2013

AIA TAP AWARDS

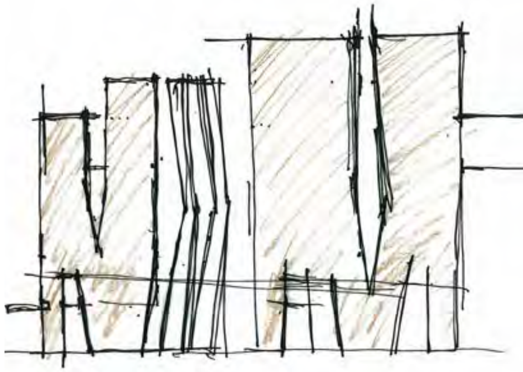
HEALTH SCIENCES EDUCATION BUILDING
PHOENIX BIOMEDICAL CAMPUS

A COLLABORATIVE, INTERACTIVE PLANNING AND DESIGN PROCESS, CRUCIALLY AIDED BY BIM, REFLECTED– AND GAVE FORM TO – THE EDUCATIONAL VISION OF TEAM-BASED, INTERDISCIPLINARY MEDICAL EDUCATION.

The Health Sciences Education Building (HSEB) is part of an inter-institutional, integrated urban campus for biomedical education and research.

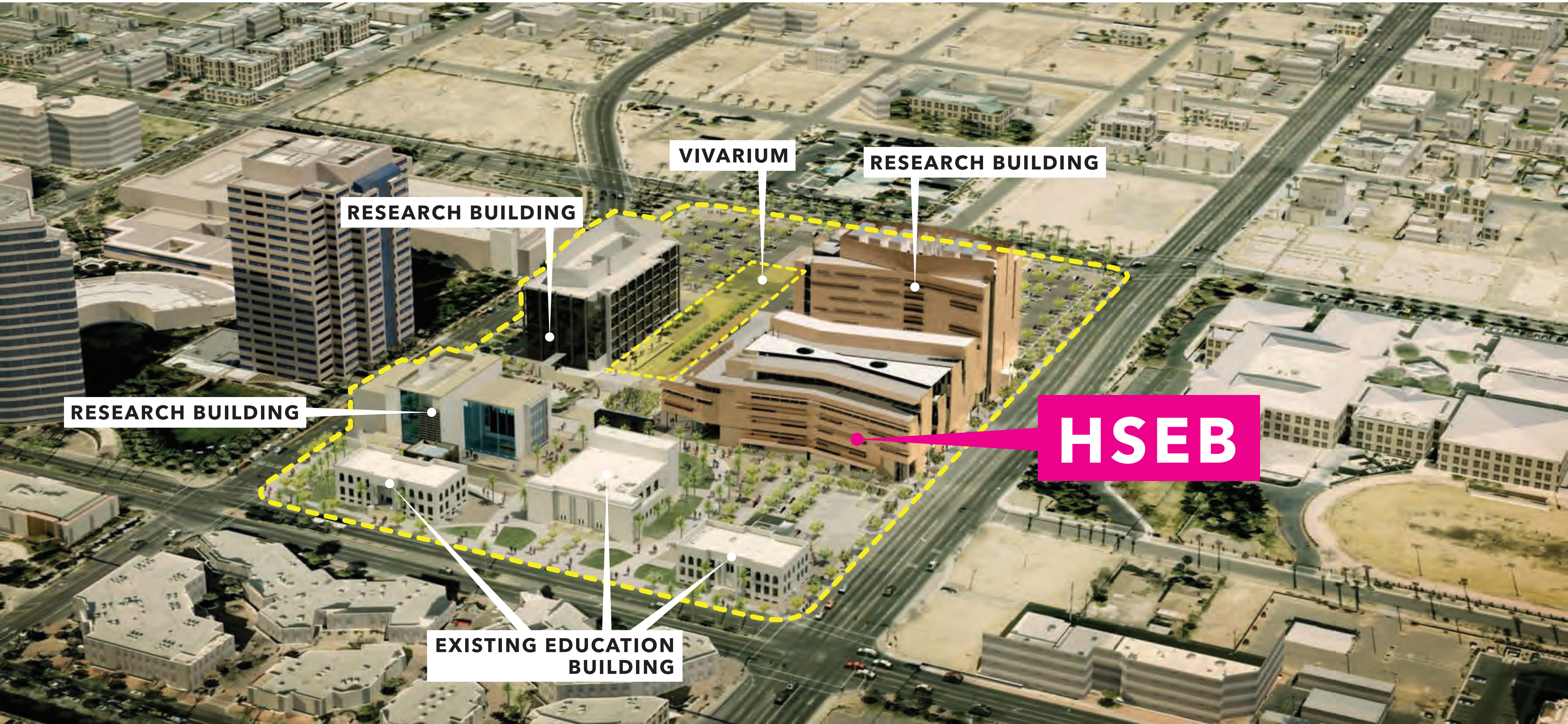
The design, which is targeting LEED®-NC Gold certification, responds to the need to reduce resources in the desert climate.

The 268,000-square-foot, six-story facility consists of administrative and faculty offices, many varied lecture and classroom spaces, clinical skills and simulation suites, gross anatomy facilities, and student amenities such as a learning resource center and a cafeteria.



1. BUILDING DESIGN & CONTEXT

PHOENIX BIOMEDICAL CAMPUS



The building's central organizing element is known as "The Canyon." This dramatic element, carved out of the building block to minimize solar exposure and maximize self-shading, allows light from, and visual connection to, the exterior. Defined by two academic wings and "The Mixing Bar," this exterior space is protected overhead by a fabric structure, tempered with landscaping and semi-conditioned with relief air. The Mixing Bar, as its name implies, is designed to foster cross-discipline interaction, critical for the sharing of information among various health sciences students.

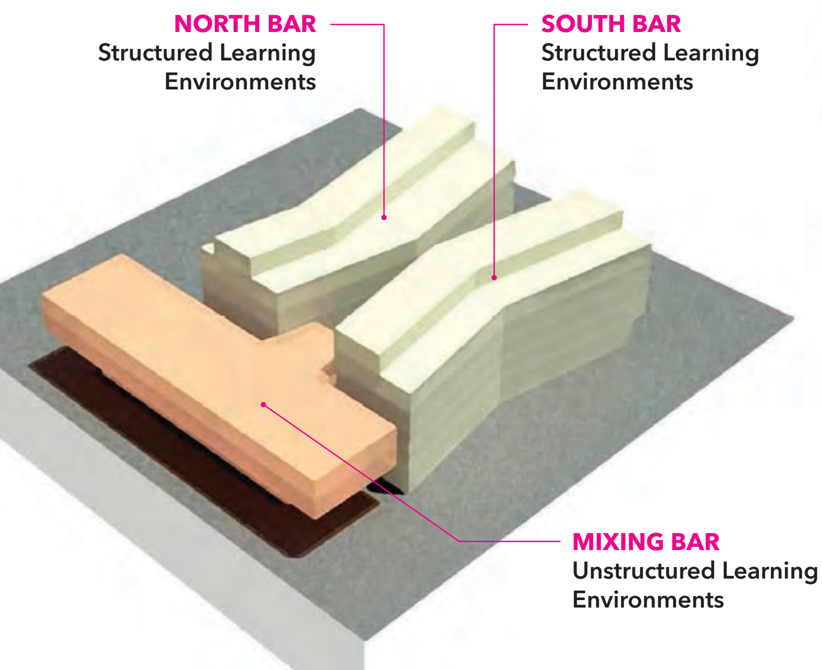
The context was demanding: HSEB, in addition to the program and design requirements of a complex medical education building, was a particularly challenging project in that its budget and schedule were both reduced during the design and construction process. Along with that challenge came yet another: maintaining the integrity of the owner's vision and the architect's design through to the building's delivery.

A SEASONED, COLLABORATIVE APPLICATION OF BIM MADE CRUCIAL DIFFERENCES, PARTICULARLY WITH THE ADDED COMPLEXITY OF THE TEAM:

**TWO UNIVERSITY CLIENTS,
TWO ARCHITECTURE FIRMS,
TWO BUILDERS.**

The team used BIM to collaboratively set and meet standards during each phase of the design and construction process. From the earliest design phases, for example, the architect, owner, and CM developed a success plan to outline BIM goals and protocols. Then, further along, the growing team developed a plan to implement BIM as construction trades started work on detailed modeling.

BIM was an important part of the effort to maintain and enhance the design concept. For example, there were frequent model transfers that provided up-to-date design intent, as well as a design evolution log. The log tracked changes with their associated costs, which enabled informed, expedient decisions and design models that amplified the team's ability to coordinate along each step. Additionally, live data linking of coordination files allowed trades to upload files onto a Master NWF to which all team members had ready access, a step that also increased communication and efficiency.



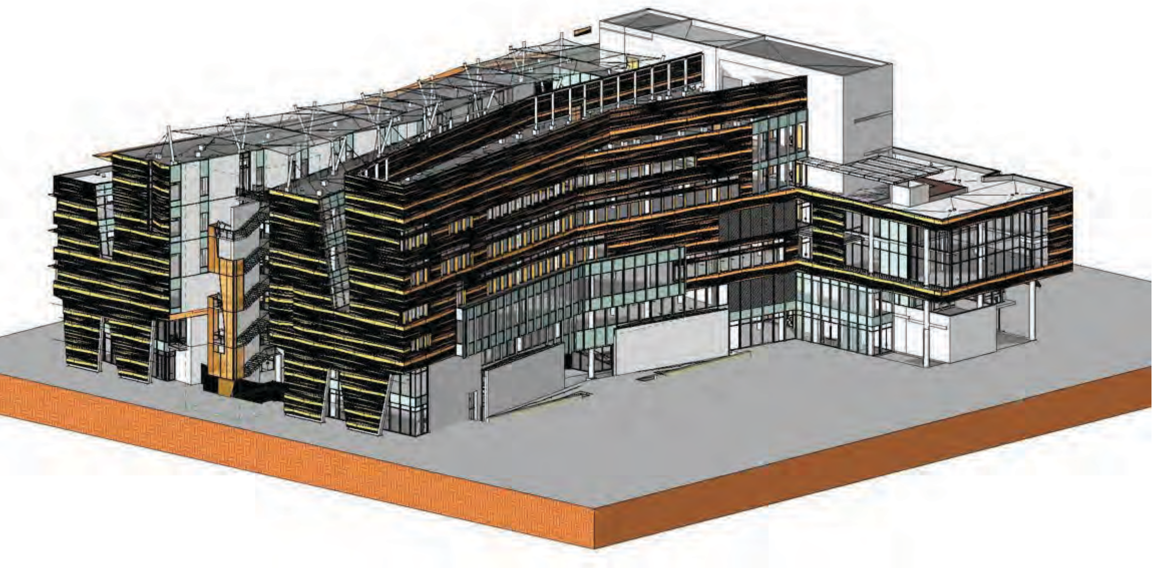
LEVEL 1

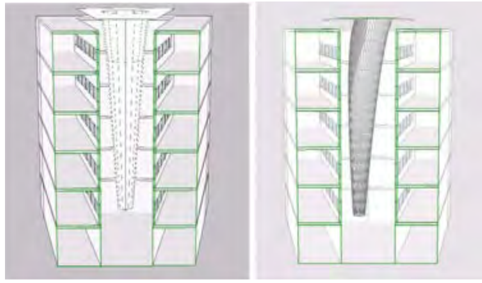
1 Canyon
2 Lecture Halls
3 Student Lounge
4 Cafe
5 Lobby

It wasn't just the technology, but how it was used. For example, the owner, design team and CM/trades agreed on responsibilities—namely who would model what, and to what level of detail, and at what point in the process and those agreements were memorialized in the contract documents. For example:

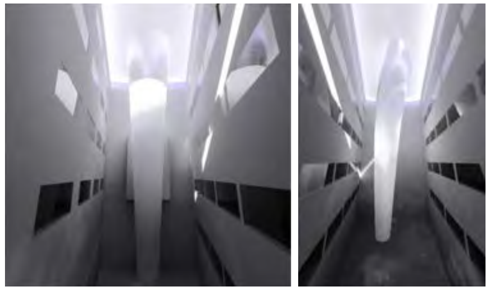
1. **Architect** - authors design model for coordination
2. **Structural engineer** - authors design model; reviews coordination model
3. **MEP engineer** - authors design model; reviews coordination model
4. **Telecommunications engineer** - authors design model; reviews coordination model
5. **Construction manager** - manages BIM coordination; performs model-based estimating
6. **MP trade contractor** - authors coordination and fabrication model
7. **Electrical trade contractor** - authors coordination and fabrication model
8. **Metal cladding contractor** - authors coordination and fabrication model
9. **Concrete contractor** - authors coordination and erection model
10. **Exterior and interior glazing contractor** - authors coordination and fabrication model
11. **Framing and Drywall contractor** - authors coordination and fabrication model

Those models were used, among other things, for design visualization and validation, constructability surveys, quantity take-offs and cost estimating, 3D coordination, virtual prototypes, 4D construction scheduling and fabrication.

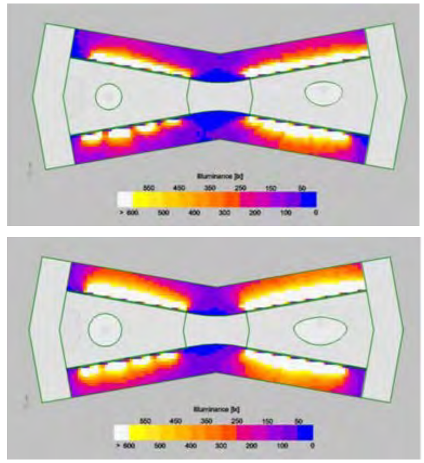




Section through 3D model with two different down-shaft pipe shapes for daylight modeling



Simulation results of illuminance calculated with RADIANCE

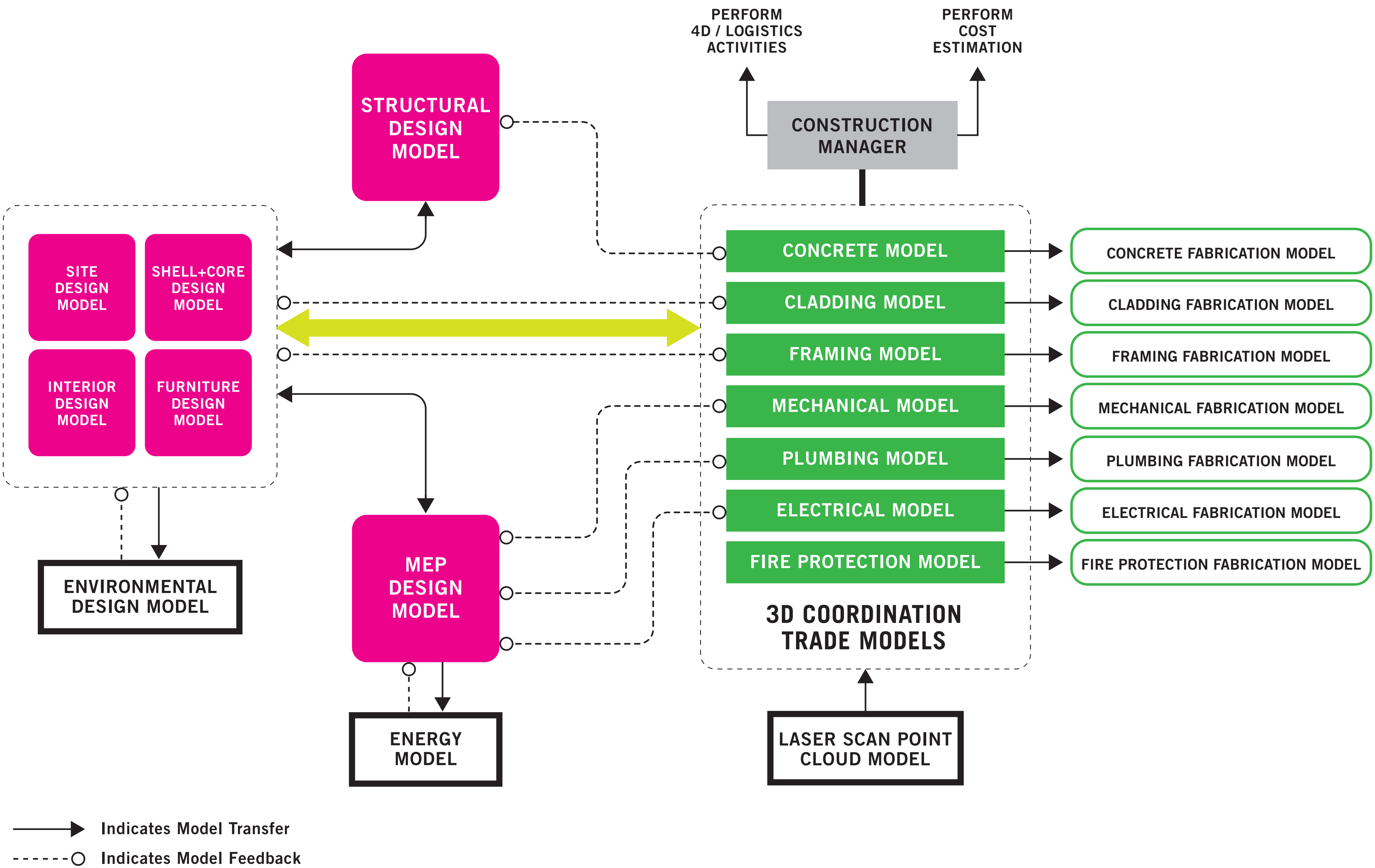


Simulation results of daylight coefficient on adjacent floors calculated with RADIANCE

Phoenix Biomedical Campus - HSEB Responsibility Matrix

The goal of the BIM model is to create a digital prototype of the building. If the element is not generating its dimensional infromation, dimensions will be accurate and correspond with any specs or details pertaining to the modeled element.

Item	Contract Documents		Coordination Activities				Level of Detail			Notes
	Primary Responsibility	Review	Primary Responsibility	Secondary Responsibility	Review	Additional 3D Modeling Notes	Contract Documents	Shop Drawings	Closeout	
GENERAL CONCEPTS										
Hardware							LOD200			
Components/Equipment	AOR									
Connection Points for Utilties (Toilets, sinks, headwalls, ect)							*	LOD400	LOD400	* Requires additional discussion
In wall/ceiling support requirments (Misc steel)							*	LOD400	LOD400	
Equipment representation where needed							LOD200	LOD400	LOD400	
Cabinetry										
Layout	AOR						LOD200	LOD400	LOD400	
Type	AOR						LOD200	LOD400	LOD400	
True Representation	AOR						LOD100	LOD400	LOD400	
STRUCTURAL										
Beams and Columns										
Size and atributes			ST				LOD300	LOD400	LOD500	
Connections (gusset plates, ect.)	SEOR		ST				LOD200	LOD300	LOD300	
Slabs *See architectural*	SEOR									
Perimeter Definition	AOR		CC			1	LOD200	LOD 300	LOD 300	
Shaft Openings	AOR		CC			1	LOD200	LOD300	LOD300	
Thickness	AOR		CC			1	LOD100	LOD300	LOD300	
Foundations										
Slabs	SEOR		CC			1	LOD200	LOD300	LOD300	
Footings \ MAT Slab	SEOR		CC			1	LOD200	LOD300	LOD300	
Seismic Bracing										
Mechanical	*		CC			1	LOD100	LOD400	LOD400	*Requires additional discussion
Plumbing	*		CC			1	LOD100	LOD400	LOD400	*Requires additional discussion
Electrical	*		CC			1	LOD100	LOD400	LOD400	*Requires additional discussion
Fire Protection	*		CC			1	LOD100	LOD400	LOD400	*Requires additional discussion
Equipment Support	*		CC			1	LOD100	LOD400	LOD400	*Requires additional discussion
HEATING VENILATION AND AIR CONDITIONING										
Ducting								LOD400	LOD400	
Main and medium pressure			MC		MEOR			LOD400	LOD400	
Low pressure			MC		MEOR			LOD400	LOD400	
Shafts/Risers			MC		MEOR			LOD400	LOD400	
Flex			MC		MEOR					
Insulation			MC		MEOR					
Hangers & Supports			MC		MEOR					
Seismic Bracing			MC		MEOR					
Isolation/Balancing Dampers			MC		MEOR					



PERFORM
4D / LOGISTICS
ACTIVITIES
PERFORM
COST
ESTIMATION
STRUCTURAL
DESIGN
MODEL
CONSTRUCTION
MANAGER
SITE
DESIGN
MODEL
SHELL+CORE
DESIGN
MODEL
INTERIOR
DESIGN
MODEL
FURNITURE
DESIGN
MODEL
CONCRETE MODEL
CLADDING MODEL
FRAMING MODEL
MECHANICAL MODEL
PLUMBING MODEL
ELECTRICAL MODEL
FIRE PROTECTION MODEL
3D COORDINATION
TRADE MODELS
CONCRETE FABRICATION MODEL
CLADDING FABRICATION MODEL
FRAMING FABRICATION MODEL
MECHANICAL FABRICATION MODEL
PLUMBING FABRICATION MODEL
ELECTRICAL FABRICATION MODEL
FIRE PROTECTION FABRICATION MODEL
ENVIRONMENTAL
DESIGN MODEL
MEP
DESIGN
MODEL
ENERGY
MODEL
LASER SCAN POINT
CLOUD MODEL
Indicates Model Transfer
Indicates Model Feedback

2. COPPER SKIN

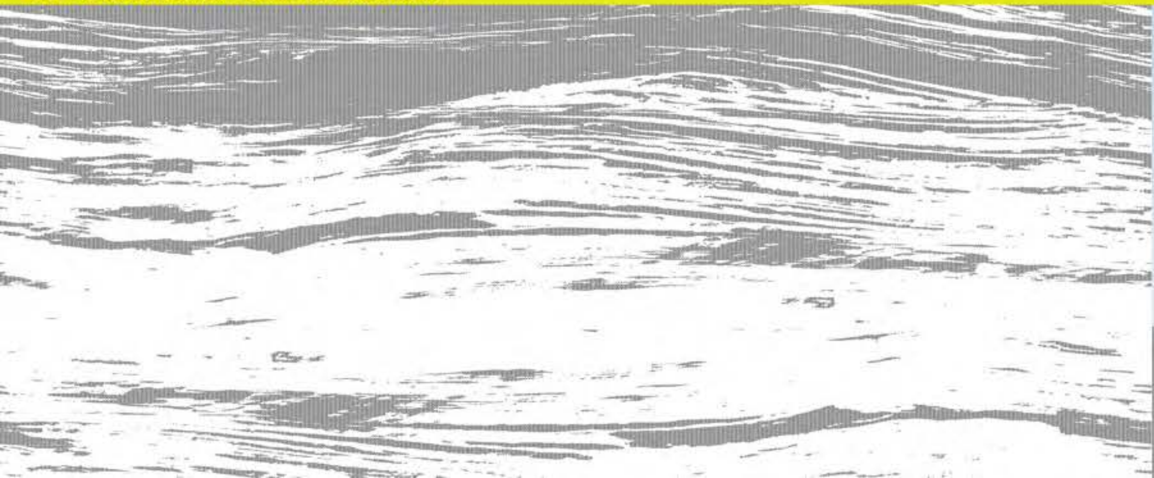
HSEB's façade comprised of copper, a recycled material that originates in Arizona, is fissured, formed, bent, and perforated, referencing the striations of the surrounding mountains, while providing the final layer of a metal rainscreen. Not only is the cladding the signature aesthetic feature of the building, but it also serves to mitigate the extreme temperature differences between the exterior and the interior. In order to do so, its design had to meet precise requirements.

COPPER SKIN – CONCEPTUAL STUDIES

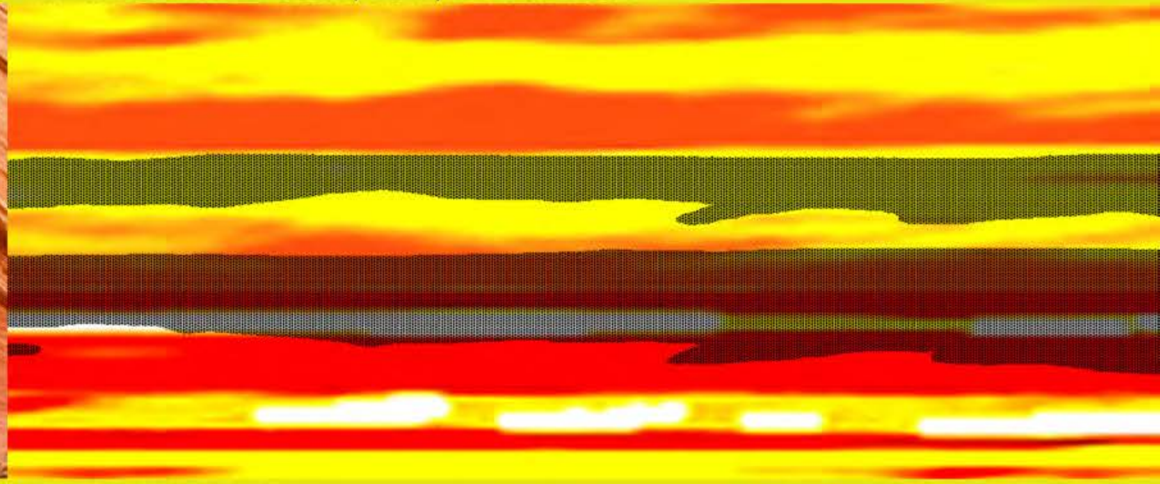
1. CANYON IMAGE

2. IMAGE DISTORTION

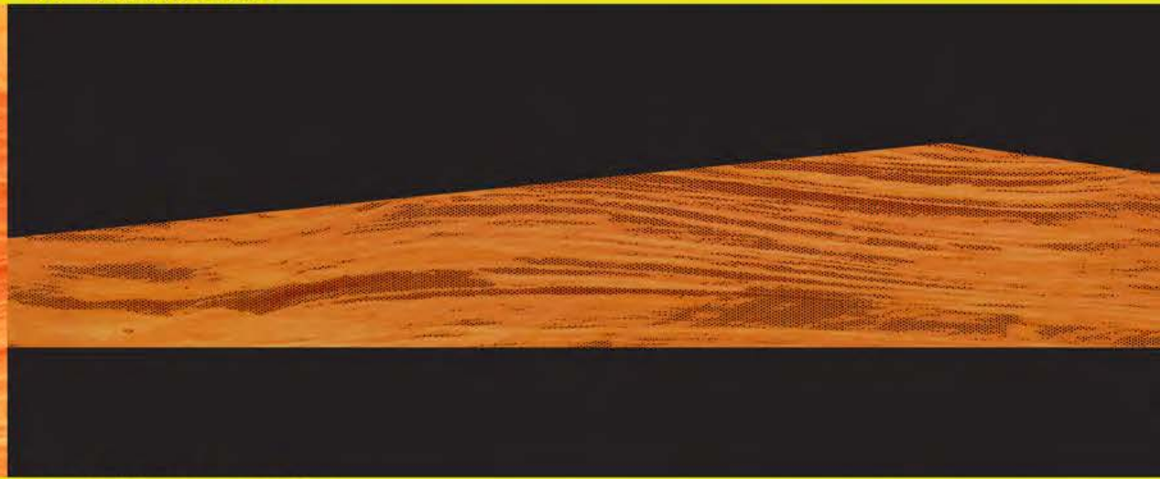
3. POSITIVE/NEGATIVE BITMAP



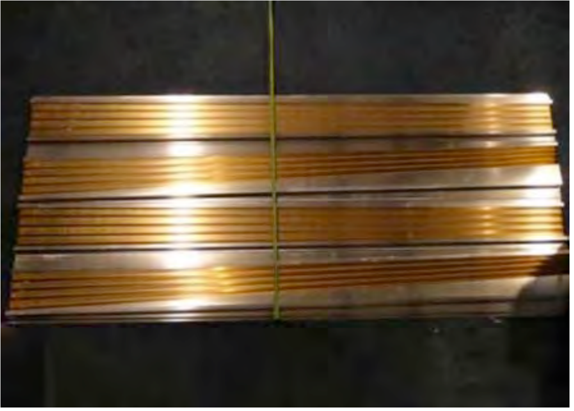
4. PANEL MAP – SOLID, VOID, PERFORATION



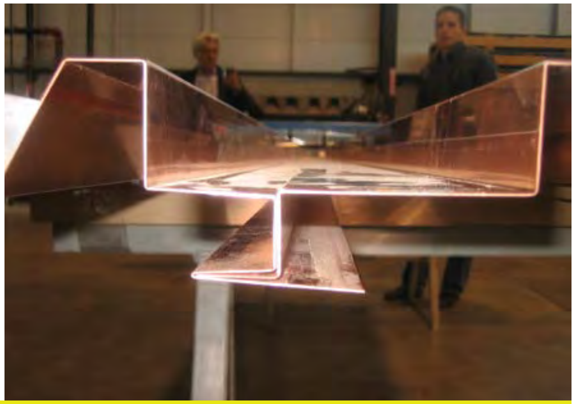
5. 2D PANEL MAP



6. ELEVATION STUDY



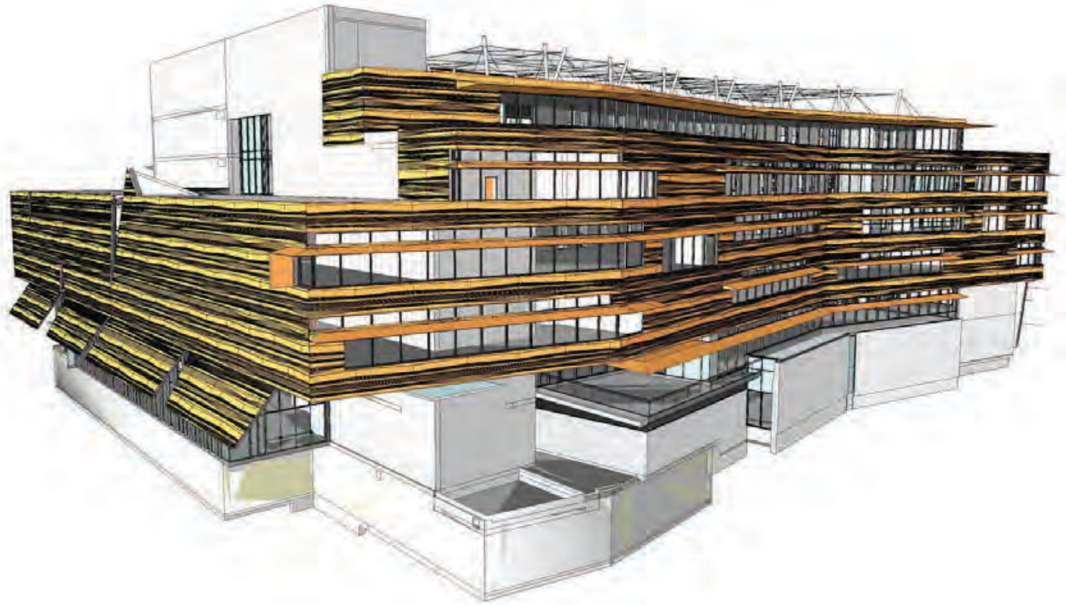
COPPER PROFILE MOCK-UPS



ARCHITECT'S STATEMENT

BIM was crucial in this process, and enabled team members to achieve their goals for the cladding collaboratively. For example, the architect's Revit model was transferred to the metal cladding contractor who, in turn, translated the model into a fabrication model. Team members optimized the copper panel pattern and configuration to create the appearance of a naturally occurring random pattern, while utilizing only 13 panel types, all modeled, located and scheduled in Revit. The panel size and depth balanced visual and performance goals with cost-saving strategies such as keeping overall panel size to domestically available copper. Using BIM was pragmatic in another way: it saved money by enabling quick quantity take-offs. This allowed for early copper procurement ahead of an anticipated material cost increase.

VIRTUAL PANEL MOCK-UP



COPPER PANEL MOCK-UPS

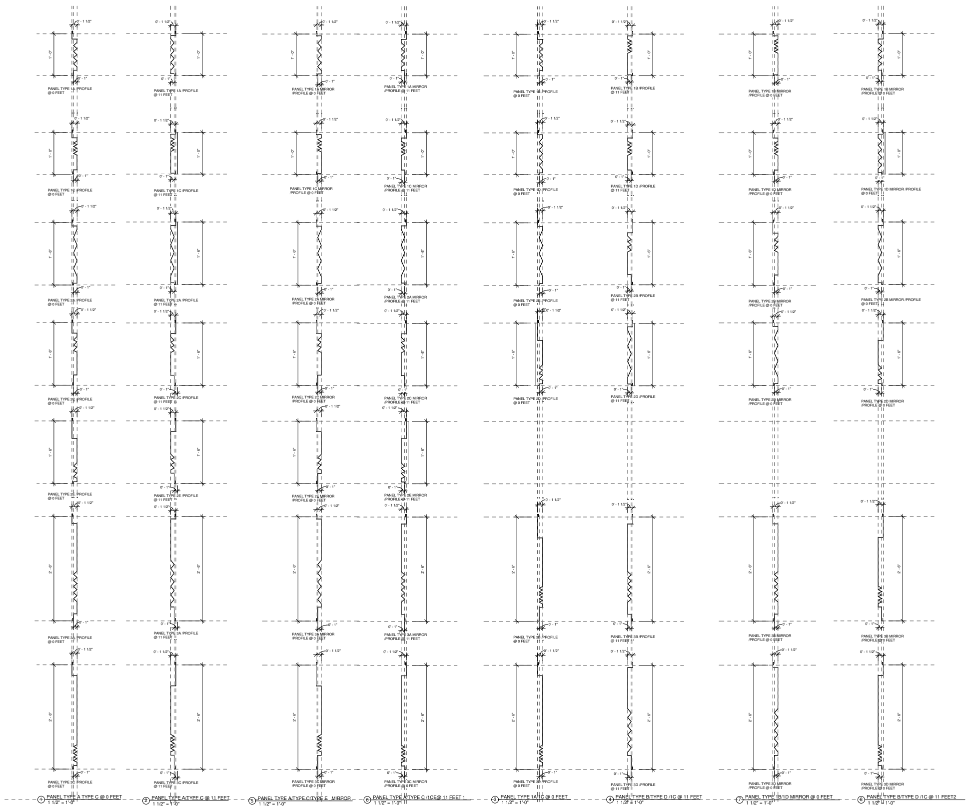
1ST

2ND

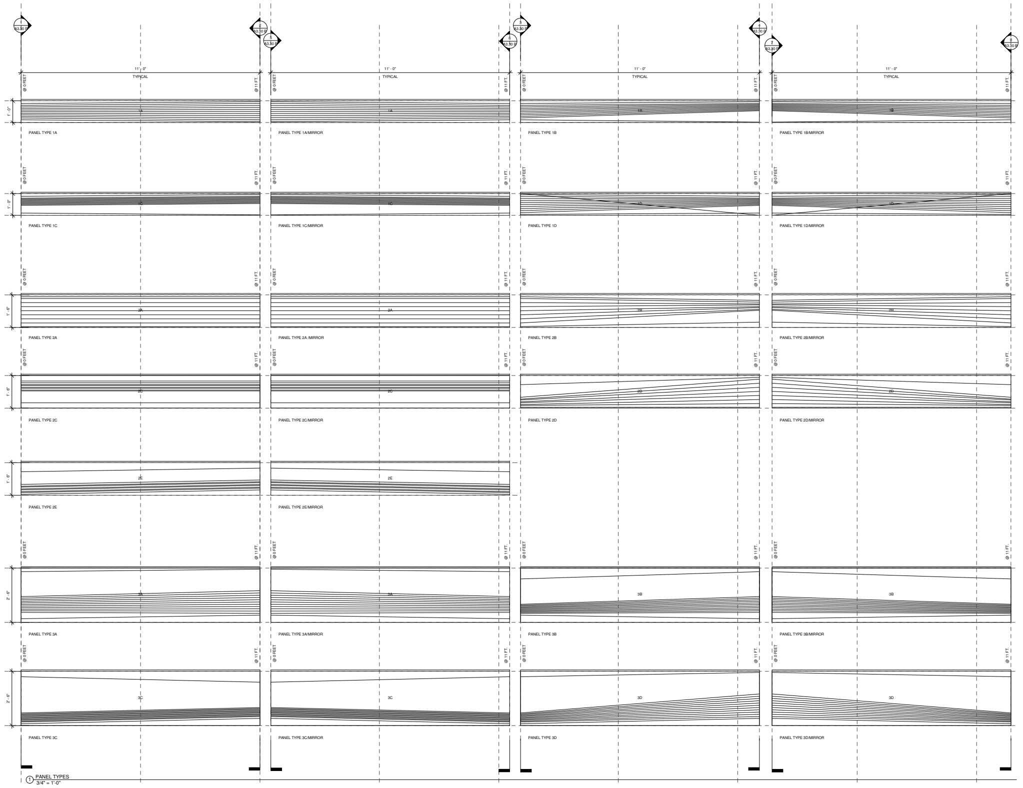
3RD

4TH

PANEL SECTIONS

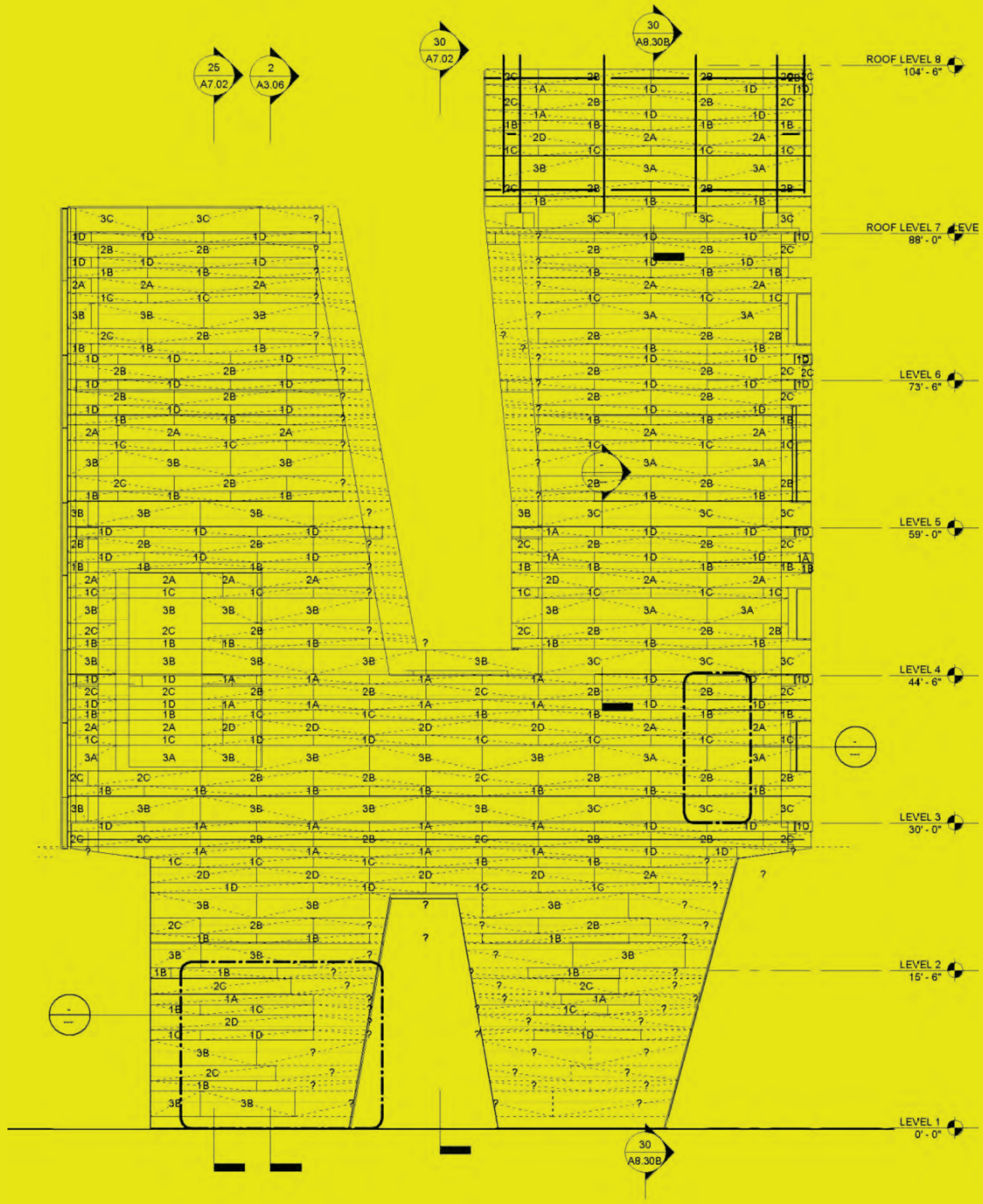


PANEL ELEVATIONS



EAST ELEVATION SKETCH

EAST ELEVATION PANEL TYPES

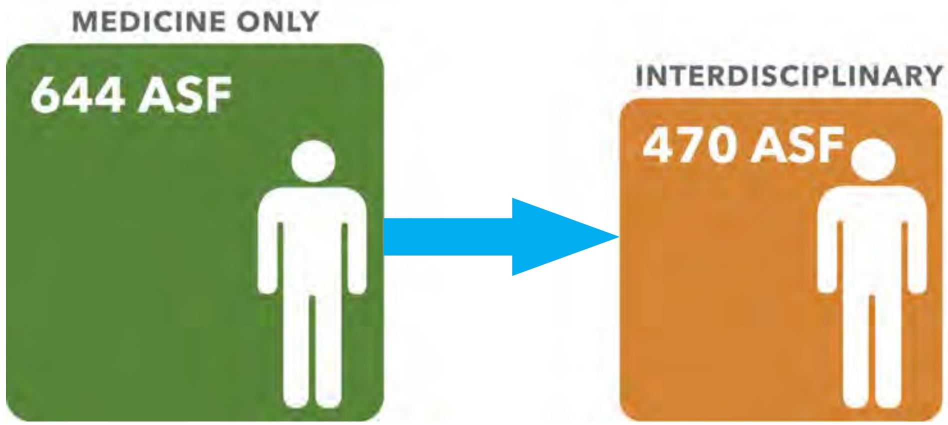


THE FINAL COPPER CLADDING COST WAS A 48% REDUCTION OVER THE SCHEMATIC COST ESTIMATE, A RESULT THAT WAS ACHIEVED THROUGH A SERIES OF INTENSE WORK SESSIONS, VIRTUAL AND PHYSICAL MOCK-UPS, AND WEEKLY MODEL EXCHANGES.

3.

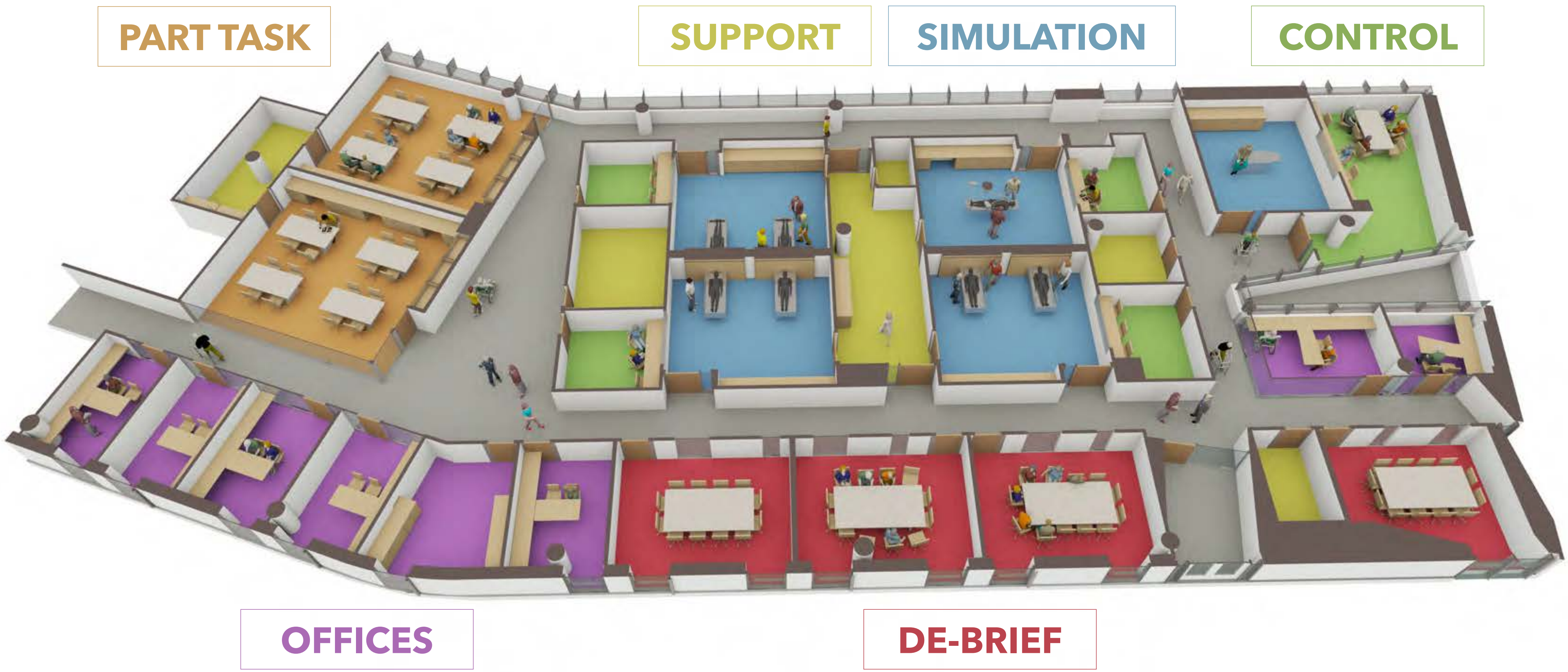
INTERACTIVE USER EXPERIENCE

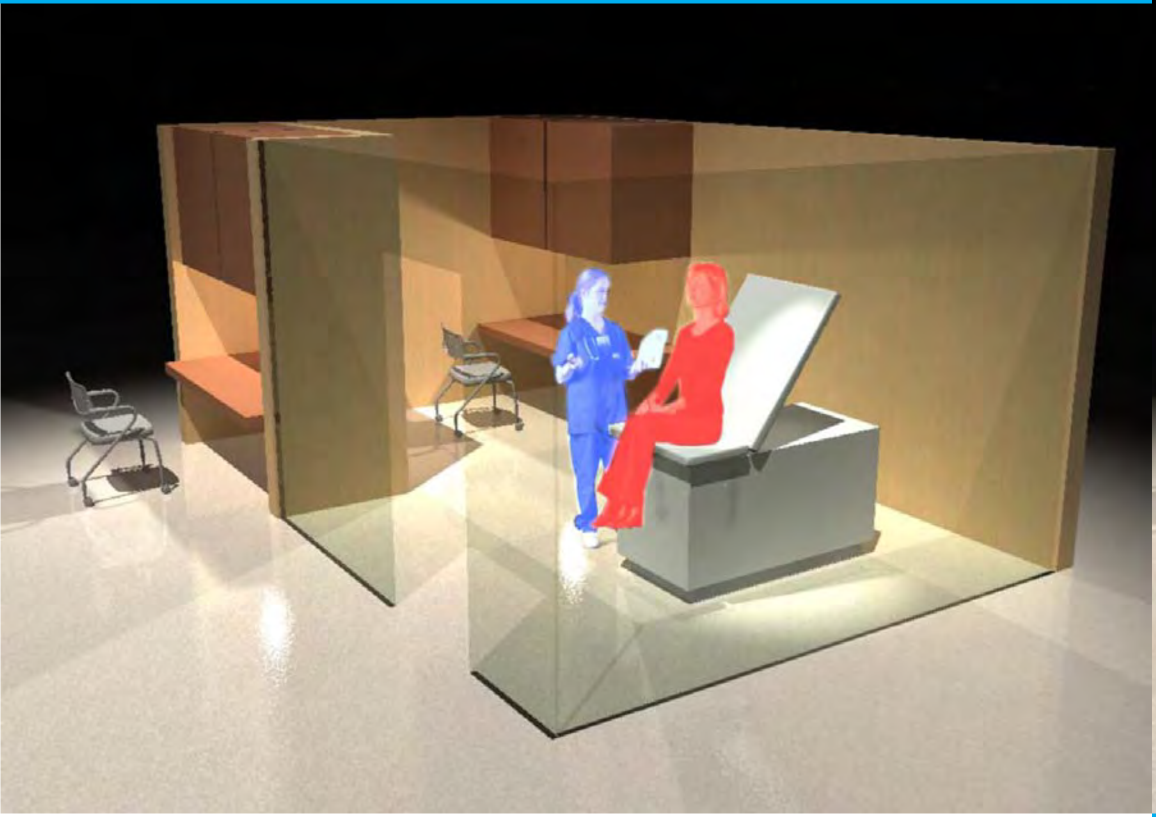
Contemporary medical school facilities must keep pace with accelerating curricular changes that emphasize problem-based learning, new technologies, and new student-learning styles. There are shifts toward interprofessional education models that mirror real-world experiences, place renewed emphasis on the patient, and train students to problem-solve collaboratively as a team.

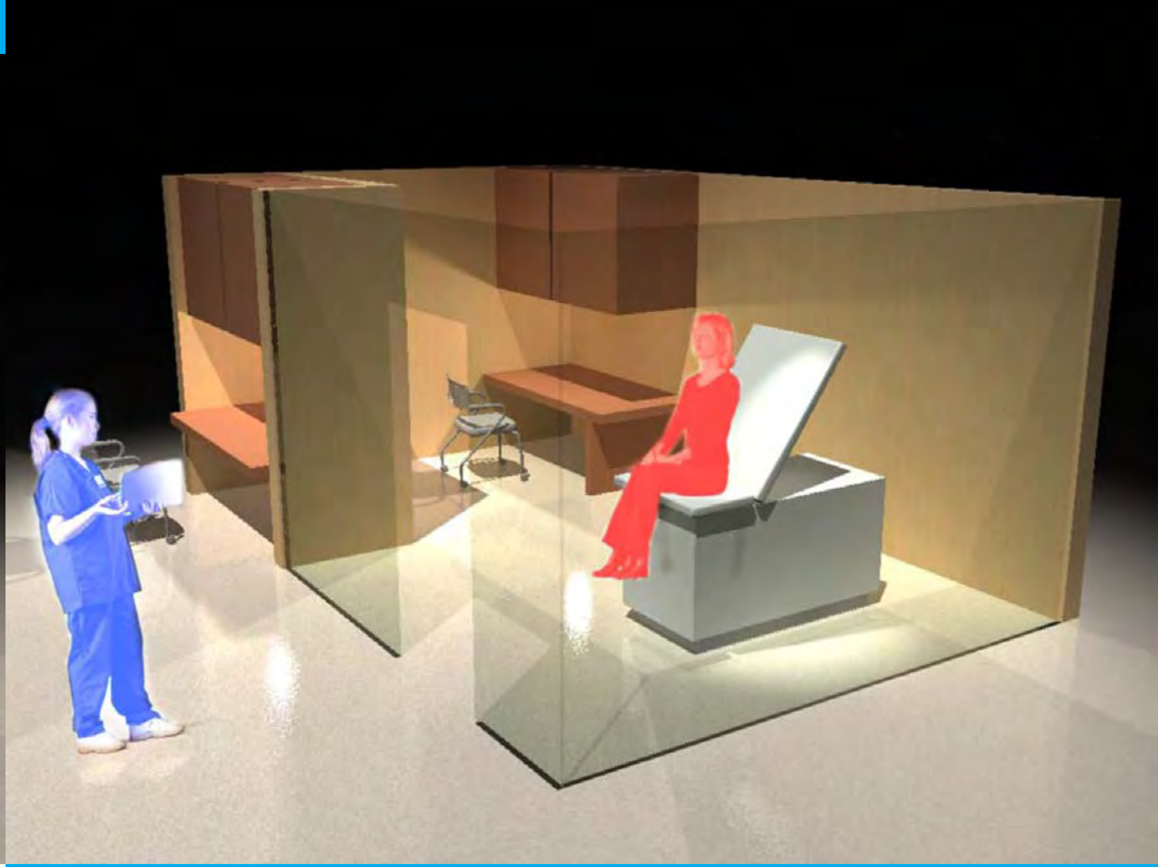


ASF PER STUDENT REDUCTION DUE TO SHARED SPACE

Using BIM from early in the programming phase helped instill the project's corresponding mission of collaboration—strategically enabled in part through shared space. Emphasis was placed on the development of such spaces, not discipline, and each user group collectively involved medical, nursing, and allied health representatives. BIM was crucial in that it enabled the development of three-dimensional room 'diagrams' and facilitated a highly visual programming and design process with the users. The additional clarity provided by 3D modeling promoted a sense of 'group authorship' amongst a diverse set of users, allowing them to envision how multiple disciplines would ultimately inhabit and function in the HSEB. An innovative application of BIM had the owner import the Revit model into a virtual reality cave platform and walk through the design.





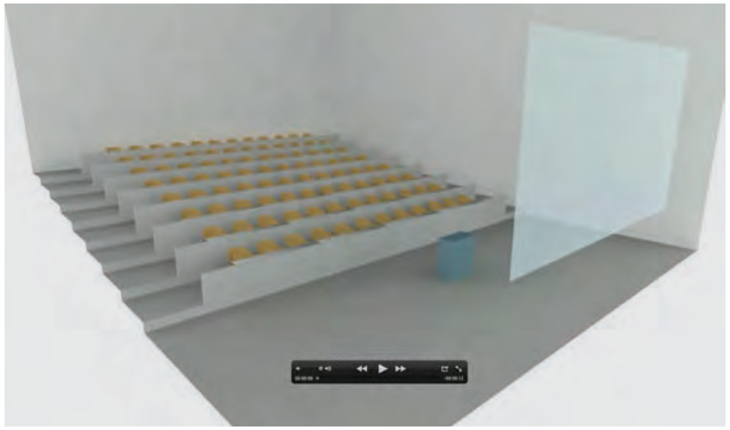


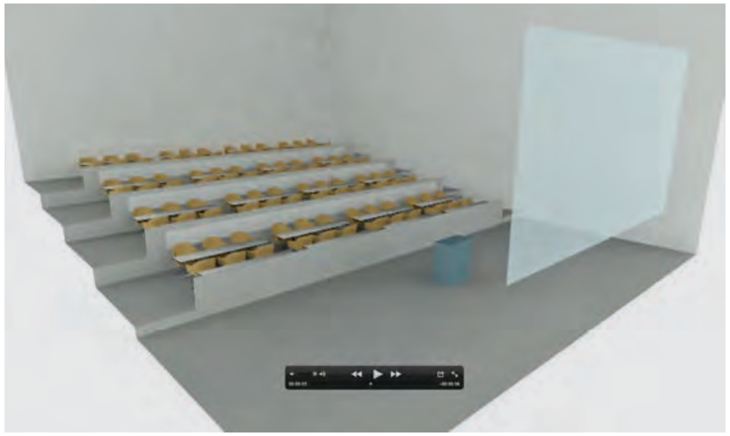
OWNER'S STATEMENT

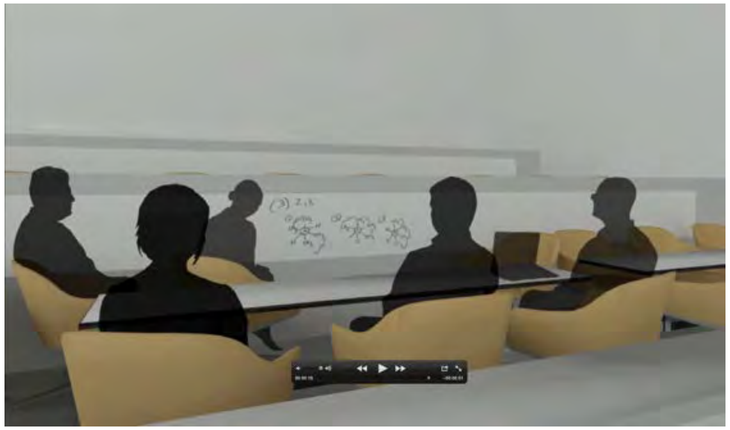
We explored through BIM the idea of new ways of teaching and unprecedented ways of sharing space between colleges. The BIM design process expedited the programming process and resulted in the universities' ability to contribute to the building, which resulted in an overall reduction of program area. The BIM process for this project is a model for future projects we undertake.

LECTURE HALL

Programming animation describes evolution of lecture hall.

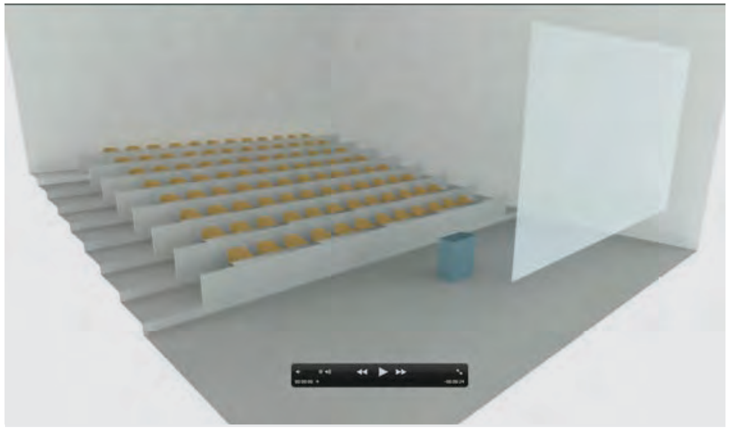






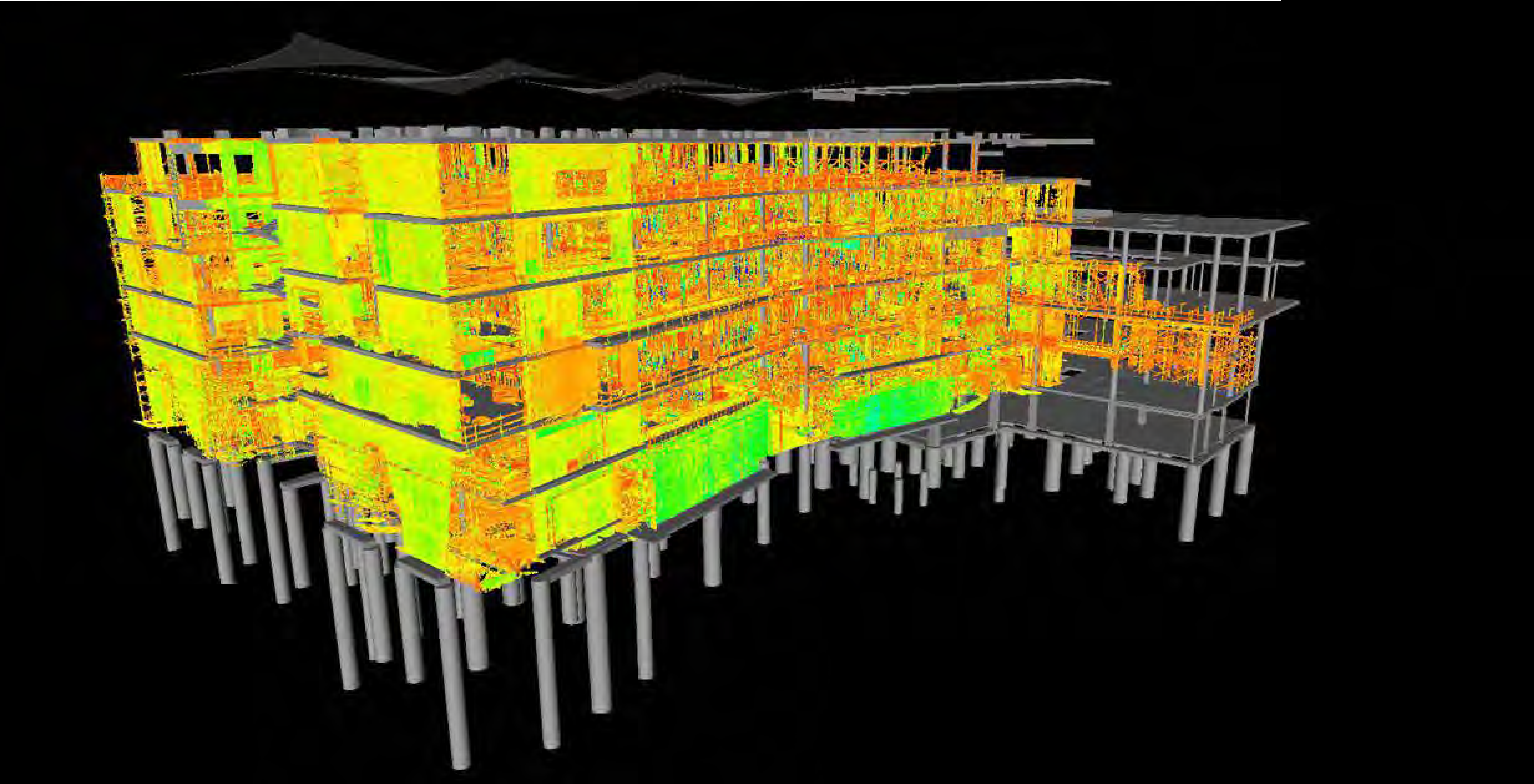
LEARNING STUDIO

Programming animation describes evolution of classroom.



If medical education is assertively moving in these directions, then so too must the physical design of medical schools themselves.

Time and budget constraints on the project also required the design and construction team and the owner to communicate with each other across the board. BIM was integral there as well, by speeding the process and cutting out guesswork when validating spatial requirements, reviewing and approving design options, understanding complex details and confirming maintenance requirements.



4.

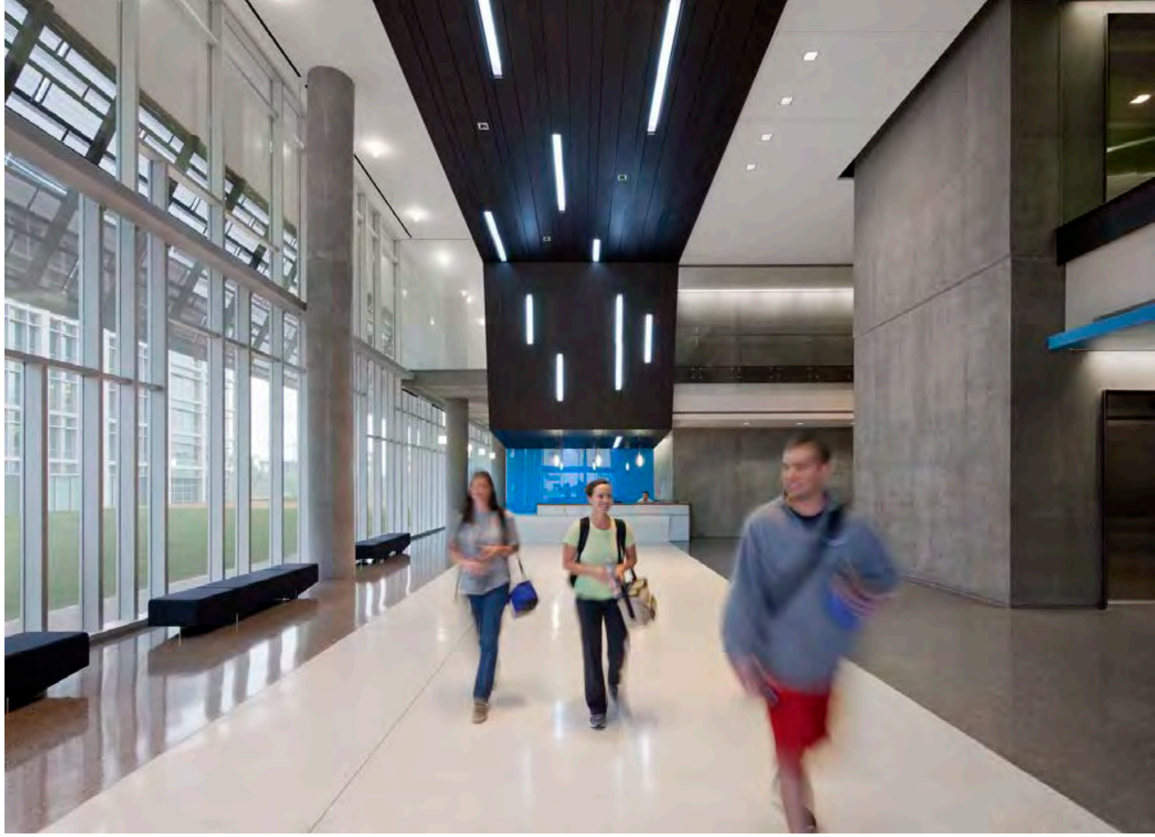
VERTICAL BIM TEAM INTEGRATION

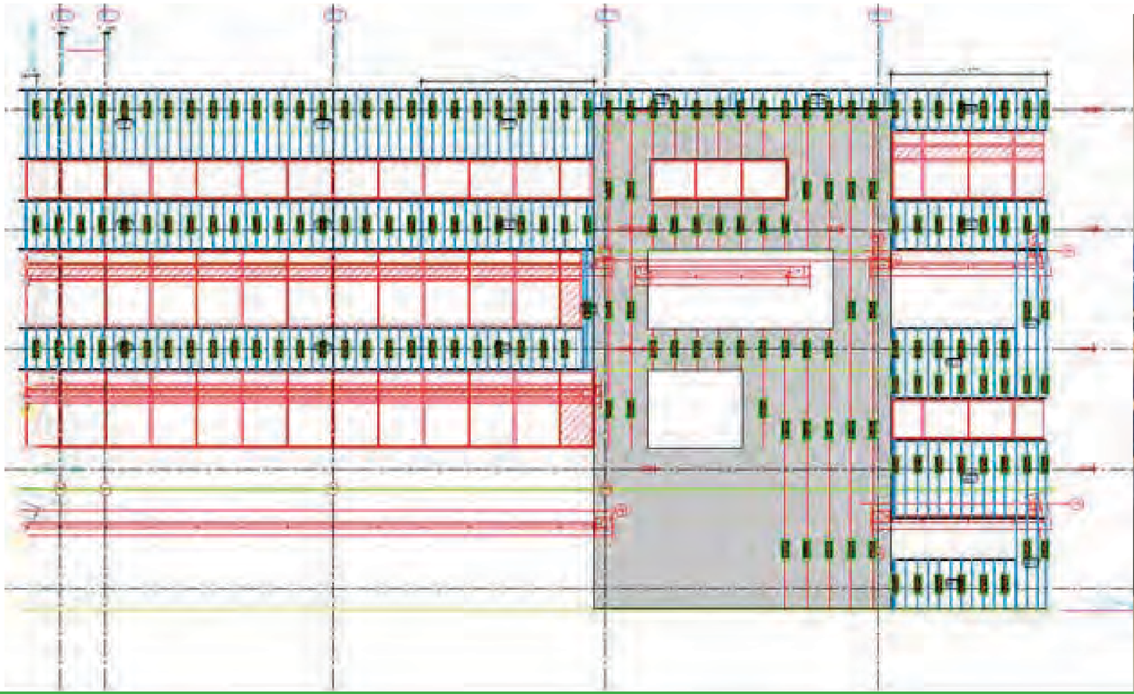
BIM was a crucial component of the integrated design and construction coordination process for HSEB. A short timetable required not only an overlap of the design and construction phases, but designs also had to be quickly delivered and integrated. The team shared those up-to-date designs with trades for accurate and timely installation in the field.

The 3D-coordination aspect of BIM made possible simplified installation of exacting architectural features, and also enabled team members to coordinate the precise detailing of penetrations and openings in exposed architectural concrete walls, an important interior design feature. The upshot of such applications: providing 3D as-built to the owner.

Pre-concrete pour laser scans were also attempted to identify any discrepancies in the field, and while this process resulted in varying degrees of success, the team learned in a valuable lesson that schedule and culture need to change for this step to succeed in the future.

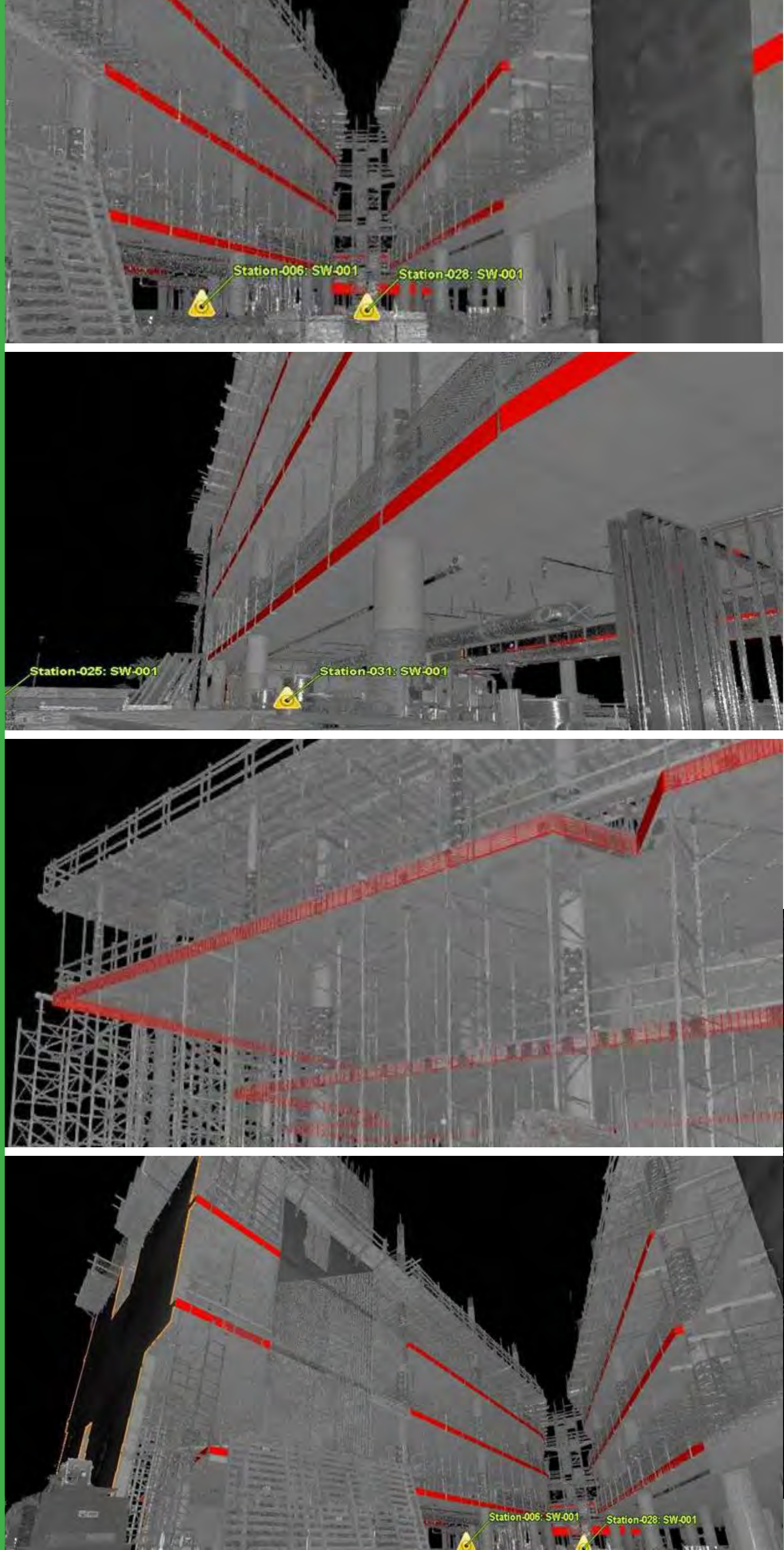
Another use for BIM enabled more, and more detailed levels of prefabrication: in addition to the traditional systems coordination, the contractor modeled and pre-assembled an exterior back-up wall, improving quality and increasing productivity by 20%.



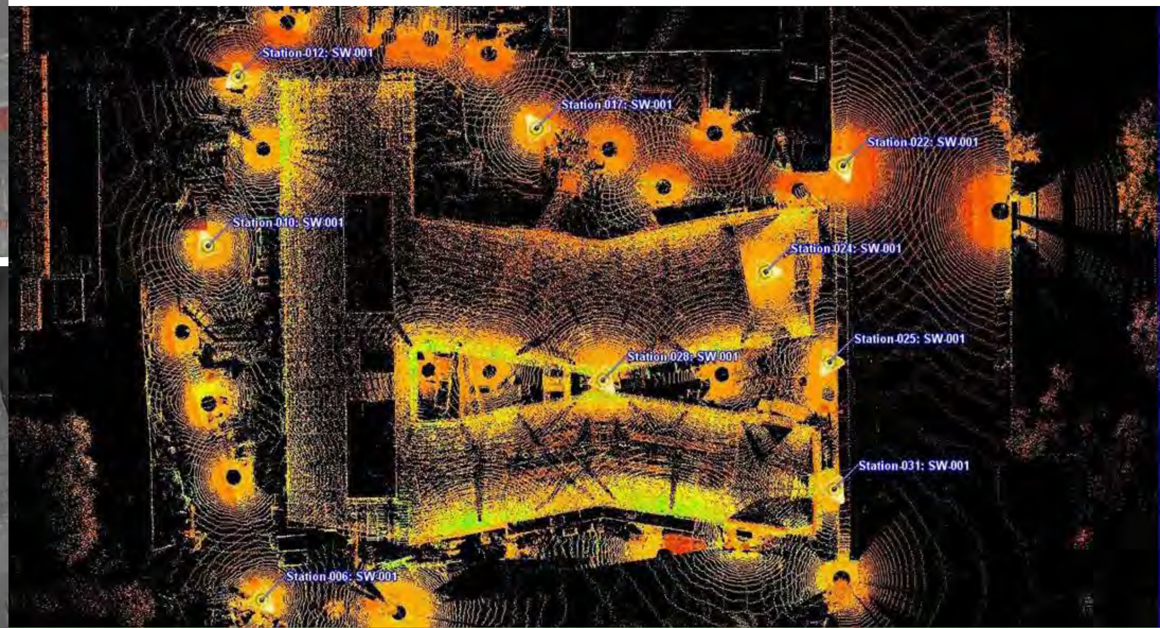


EXTERIOR BACK-UP WALL ERECTION DRAWING AND INSTALLATION

SLAB DECK EDGE OVERLAY

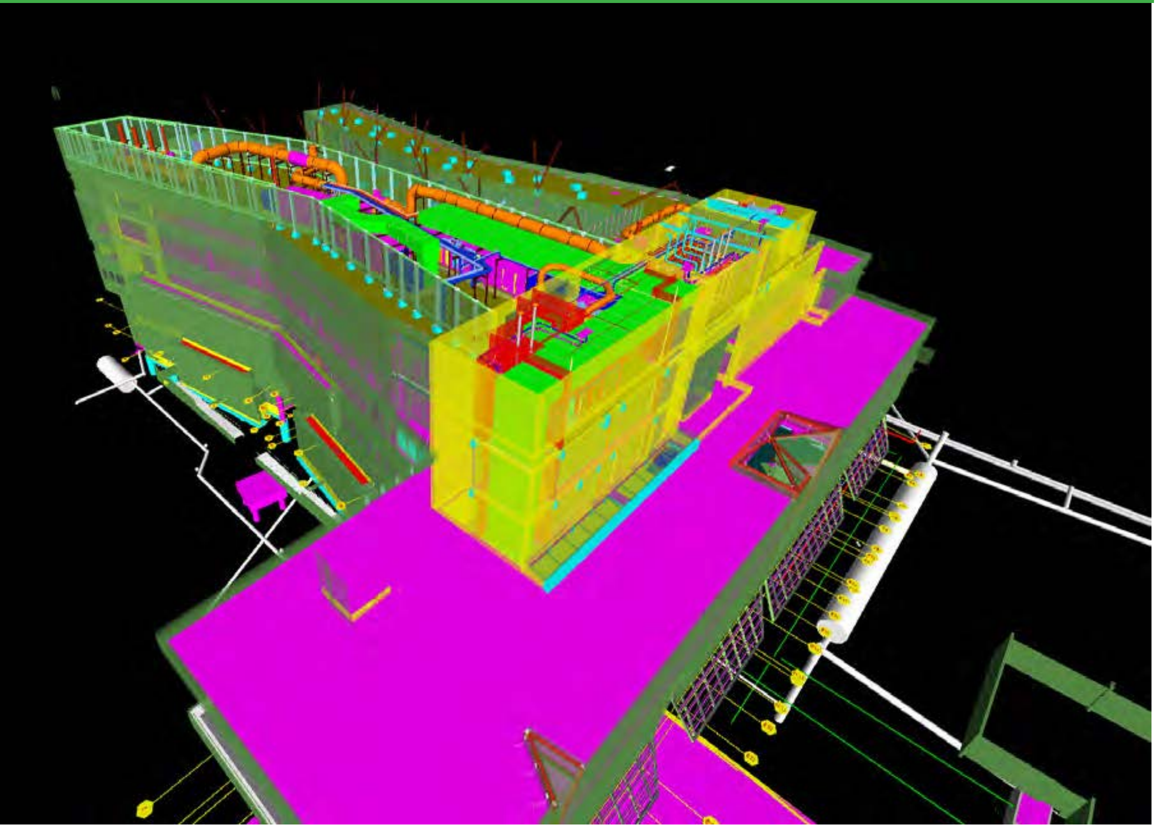


IN A NOVEL USE OF THE TECHNOLOGY, LASER SCANNING OF THE CONCRETE STRUCTURE WAS UNDERTAKEN AND A POINT CLOUD "AS-BUILT" WAS OVERLAID WITH THE COORDINATION BIM FOR FURTHER ACCURACY DURING CONSTRUCTION.



SLAB DECK EDGE SURFACE EXTRACTION

NAVISWORKS COORDINATION MODEL



BIM KIOSK

Yet another practice enhanced collaboration at the building site itself. Team members met with craft workers in the construction area for planning meetings that utilized BIM kiosks to review various models visually.

Applying and sharing BIM modeling reflected the collaborative approach here. So did a non-technological factor that was also crucial to the successful completion of HSEB: having all pertinent parties participate in meetings, either in person or virtually. That participation fostered trust, established a unified team, and sustained team unity.

CONTRACTOR'S STATEMENT

The most important advantage BIM delivered to the HSEB project was dramatic cost savings and schedule reduction. Construction contingency was drawn down only 25% for construction-related purposes, allowing the client to use the remaining contingency for program and equipment purchases they otherwise would not have been able to fund.