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

- 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

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The Site

DOWNTOWN PHOENIX

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<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Design Time</td>
<td>12 – 15 months</td>
</tr>
<tr>
<td>Construction Document Permitting</td>
<td>2 – 4 months</td>
</tr>
<tr>
<td>Demo &amp; Utility Relocations</td>
<td>2 – 3 Months</td>
</tr>
<tr>
<td>New Construction</td>
<td>15 months</td>
</tr>
<tr>
<td>Commissioning</td>
<td>2 months</td>
</tr>
<tr>
<td>Owner Occupancy and Soft Start-up</td>
<td>2 months</td>
</tr>
<tr>
<td>Total Normal Design, Permit &amp; Construction</td>
<td>35 – 41 months</td>
</tr>
</tbody>
</table>

**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

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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

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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
Build the Team

SUNDT Construction
Construction

HDR Architecture
Architect of Record and MEP

EHRLICH Architects
Design Architect

CTS
Structural

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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
Establish Relationships

TEAM INTEGRATION

DESIGN CONSULTANTS
- C.T.S. STRUCTURAL
- HDR MECHANICAL
- HDR ELECTRICAL
- HDR PLUMBING

COLLABORATIVE SYSTEMS DESIGN

SUB-CONTRACTORS
- SUNDT CONCRETE
- UNIVERSITY MECHANICAL
- KEARNEY ELECTRIC
- UNIVERSITY MECHANICAL

OWNER
- USERS
- FACILITIES

ARCHITECT

ESTIMATORS

CONTRACTOR

DRAWINGS

SPECIFICATIONS

BUDGET

SCHEDULE

MAN POWER

CURTAIN WALL

MASONRY

ELEVATORS

WATER PROOFING

ACCOUSTICS
- A/V BROADCAST
- CODE / LIFE SAFTEY
- LANDSCAPE

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The Culture of Success

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

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What it’s not!

I’m sure glad the hole isn’t in our end...
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

What it IS!

- Proximity leads to Communication (it’s not always pretty)
- Communication leads to Understanding
- Understanding leads to Respect
- Respect fosters Cooperation
Integrated Practice

...DON'T GET TOO COMFORTABLE?

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Cronkite School of Journalism - KAET Channel 8
Design Evolution Log

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

$71,000,000

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

<table>
<thead>
<tr>
<th>EXTERIOR SKIN / ROOFING SYSTEMS</th>
<th>Sundt Parametric Cost Model</th>
<th>HDR/SEA Design as of 4/29/08</th>
<th>VARIANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Shear Walls</td>
<td>$51.30 SF 21,545 $1,105,259</td>
<td>$0.00 SF - $0</td>
<td></td>
</tr>
<tr>
<td>Level-1, 10' shear walls, w/ deep form liner, rebar 300 lb/cy</td>
<td>$57.97 SF 5,000 $202,988</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level-2, 10' shear walls, w/ deep form liner, rebar 300 lb/cy</td>
<td>$61.09 SF 3,323 $202,988</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level-3, 10' shear walls, w/ deep form liner, rebar 300 lb/cy</td>
<td>$61.09 SF 3,323 $202,988</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level-4, 10' shear walls, w/ deep form liner, rebar 300 lb/cy</td>
<td>$61.09 SF 3,323 $202,988</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level-5, 10' shear walls, w/ deep form liner, rebar 300 lb/cy</td>
<td>$61.09 SF 3,323 $202,988</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level-6, 10' shear walls, w/ deep form liner, rebar 300 lb/cy</td>
<td>$61.09 SF 3,323 $202,988</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level-7, 10' shear walls, w/ deep form liner, rebar 300 lb/cy</td>
<td>$61.09 SF 3,323 $202,988</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Form liner in concrete shear walls</td>
<td>$7.90 SF 13,296 $105,038</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEL Item - Sup #03 - Reduce concrete shear walls to min. required.</td>
<td>-$10,732.00 Ls 1 ($10,732)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEL - Sup #07 - Change form liner to 4x8' reveal w/ light/medium sandblast</td>
<td>-$34,469.00 LS 1 ($24,469)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Square Footage of Metal Panels</strong></td>
<td>$1,210,296.90</td>
<td>$1,174,959.52 ($35,337.36)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exterior Scaffolding</th>
<th>SF 34,841</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal Panels</td>
<td>$45.00 SF 47,762 $2,149,290.00</td>
</tr>
<tr>
<td>6&quot; 18 ga 16' o.c. w/1 layer Densglass</td>
<td>$0.00 SF 26,522 $1,193,490.00</td>
</tr>
<tr>
<td>R-19 Batt Insulation</td>
<td>$7.26 SF 26,522 $182,549.12</td>
</tr>
<tr>
<td>Copper at Auditorium</td>
<td>$0.00 SF 0.00</td>
</tr>
<tr>
<td>Framing at Auditorium Copper</td>
<td>$0.00 SF 0.00</td>
</tr>
<tr>
<td>Metal Column Covers</td>
<td>$200.00 UF 168 $33,600.00</td>
</tr>
</tbody>
</table>

**VARIANCE**

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# DESIGN & PERMIT SCHEDULE

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

ALL STAKEHOLDERS ARE PART OF THE TEAM

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Remote Collaboration

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Work Smart

• 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

Design

Pre-Construction

Construction

Operation

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Rapid Design Evolution

RESPONSIVE DESIGN

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

Week 2
Week 4
Week 5
Week 7

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Rapid Design Evolution

Week 2

Week 4

Week 5

Week 5

11.12.2006
6 Stories
217,000 sq.ft.

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Rapid Design Evolution

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

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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

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Design Strategy

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Design Visualization

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Design Visualization

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Clear Communication
Clear Communication
Clear Communication
BIM Coordination Plan
LEAN SHOP DRAWING PROCESS

START DATES

DESIGN DELIVERABLES

MEP DELIVERABLES

BELOW SOG UTILITIES

LEVEL 1

LEVEL 2

LEVEL 3

LEVEL 4

LEVEL 5

LEVEL 6

LEVEL 7 & ROOF

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Pre-Construction Clash Detection

- Collision Detection
- Shop Drawing Coordination

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Pre-Construction Clash Detection

- Mechanical Room before NavisWorks

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Pre-Construction Clash Detection

- Mechanical Room after NavisWorks

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Fully Coordinated Construction Model

• 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

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

LEAN SHOP DRAWING PROCESS

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FCC Frequency Bands

- Bla bla bla
- Bla bla bla
- Bla bla bla
Public Art – Light & Reflection

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The Results of Successful Collaboration

14.33 months in 120 seconds

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## Construction Schedule

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

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Lessons Learned

**SOFTWARE WORK FLOW**

**DESIGN MODEL**
- Architecture: Revit → AutoCAD ADT
- Structural: Revit Structure
- M/E/P: AutoDesk Building Systems
- Fire: None

**SHOP COORDINATION MODEL**
- Architecture: Revit
- Structural: Revit Structure
- M/P: CAD Duct, Quick Pen
- Fire: Quick Pen

**MANUAL COORDINATION**

**NAVIS WORKS COORDINATION**

**CHALLENGE:** Better Integrate Design and Shop Drawing Process

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THE END