

Preserving an Icon Re-envisioning the Enclosure of the United State Air Force Academy Cadet Chapel

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The United States Airforce Academy Cadet Chapel, an award winning National Historic Landmark, exemplifies modernist architecture with its minimalist style and use of contemporary materials. Despite its brilliance, the building has experienced persistent water leakage to the interior since its construction.

This case study will explore the design challenges of integrating a modern rainscreen system behind a replication of the historic aluminum cladding, including the decision-making process leading to unique solutions for this distinctive building.



Bryan Rouse, AIA

Since joining WJE in 1995, Bryan Rouse has performed hundreds of evaluations and investigations of distressed and deteriorated conditions in existing buildings and other structures. His responsibilities have included designing repairs, developing construction documents, and providing field observation services for repair work during the construction phase.

Emily Ryba

Emily Ryba is experienced in historical research and the production of construction documents for the repair and rehabilitation of historic buildings. She has assisted on surveys of buildings of contemporary and historic construction and has conducted facade and condition assessments and investigations, as well as numerous water penetration and air leakage testing procedures.



Learning Objectives

- Identify the causes of water leakage issues in a significant, historic modernist structure.
- Analyze the building enclosure design and water management system of the existing building compared to the current repair design.
- 3. Discuss determination and implementation of the design-phase performance mock-up process for the repair design.
- 4. Evaluate the results and lessons learned from the mock-up construction and testing to inform the final repair design.



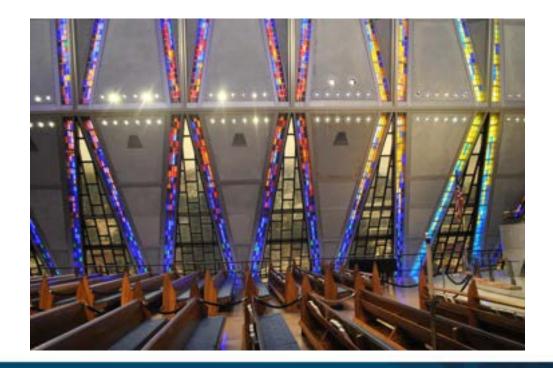








- Designed by Walter Netsch at SOM (Chicago)
- Built 57 years ago
 - Premiere example of modernist architecture
 - National Historic Landmark in 2004











Leaked Immediately

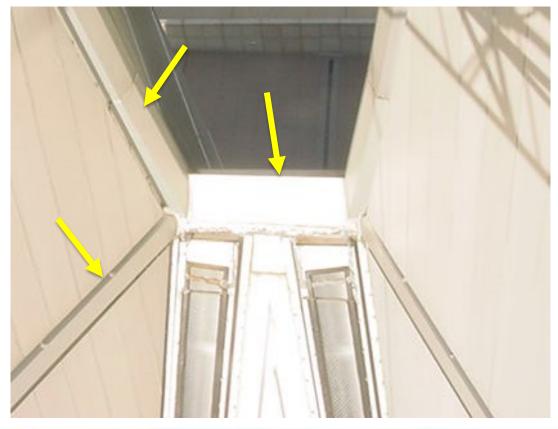






- Leaked Immediately
 - Overclad some of the details

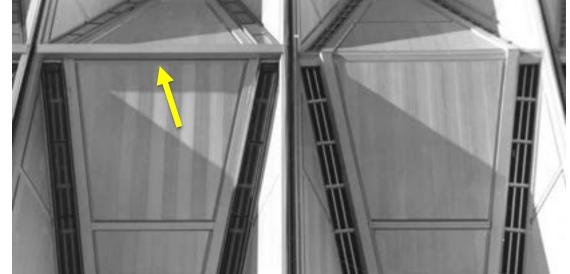


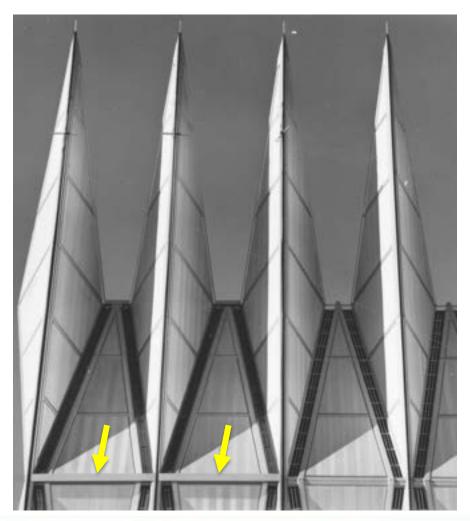






- Leaked Immediately
 - Overclad some of the details
 - Added gutters

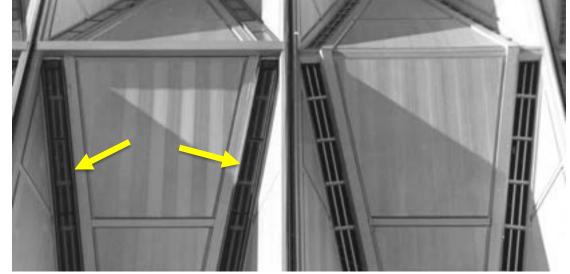


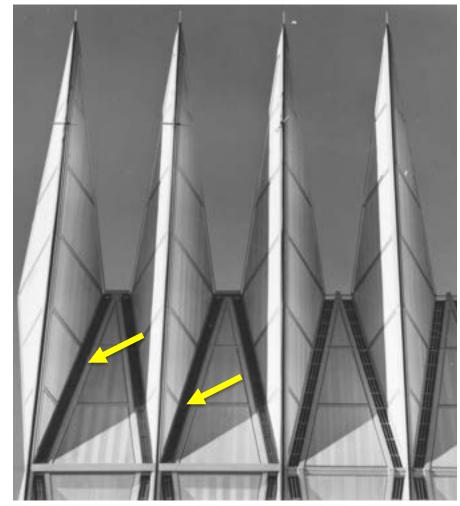






- Leaked Immediately
 - Overclad some of the details
 - Added gutters
 - Added storm windows









- Leaked Immediately
 - Overclad some of the details
 - Added gutters
 - Added storm windows
- Still leaked

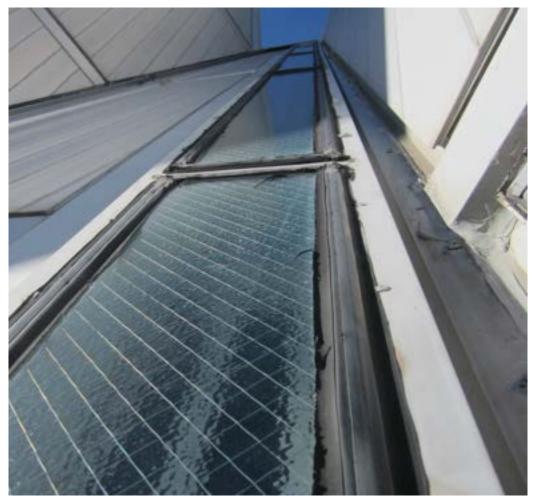






- Leaked Immediately
 - Overclad some of the details
 - Added gutters
 - Added storm windows
- Still leaked
 - Second generation of storm window









Leaked Immediately

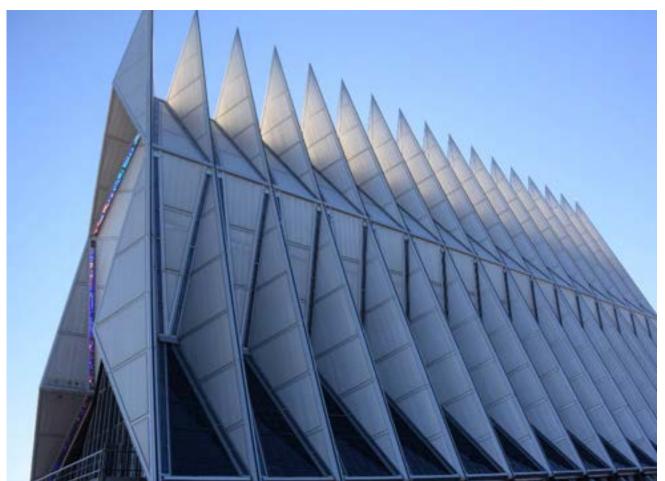
- Overclad some of the details
- Added gutters
- Added storm windows
- Still leaked
 - Second generation of storm window
 - Multiple campaigns of sealant on top of sealant

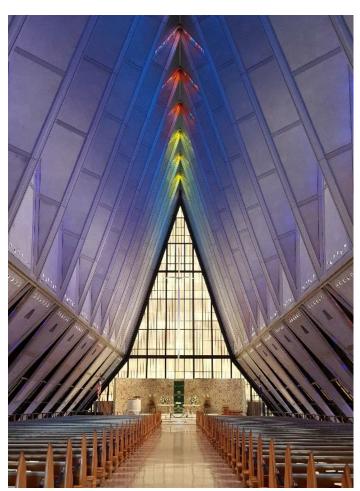




Chapel Restoration Design Goal: Solve the water leakage without changing the appearance











Tetrahedron

[te-truh-hee-druhn]





Tetrahedron

[te-truh-hee-druhn]

"I started scribbling, drawing, trying to get a repetitive feature"

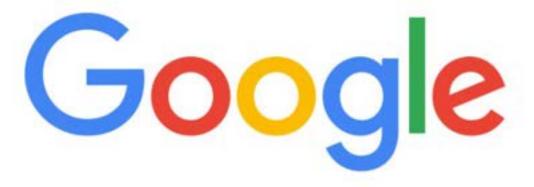
Ken [Nasland] said "What are you doing? Trying to draw a tetrahedon?"

I said, "What's a tetrahedron?"

- Walter Netsch, SOM Journal, 2001







tetrahedron











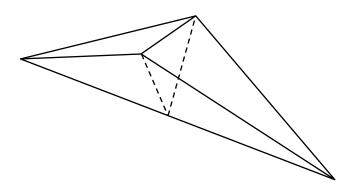


...a tetrahedron is a polyhedron composed of four triangular faces, six straight edges, and four vertex corners. The tetrahedron is the simplest of all the ordinary convex polyhedra and the only one that has fewer than 5 faces.





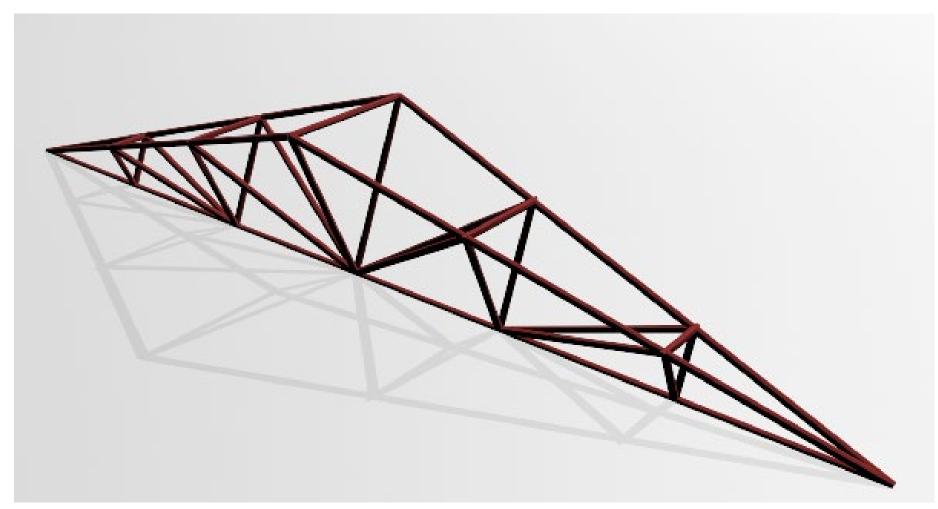




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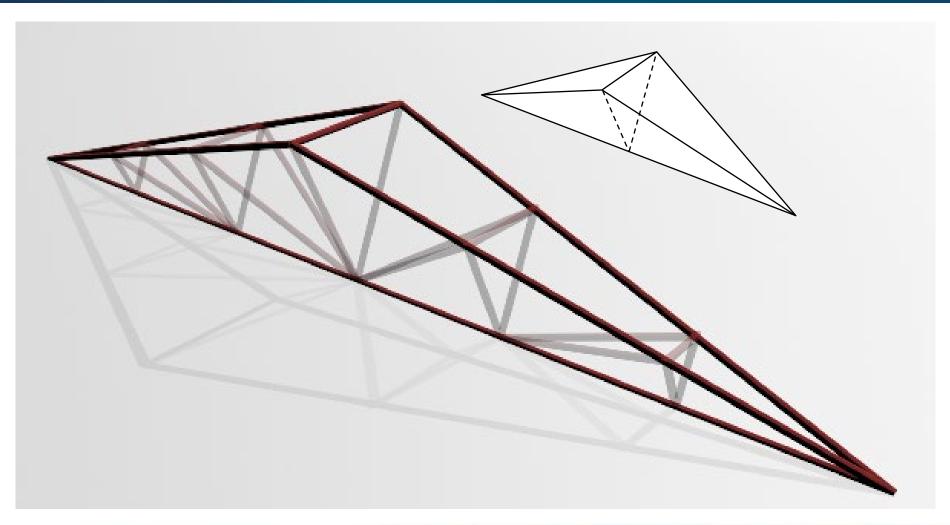














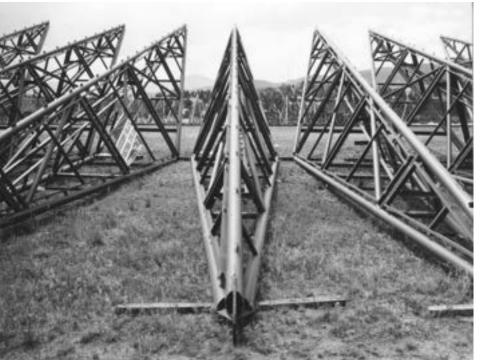








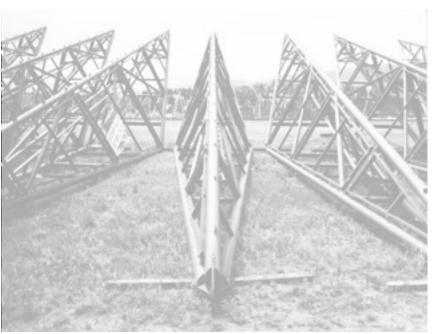


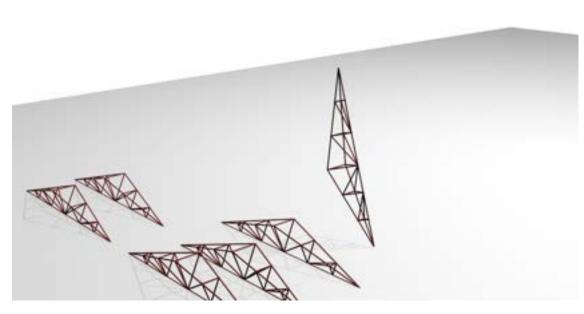






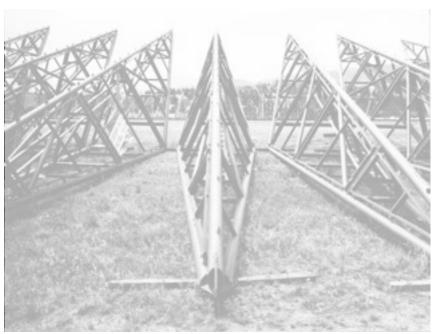


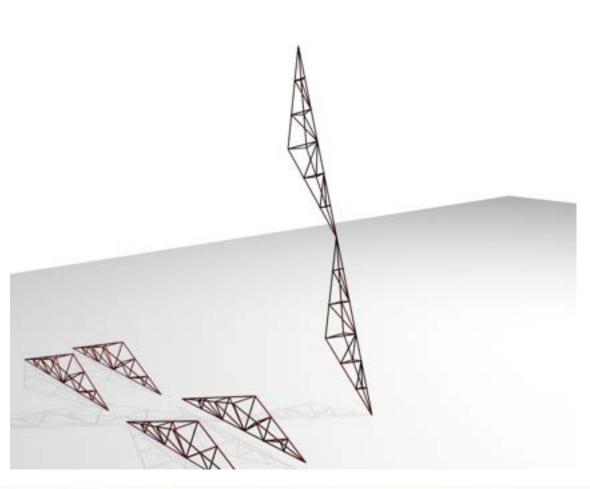






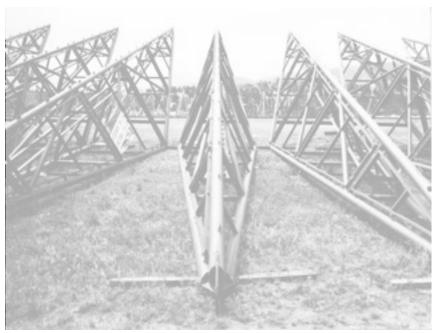


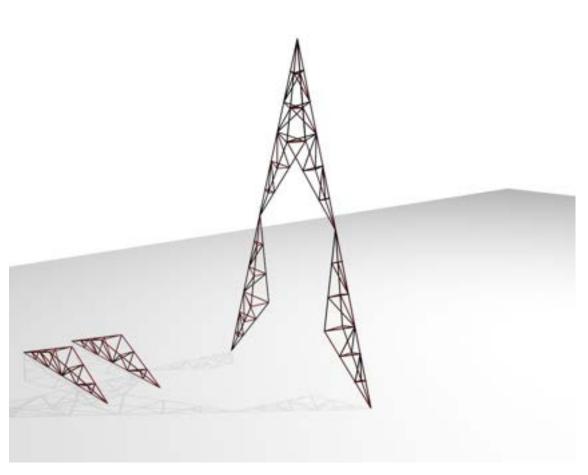






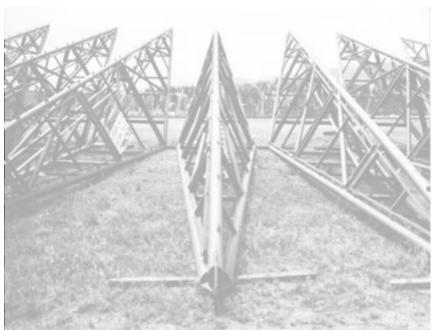


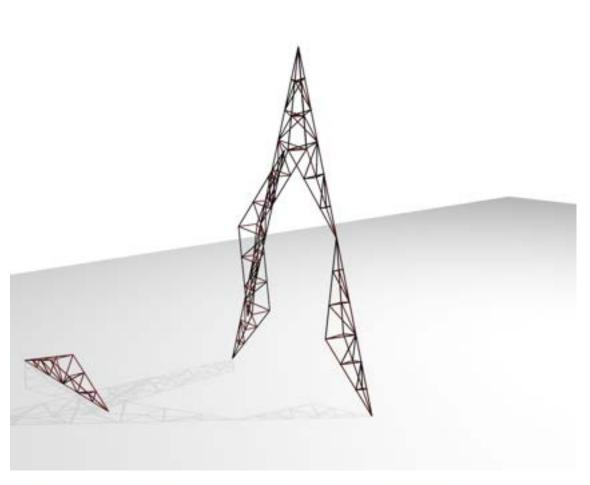






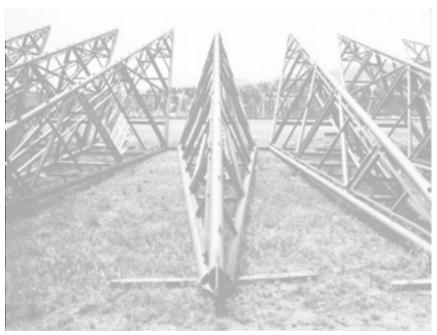


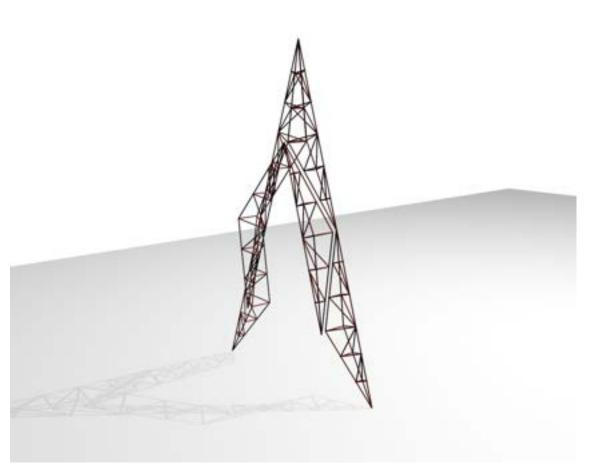






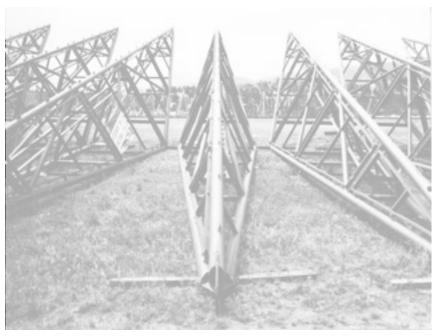


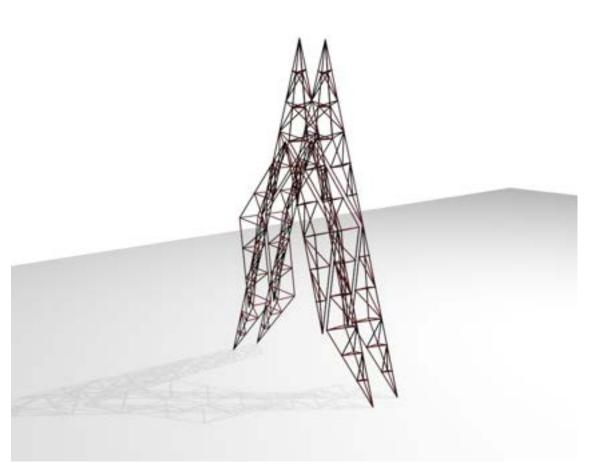






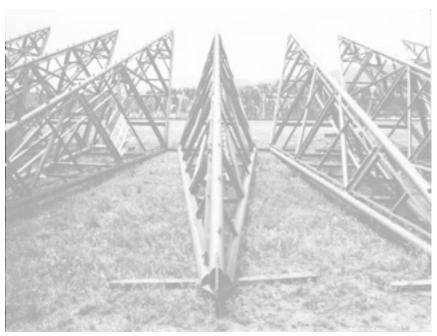


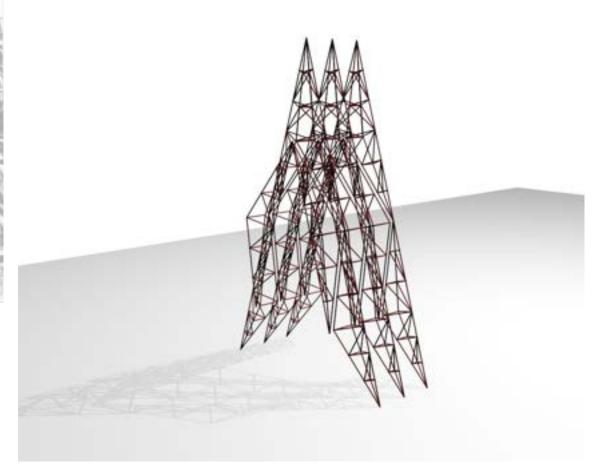






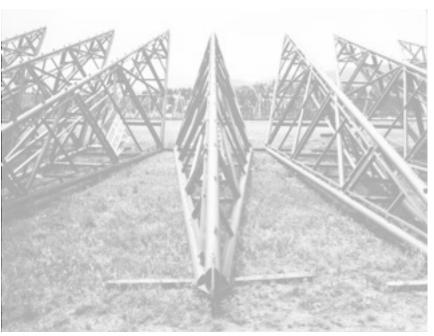


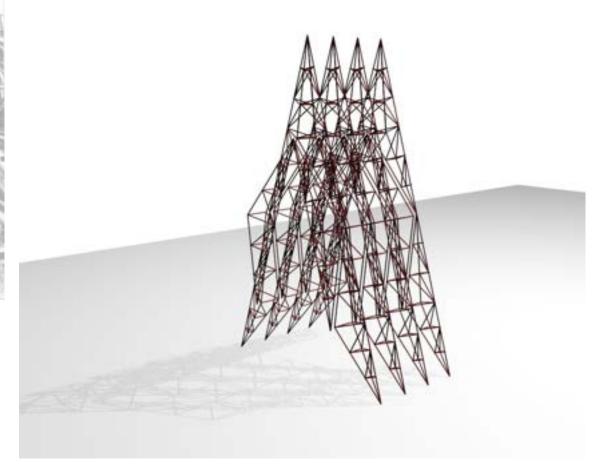






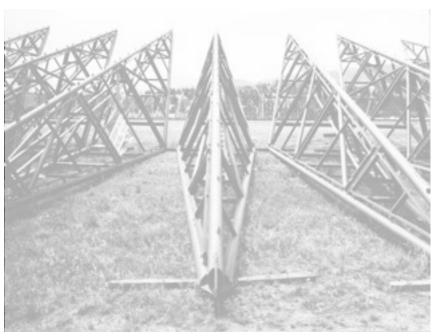


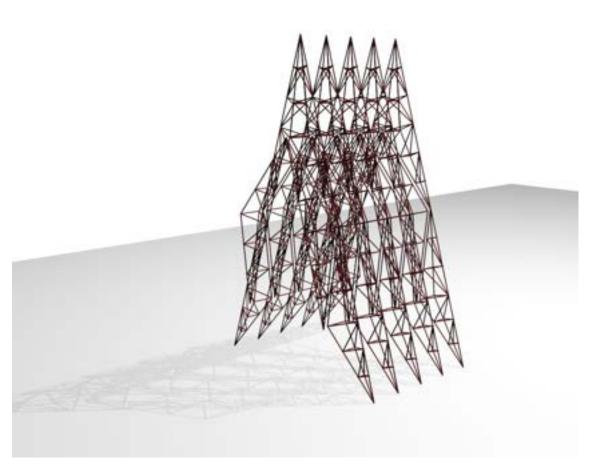






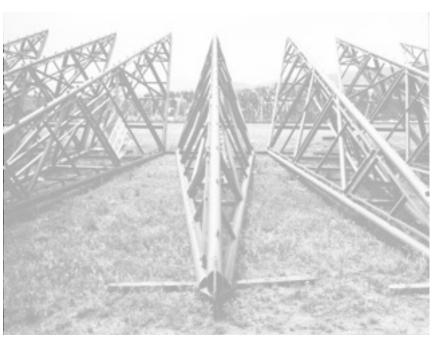


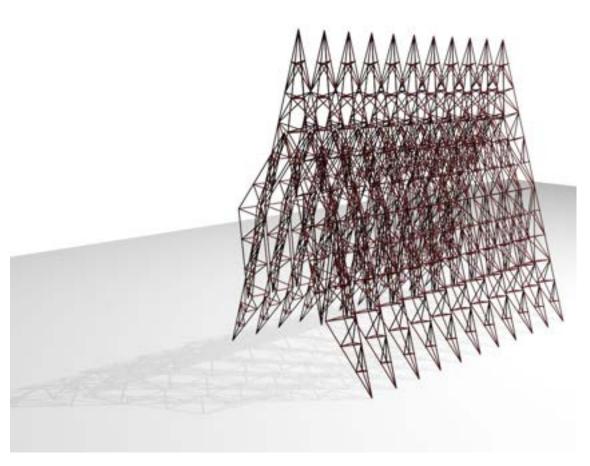






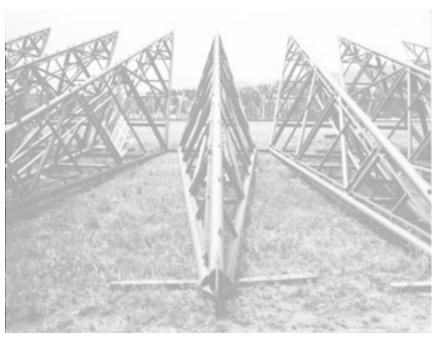


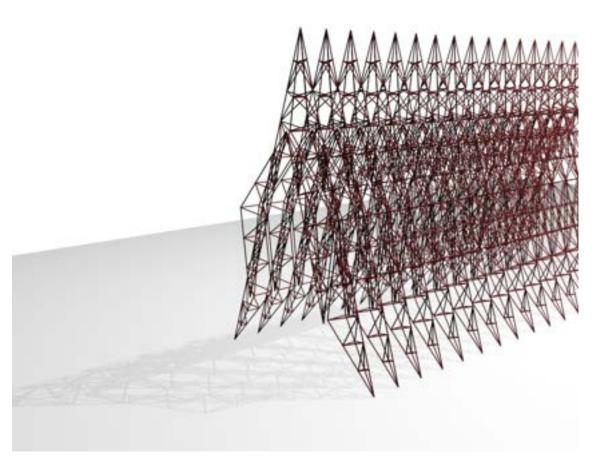










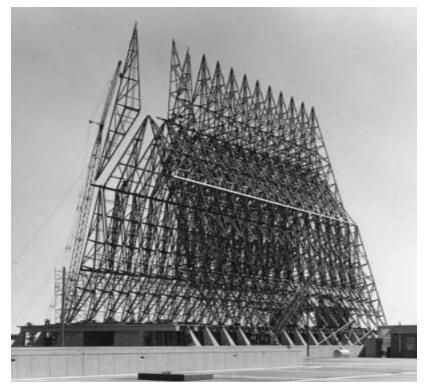








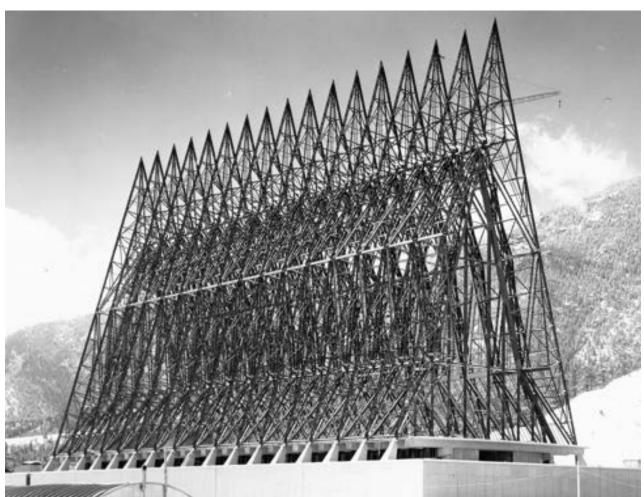


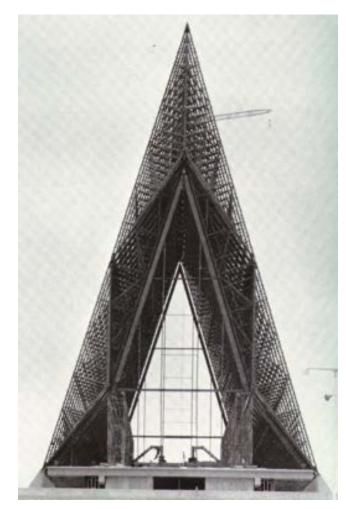




OVERVIEW Structure – Skeletal Frame









OVERVIEW Enclosure System













OVERVIEW Side Windows



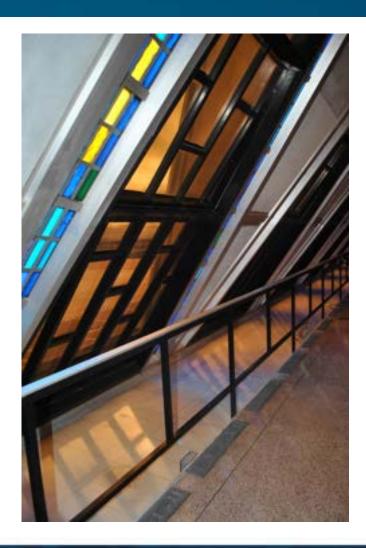




OVERVIEW Side Windows



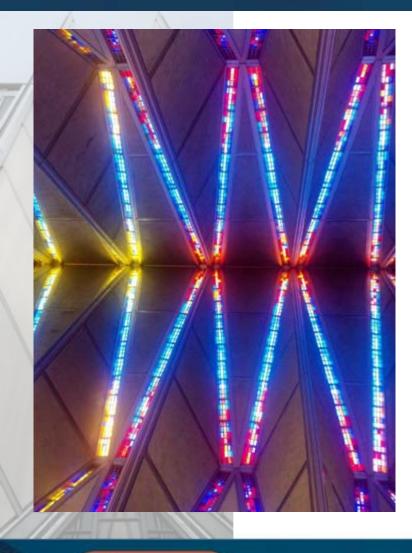








OVERVIEW Strip Windows





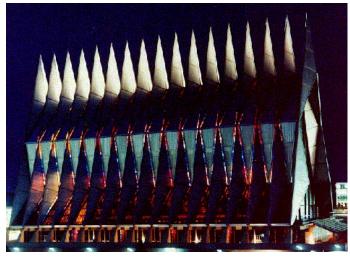


OVERVIEW Strip Windows





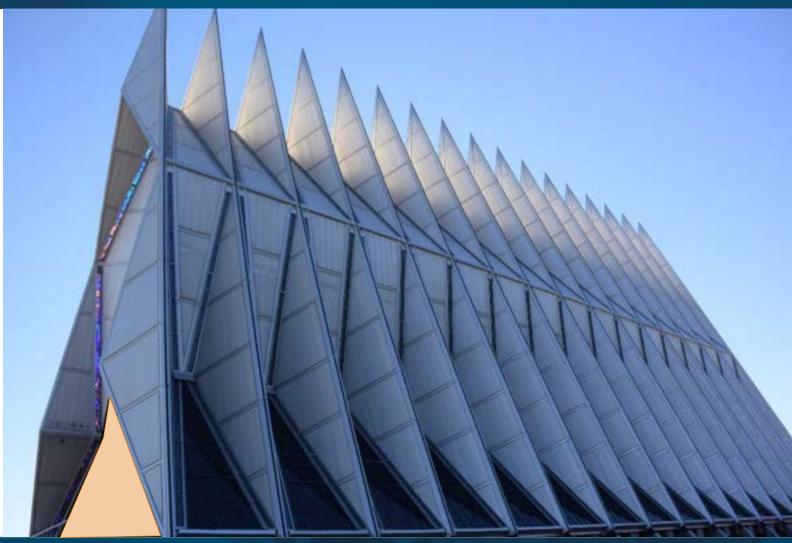






OVERVIEW End Walls

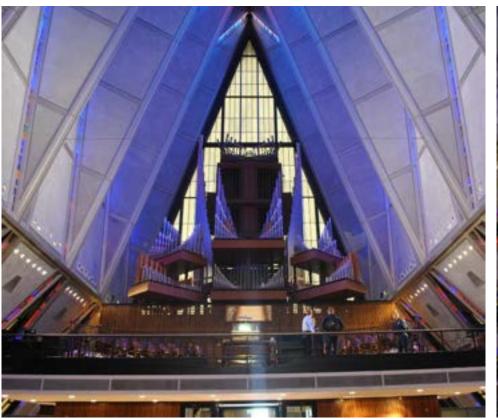






OVERVIEW End Walls







South End Wall

North End Wall

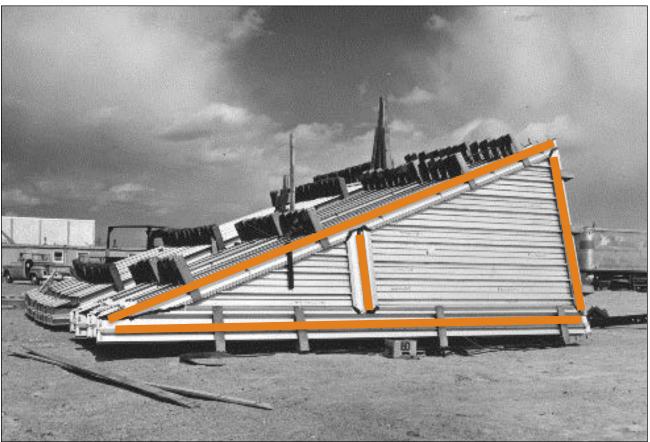


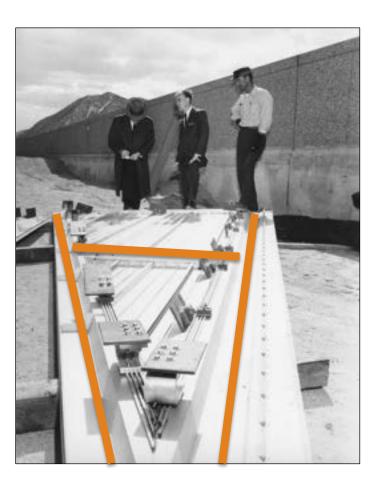






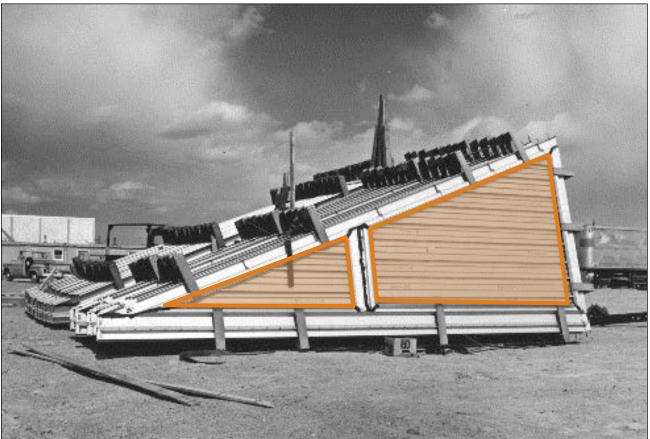


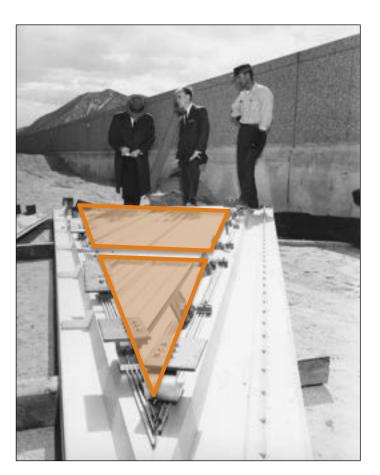














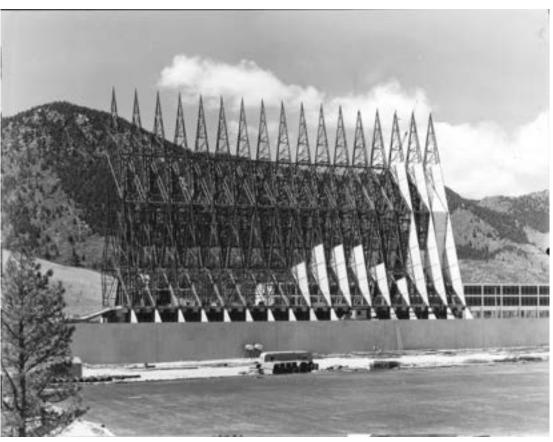












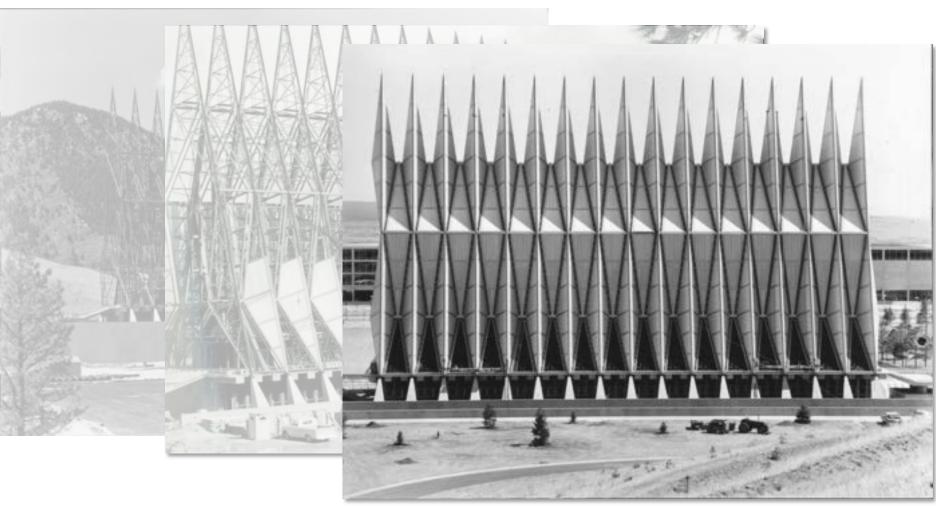






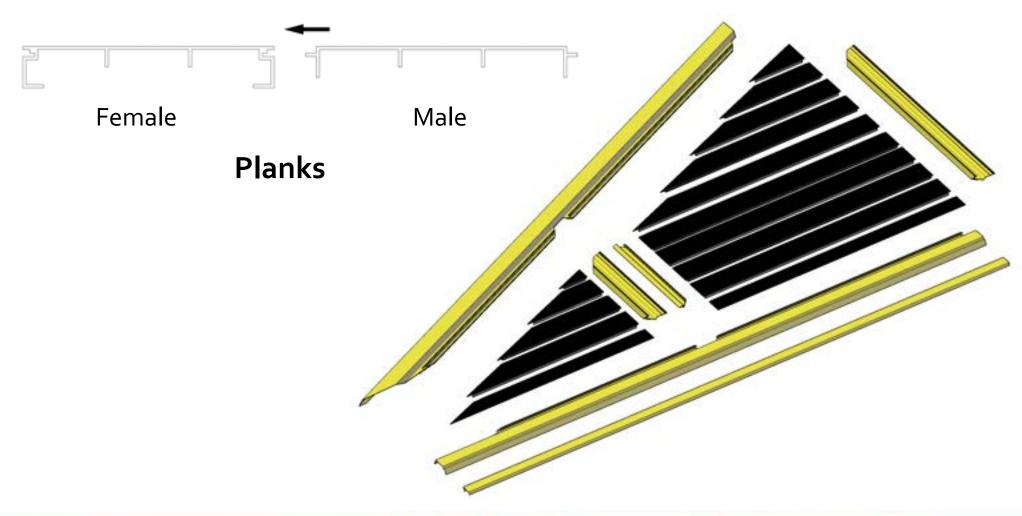






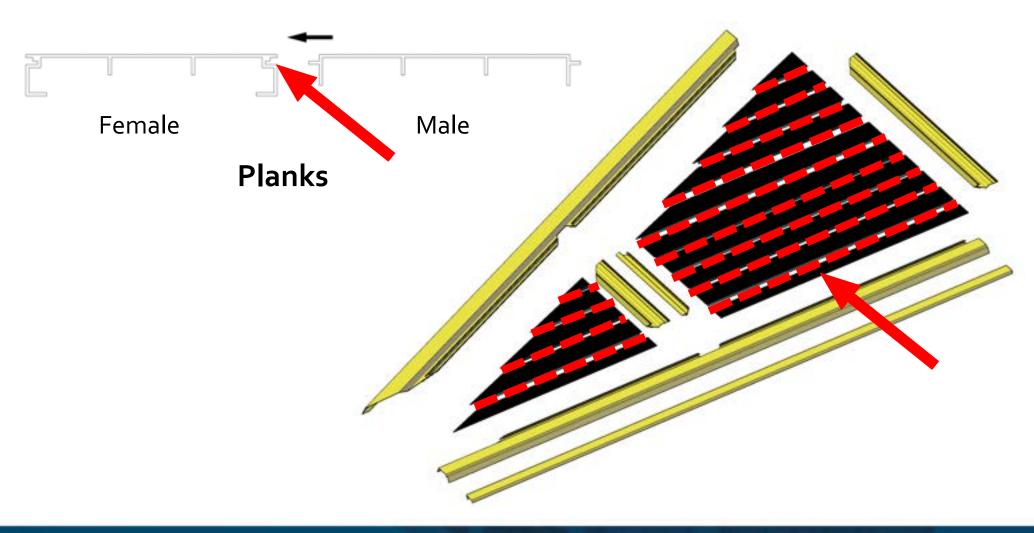






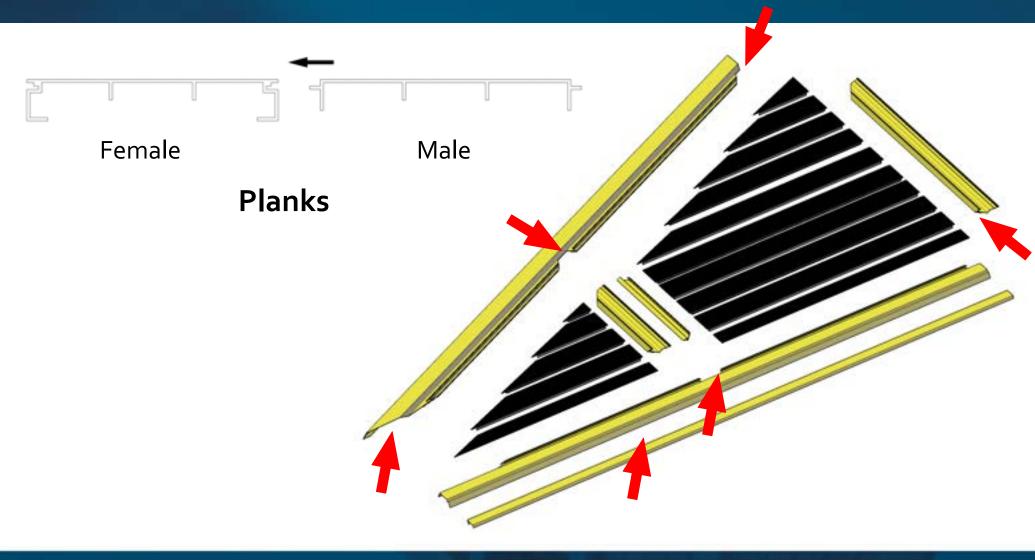






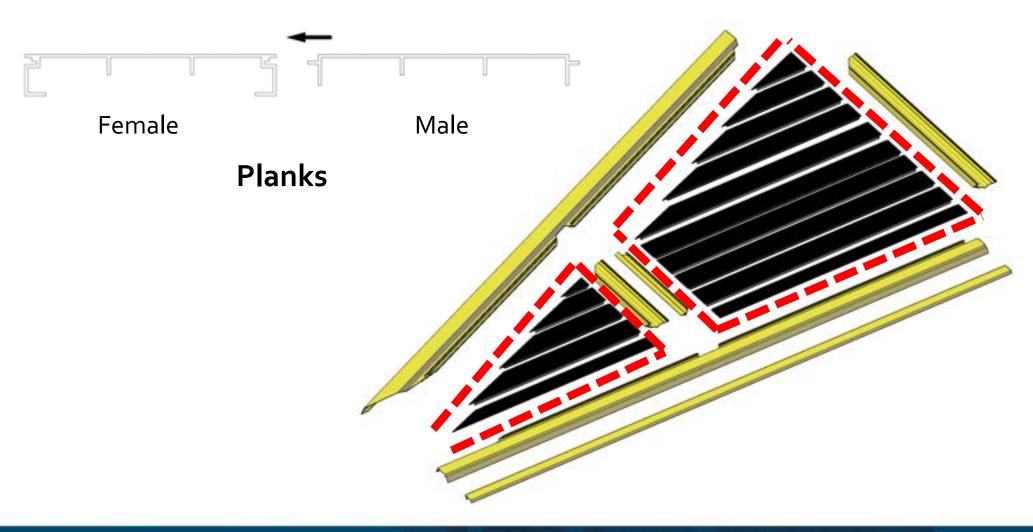








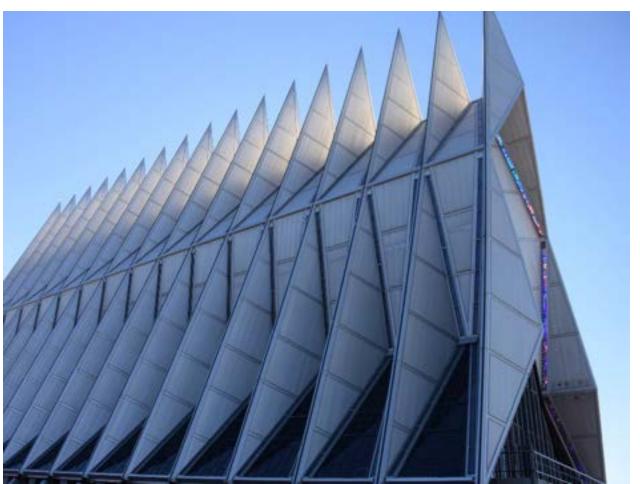






Chapel Restoration Design Goal: Solve the water leakage without changing the appearance



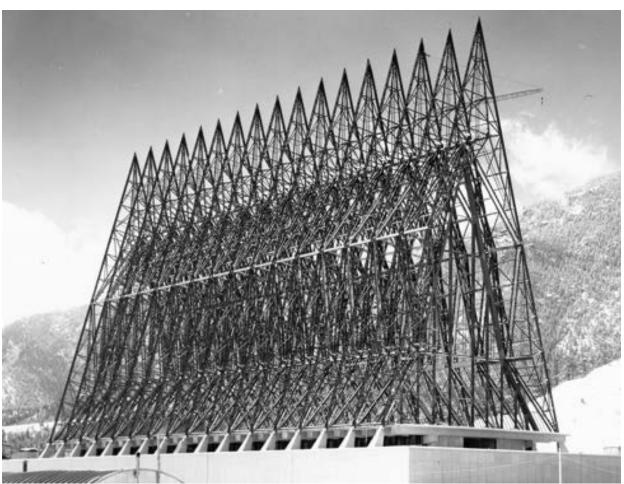


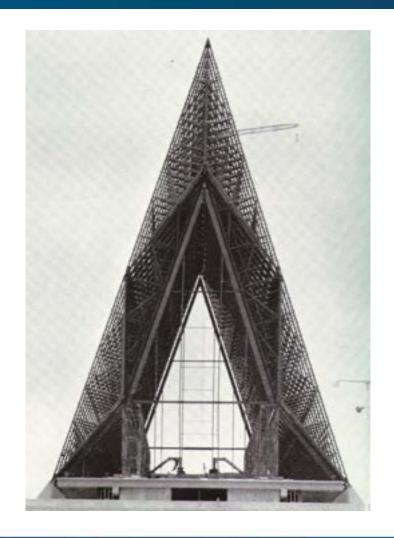




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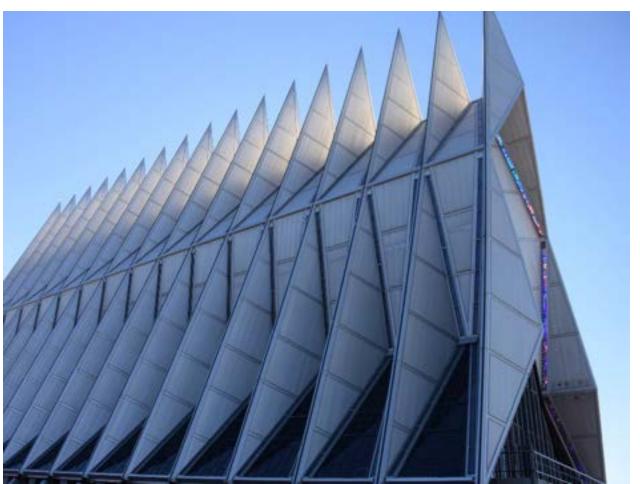






Chapel Restoration Design Goal: Solve the water leakage without changing the appearance





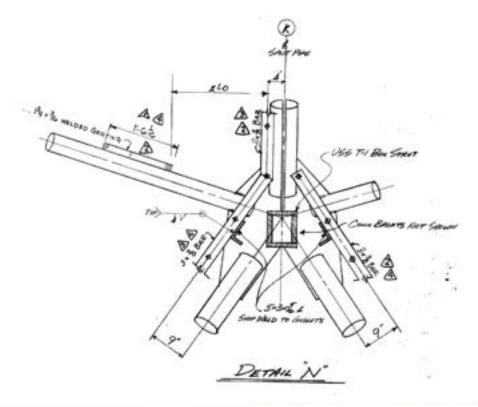


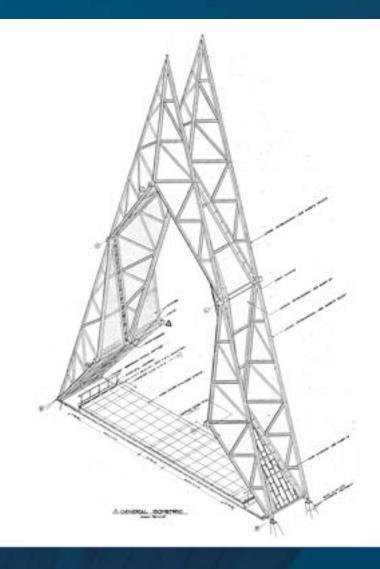


Historical Documents → Investigation → Recladding Design



- Architectural Drawings (SOM)
- Structural Steel Shop Drawings (Mississippi Valley)
- Cladding Shop Drawings (Cupples)

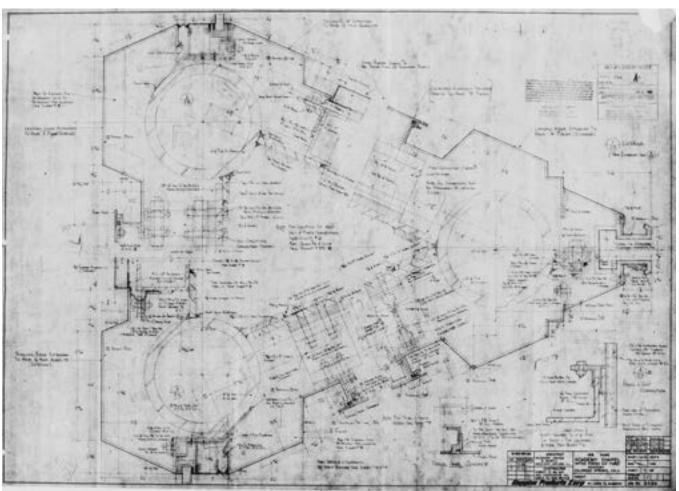


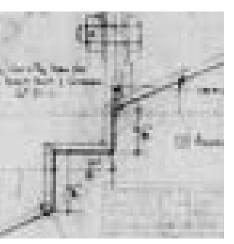




Historical Documents





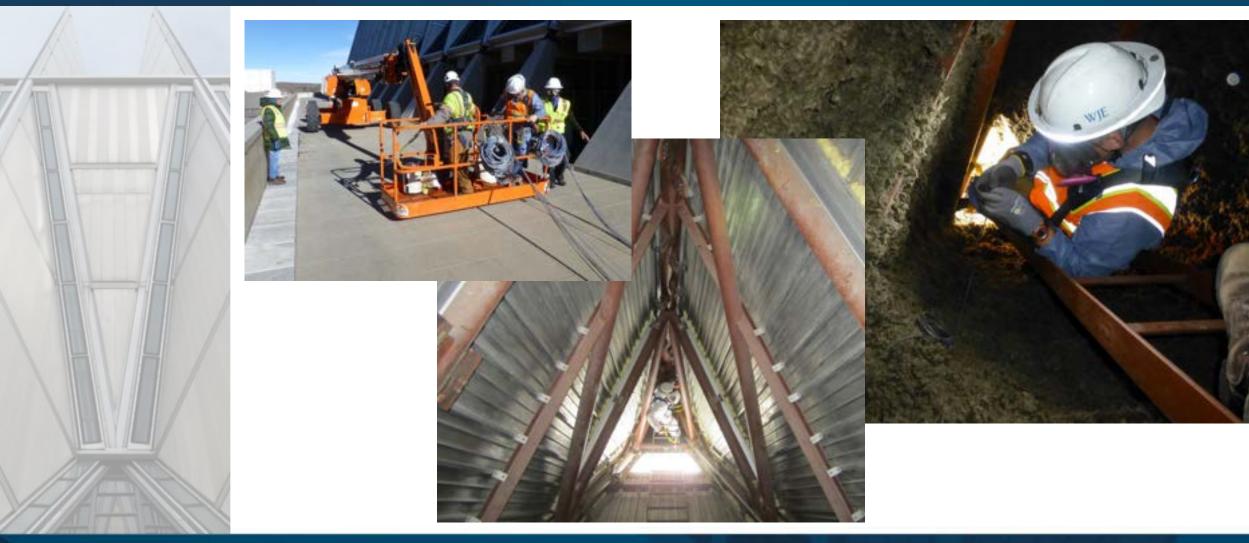




Microfiche



Field Investigation



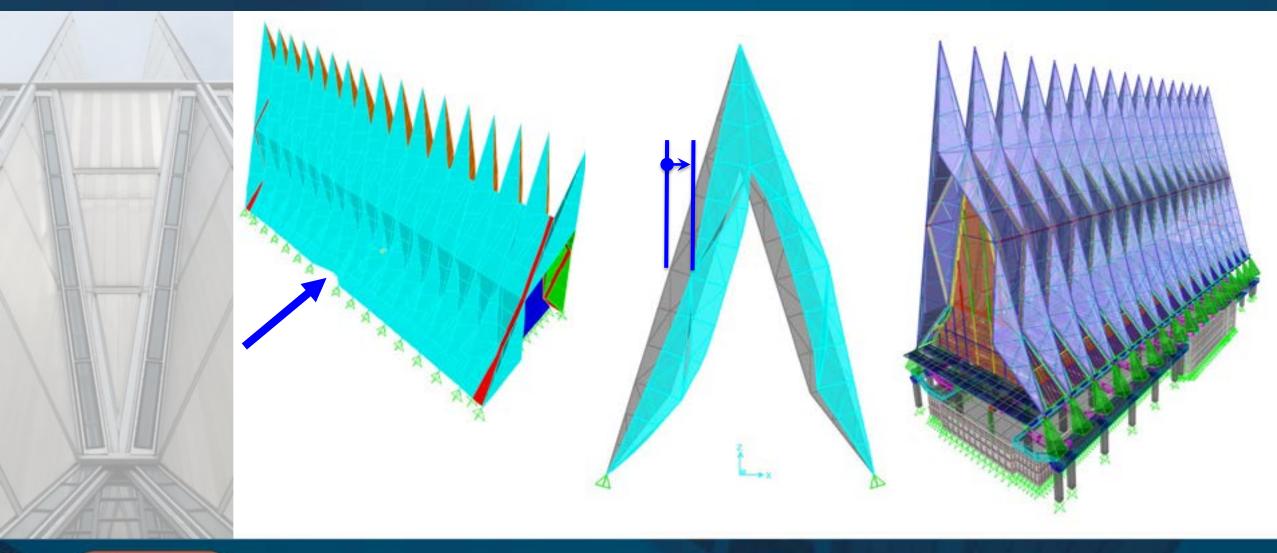


Wind Tunnel Testing





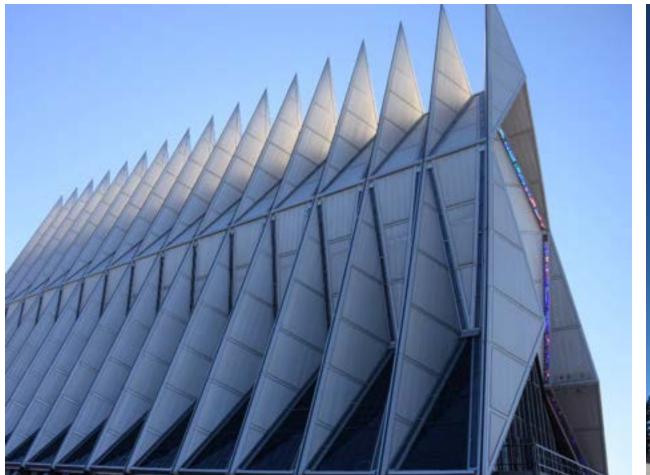
Structural Computer Analysis





RECLADDING DESIGN

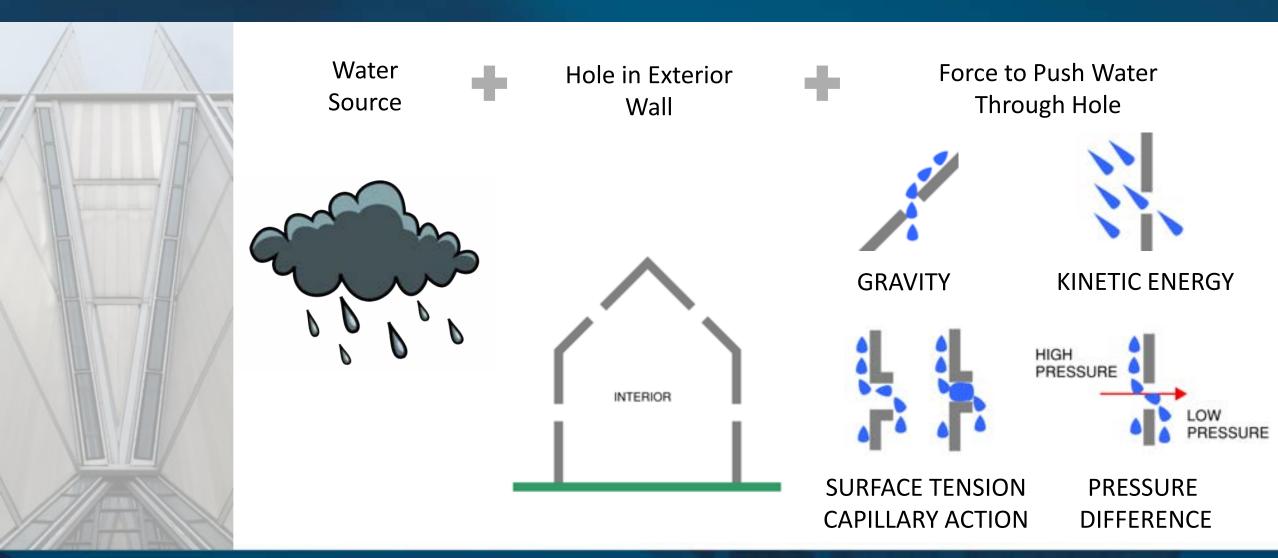








ENCLOSURE How Buildings Leak





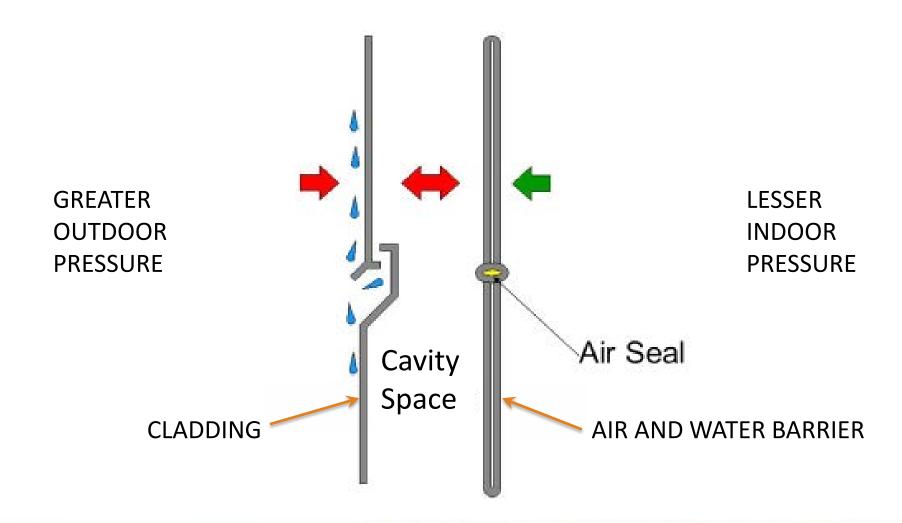
ENCLOSURE How Buildings Leak





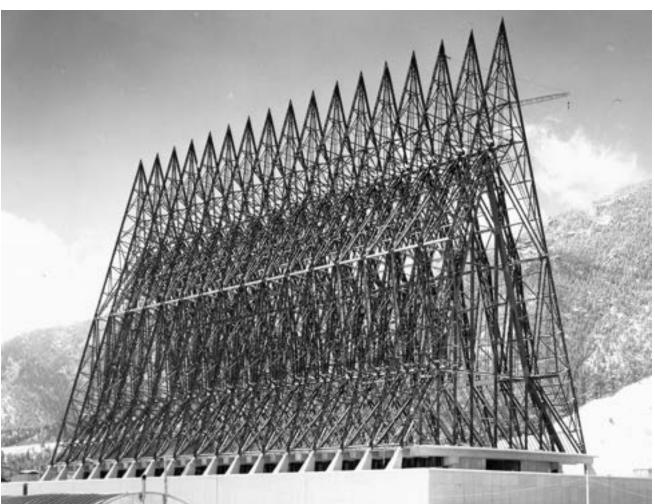


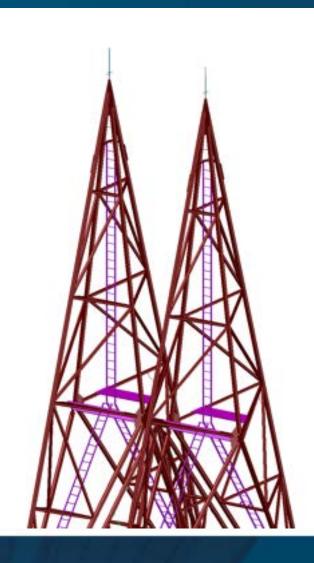






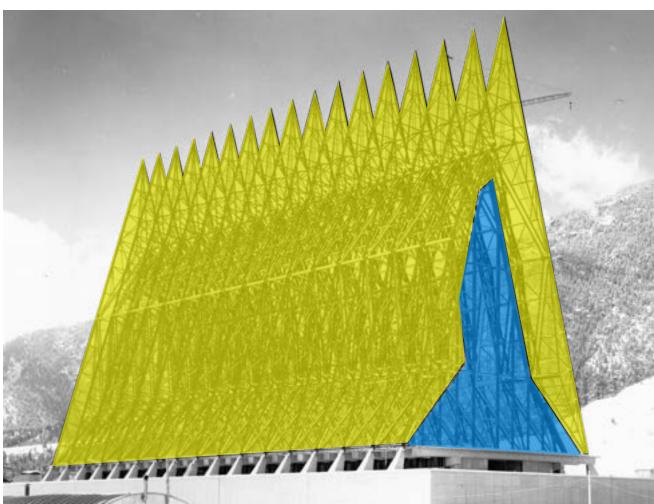


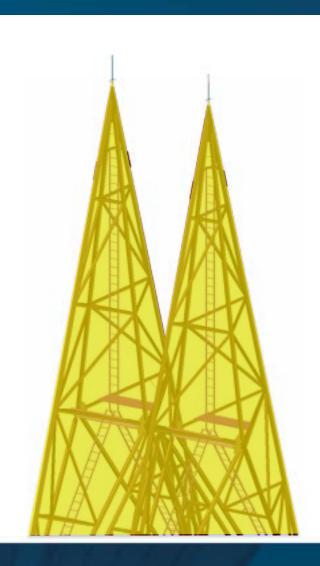






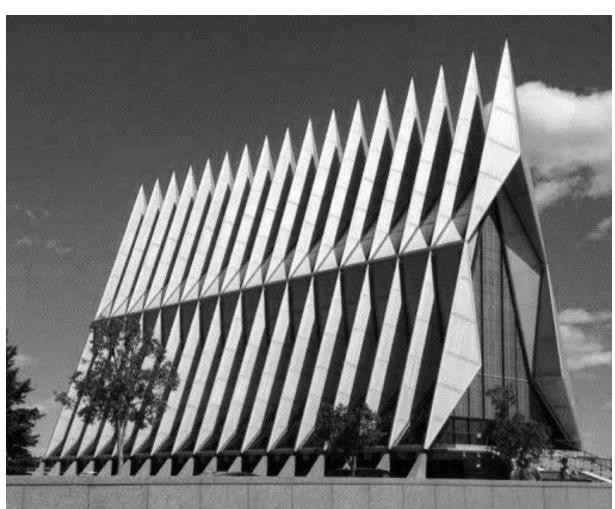


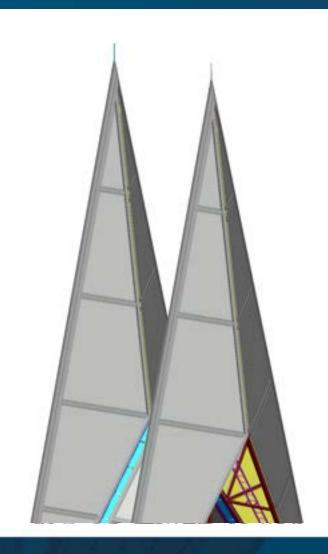




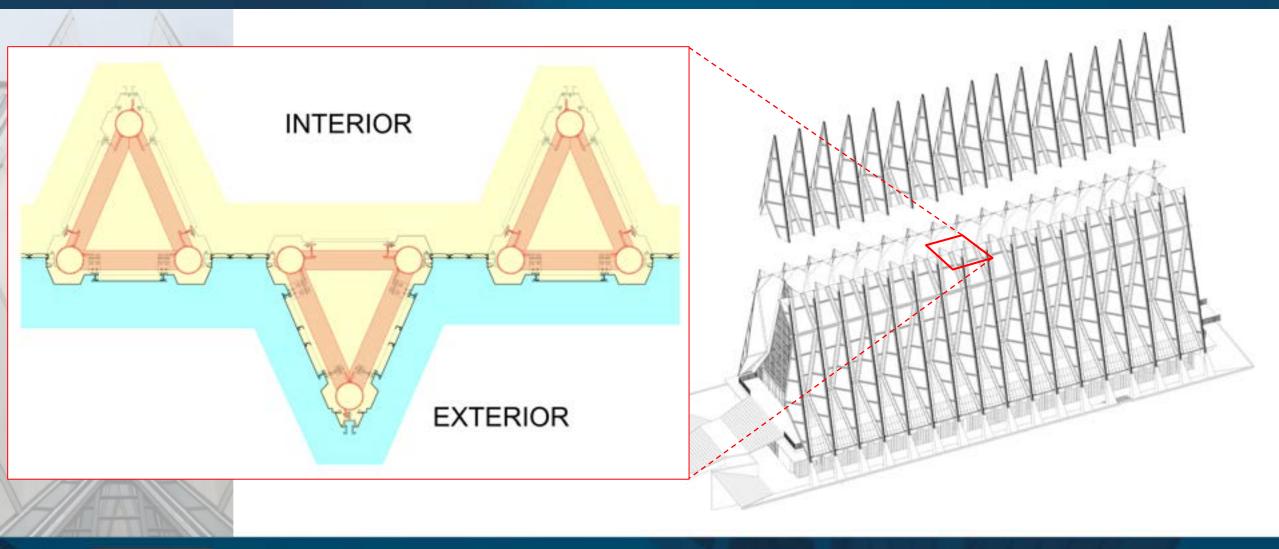




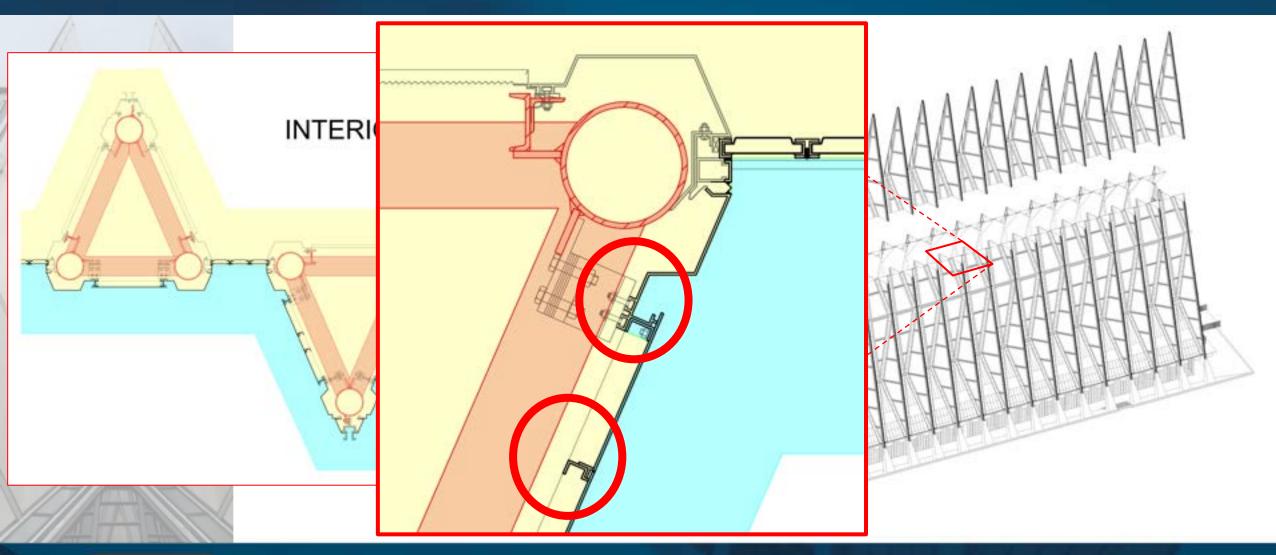








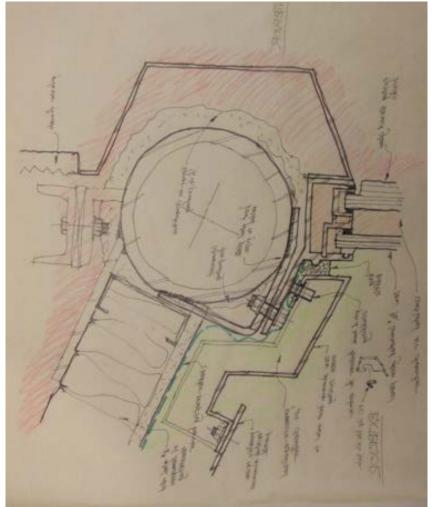


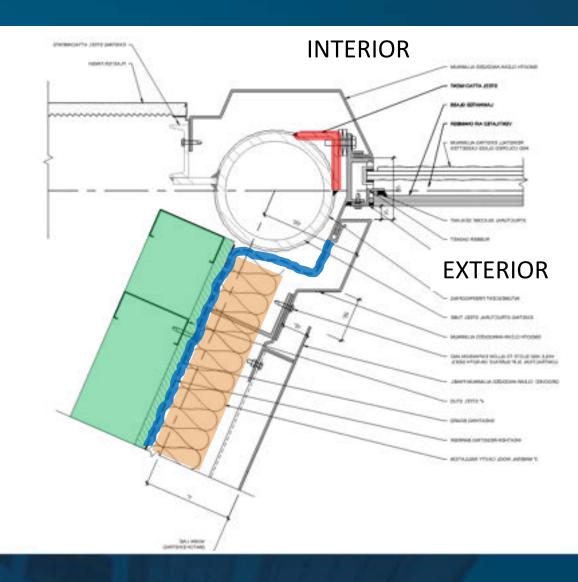




ENCLOSURE Rainscreen Concept

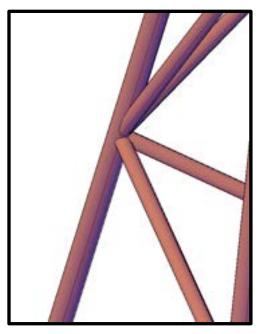




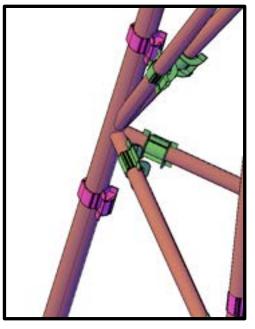




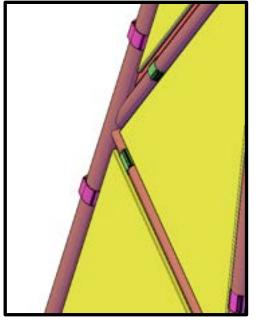




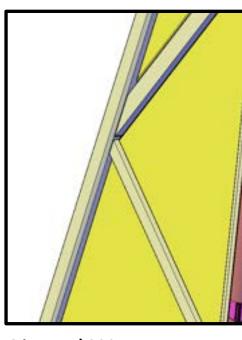




Anchors



Air and Water-Resistive Panes

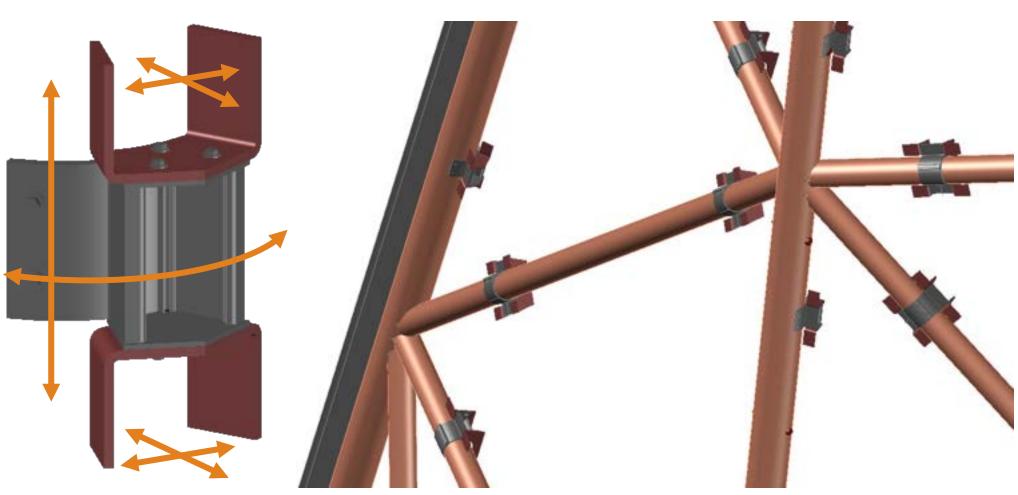


Air and Water-Resistive Covers



ENCLOSURE Pipe Clamps / Saddles







ENCLOSURE Backup Panel







ENCLOSURE Backup Panel

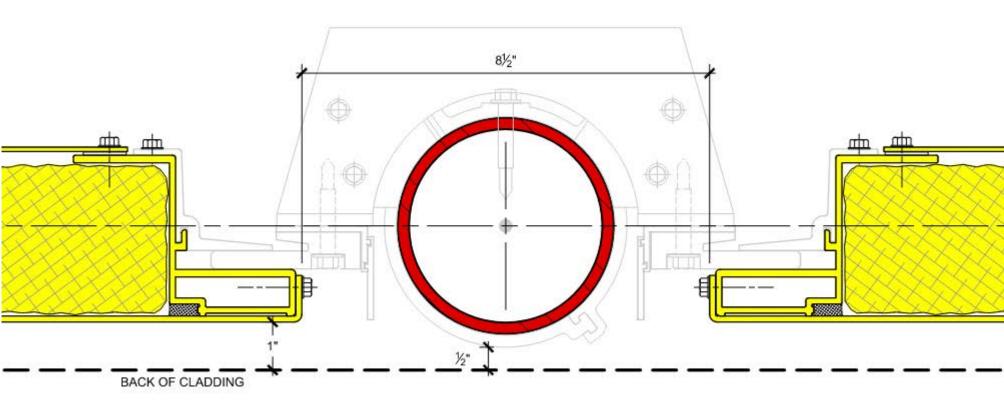


AIR & WATER RESISTIVE PANELS **INTERIOR ALUMINUM BACK PANEL** (0.060 INCHES) MINERAL WOOL **INSULATION (3 INCHES)** PERIMETER EXTRUSION & **INTERNAL STIFFENERS ALUMINUM FACE PANEL** (0.125 INCHES)

EXTERIOR

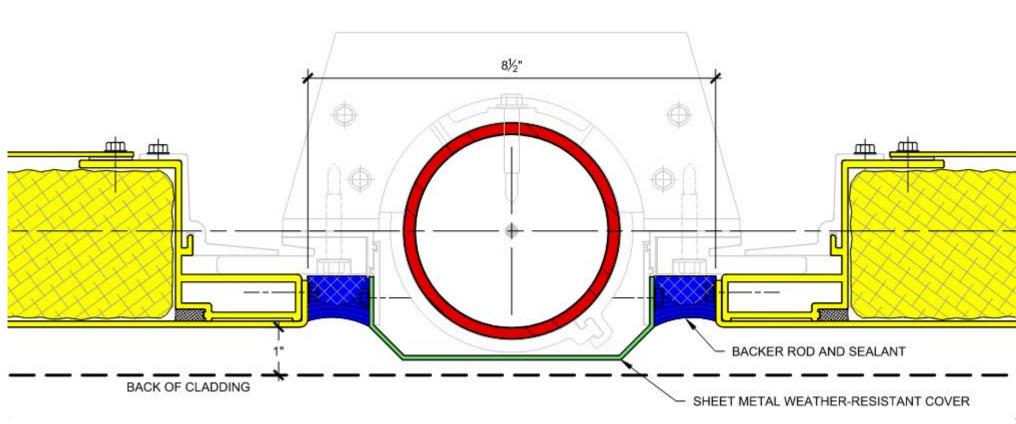




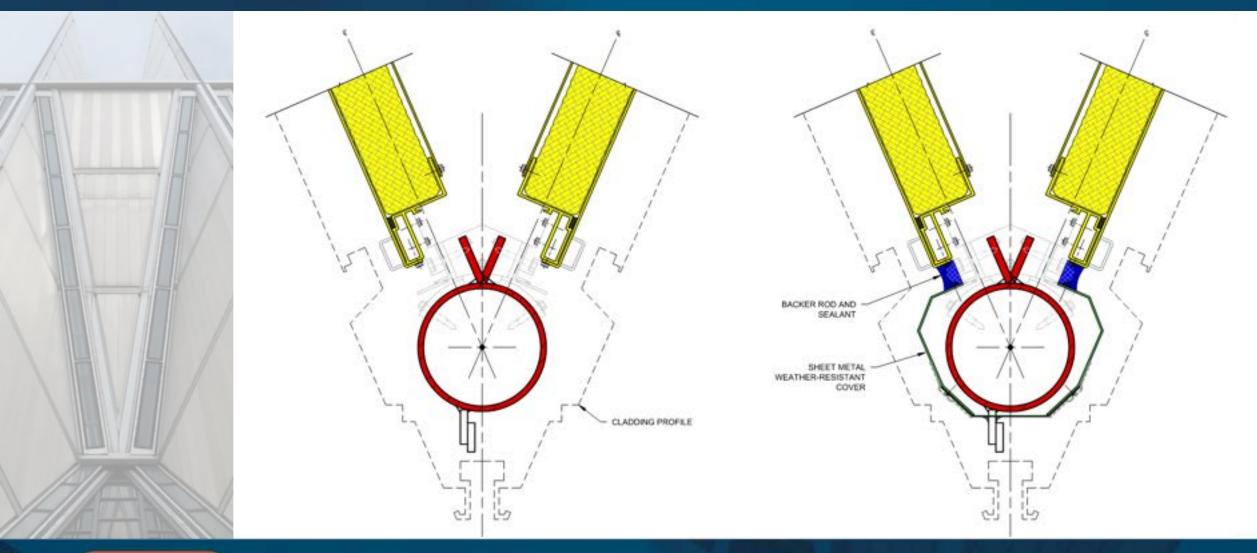








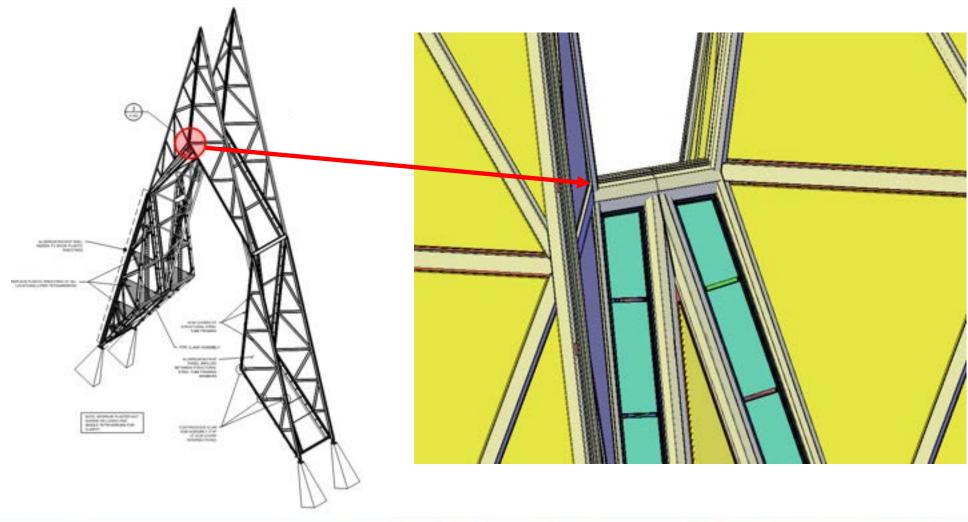






ENCLOSURE Backup – Structural Steel Covers

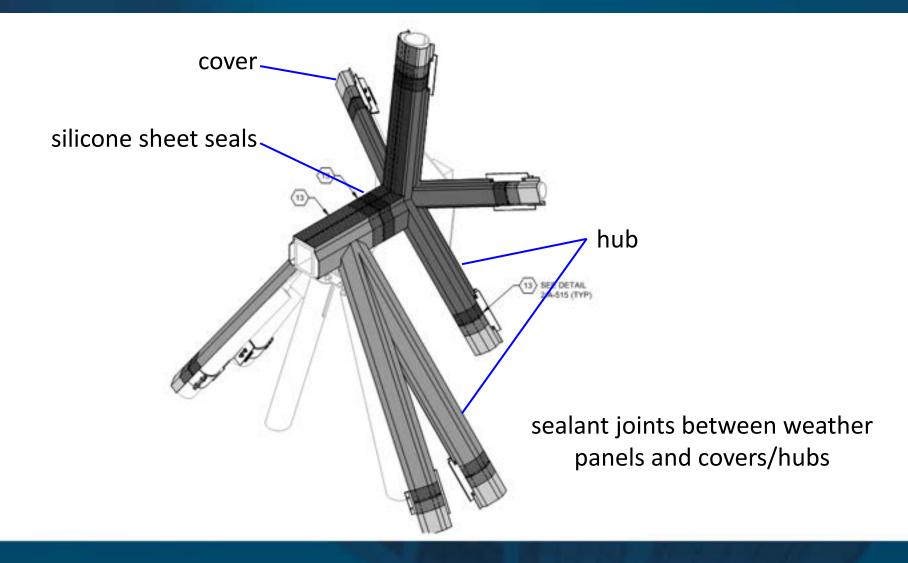






ENCLOSURE Backup – Structural Steel Covers

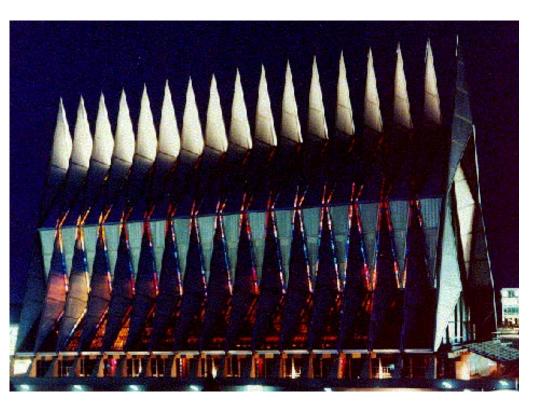




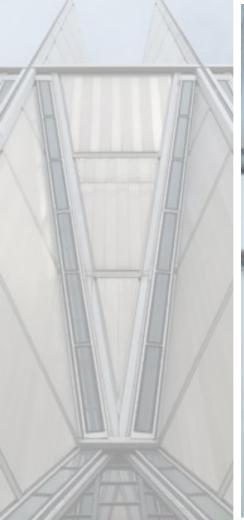


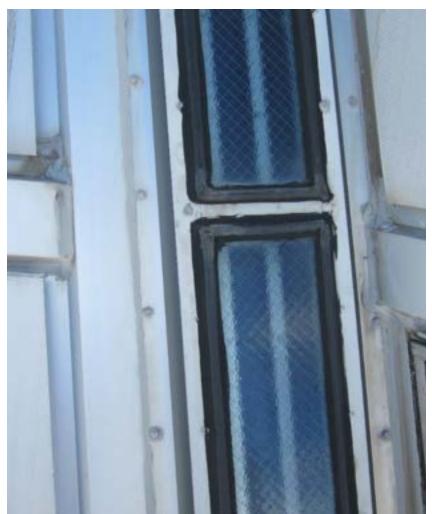


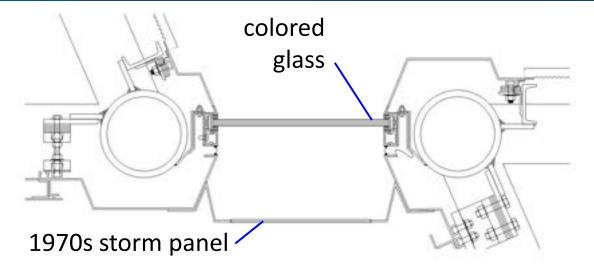


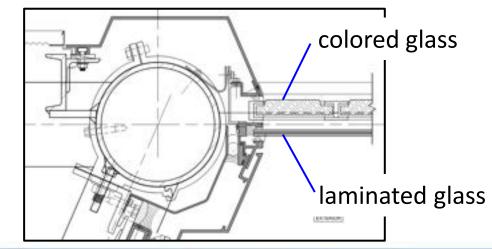






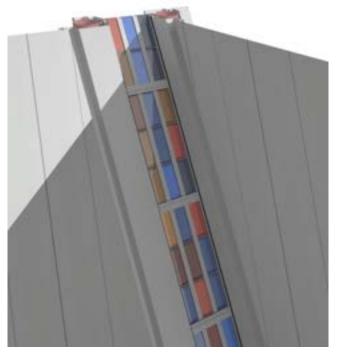




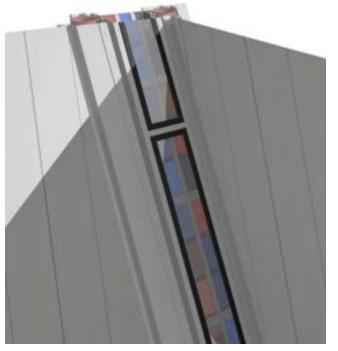




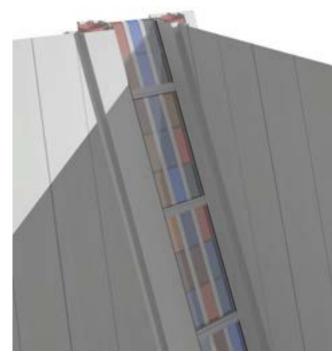








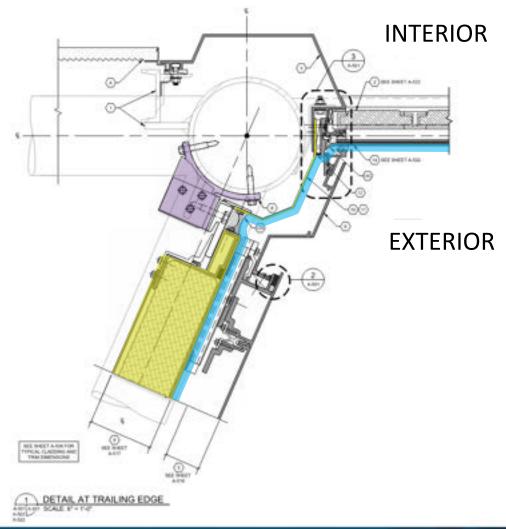
1970s STORM PANEL

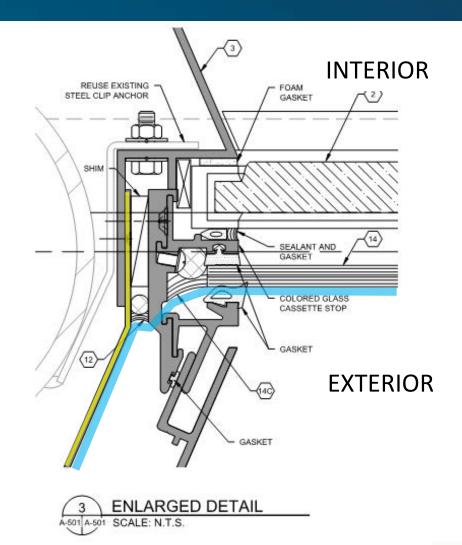


RECLADDING DESIGN



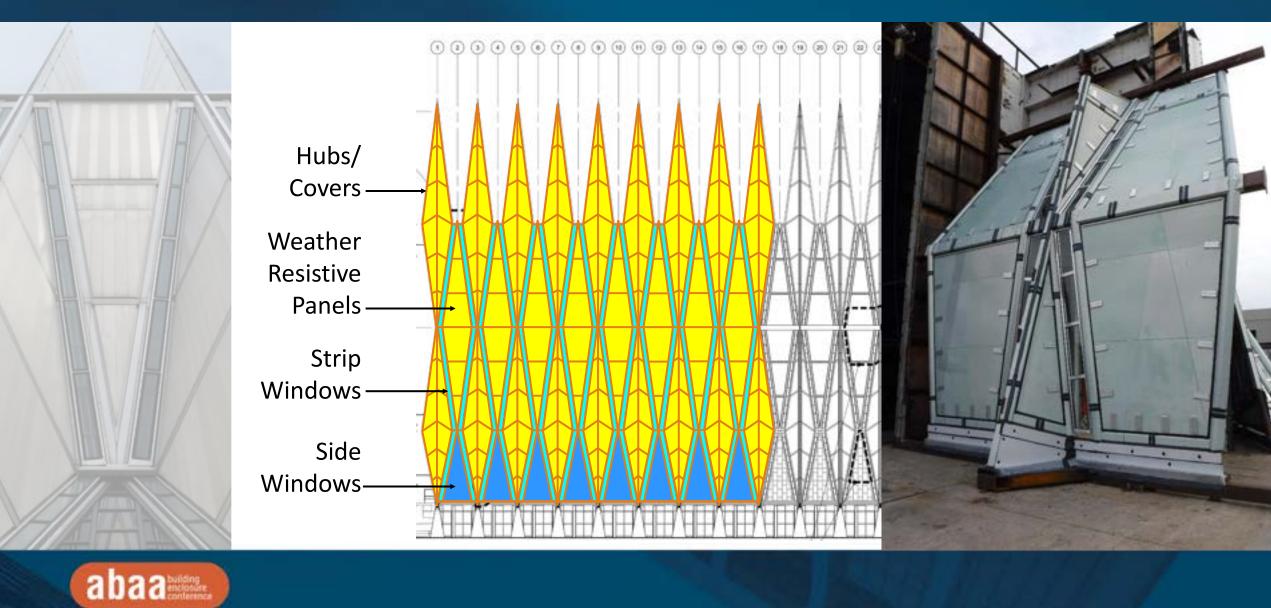






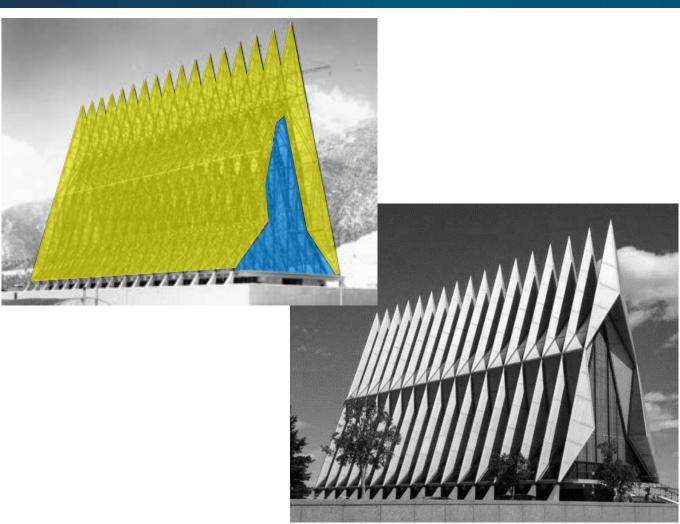


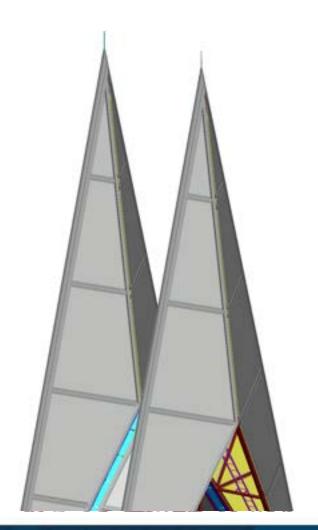
ENCLOSURE Air and Water Barrier System



ENCLOSURE Cladding Panels



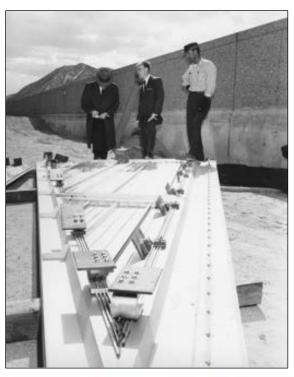








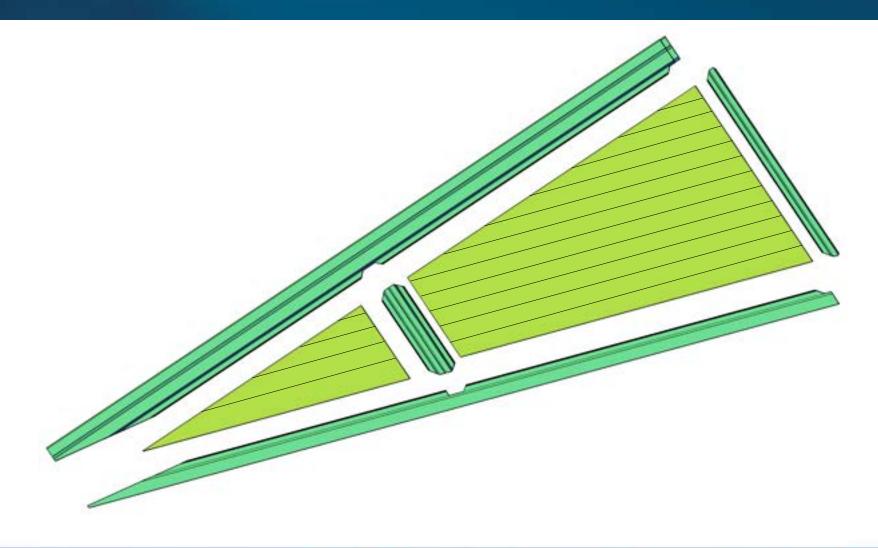




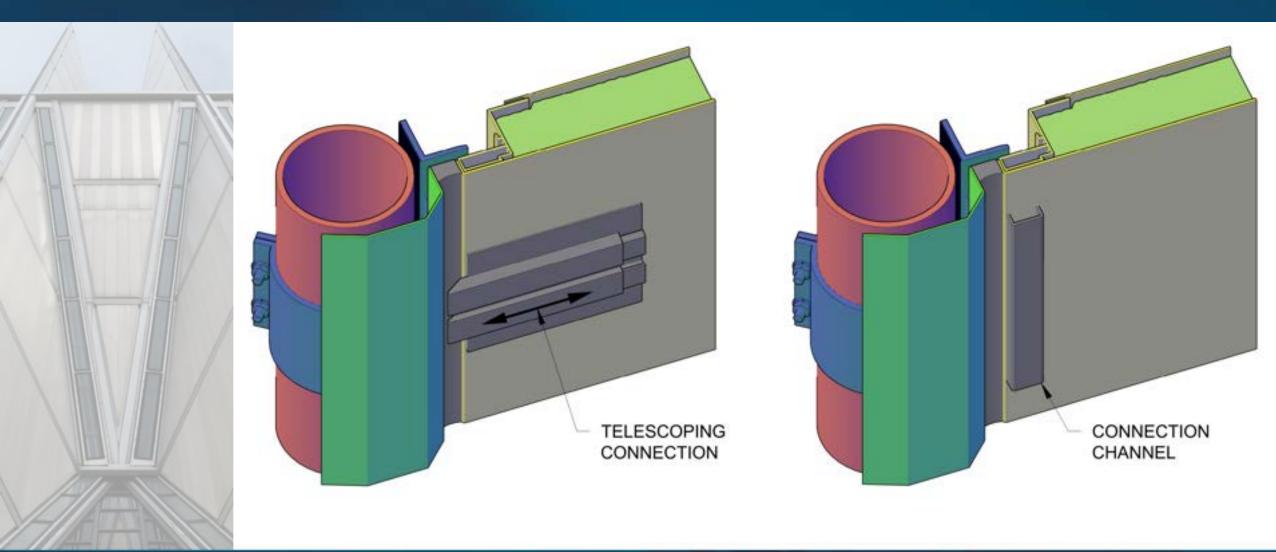






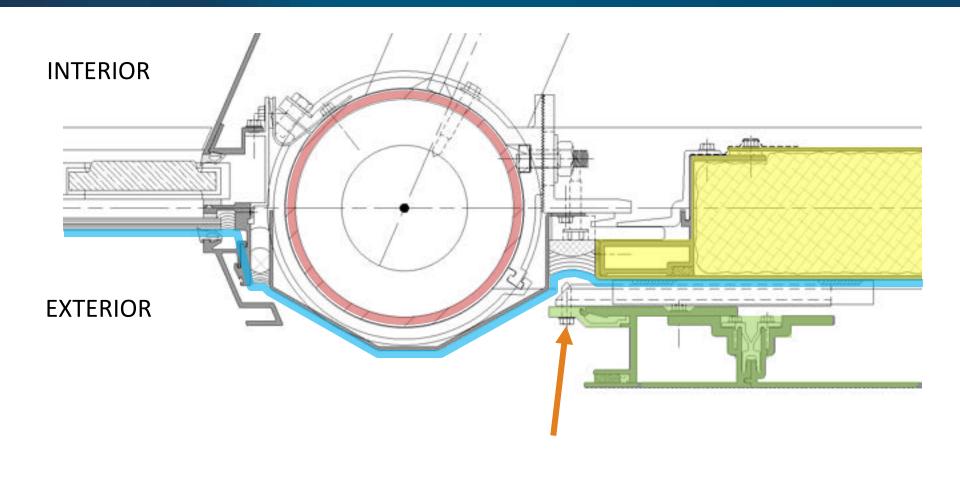






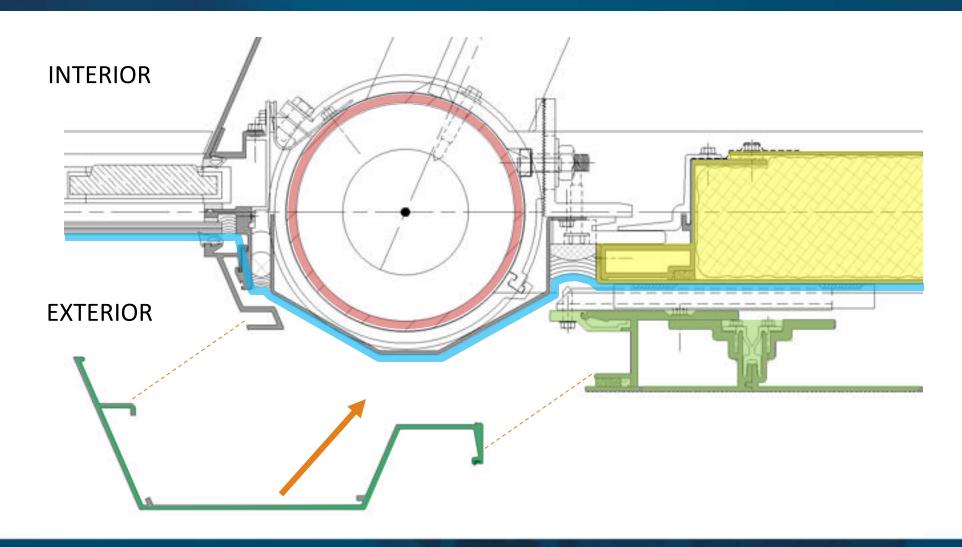








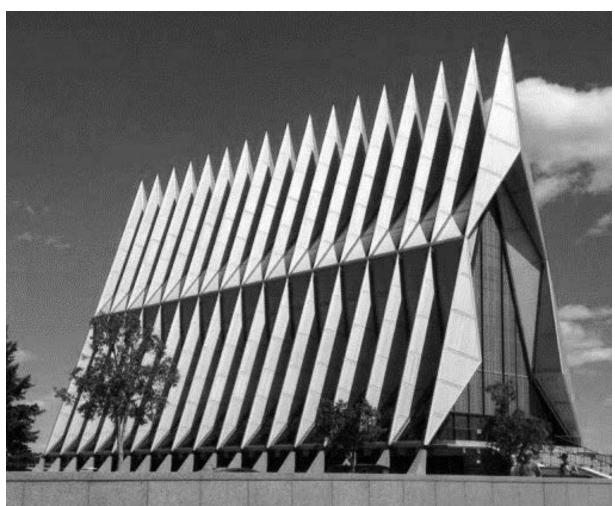


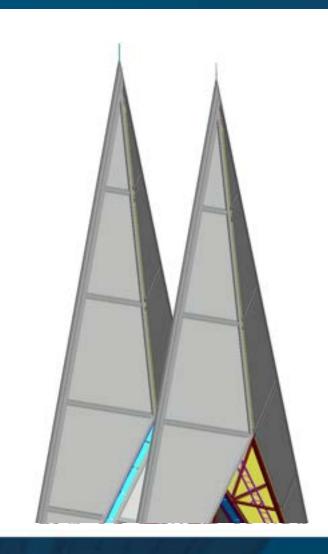




ENCLOSURE Completed Rainscreen





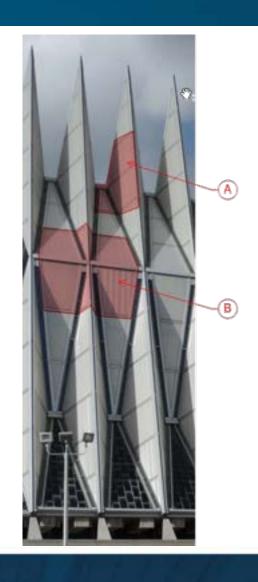




DESIGN PHASE PERFORMANCE MOCK-UP



- ALLOWS CONSTRUCTABILITY EVALUATION
- ALLOWS AESTHETIC BUY-IN BY STAKEHOLDERS
- ALLOWS PERFORMANCE CONFIRMATION
- ALLOWS FINAL DESIGN TO GATHER "LESSONS LEARNED" WHICH WILL REDUCE BID UNCERTAINTIES





MOCK-UP



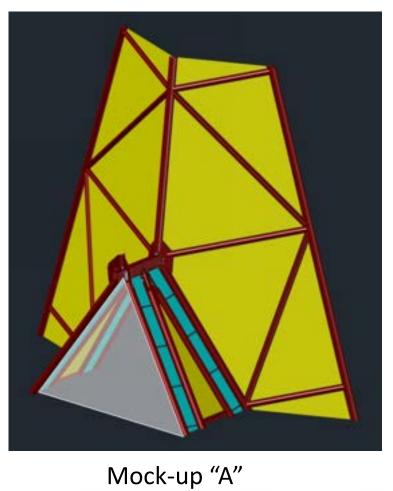


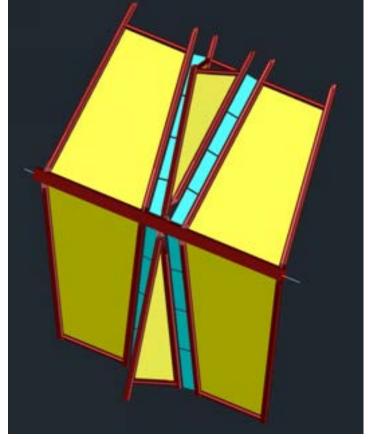




DESIGN PHASE PERFORMANCE MOCK-UP





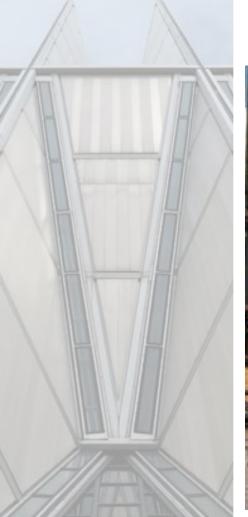








DESIGN PHASE PERFORMANCE MOCK-UP – Steel Erection







Mock-up "B"



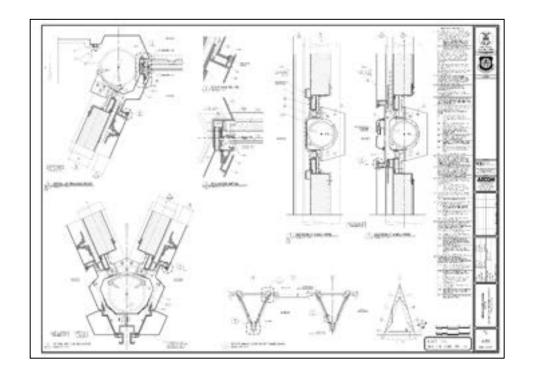
Mock-up "A"





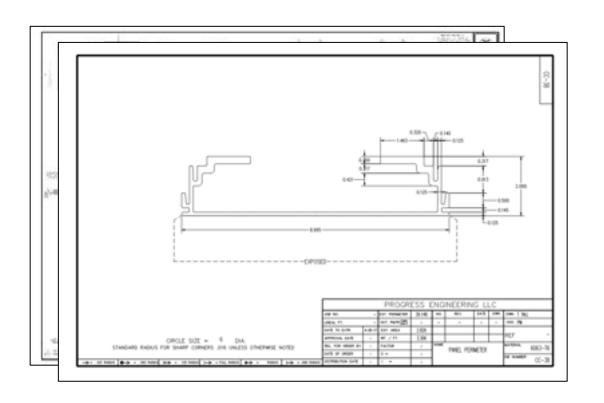


- Design Drawings
 - Architect





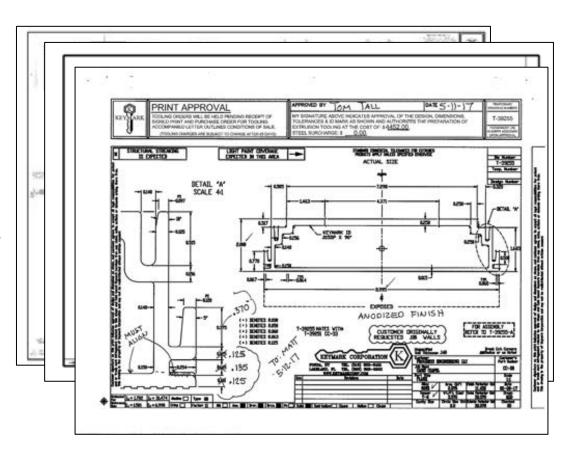
- Design Drawings
 - Architect
- Die Drawings
 - Contractor







- Design Drawings
 - Architect
- Die Drawings
 - Contractor (detailer)
- Tooling Drawings
 - Extruder
 - Reviewed by Contractor







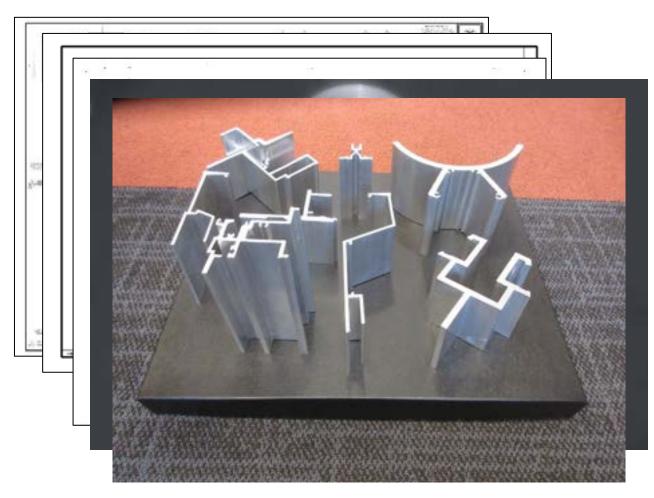
- Design Drawings
 - Architect
- Die Drawings
 - Contractor
- Tooling Drawings
 - Extruder
 - Reviewed by Contractor
- Dies Fabrication
 - For the Extruder







- Design Drawings
 - Architect
- Die Drawings
 - Contractor
- Tooling Drawings
 - Extruder
 - Reviewed by Contractor
- Dies Fabrication
 - For the Extruder
- Extrusion Samples
 - Extruder
 - Reviewed by Contractor







- Design Drawings
 - Architect
- Die Drawings
 - Contractor
- Tooling Drawings
 - Extruder
 - Reviewed by Contractor
- Dies Fabrication
 - For the Extruder
- Extrusion Samples
 - Extruder
 - Reviewed by Contractor
- Extrusions
 - Minimum run ~500 pounds





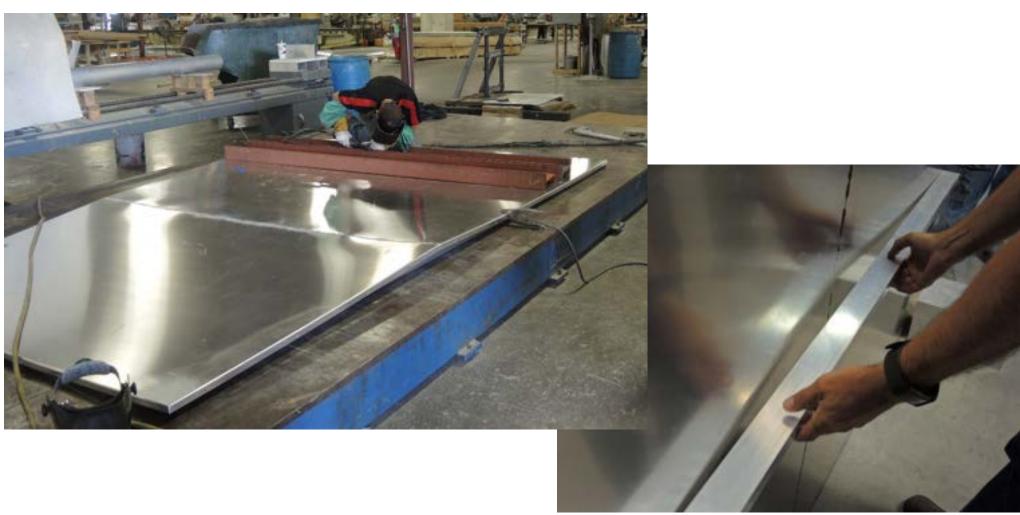
DESIGN PHASE PERFORMANCE MOCK-UP – Panel Fabrication





DESIGN PHASE PERFORMANCE MOCK-UP – Panel Fabrication





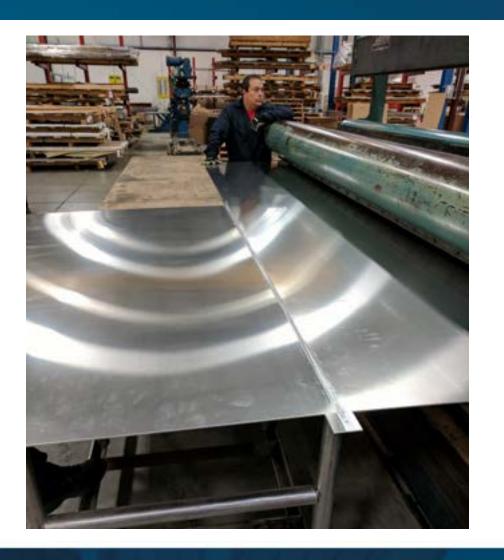


DESIGN PHASE PERFORMANCE MOCK-UP – Panel Fabrication



Lesson Learned #1



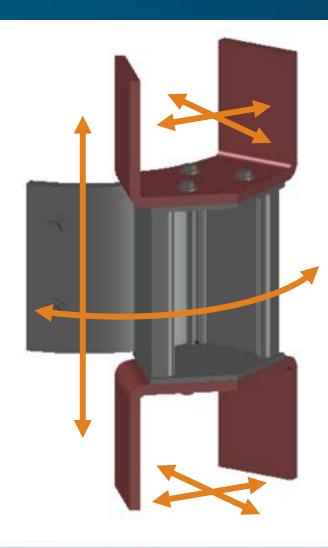




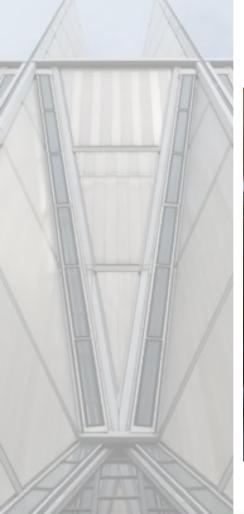
DESIGN PHASE PERFORMANCE MOCK-UP - Assembly







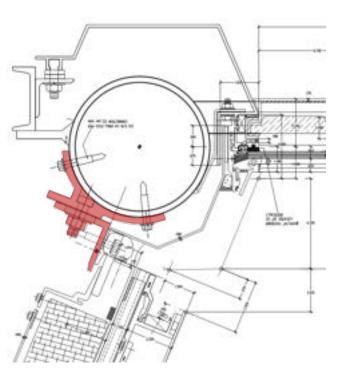




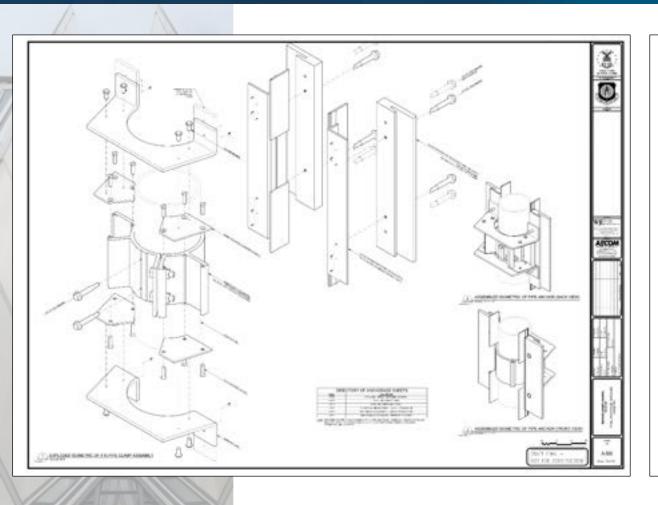


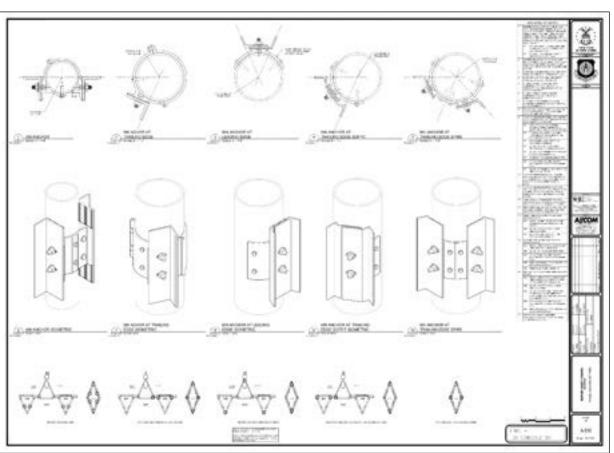


Lesson Learned #2



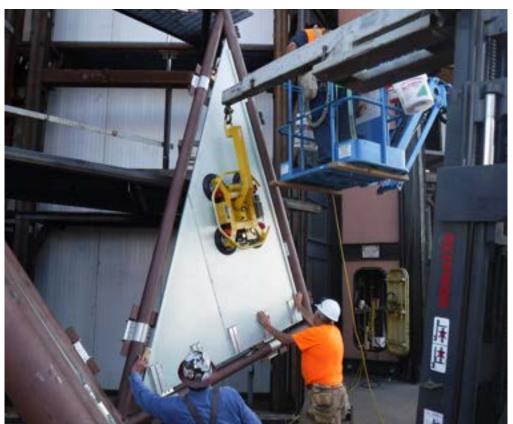








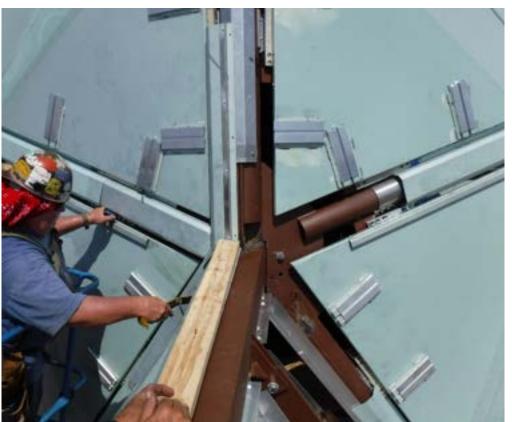










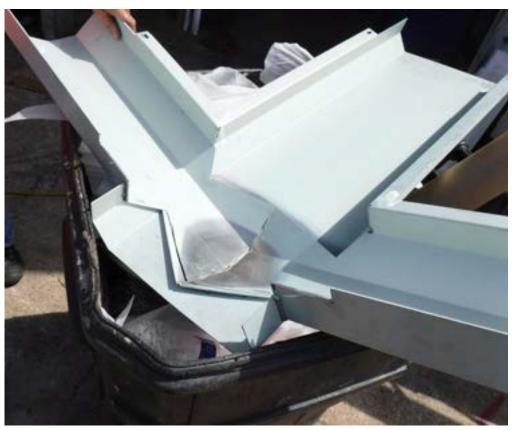












Lesson Learned #3

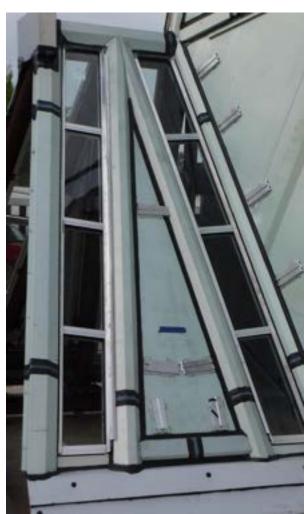












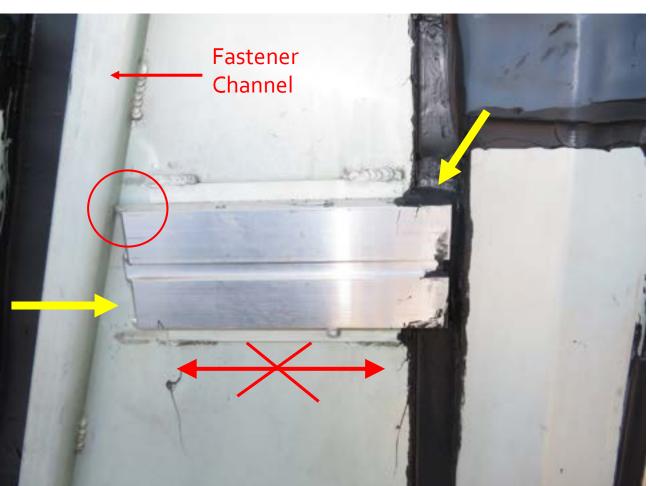












Lesson Learned #5









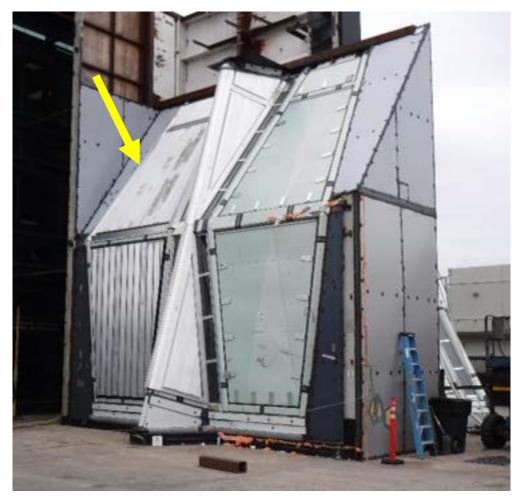














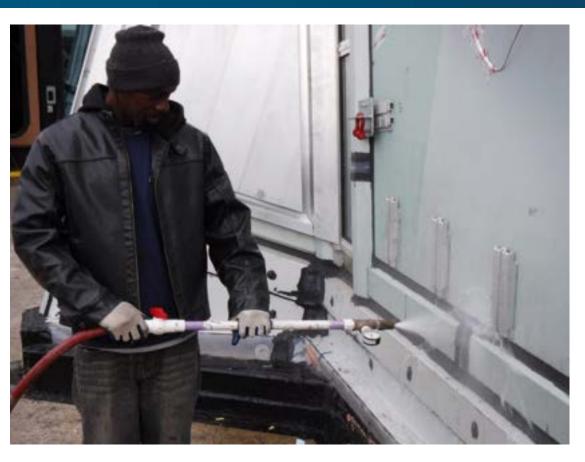












Lesson Learned #6









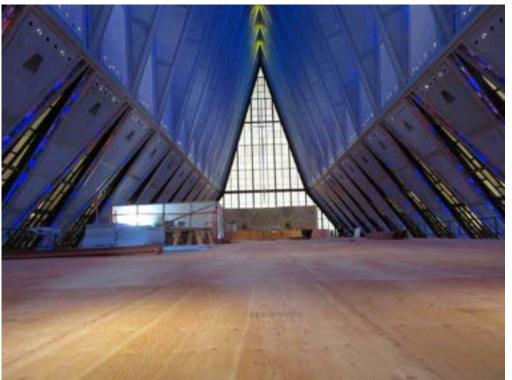








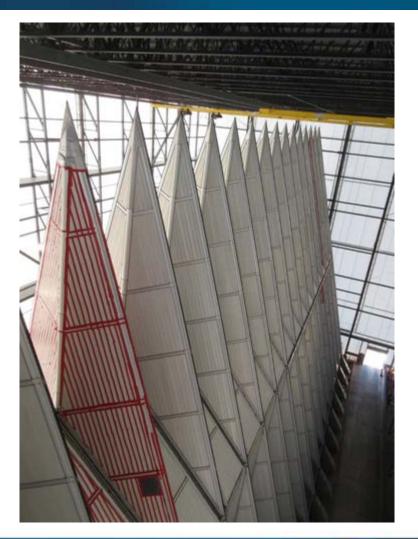




































Thank You

Bryan Rouse brouse@wje.com 312.372.0555

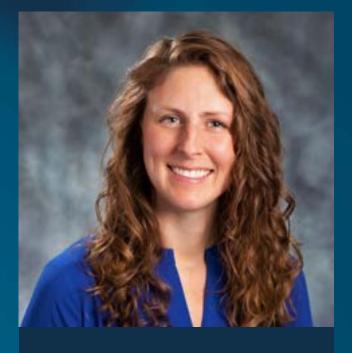
Emily Ryba eryba@wje.com 303.914.4300



Bryan Rouse, AIA

Associate Principal

WJE



Emily Ryba Associate III WJE

