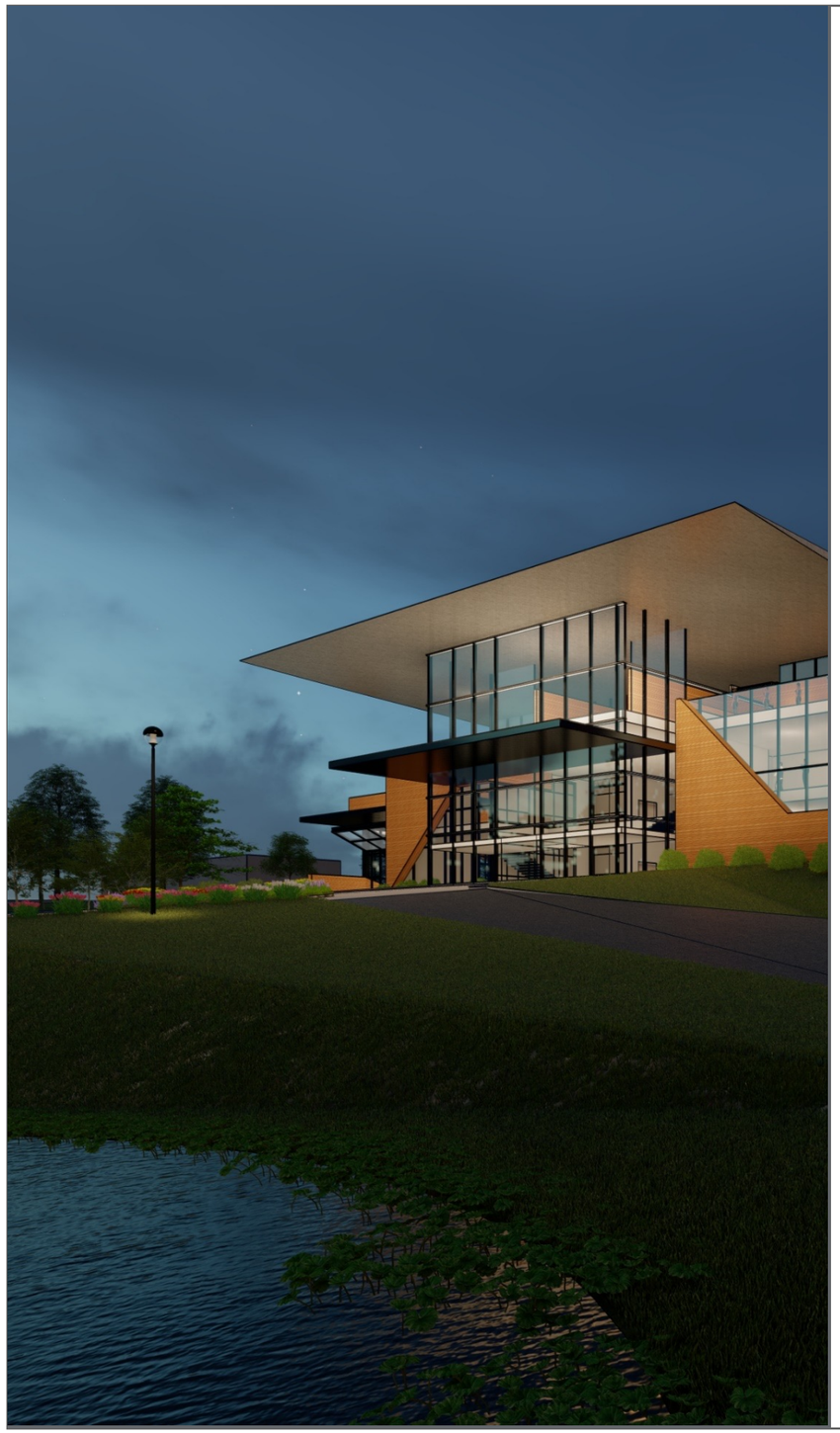
- Perimeter door detection and alarm will be included.
- All exterior entry doors shall have campus standard card readers or biometric screening.
- All interior doors to labs will have access control.

Security Camera

- Security cameras will be located near all exterior openings, docks, public lobbies and hallways.
- The camera system will be integrated with the existing campus police camera network.

Fire Alarm

- An addressable fire alarm system will be installed with audio-visual notification devices meeting building code and ADA requirements for voice evacuation.



Manufacture Missouri Ecosystem

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