Integrated Practice and Collaboration

The Cronkite Experience

SUNDT CONSTRUCTION
Terry Abair

HDR ARCHITECTURE
Michael Jackson

Case Study

Content:

- The Challenge
- The Pursuit
- Team and Goal Alignment
- Plan the Work & Work the Plan
- Key Design Concepts
- Design to Budget and Process
- Design Time-line and LEAN Processes
- Packaging & Permitting
- Construction & LEAN Processes
- What Success Looks Like

Case Study

THE CHALLENGE

1. City of Phoenix Build-to-Suit for ASU
2. Downtown Phoenix, AZ
3. 225,000 – 250,000 sf.
4. $71,000,000 Total Budget
5. 20 months to Program, Design, Permit, Construct and Commission
6. Design / Build + BIM

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A Public / Public Partnership

The City of Phoenix

Arizona State University

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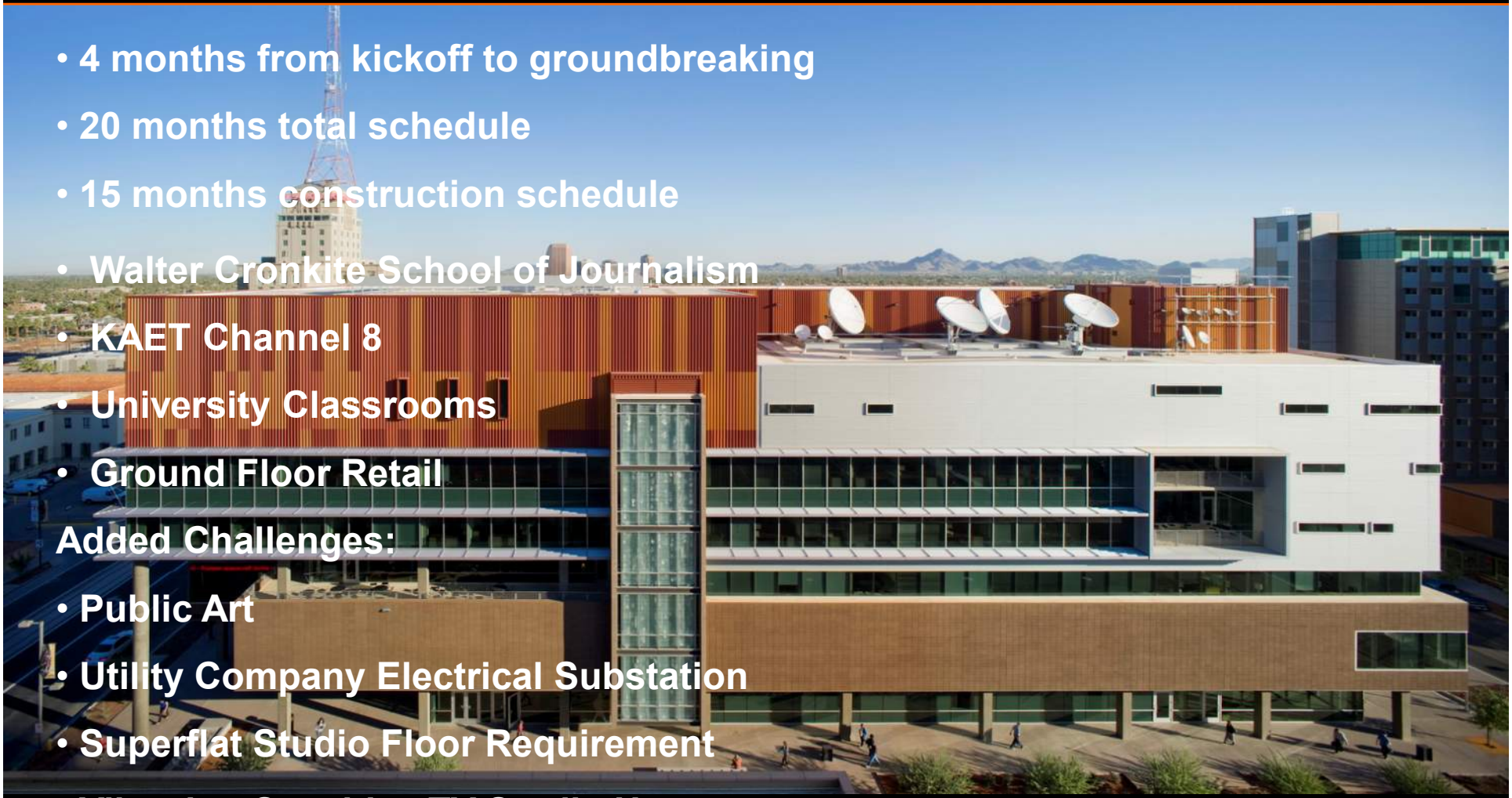
Project Challenge

PROGRAM CHALLENGE



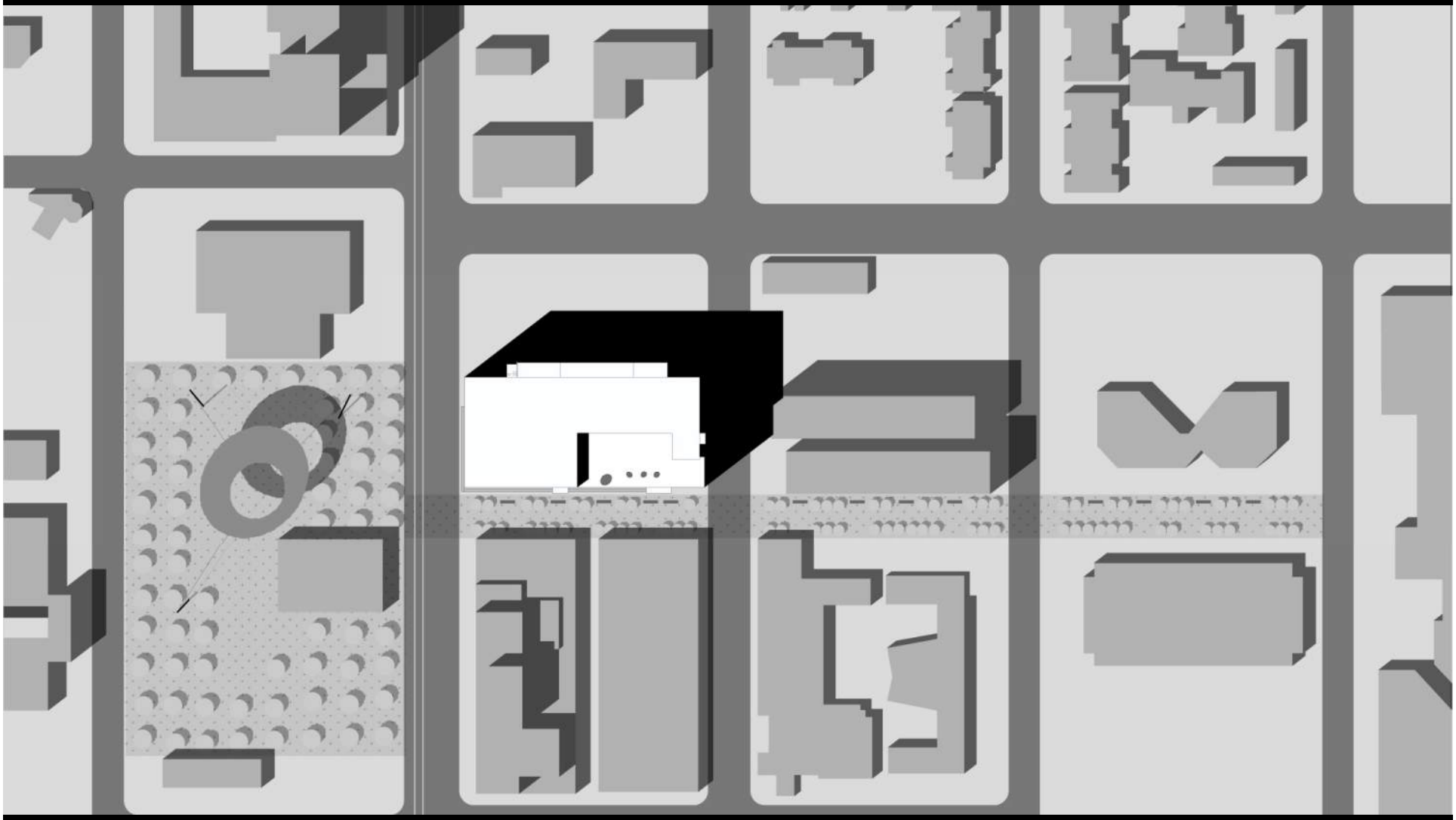
- 4 months from kickoff to groundbreaking
- 20 months total schedule
- 15 months construction schedule
- Walter Cronkite School of Journalism
- KAET Channel 8
- University Classrooms
- Ground Floor Retail

Added Challenges:

- Public Art
- Utility Company Electrical Substation
- Superflat Studio Floor Requirement
- Vibration Sensitive TV Studio Uses

The Site

DOWNTOWN PHOENIX



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The Site

DOWNTOWN PHOENIX

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Pursuit: Our Go – No Go Schedule

Normal Design Time	12 – 15 months
Construction Document Permitting	2 – 4 months
Demo & Utility Relocations	2 – 3 Months
New Construction	15 months
Commissioning	2 months
Owner Occupancy and Soft Start-up	2 months
Total Normal Design, Permit & Construction	35 – 41 months

Our Plan (Commit to 20 months program, design, permit & construct):

7 Permit Packages

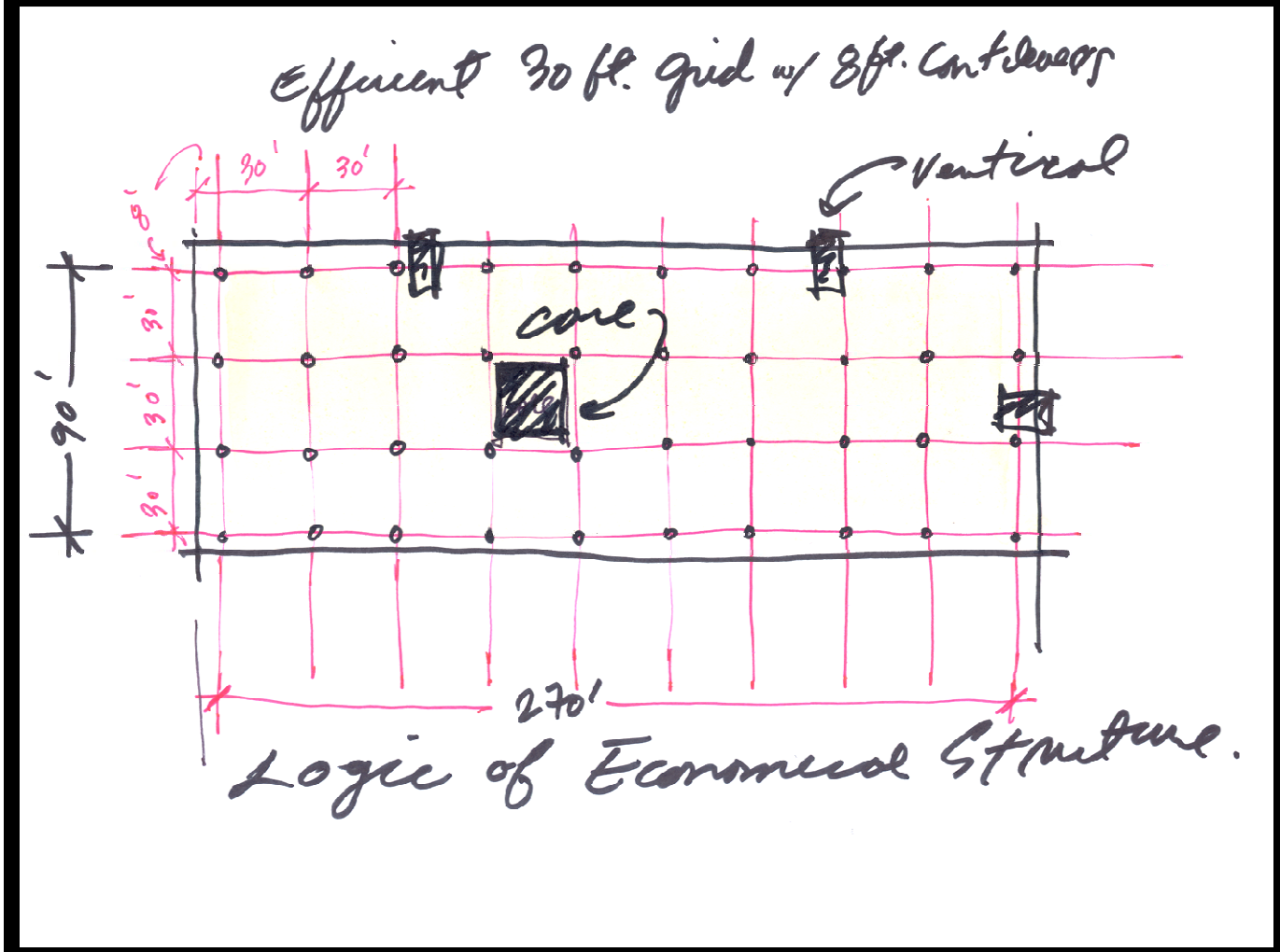
9 months to Program, Design and Permit Complete Building

15 months of New Construction Overlapping the Design 4 ½ months

Owner FF&E, Move-in & Soft Start-up 2 ½ months

Our Go – No Go Design

SCHEDULE CHALLENGE = STRUCTURAL CHALLENGE

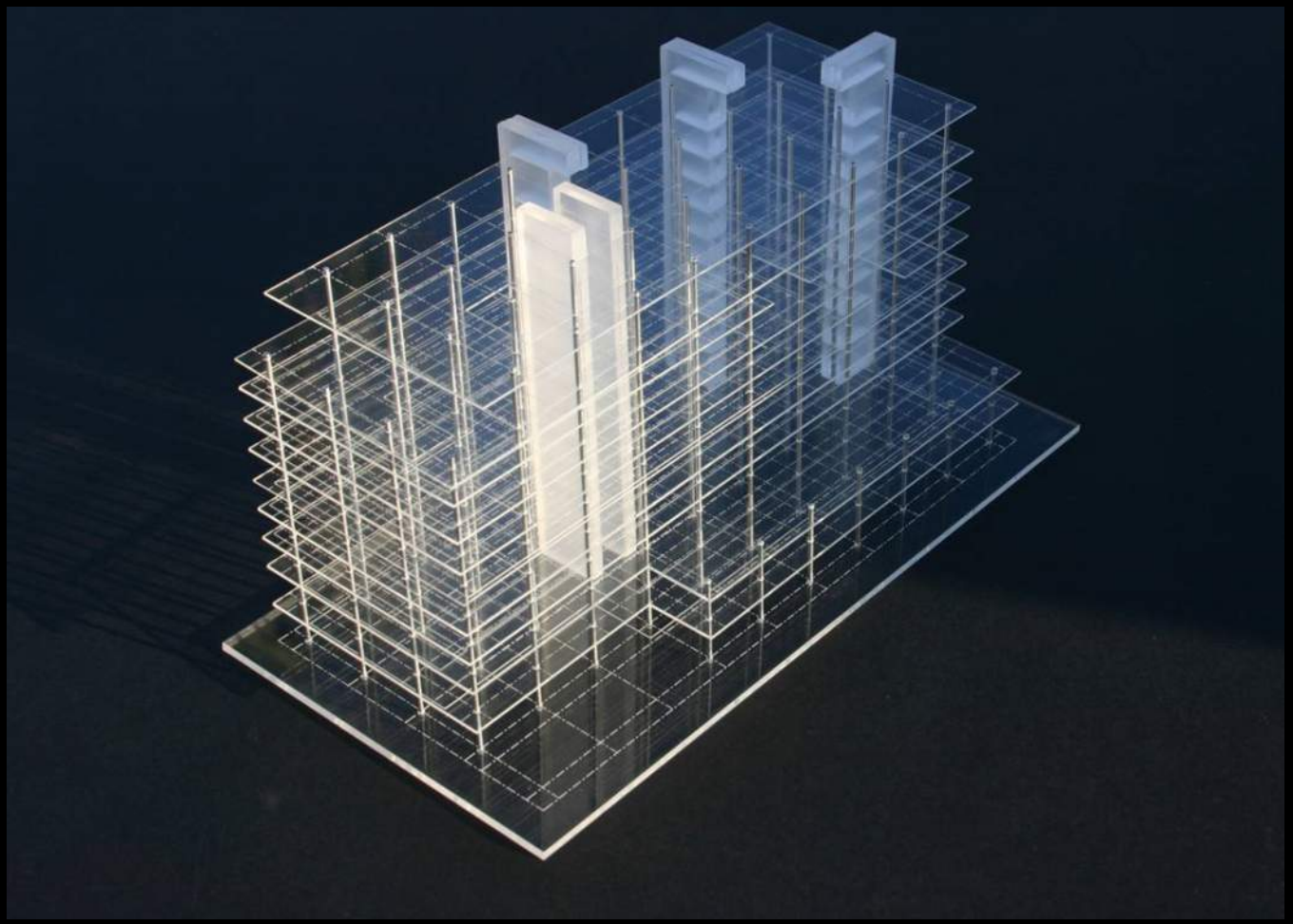


Key Concepts:

1. Cast-in-place Concrete
2. Column Hung Form System
3. 8 FT. Maximum Cantilever
4. Maximize Building Footprint
5. 30,000 SF +/- Floor Plates
6. 2 Pours, Maximize PT Pull Lengths
7. Minimize Shear-walls
8. No Basement, No Transfer Girders
9. All Goals Designed to Minimize Deck Cycle Times

The Pursuit

SCHEDULE CHALLENGE = STRUCTURAL CHALLENGE



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The Pursuit

SCHEDULE CHALLENGE = STRUCTURAL CHALLENGE

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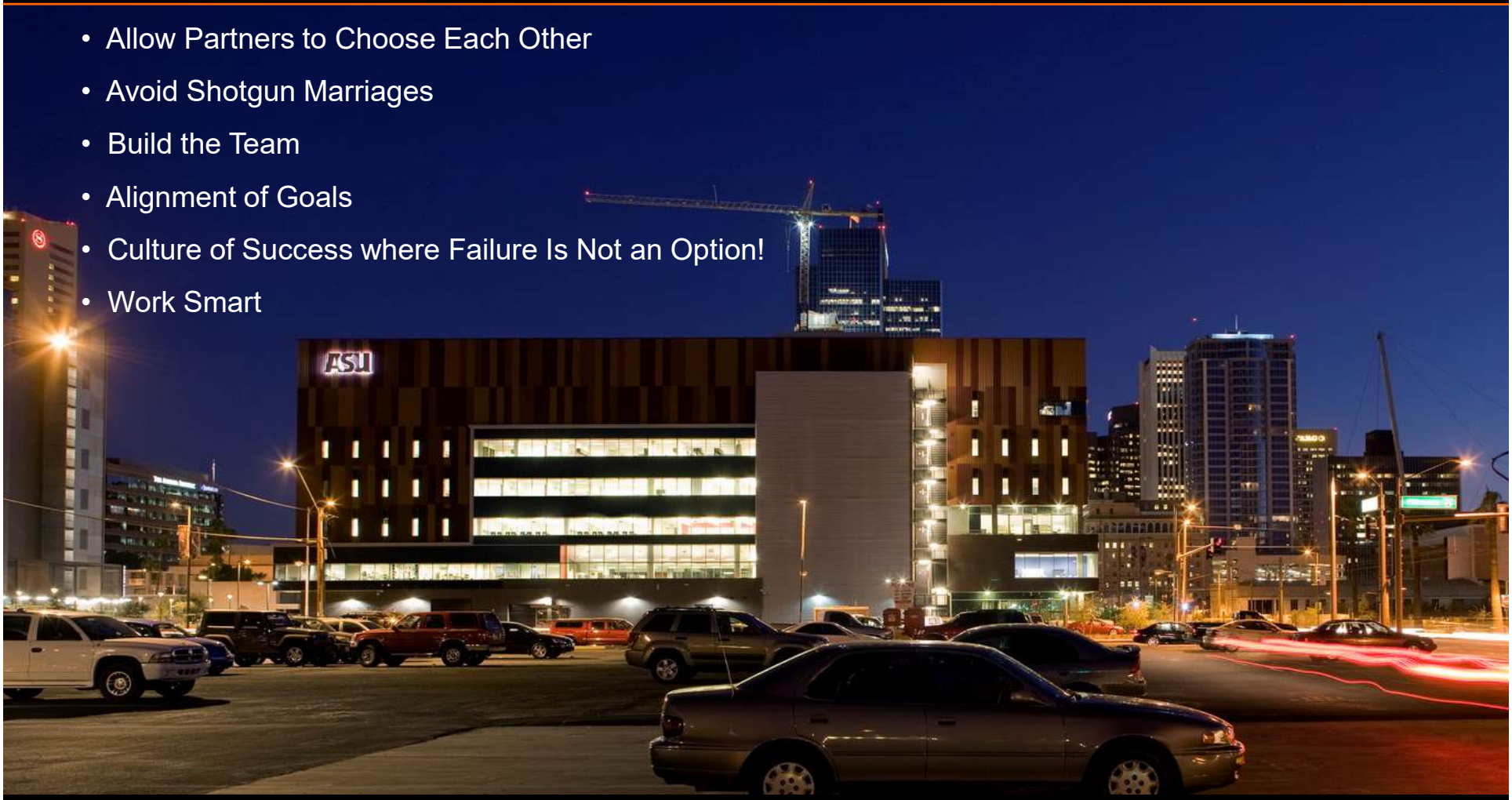
How Did We Get There ?

- Allow Partners to Choose Each Other
- Avoid Shotgun Marriages
- Build the Team
- Alignment of Goals
- Culture of Success where Failure Is Not an Option!
- Work Smart



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Build the Team

CORE DESIGNERS

SUNDT Construction
Construction

HDR Architecture
Architect of Record and MEP

EHRLICH Architects
Design Architect

CTS
Structural

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Build the Team

KEY SUBCONTRACTORS

Core Subcontractor Partners

- SUNDT - Concrete & Civil
- University Mechanical – HVAC & Plumbing
- Kearney Electric – Electrical & Special Systems
- KT Fab – Glass & Glazing Systems

Additional Qualification & Price Based Selections

- Progressive Contracting Group (PCG) – Framing & Drywall
- Elward – Metal Panel System
- Sun Valley Masonry - Masonry

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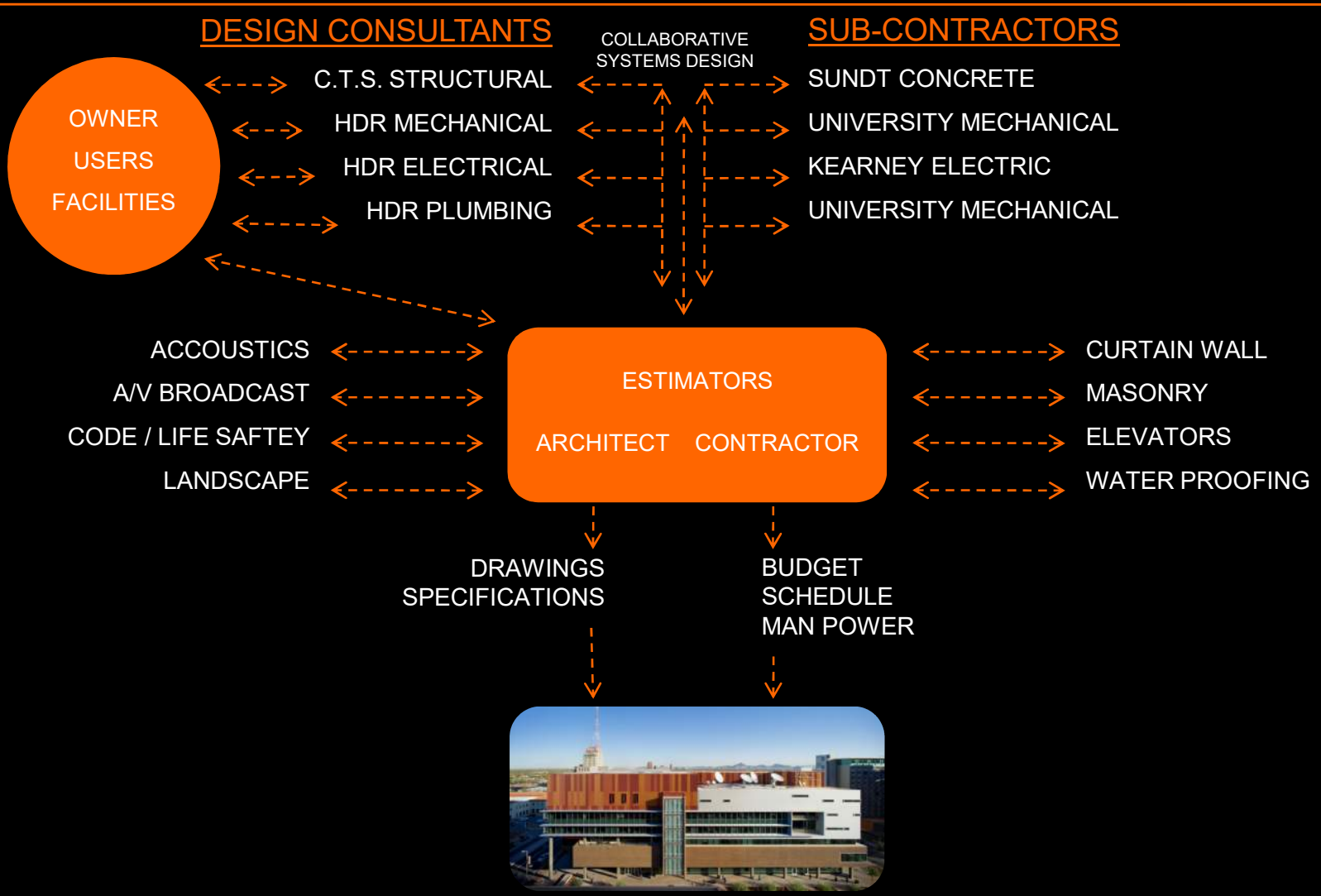
Establish Relationships

TEAM INTEGRATION



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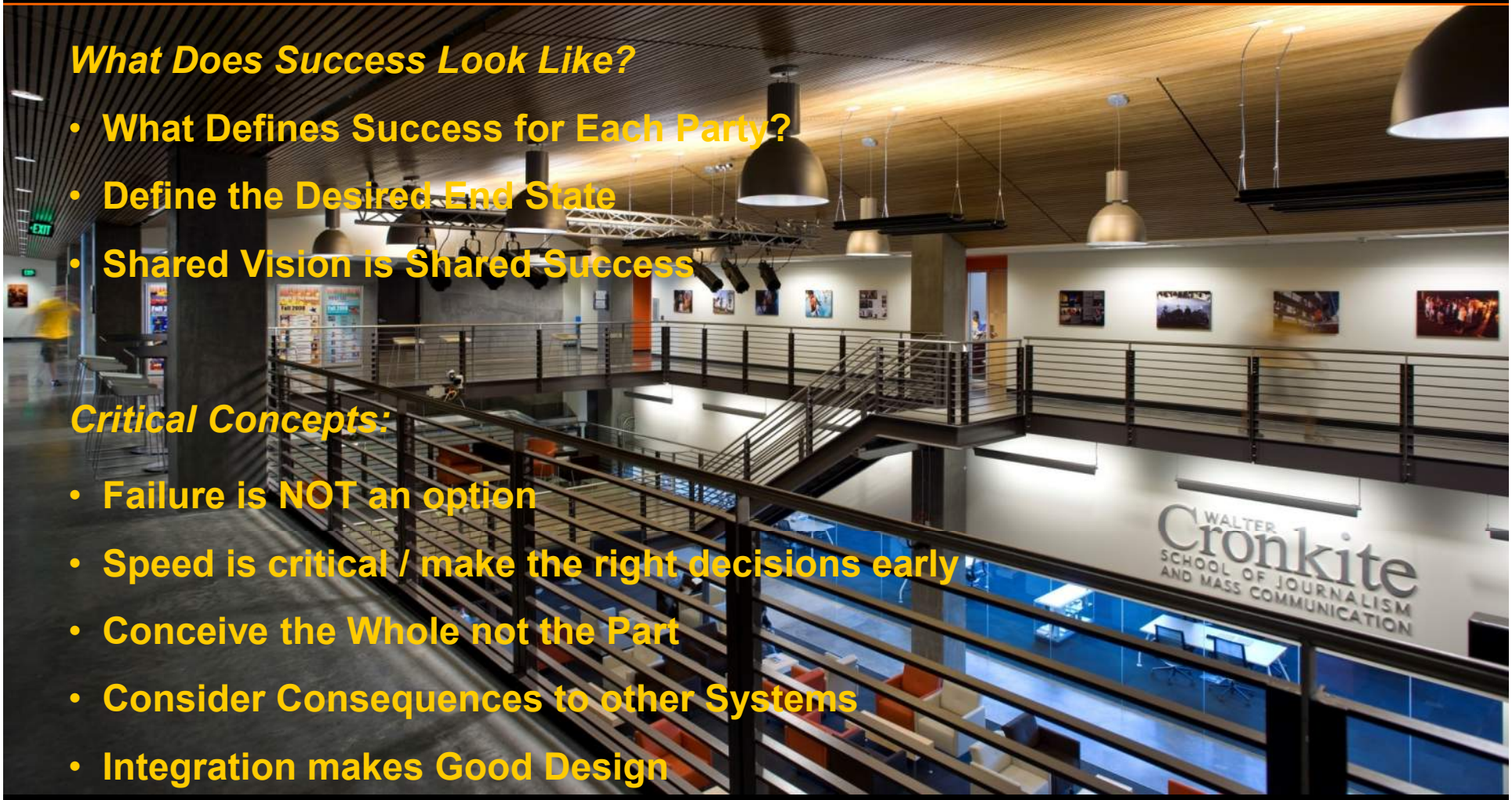
The Culture of Success

WHAT DOES SUCCESS LOOK LIKE ?



What Does Success Look Like?

- **What Defines Success for Each Party?**
- **Define the Desired End State**
- **Shared Vision is Shared Success**

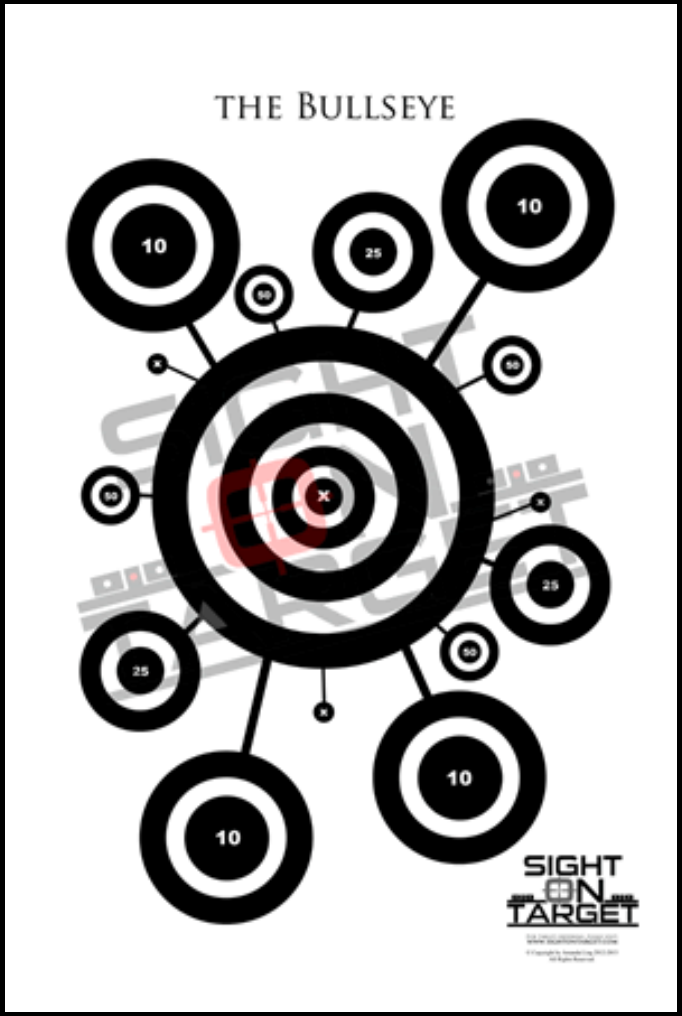
Critical Concepts:

- **Failure is NOT an option**
- **Speed is critical / make the right decisions early**
- **Conceive the Whole not the Part**
- **Consider Consequences to other Systems**
- **Integration makes Good Design**

What it's not!

Alignment is Seeking the Same *GOAL*

What it's not!



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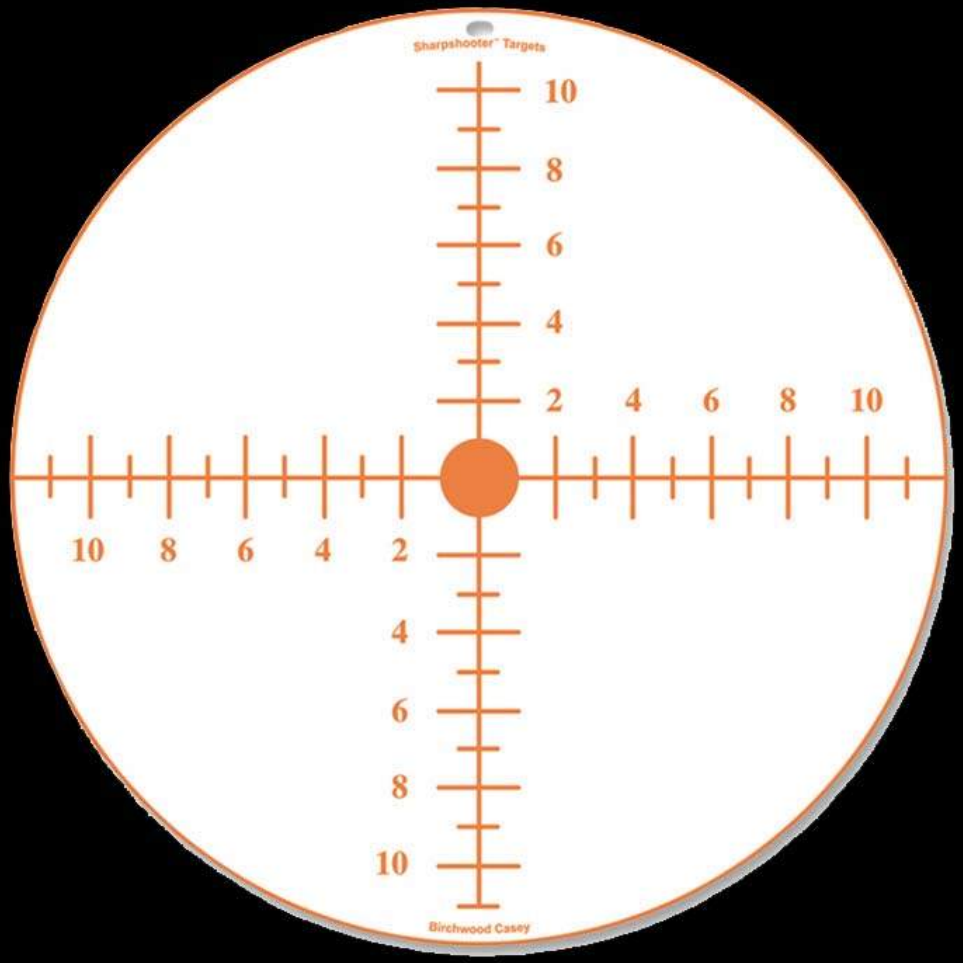
Alignment – The Same Bullseye

What it IS!



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Alignment – The Vulcan Mind Meld

What it IS!

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Collaboration – The Efficient Machine

What it IS!

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Collaboration

CO LOCATION & THE VULCAN MIND MELD

What it IS!

- **Proximity leads to Communication (it's not always pretty)**
- **Communication leads to Understanding**
- **Understanding leads to Respect**
- **Respect fosters Cooperation**

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Integrated Practice

…DON'T GET TOO COMFORTABLE ?

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Cronkite School of Journalism - KAET Channel 8

Design Evolution Log

SUNDT CONSTRUCTION, INC.

December 3, 2008

Program S.F.	244,000
Revised S.F.	223,229
Current S.F.	223,229
Delta	20,771

COST MODEL	71,000,000
ACCEPTED CHANGES:	0
CURRENT BUDGET:	71,000,000
TARGET BUDGET:	71,000,000
BUDGET STATUS:	0
Excludes "Indirects" ---> REMAINING POTENTIAL:	1,898,431
Excludes "Indirects" ---> REJECTED:	0

		1/25/2007 DEL	ACCEPTED CHANGES	CURRENT BUDGET	COST PER SQ. FT.	% CHANGE
01	GENERAL REQUIREMENTS	2,019,996	0	2,019,996	$ 9.05	0.00%
02	SITEWORK	1,532,706	(30,595)	1,502,111	$ 6.73	-2.00%
03	SUBSTRUCTURE	1,323,592	0	1,323,592	$ 5.93	0.00%
04	SUPERSTRUCTURE	7,092,010	(157,410)	6,934,600	$ 31.06	-2.22%
05	EXTERIOR WALL	4,132,040	0	4,132,040	$ 18.51	0.00%
06	ROOFING	190,687	0	190,687	$ 0.85	0.00%
07	INTERIOR CONSTRUCTION	5,004,561	0	5,004,561	$ 22.42	0.00%
08	INTERIOR FINISH	1,813,179	0	1,813,179	$ 8.12	0.00%
09	SPECIALTIES	47,918	0	47,918	$ 0.21	0.00%
10	EQUIPMENT & FURNISHINGS	153,171	0	153,171	$ 0.69	0.00%
11	SPECIAL CONSTRUCTION	7,500	0	7,500	$ 0.03	0.00%
12	CONVEYING SYSTEM	1,362,023	157,410	1,519,433	$ 6.81	11.56%
13	FIRE SPRINKLER	595,891	0	595,891	$ 2.67	0.00%
14	PLUMBING	948,790	0	948,790	$ 4.25	0.00%
15	MECHANICAL	7,620,655	0	7,620,655	$ 34.14	0.00%
16	ELECTRICAL	6,259,055	(2,033)	6,257,022	$ 28.03	-0.03%
	Northwind Connection Cost	0	0	0	$ -	#DIV/0!
	LEED Premium	38,396	0	38,396	$ 0.17	0.00%
	Subcontractor Default Insurance	412,422	0	412,422	$ 1.85	0.00%
	Labor Escalation	761,676	0	761,676	$ 3.41	0.00%
	Material Escalation	761,676	0	761,676	$ 3.41	0.00%
	Design Contingency	992,046	32,628	1,024,674	$ 4.59	3.29%
	Subtotal	**$ 43,069,987**	**$ -**	**$ 43,069,987**	**$ 192.94**	**0.00%**
	INDIRECTS:					
	General Conditions	2,471,690	0	2,471,690	$ 11.07	0.00%
	PL & PD Ins	610,035	0	610,035	$ 2.73	0.00%
	Builders Risk Ins	58,231	(0)	58,231	$ 0.26	0.00%
	G C Bond	415,933	(0)	415,933	$ 1.86	0.00%
	Contractors Contingency	2,772,886	0	2,772,886	$ 12.42	0.00%
	Sales Tax	2,919,849	0	2,919,849	$ 13.08	0.00%
	Contractors O.H. & P.	3,139,117	(0)	3,139,117	$ 14.06	0.00%
	Subtotal	**$ 12,387,741**	**$ 0**	**$ 12,387,741**	**$ 55.49**	**0.00%**
	CONSTRUCTION COST	**$ 55,457,728**	**$ 0**	**$ 55,457,728**	**$ 248.43**	**0.00%**
	SOFT COSTS					
	Design Fees	7,910,994	0	7,910,994	$ 35.44	0.00%
	DESIGN BUILDER CONTRACT	**$ 63,368,722**	**$ 0**	**$ 63,368,722**	**$ 283.87**	0.00%
	CITY OF PHOENIX SOFT COST					
	CoP Soft Cost	7,631,278	0	7,631,278	$ 34.19	0.00%
	Total	**$ 71,000,000**	**$ 0**	**$ 71,000,000**	**$ 318.06**	**0.00%**

Design to Budget

Design Evolution Log

COST MODEL – LINE ITEM MANAGEMENT

Key Concepts:

1. Reverse Engineer Owners ***Entire Budget***
2. Manage Design to the ***Direct Cost Line***
3. ***System Accountability by Designer and Trade Contractor***
4. ***Cost Breach by D-B Line Item Team Means Asking Entire Project Team for Part of Their Budget or Design Contingency Relief***

Design Evolution Logs

		Sundt Parametric Cost Model				HDR/SEA Design as of 4/29/08				VARIANCE
		$/Ut	UT	QTY	Extension	$/Ut	UT	QTY	Extension	OVER / (UNDER)
EXTERIOR SKIN / ROOFING SYSTEMS										
Concrete Shear Walls										
	Concrete shear walls (move from superstructure)	$51.30	SF	21,545	$1,105,259	$0.00	SF	-	$0	
	Level-1, 18" shear walls, w/ deep form liner, rebar 300 lbs/cy					$57.97	SF	5,000	$0	
	Level-2, 18" shear walls, w/ deep form liner, rebar 300 lbs/cy					$61.09	SF	3,323	$202,966	
	Level-3, 18" shear walls, w/ deep form liner, rebar 300 lbs/cy					$61.09	SF	3,323	$202,966	
	Level-4, 18" shear walls, w/ deep form liner, rebar 300 lbs/cy					$61.09	SF	3,323	$202,966	
	Level-5, 18" shear walls, w/ deep form liner, rebar 300 lbs/cy					$61.09	SF	3,323	$202,966	
	Level-6, 18" shear walls, w/ deep form liner, rebar 300 lbs/cy					$59.59	SF	2,890	$172,216	
	Level-7, 18" shear walls, w/ deep form liner, rebar 300 lbs/cy					$60.82	SF	3,716	$225,991	
8	Form liner in concrete shear walls	$7.90	SF	13,296	$105,038	$0.00	SF	-	$0	
11	DEL Item - Sup #03 - Reduce concrete shear walls to min. required.					-$10,732.00	Ls	1	($10,732)	
12	DEL - Sup #07 - Change form liner to 4'x8' reveal w/ light/medium sandblast					-$24,469.00	LS	1	($24,469)	
					$1,210,296.90				$1,174,959.52	($35,337.38)
	Total Square Footage of Metal Panels		SF	34,841			SF	24,898		(9,943)
	Exterior Scaffolding					$275,000.00	LS	1	$275,000.00	
Exterior Metals					$0.00				$0.00	
1	Metal Panels	$45.00	SF	47,762	$2,149,290.00	$45.00	SF	26,522	$1,193,490.00	
	6" 18 ga 16" o.c. w/1 layer Densglass				$0.00	$7.26	SF	26,522	$192,549.72	
	R-19 Batt insulation					$1.00	SF		$0.00	
2	Copper at Auditorium				$0.00	$50.00	SF		$0.00	
	Framing at Auditorium Copper					$15.37	SF		$0.00	
3	Metal Column Covers	$200.00	LF	168	$33,600.00				$0.00	

DESIGN & PERMIT SCHEDULE

	Planned	Actual Scheduled
Scope Meeting	10-09-06	10-09-06
Program Verification Blocking & Stacking Complete	12-19-06	11-15-06
Preliminary Design Complete	03-05-07	01-25-07
Site Plan Approval (Key to Project)	04-13-07	01-31-07
Demo / Utility Permit	05-11-07	12-13-07
Foundation Permit	04-10-07	04-11-07
Superstructure Permit	05-22-07	05-27-07
Core & Shell Building permit	08-09-07	06-19-07
Tenant Fit-up Permit	09-07-07	07-19-07

Collaboration

ALL STAKEHOLDERS ARE PART OF THE TEAM

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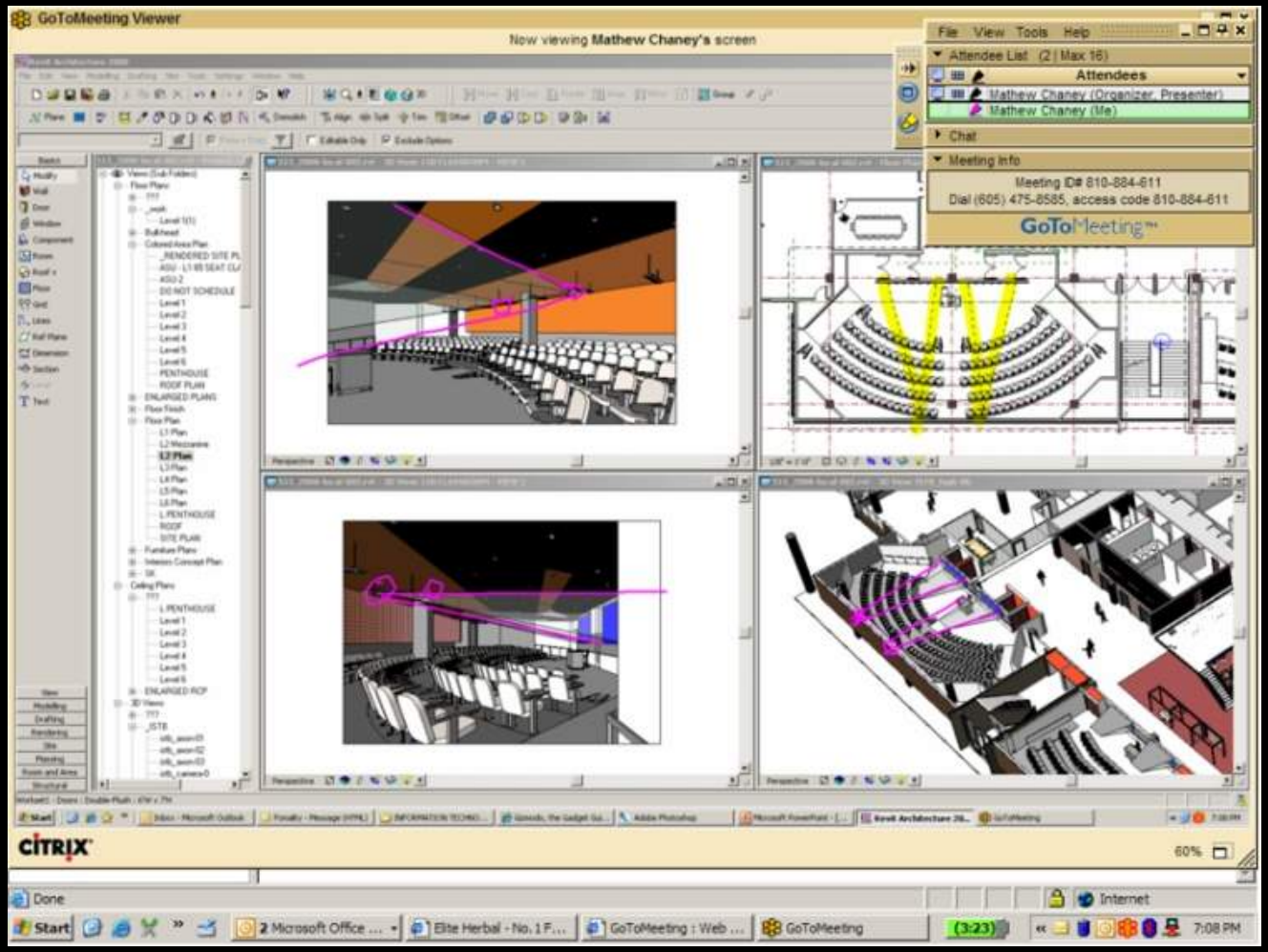
Remote Collaboration

GOTOMEETING.COM



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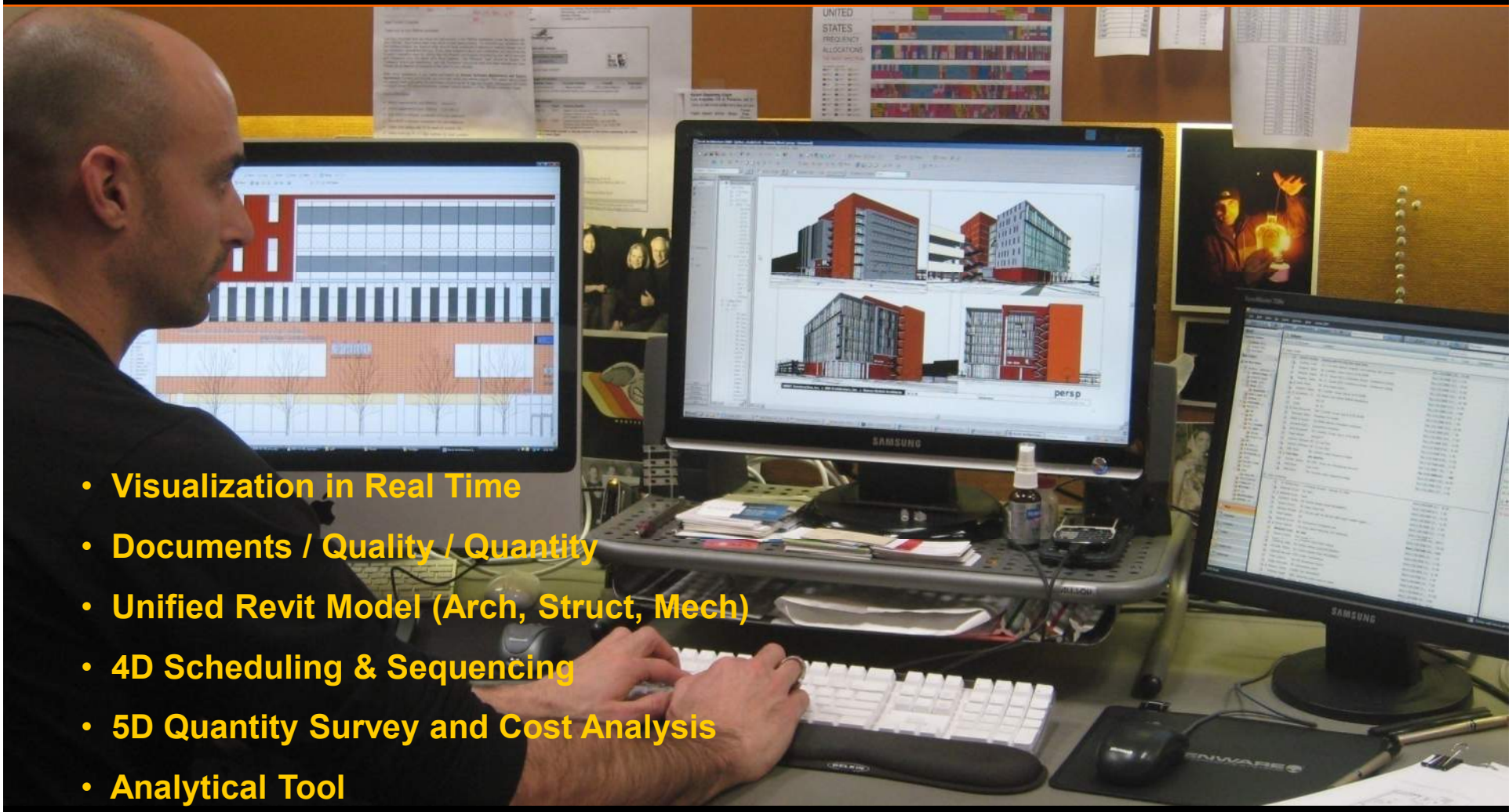
Work Smart

BUILDING INFORMATION MODELING



- **Visualization in Real Time**
- **Documents / Quality / Quantity**
- **Unified Revit Model (Arch, Struct, Mech)**
- **4D Scheduling & Sequencing**
- **5D Quantity Survey and Cost Analysis**
- **Analytical Tool**

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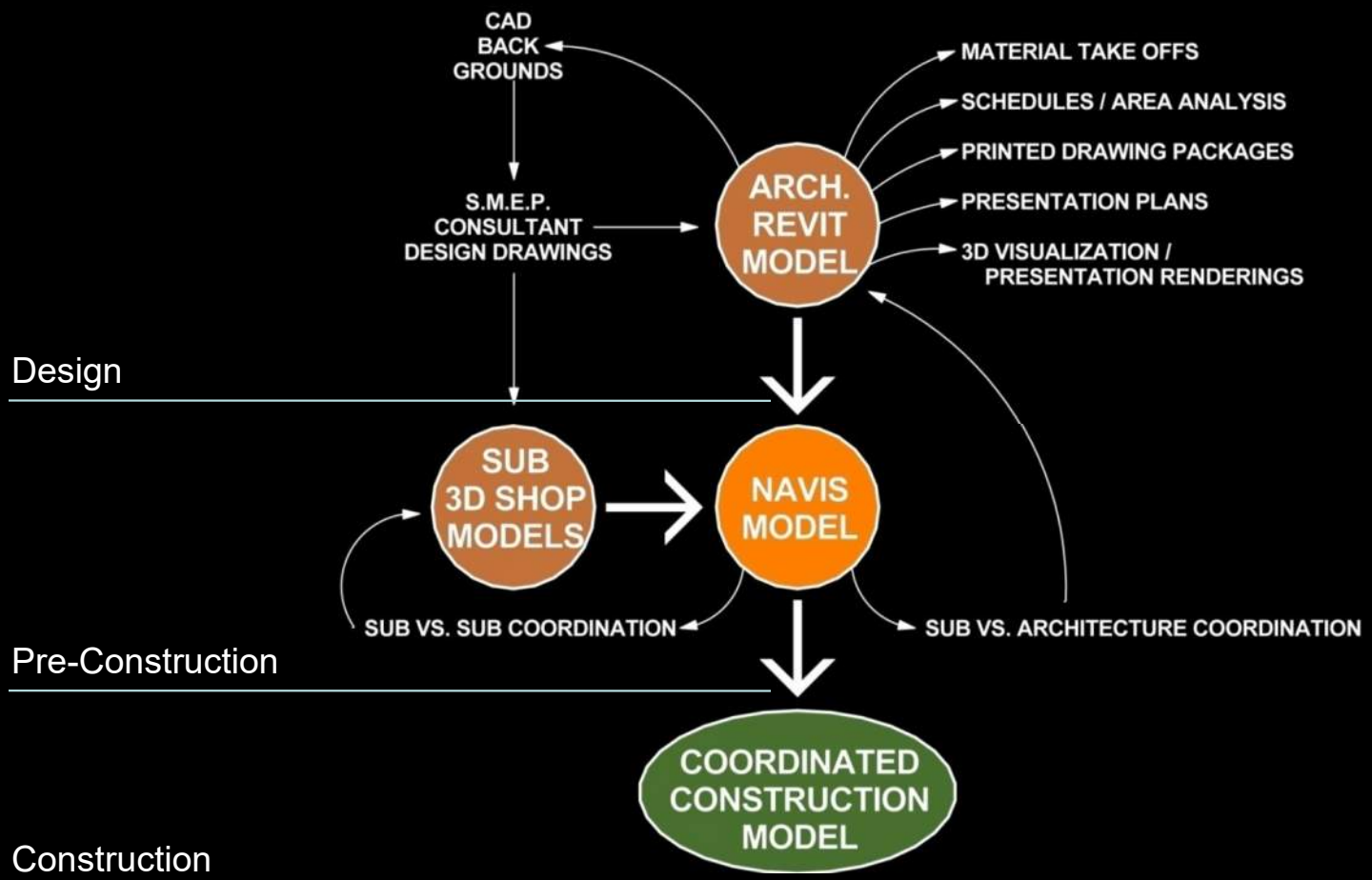
BIM Workflow



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Rapid Design Evolution

RESPONSIVE DESIGN

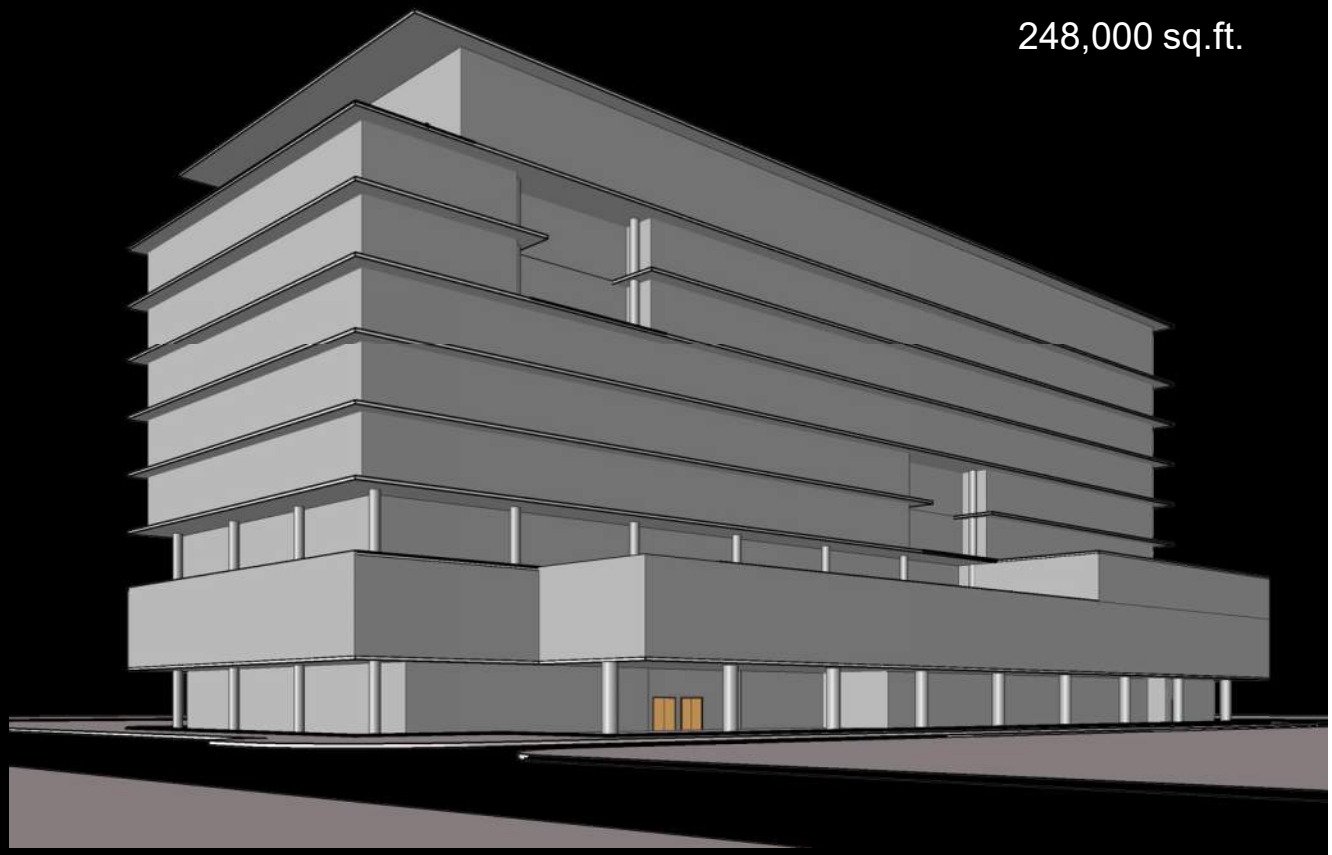
Week 2

Week 4

Week 5

Week 7

Week 2
10.25.2006
9 Stories
248,000 sq.ft.



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Rapid Design Evolution

RESPONSIVE DESIGN

Week 2

Week 4

Week 5

Week 7

Week 4
11.06.2006
7 Stories
242,000 sq.ft.

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Rapid Design Evolution

RESPONSIVE DESIGN

Week 2

Week 4

Week 5

Week 7

Week 5
11.12.2006
6 Stories
217,000 sq.ft.

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Rapid Design Evolution

RESPONSIVE DESIGN

Week 2

Week 4

Week 5

Week 6

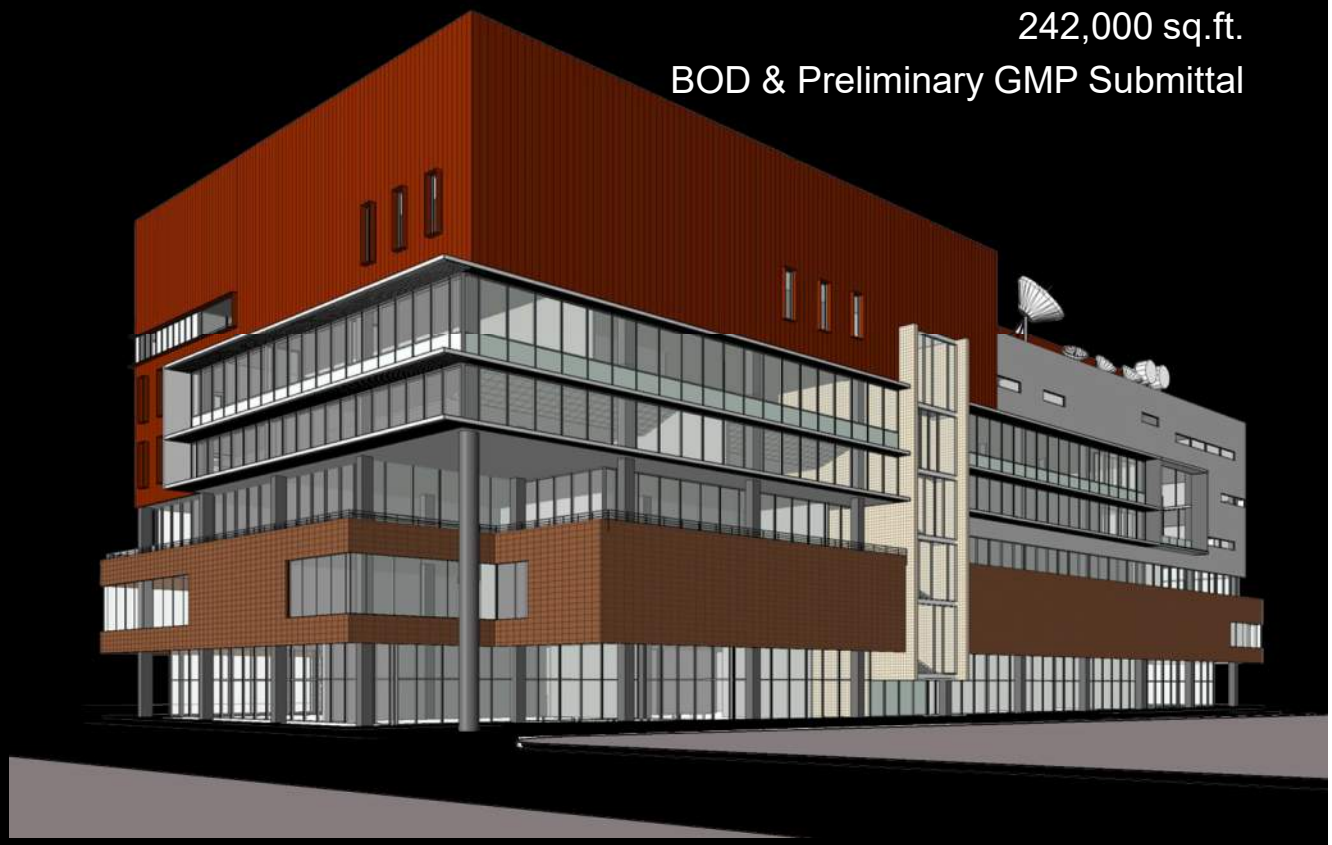
Week 6

11 - 14 - 2006

6 Stories + Mech Mezzanine

242,000 sq.ft.

BOD & Preliminary GMP Submittal



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BIM Applied

THREE DIMENSIONAL DATA BASE

SUNDT Construction :: HDR Architecture :: Ehrlich Architects

BIM Applied

THREE DIMENSIONAL DATA BASE

SUNDT Construction :: HDR Architecture :: Ehrlich Architects

BIM Applied

THREE DIMENSIONAL DATA BASE

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BIM Applied

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BIM Applied

THREE DIMENSIONAL DATA BASE

SUNDT Construction :: HDR Architecture :: Ehrlich Architects

BIM Applied

THREE DIMENSIONAL DATA BASE

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Design Strategy

STRUCTUAL SYSTEM

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Design Strategy

STRUCTUAL SYSTEM

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Design Visualization

BIM (REVIT)

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Design Visualization

BIM (REVIT)

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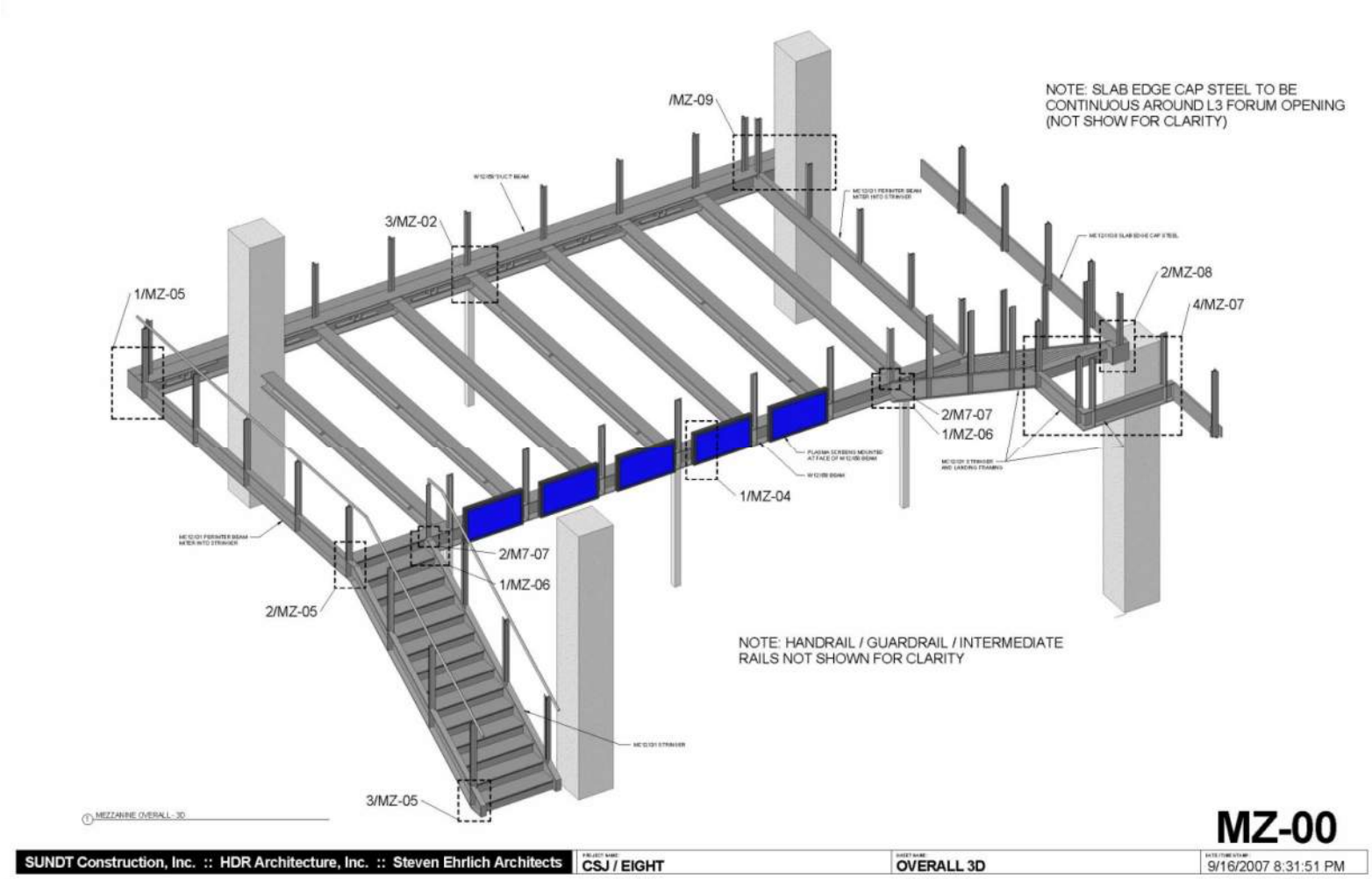
Clear Communication

DESIGN INTENT



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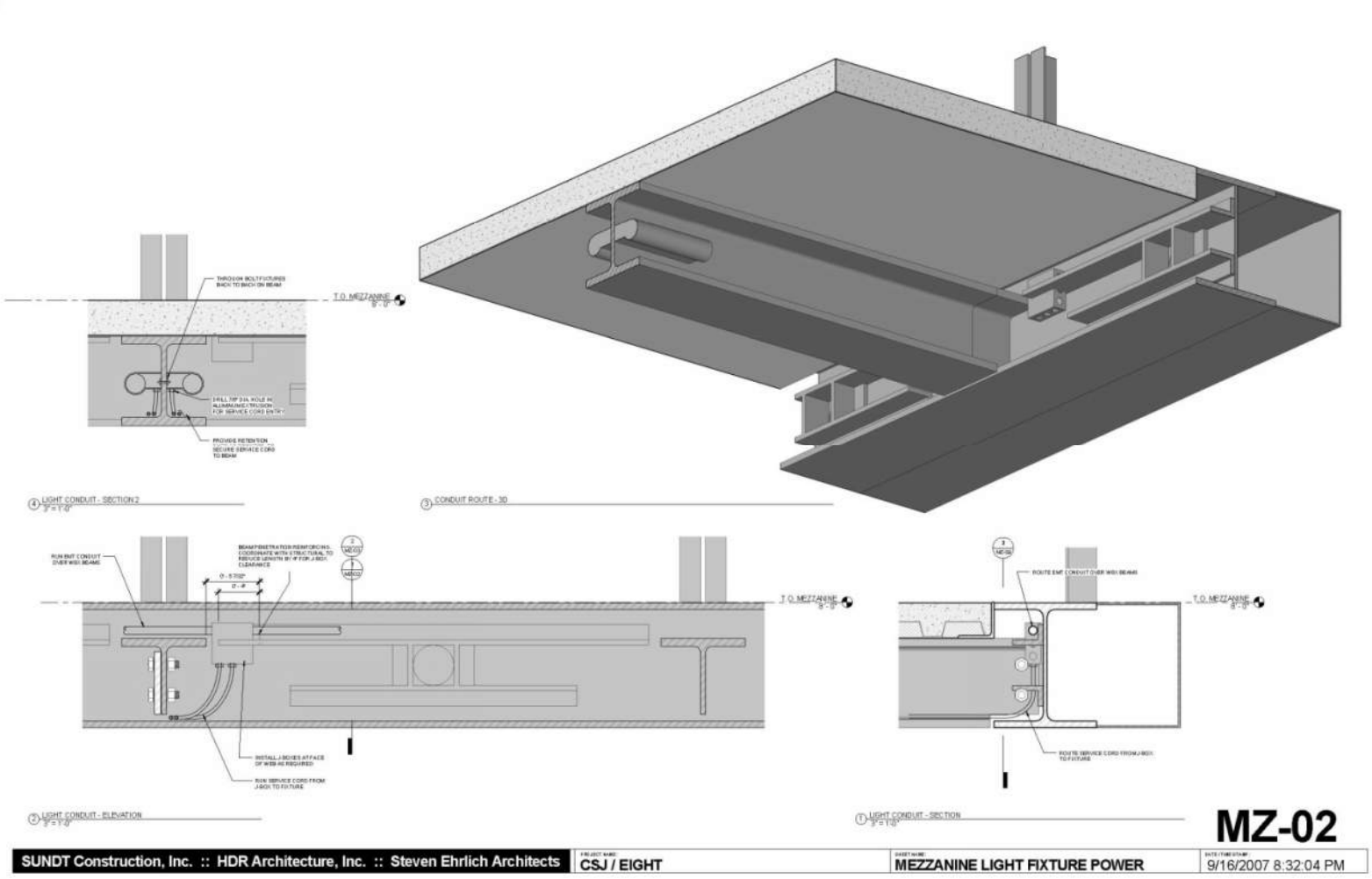
Clear Communication

DESIGN INTENT



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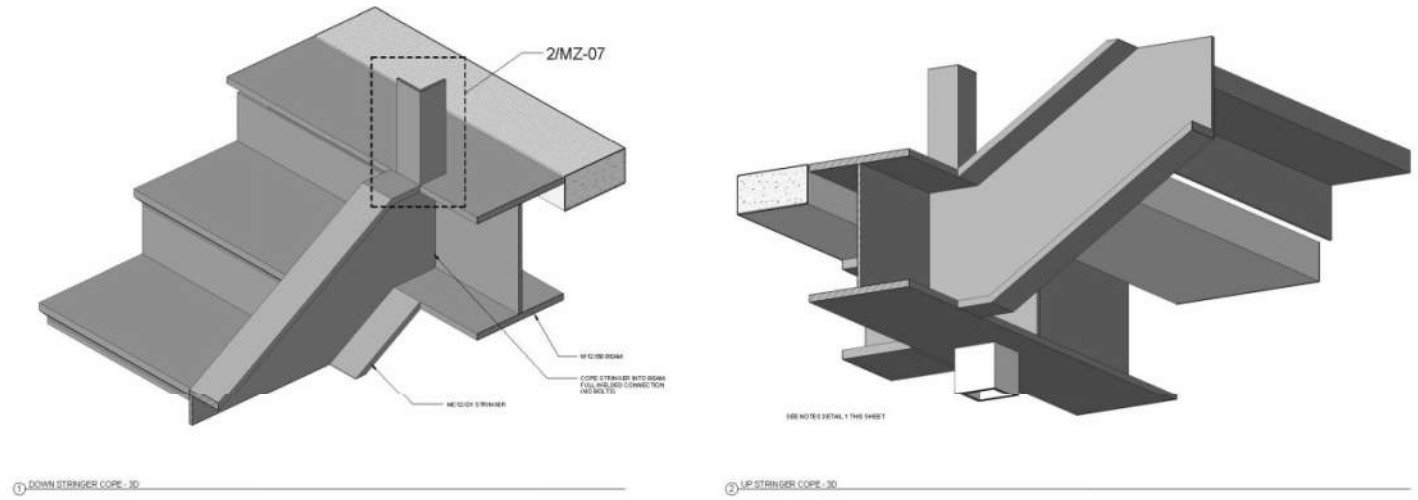
Clear Communication

DESIGN INTENT

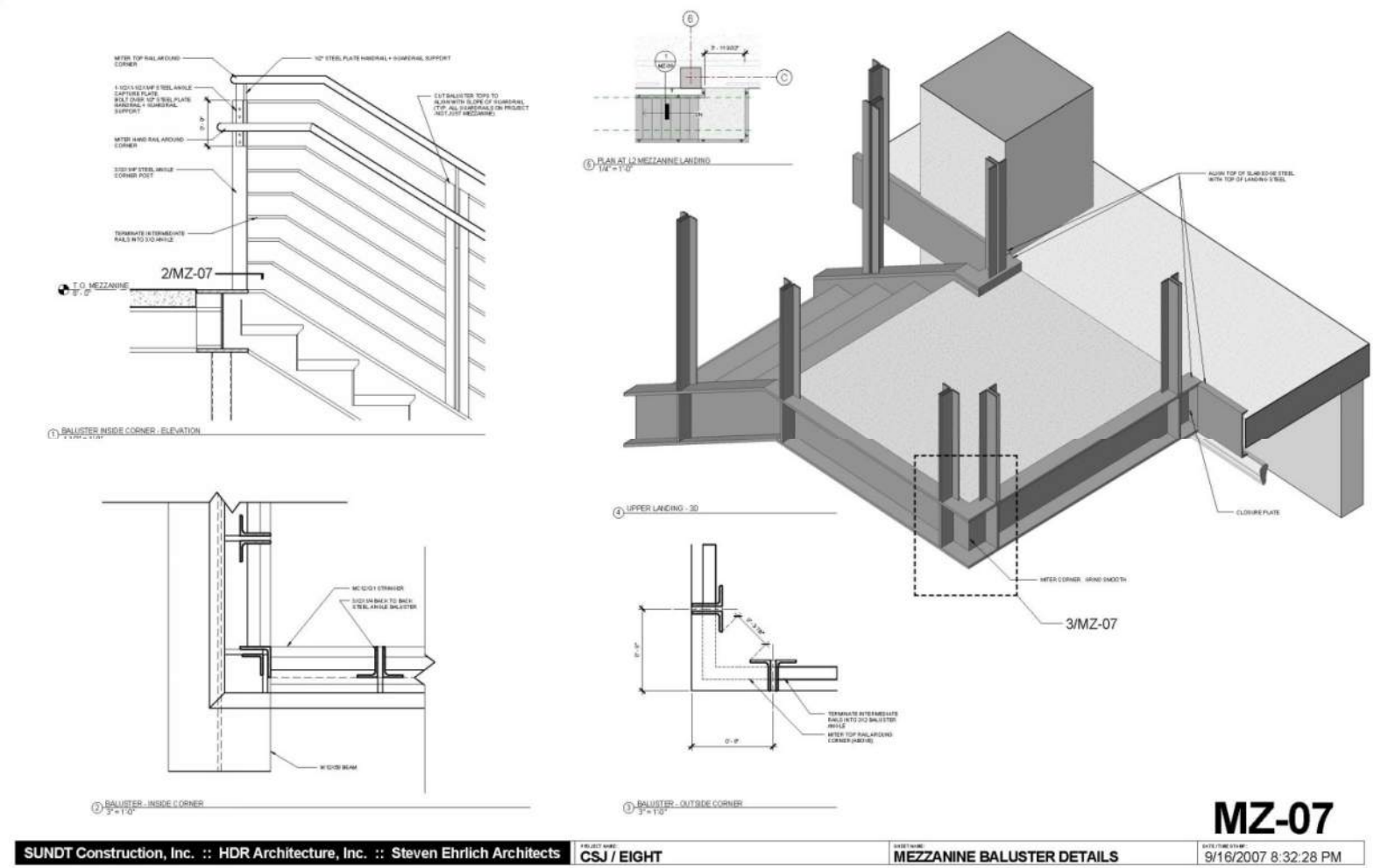


MZ-06

SUNDT Construction, Inc. :: HDR Architecture, Inc. :: Steven Ehrlich Architects	CSJ / EIGHT	MEZZANINE STEEL TRANSITIONS	9/16/2007 8:32:23 PM

Clear Communication

DESIGN INTENT



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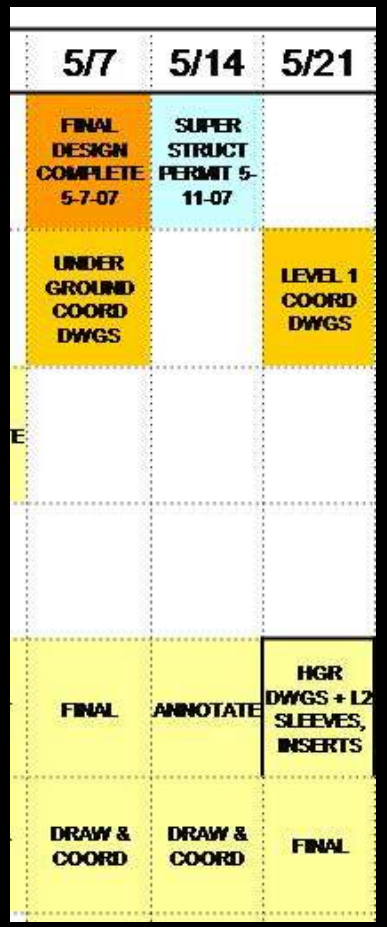
BIM Coordination Plan

LEAN SHOP DRAWING PROCESS

START DATES	2/19	2/26	3/5	3/12	3/19	3/26	4/2	4/9	4/16	4/23	4/30	5/7	5/14	5/21	5/28	6/4	6/11	6/18	6/25
DESIGN DELIVERABLES		SUPER STRUCT COMPLETE 3-01-07						SHELL DESIGN COMPLETE 4-09-07				FINAL DESIGN COMPLETE 5-7-07	SUPER STRUCT PERMIT 5-11-07				SHELL & CORE PERMIT 6-14-07		
MEP DELIVERABLES										S/W & DECK BLOCKOUT DWGS		UNDER GROUND COORD DWGS		LEVEL 1 COORD DWGS		LEVEL 2 COORD DWGS		LEVEL 3 COORD DWGS	
BELOW SOG UTILITIES		KICKOFF MEETING #1		KICKOFF MEETING #2		DRAW & COORD	DRAW & COORD	DRAW & COORD	DRAW & COORD	FINAL	ANNOTATE							MBOM	PROC & DEL
																	1ST HALF 2ND FLOOR POUR	2ND HALF 2ND FLOOR POUR	1ST HALF 3RD FLOOR POUR
LEVEL 1								DRAW & COORD	DRAW & COORD	DRAW & COORD	DRAW & COORD	FINAL	ANNOTATE	HGR DWGS + L2 SLEEVES, INSERTS	MBOM+ FAB PLN, SPLS,CL &F/F BOMs	CKSPLS+ PROC & DEL			
LEVEL 2										DRAW & COORD	DRAW & COORD	DRAW & COORD	DRAW & COORD	FINAL	ANNOTATE	HGR DWGS + L3 SLEEVES, INSERTS	MBOM+ FAB PLN, SPLS,CL &F/F BOMs	CKSPLS+ PROC & DEL	TOILET RM RI STARTS 6-28
LEVEL 3												DRAW & COORD	DRAW & COORD	DRAW & COORD	DRAW & COORD	FINAL	ANNOTATE	HGR DWGS + L4 SLEEVES, INSERTS	MBOM+ FAB PLN, SPLS,CL &F/F BOMs
LEVEL 4														DRAW & COORD	DRAW & COORD	DRAW & COORD	DRAW & COORD	FINAL	ANNOTATE
LEVEL 5																DRAW & COORD	DRAW & COORD	DRAW & COORD	DRAW & COORD
LEVEL 6																		DRAW & COORD	DRAW & COORD
LEVEL 7 & ROOF																			



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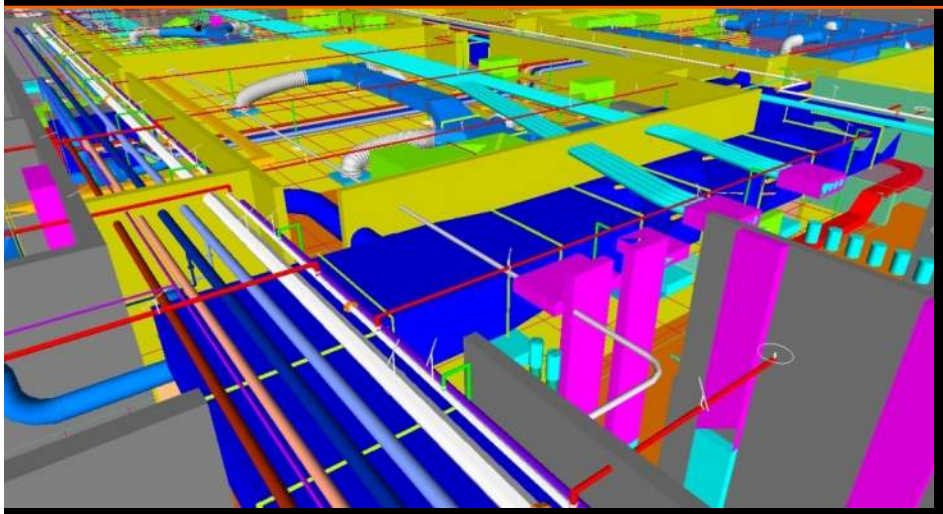
Pre-Construction Clash Detection

NAVIS WORKS



- Collision Detection
- Shop Drawing Coordination

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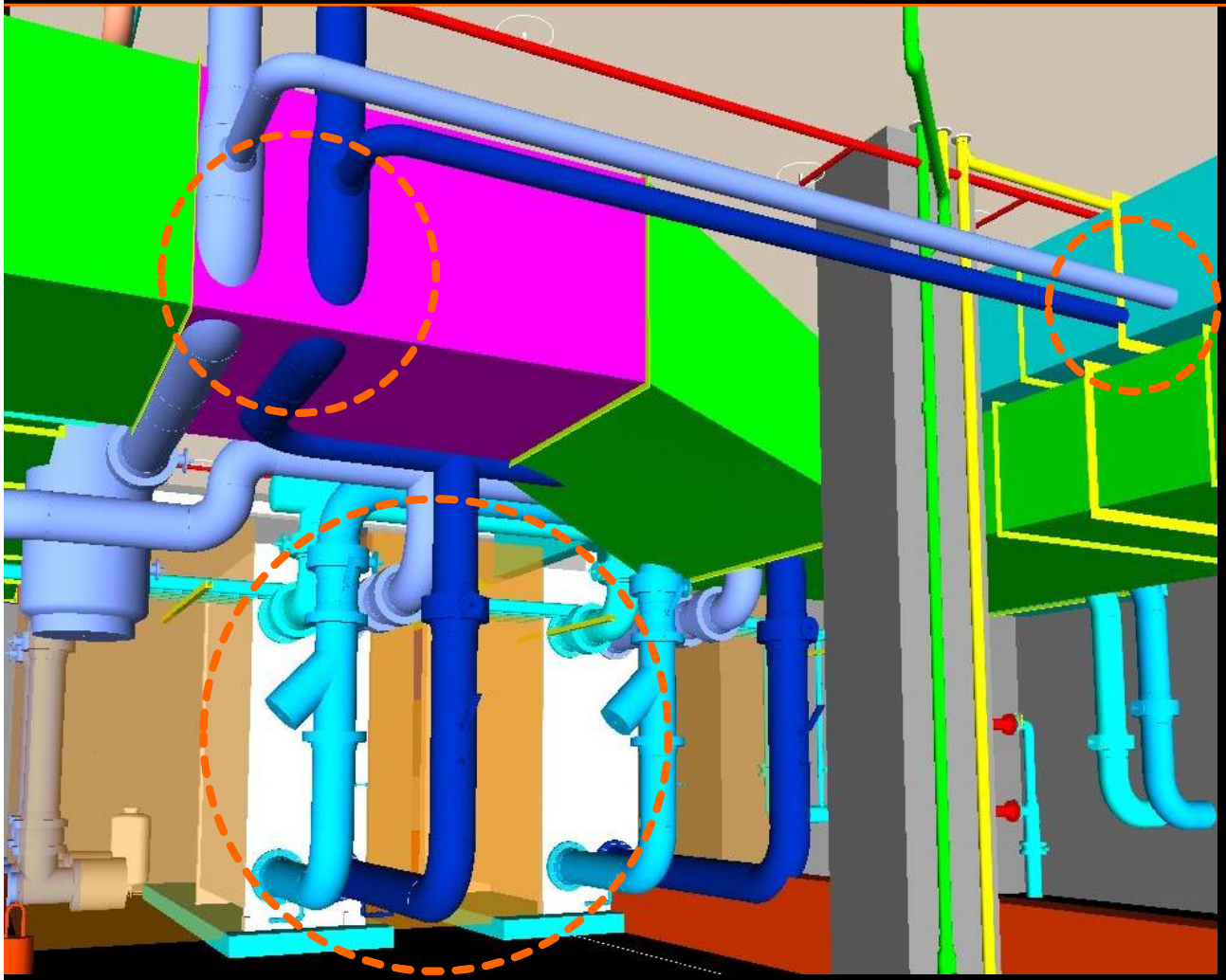
Pre-Construction Clash Detection

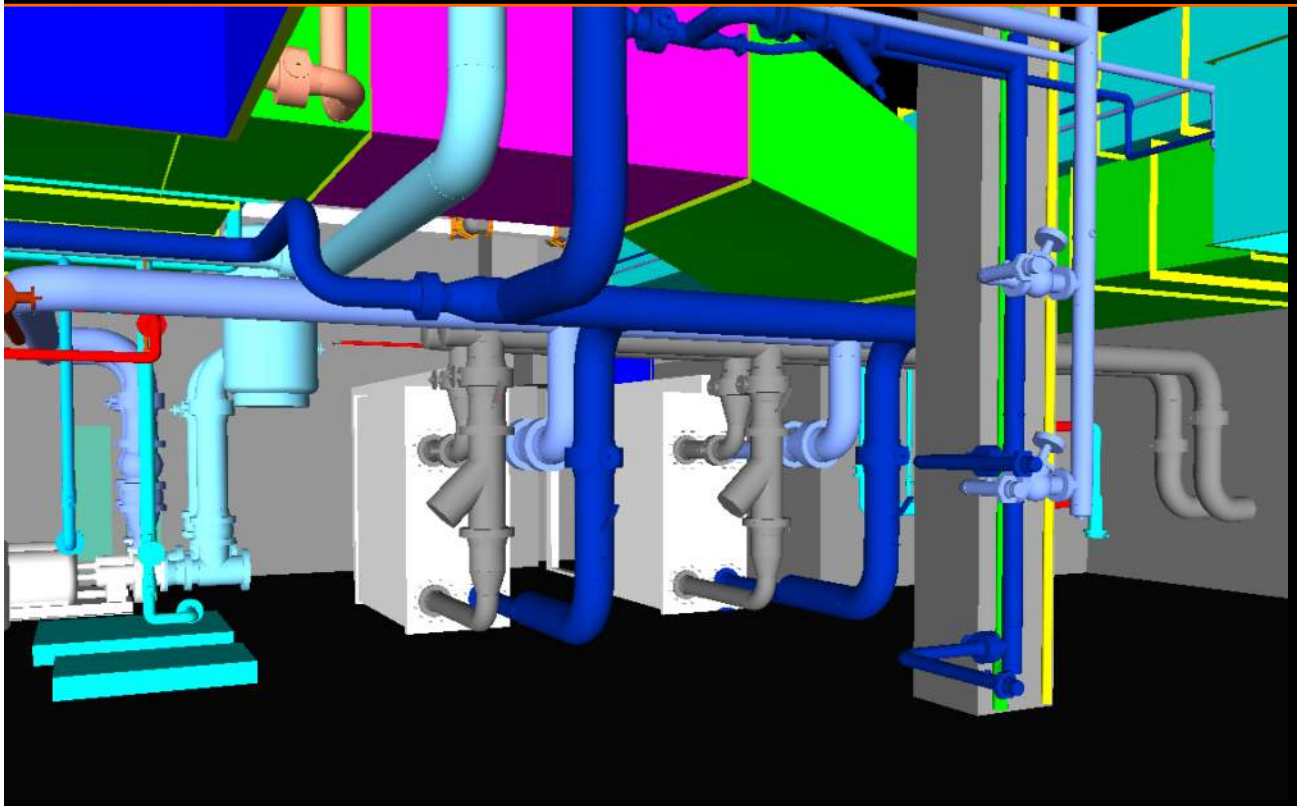
NAVIS WORKS



- Mechanical Room before NavisWorks

Pre-Construction Clash Detection

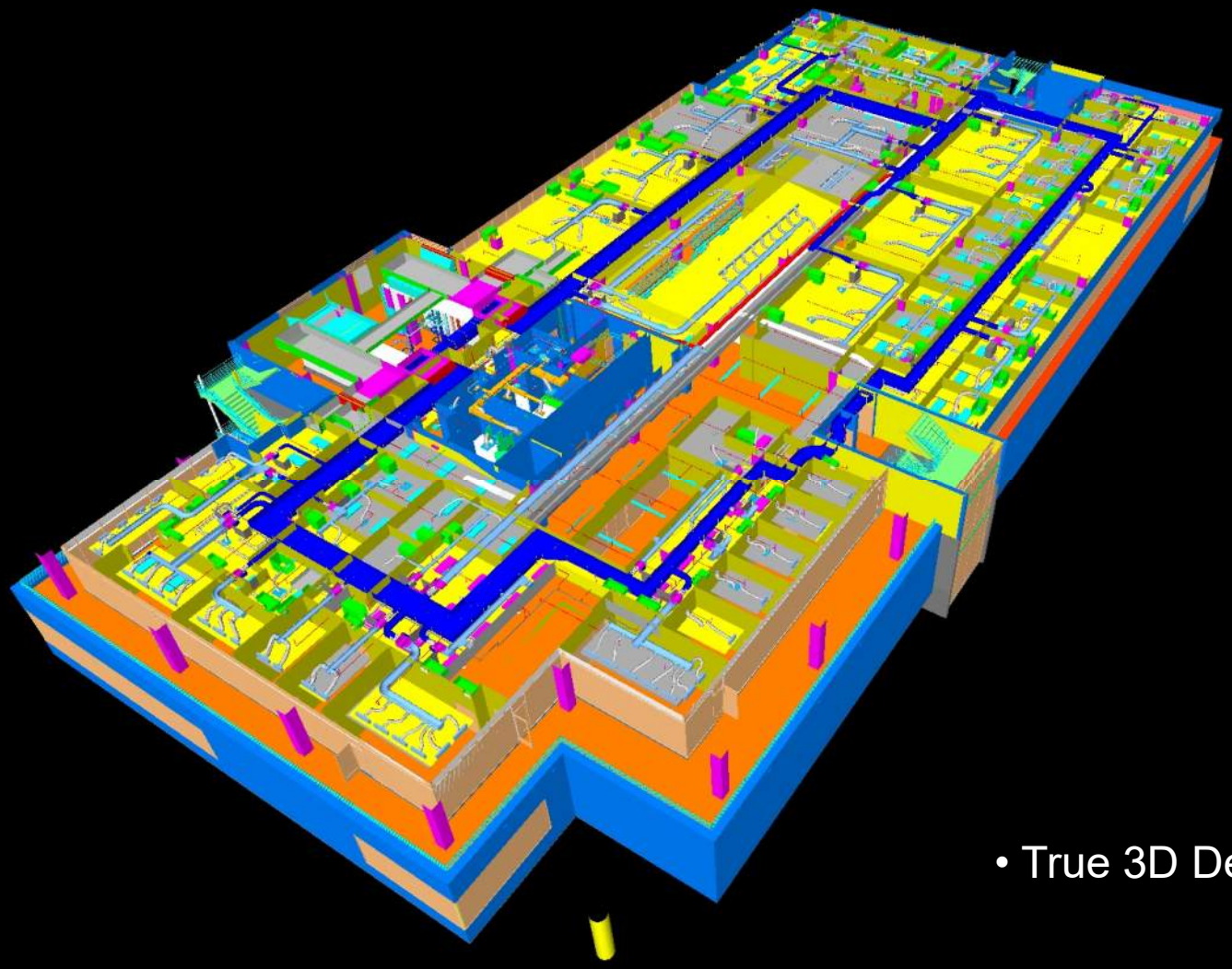
NAVIS WORKS



- Mechanical Room after NavisWorks

Fully Coordinated Construction Model

NAVIS WORKS



- True 3D Deliverables ?

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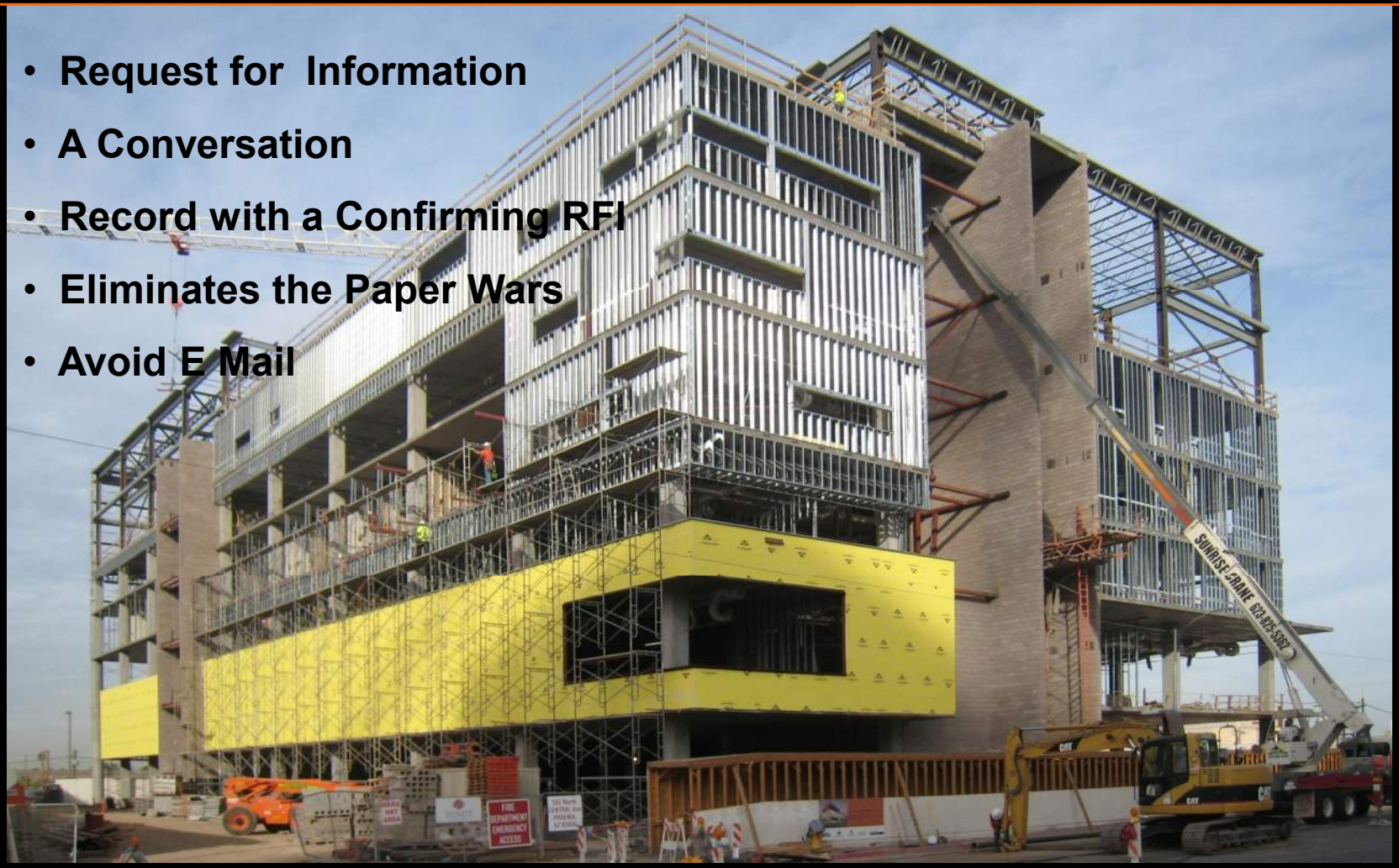
The BIM advantage

- Increased speed of delivery (time saved)
- Better coordination (fewer errors)
- Decreased costs (money saved)
- Greater productivity
- Higher-quality work

Collaborative CA

LEAN SHOP DRAWING PROCESS

- **Request for Information**
- **A Conversation**
- **Record with a Confirming RFI**
- **Eliminates the Paper Wars**
- **Avoid E Mail**



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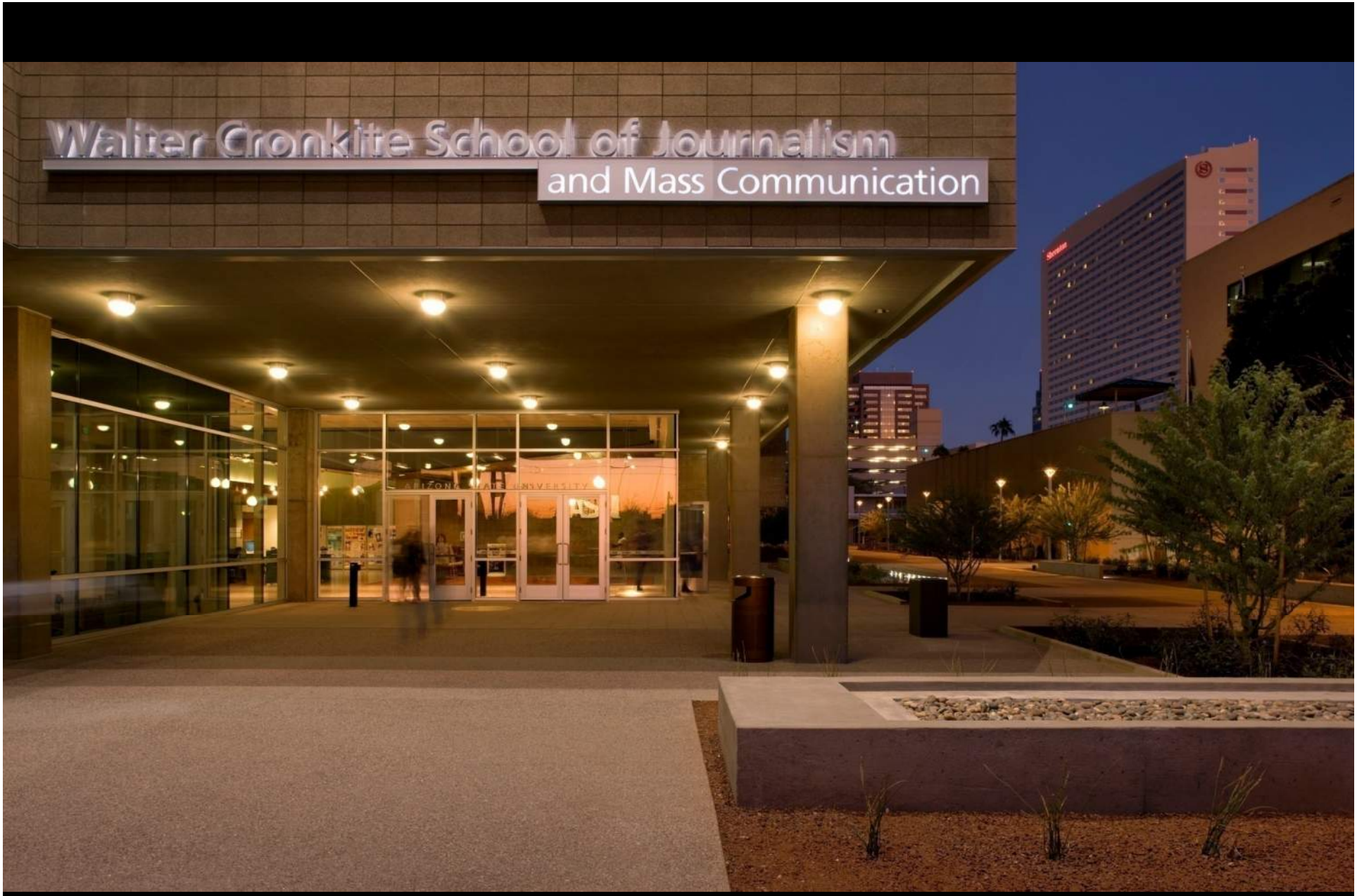

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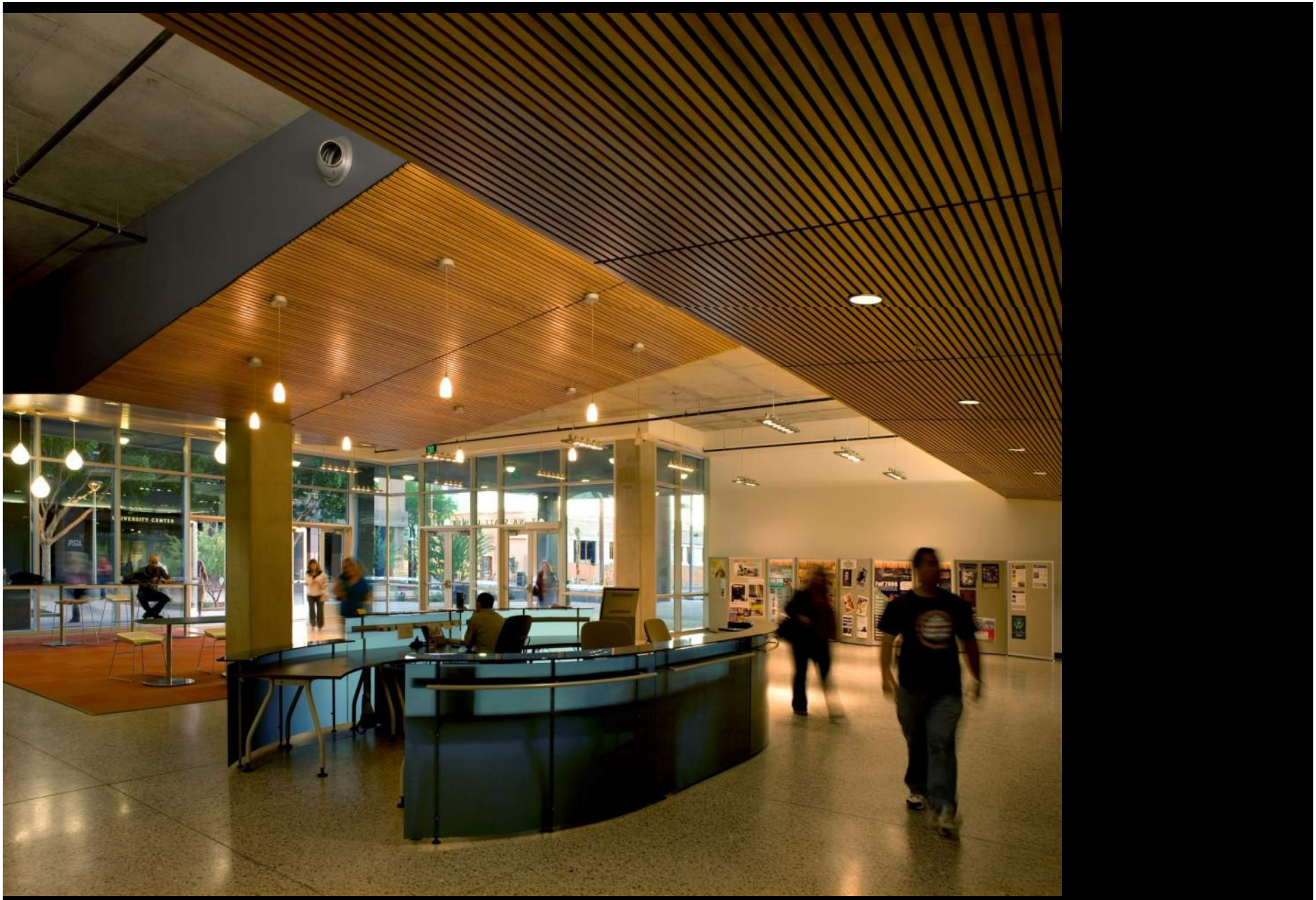

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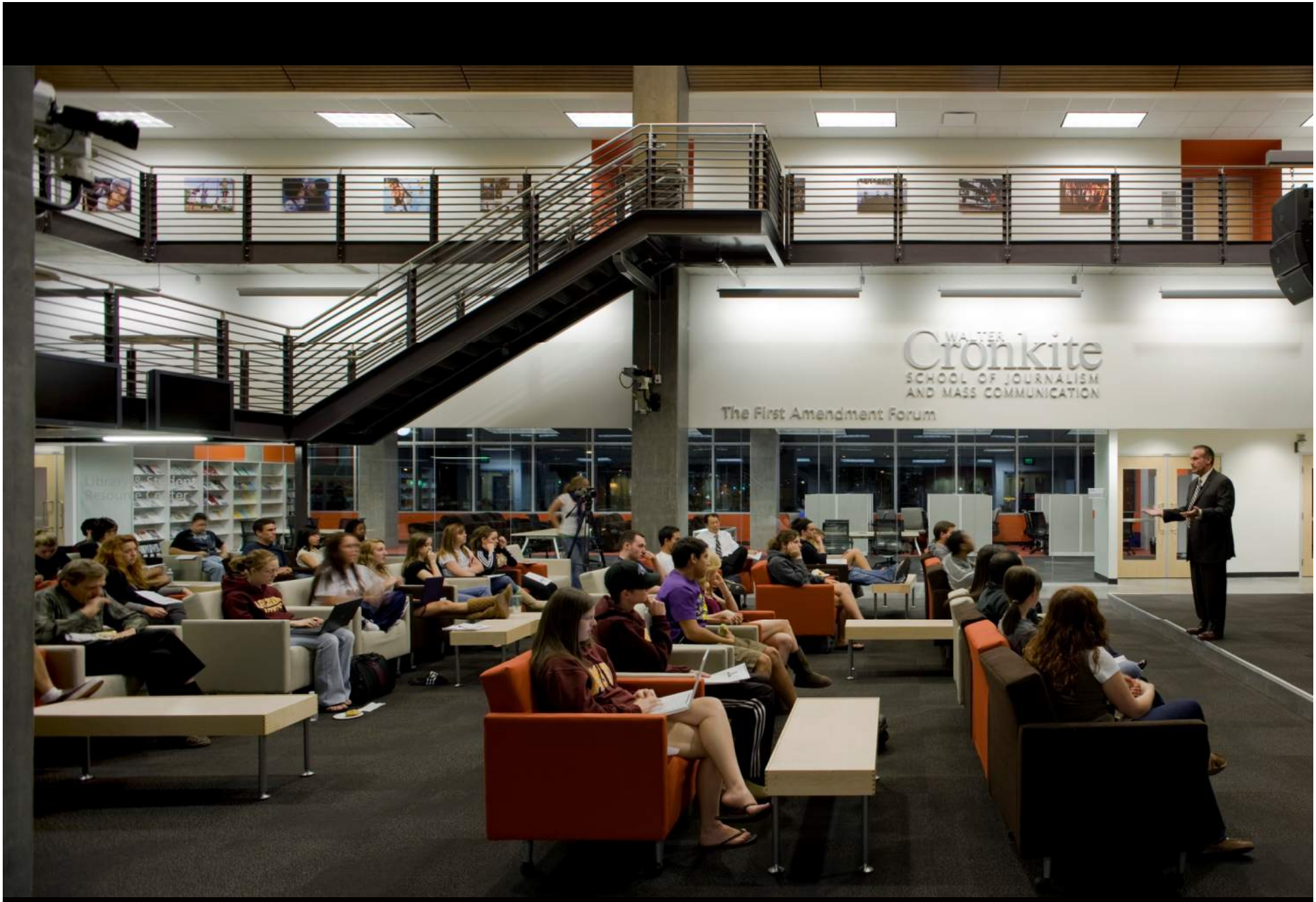

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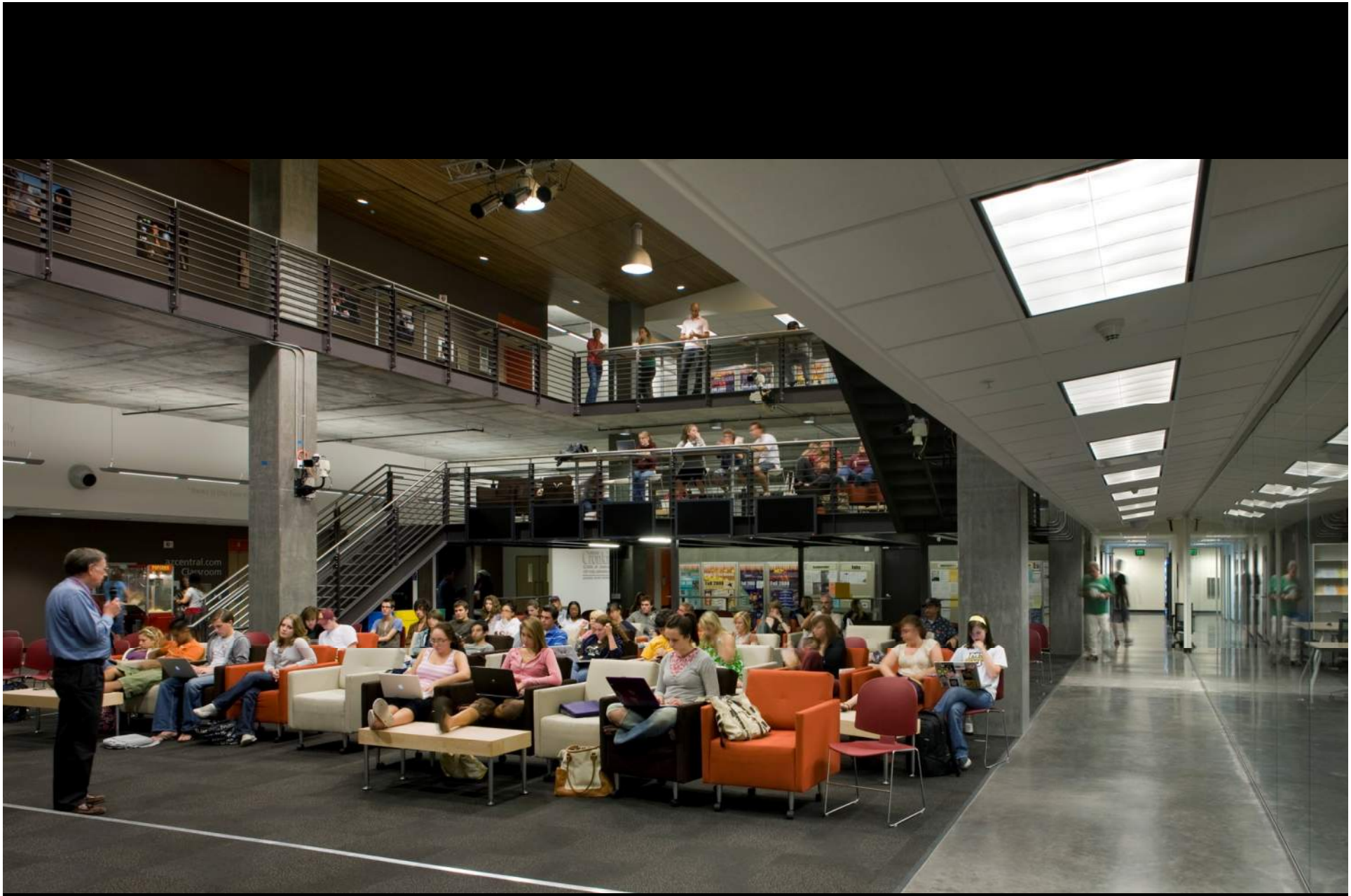

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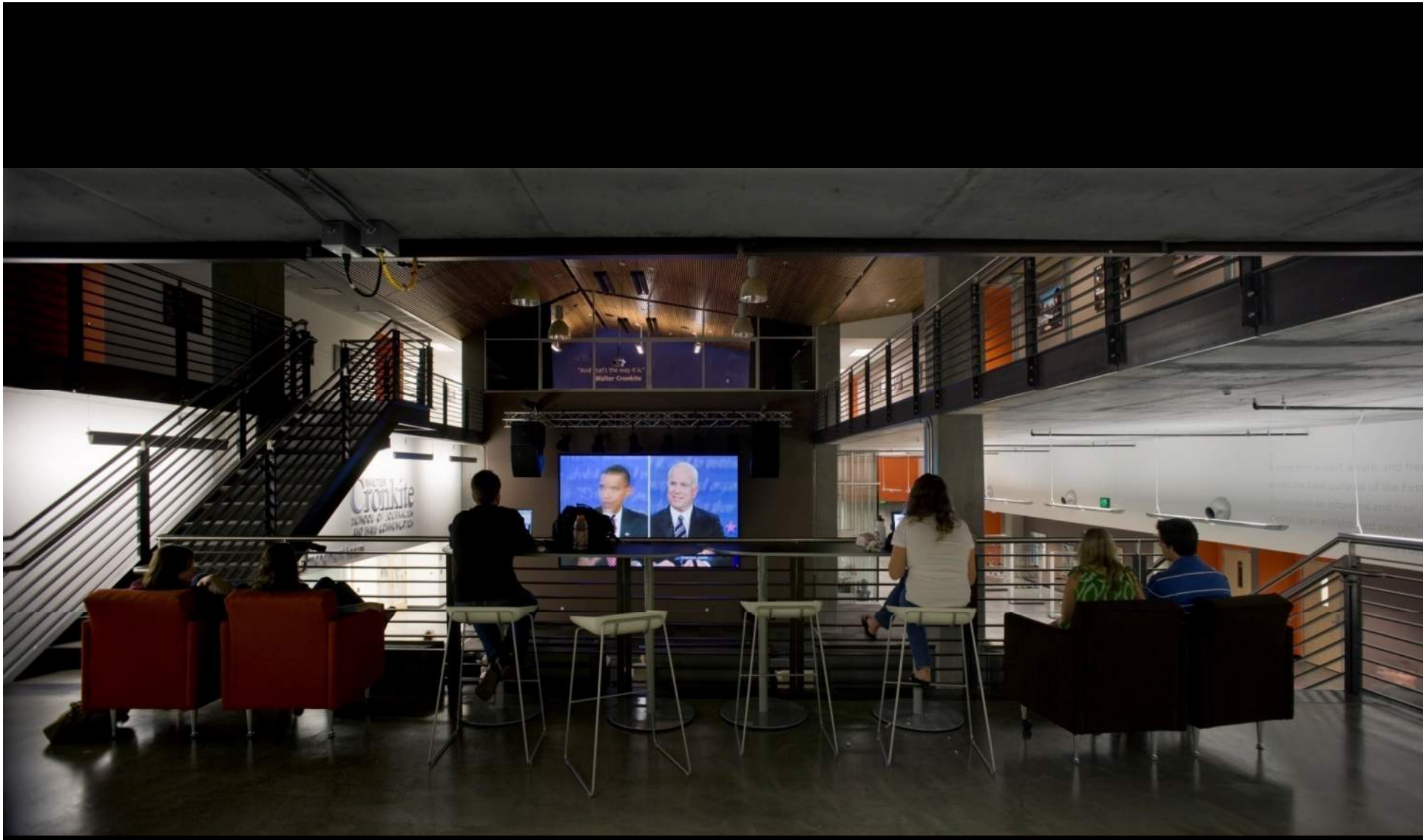

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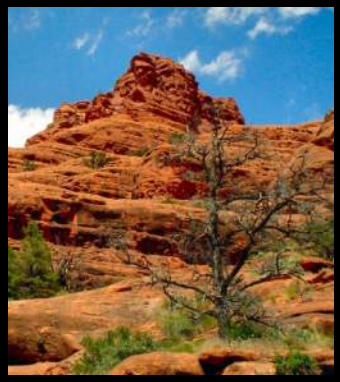
FCC Frequency Bands

Architectural Interpretation



- Bla bla bla
- Bla bla bla
- Bla bla bla

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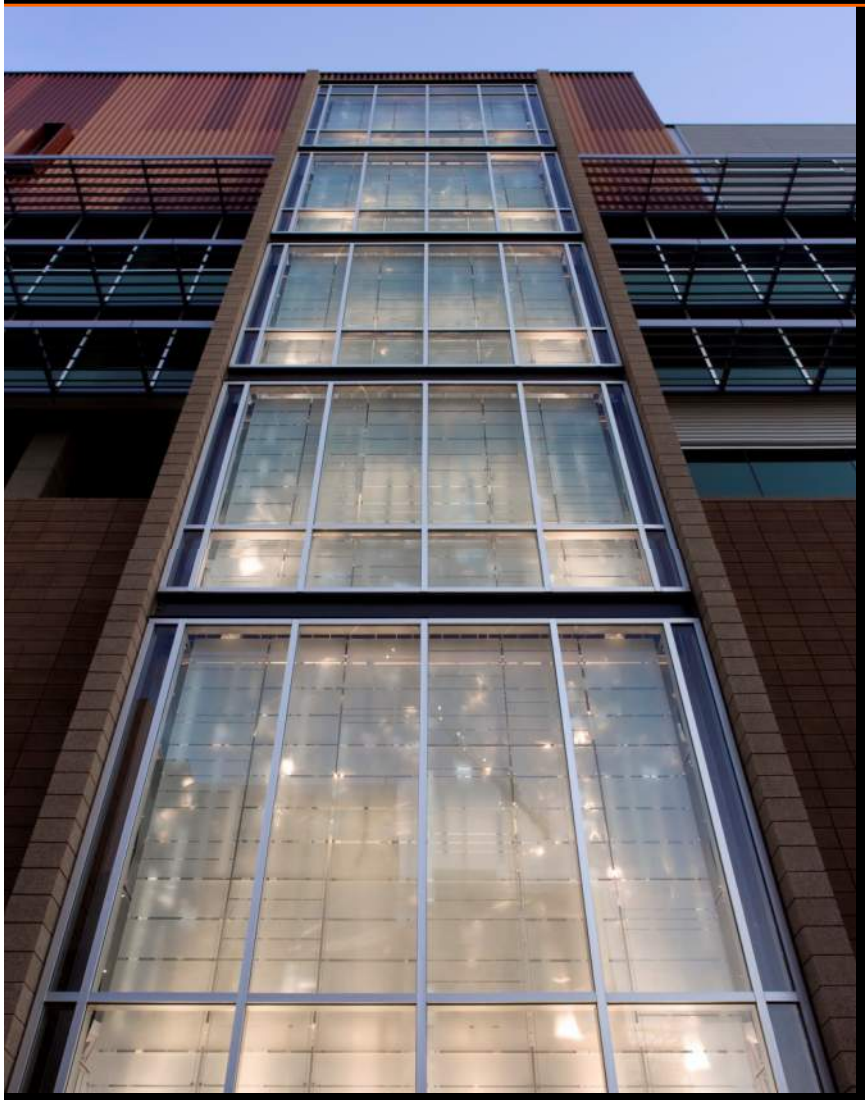
Public Art – Light & Reflection



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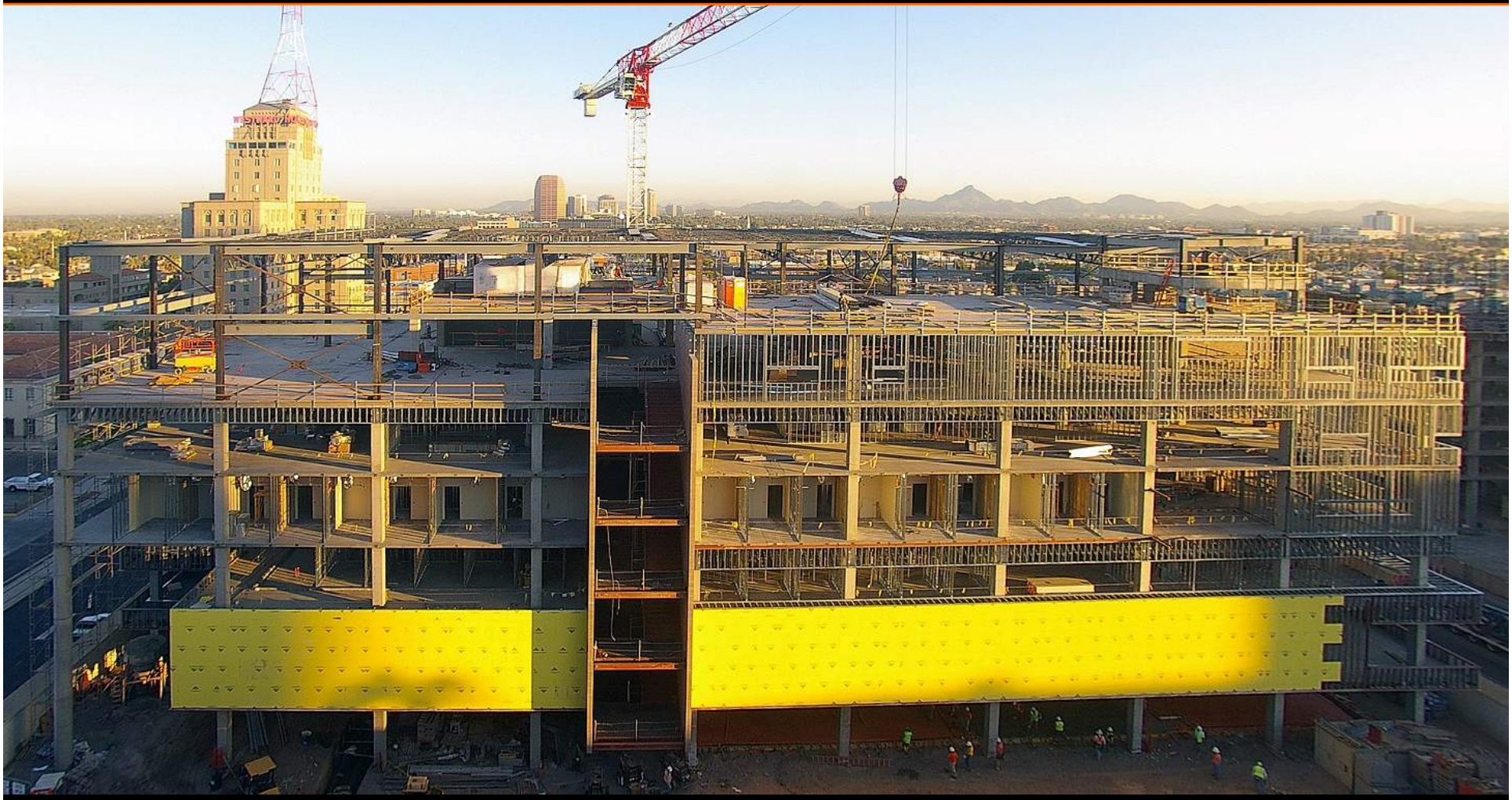
One Year After Contract Award

November, 2007



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The Results of Successful Collaboration

14.33 months in 120 seconds

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Construction Schedule

Milestone Description	Original Contract Completion	Actual Schedule Completion		Variance
Notice of Selection	06-Oct-06	06-Oct-06	A	0
Issue Final Program	10-Nov-06	14-Nov-06	A	4
Demo Permit Received	13-Dec-06	13-Dec-06	A	0
Preliminary Design Approved by Executive Committee	22-Jan-07	25-Jan-07	A	3
Official Start of the Contract	05-Dec-06	25-Jan-07	A	50
Site Plan Approved	20-Mar-07	31-Jan-07	A	-49
Mobilize - Begin Demo & Utility Relocations	21-Mar-07	05-Feb-07	A	-46
New Utilities & Site Work Permit Received	20-Mar-07	01-Mar-07	A	-19
Foundation Permit Received	10-Apr-07	12-Apr-07	A	2
Complete Team Mobilization to Site	24-Apr-07	17-Apr-07	A	-7
Start Foundation Construction	11-Apr-07	16-Apr-07	A	5
Superstructure Permit Received	06-Jun-07	29-May-07	A	-7
Shell Building Permit Received	02-Aug-07	10-Jul-07	A	-22
Start Exterior Enclosure	03-Aug-07	01-Aug-07	A	-2
Interior Fit Up Permit Received	30-Aug-07	22-Aug-07	A	-8
Top Out of Structure	30-Oct-07	21-Nov-07	A	21
Power on Date	26-Mar-08	31-Jan-08	A	-55
Penthouse MEP Complete	26-Mar-08	19-Feb-08	A	-37
Start of Building Commissioning	26-Mar-08	01-Feb-08	A	-55
1st Passenger Elevator Operational	24-Apr-08	06-Mar-08	A	-48
Exterior Enclosure Complete	28-Jan-08	23-May-08	A	115
Passenger Elevators Complete	24-Apr-08	22-May-08	A	28
Interior Construction Complete	20-May-08	23-May-08	A	3
Complete Building Commissioning	18-Jun-08	23-May-08	A	-25
Building Substantially Complete (Contract June 11, 2008)	17-Jul-08	30-May-08	A	-47
Start ASU FF&E Installation (Follows Contract Substantial Completion)	01-Jun-08	12-Jun-08	A	11
Complete ASU FF&E Installation	07-Jul-08			
Begin Move in Process (Employee Affects)	15-Jul-08			
1st - Butts in Seats (Occupancy)	17-Jul-08			
Project Final Completion	18-Aug-08			
1st - Classes Held	15-Aug-08			

Lessons Learned

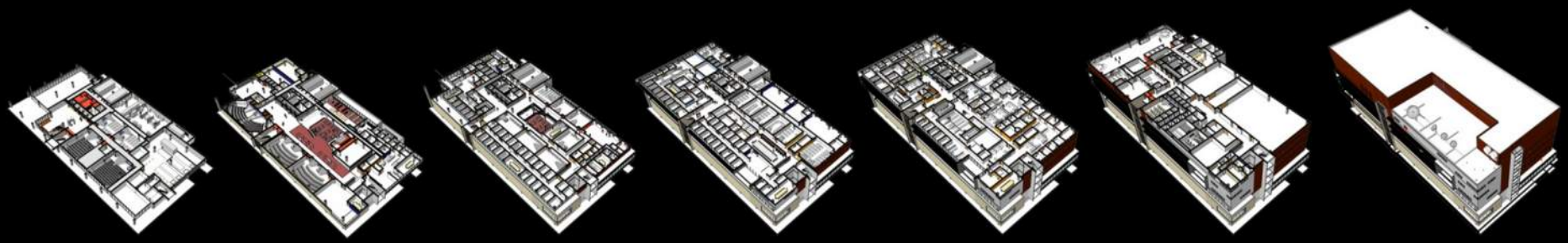
Unified Software Platform
- Revit Arch
- Revit Struct
- Revit Systems (when ready)

Navis for Design Coordination

Unified Project Server (Steelhead / Riverbed Technology)

Fire Protection Designed / Coordinated with Systems

Schedule to allow for Pre-Construction Coordination



Lessons Learned

SOFTWARE WORK FLOW

DESIGN MODEL

Architecture: *Revit → AutoCAD ADT*

Structural: *Revit Structure*

M/E/P: *AutoDesk Building Systems*

Fire: *None*

MANUAL COORDINATION

SHOP COORDINATION MODEL

Architecture: *Revit*

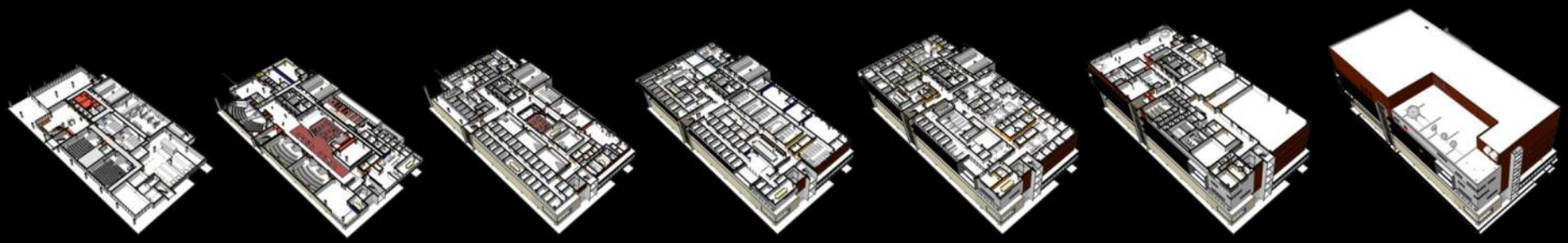
Structural: *Revit Structure*

M/P: *CAD Duct, Quick Pen*

Fire: *Quick Pen*

NAVIS WORKS COORDINATION

CHALLENGE: Better Integrate Design and Shop Drawing Process



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THE END