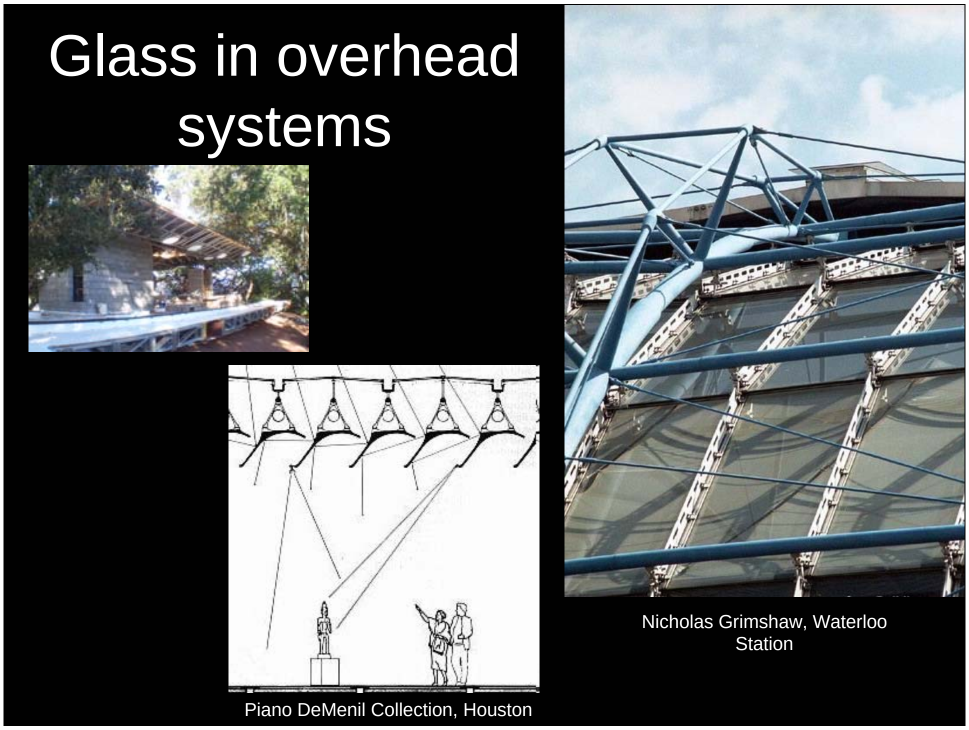


Introduction to use of glass in building skin applications. Presents glass support concepts and design of these as a process, includes issues of water/weather intrusion, movement, lighting and heat gain/loss, among others. Codes relevant: Florid Building Code Chapter 24, glass and glazing; Steel; Concrete. 0800 Glass information www.ppg.com, 0500 Metals, 0300 Concrete.

Summary: solving material/connection issues in overhead systems, changing geometry systems, thermal gain and lighting conditions.

Material/specification divisions (CSI format):

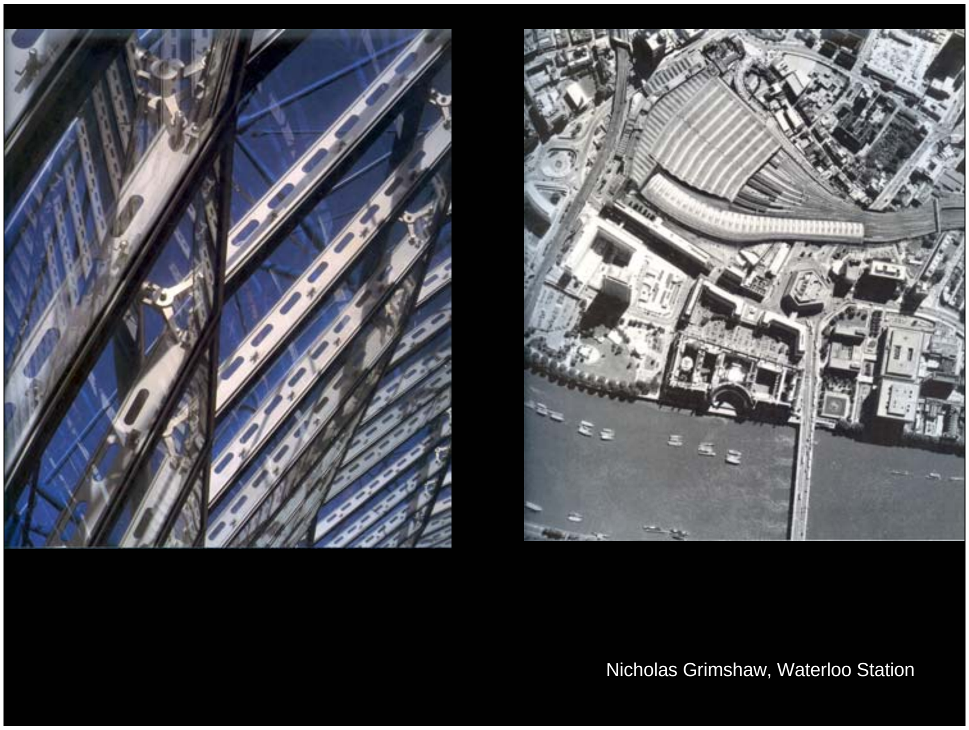
0300Concrete DeMenil overhead louvers

0500Metals, aluminum, steel sections, steel castings (sand casting), stainless casting (lost wax).

0700Weatherproofing, gasket systems for glazing previously on 6330 project as well.

0800 Glass & Glazing systems.

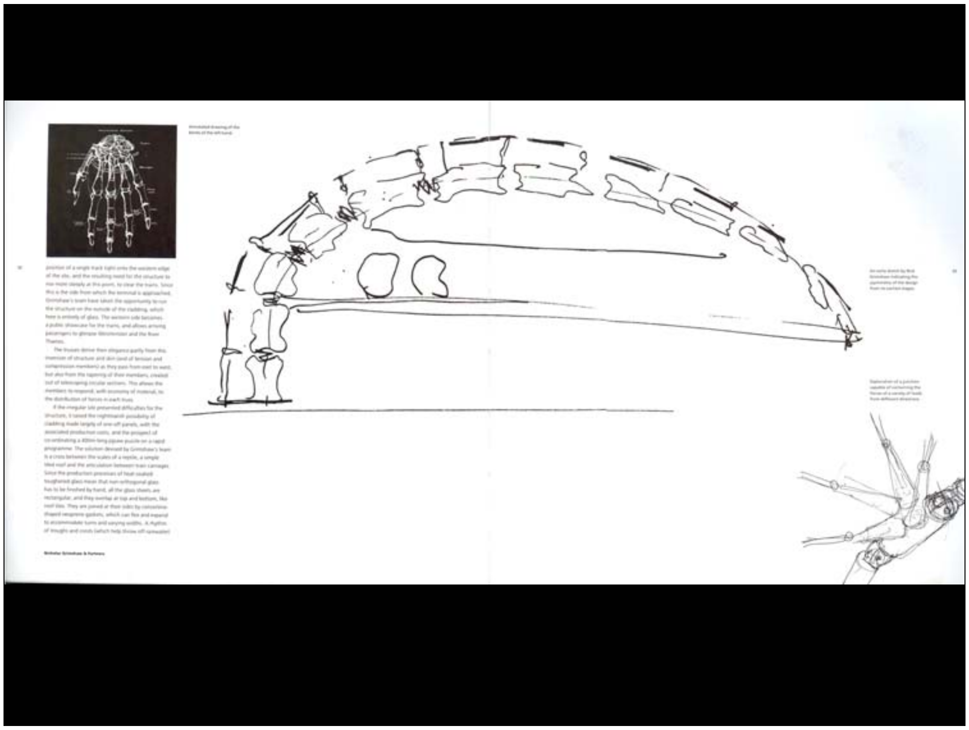
0900Finishes, paint and prep work on steel, concrete finishing (paint)



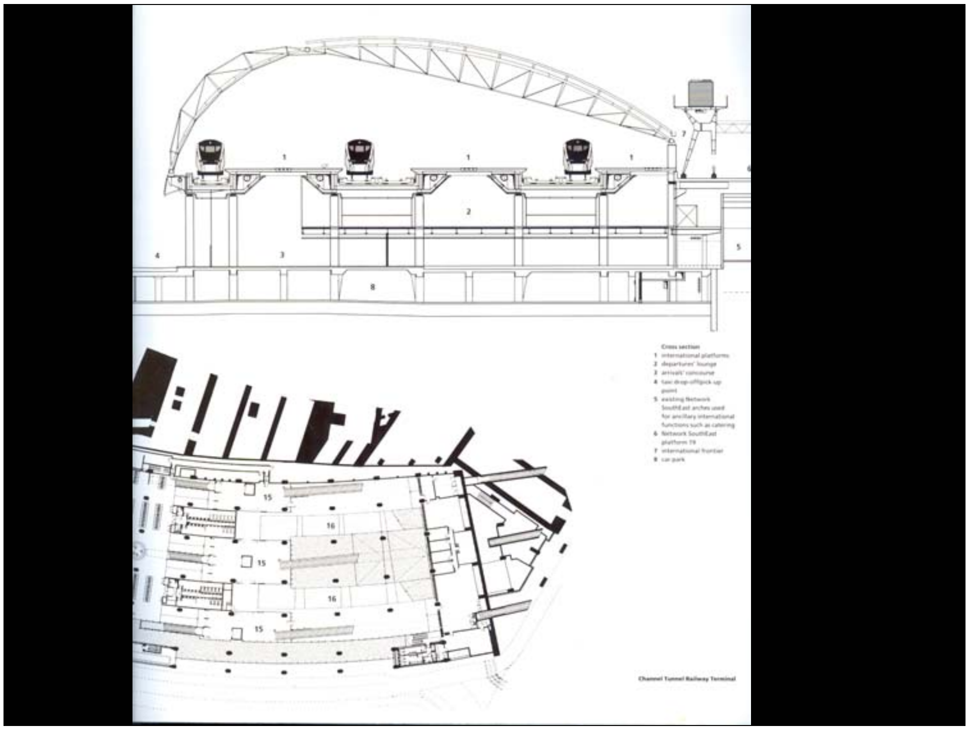
Nicholas Grimshaw, Waterloo Station

Gemetry is site driven. Need for natural light in space.

Amorphic shape presents a challenge because of glass panels. Would require many different sizes (2000+). Need a system that allows for slight angle variations and size variations required due to 'scale' like nature of overlapping skin.



Design concept. The conceptual sketch. First step to get ideas from realm of imagination to reality. Arch over space in an asymmetrical way to accommodate trains along the western edge.



Plan and section drawings develop the sketch further and define geometries, systems, and materials. 3 hinged arch provides a very large span and when done in steel, it can be very lightweight and allow for natural light system. The Western edge (left side) of the arch is glazed to admit natural light and to allow visibility of the trains from the city.

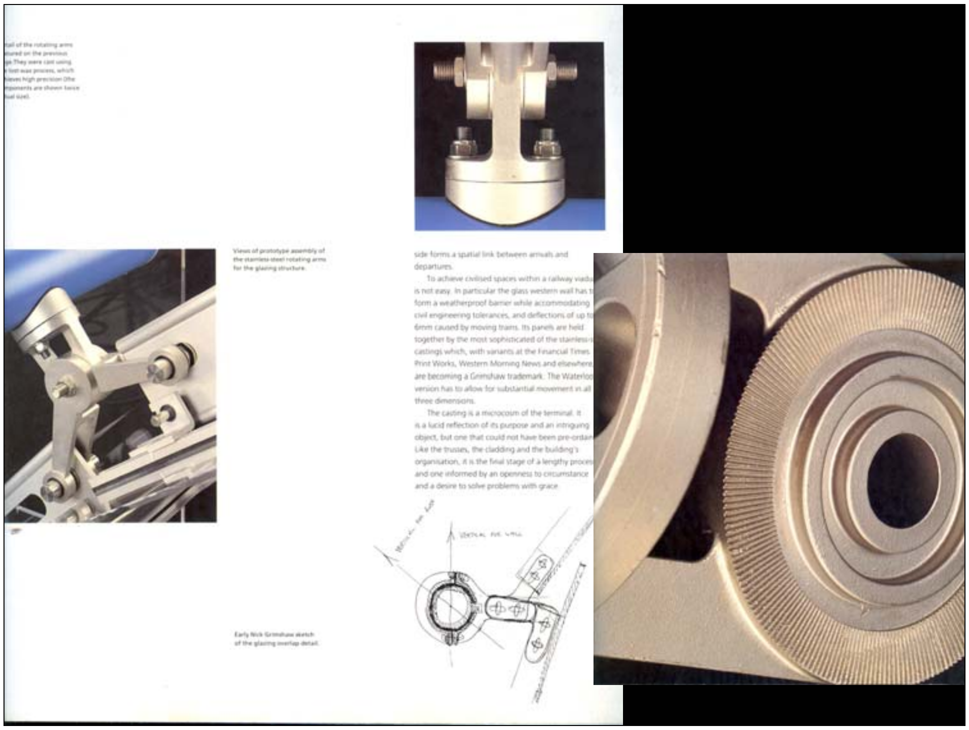
Detail of overhead plane system. Concept is to cover a large area with a clear-span open structure to house transportation space. Namely train boarding space. The glass pieces potentially had to be all custom sized pieces with non-orthogonal pieces. A glass framing system was designed to allow for overlap at top and bottom edges of the glass pieces so that they can all be straight rectangular, facilitating rapid production and installation speeds. In addition to the overlapping, the system must accommodate excessive deflections due to wind and the rapid approach and departure of the drains.


Owing to the curvature of the Waterloo Viaduct and the spread of the track alignment, the roof geometry would have required 2000 sizes of glass. For ease of construction the glass was standardised and the discrepancies were accommodated at overlapping joints.
Above: various stages of patterns for the lost-wax casting process used for the rotating arms of the overlapping junctions.

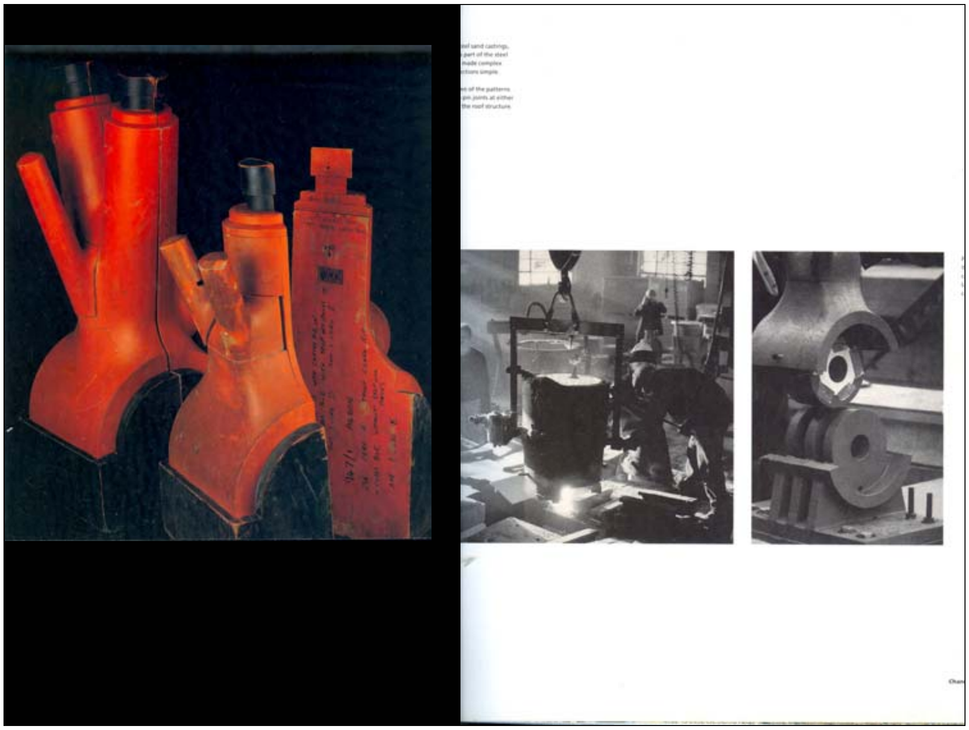
An exploded component sketch by David Kirkland of the assembly, which allows for the degree of flexibility required in the glass roof.

Nicholas Grimshaw & Partners

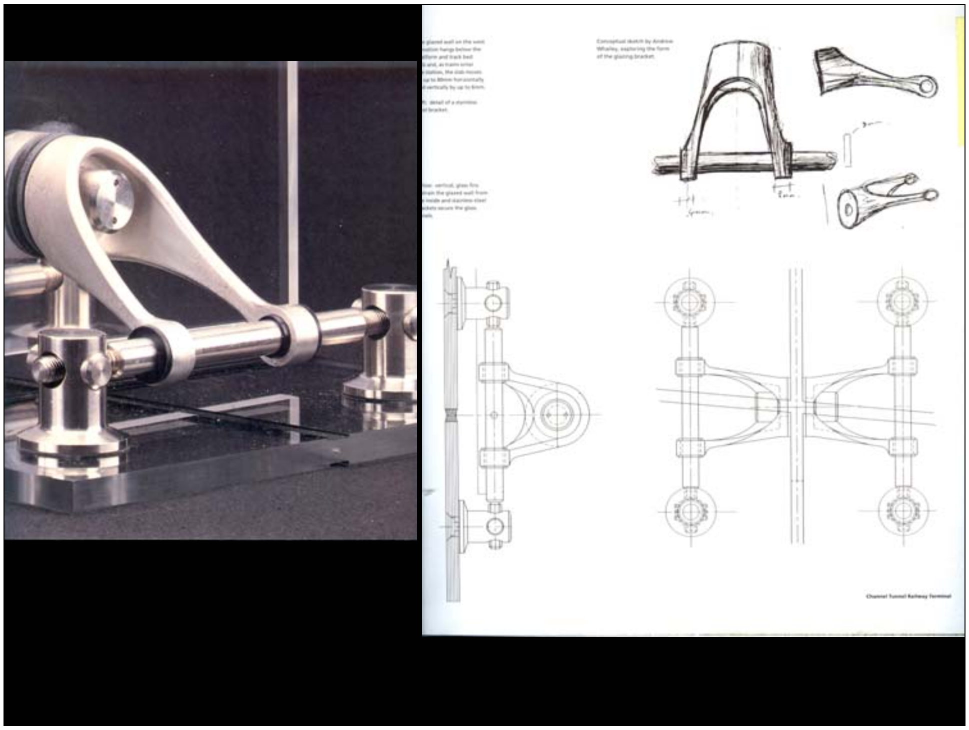
Design of the glazing system. The connector, cast stainless to allow overlap and movement. Gasket is critical, epdm rubber and accordian shape to expand, contract, and change shape with deflection.



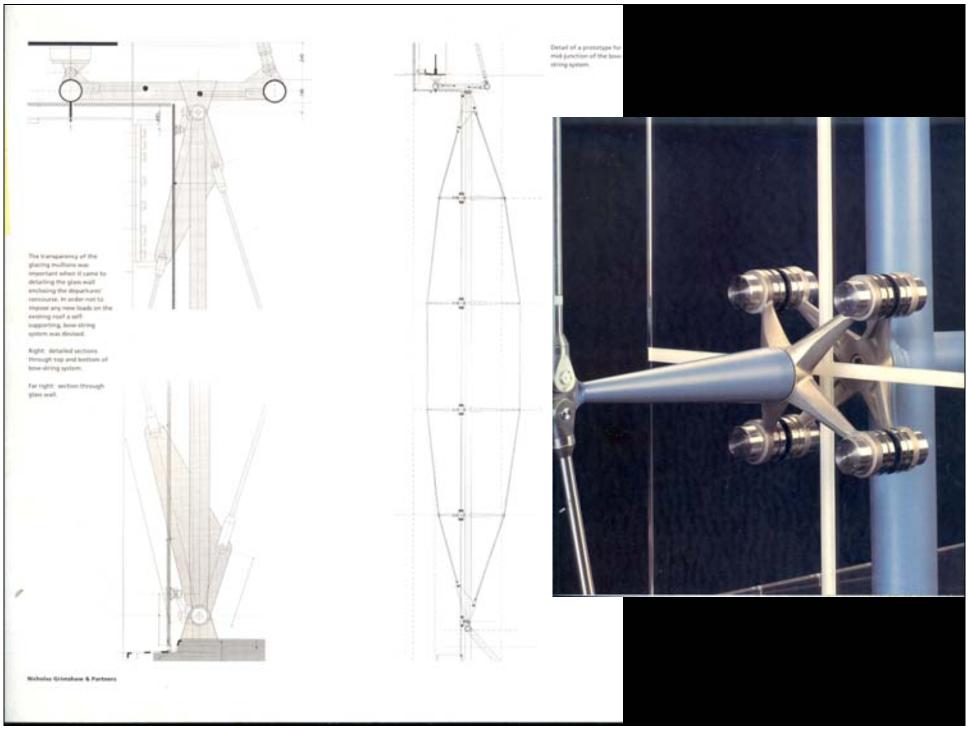
Casting adjustable for differing angles. SS pins in ends allow slip and lateral movement however restricted and limited.



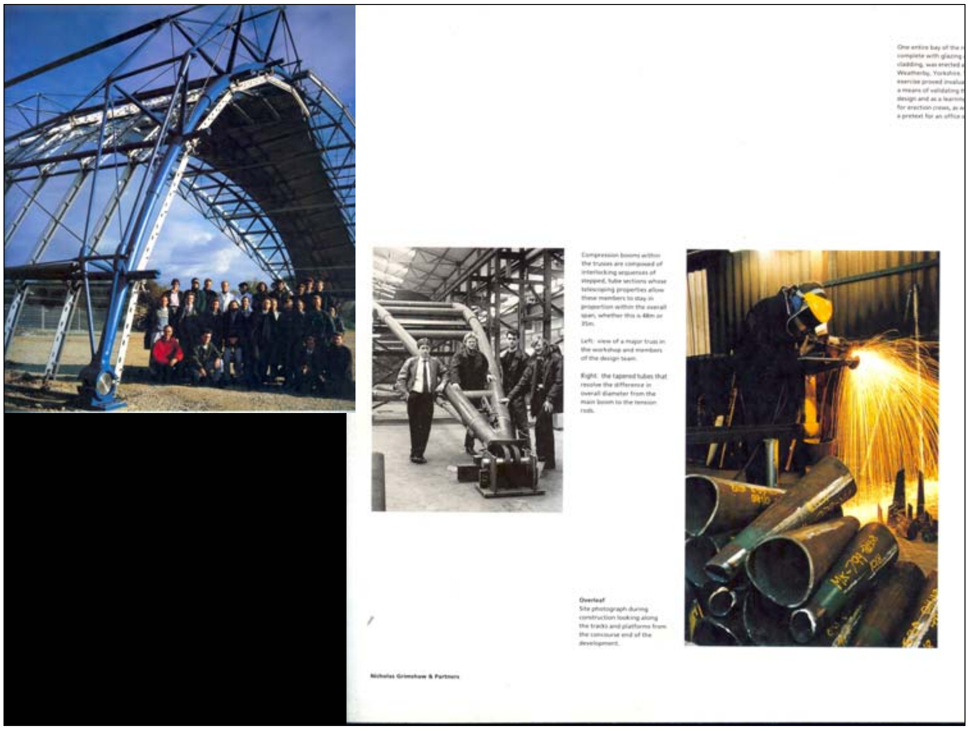
Castings for base connection of arches. Efficiency of material and repeatability with sand castings. Provides a true “hinged” arch.



Glass connectors allowing movement due to trains. Sand castings for production, Stainless steel for durability. Note the gasket and bushings (likely epdm or polypropylene) to allow for movement.



Castings once again designed to allow for restrained movements with the glass systems. This system uses a truss system made of rods and machined connectors to account for positive and negative pressures on the glass.

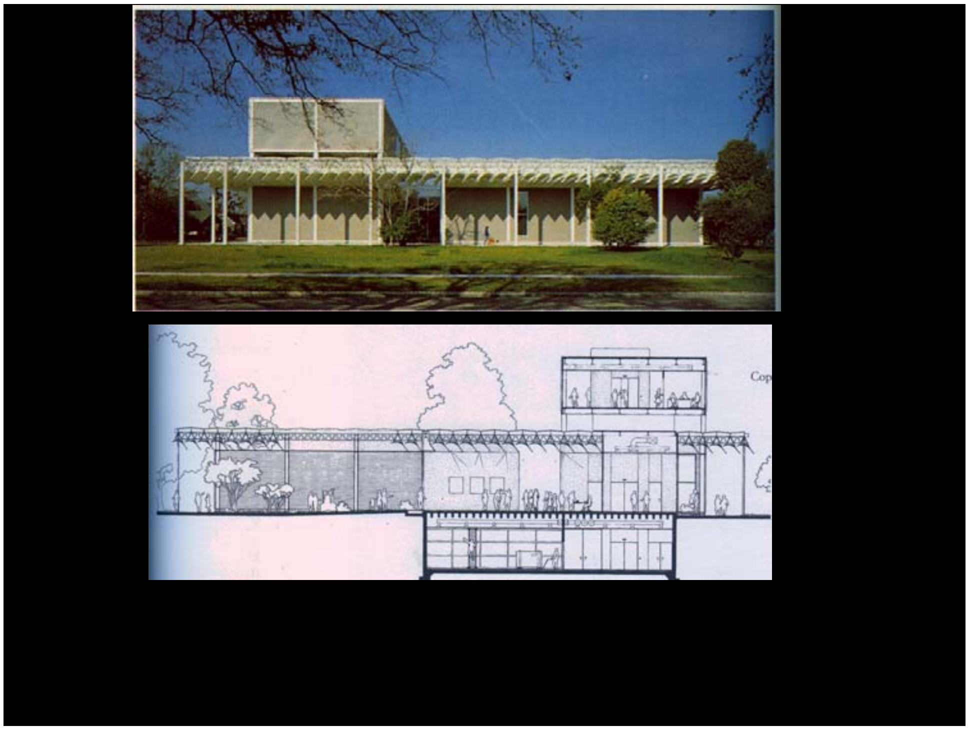


The mock up. The system is assembled with a pilot crew, closely with the design team to both learn how the system works and to develop the assembly method with the construction crew.

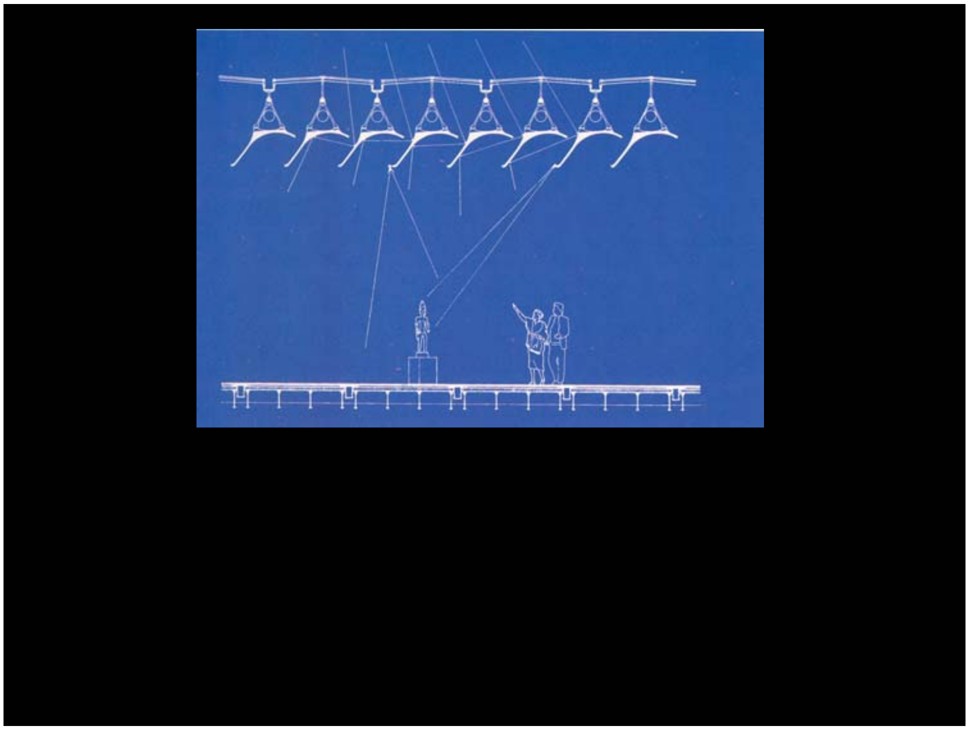
End result, the uniform light with an undulating quality. Large, clear span that is weather tight but can move with deflections imparted by the moving trains.

Renzo Piano DeMenil Collection, Houston, TX

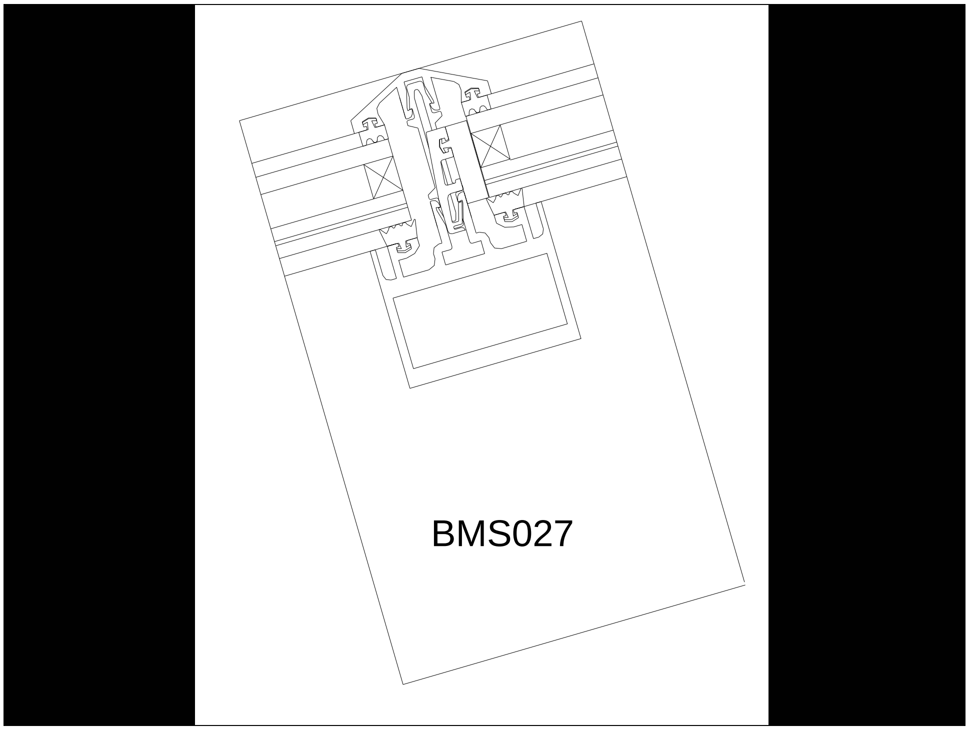
Piano and the overhead glass plane. Overhead plane as light/heat regulator. Materials and details become critical. Costs, how to control. Light becomes the critical design driver because of the collection of artwork and its sensitive nature to UV light. The Owner of the collection wanted natural light and this drove the conceptual and calculation development of the overhead system of deflected natural light through a glass plane.



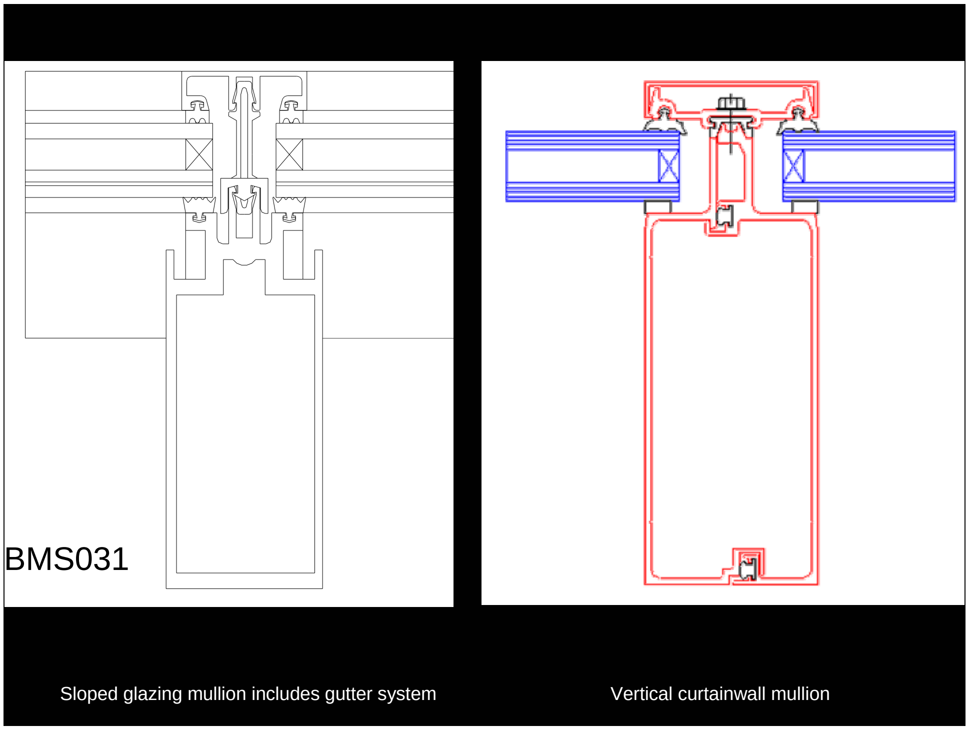
Layout of spaces as a “museum village”. A series of connected spaces that have different characters and functions. The light is the connector and the link to the outside.



Development of the concept sketch and the beginning of the calculations of diffusion. Note the glass system above the diffusers. A series of dual sloped planes with gutter troughs at the valleys to take the water away. System is likely a standard aluminum sloped glazing system like that by Vistawall. Ref: www.vistawall.com. The design challenge is to make the supporting structure between the concrete deflector “leaves” and the glass system light and delicate in order to minimize interference with the light.

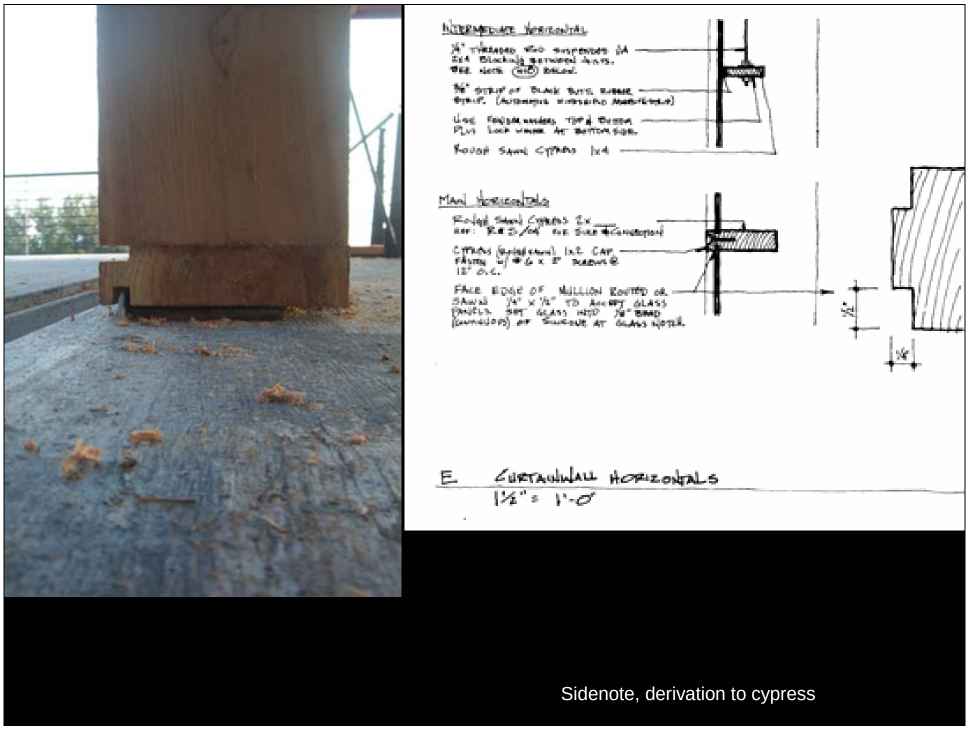


Typ. Transverse, sloped glazing mullion. note, the integral "gutter" slot in the aluminum extrusion just below the glass. This channels any water that may get past the 2 layers of gaskets over to the longitudinal mullions and out the weep holes at the lower end of the slope.



Left: Longitudinal, sloped mullions of a sloped glazing system. Note the integral “gutter” in the extrusion to channel the water to the lower end of the system to exit at the weep holes.

Right: standard vertical curtainwall pressure bar mullion. Does not have the weep gutter behind the glass. The system is still designed to weep water out the base/sill of the wall but does not require the gutter to keep the water out.



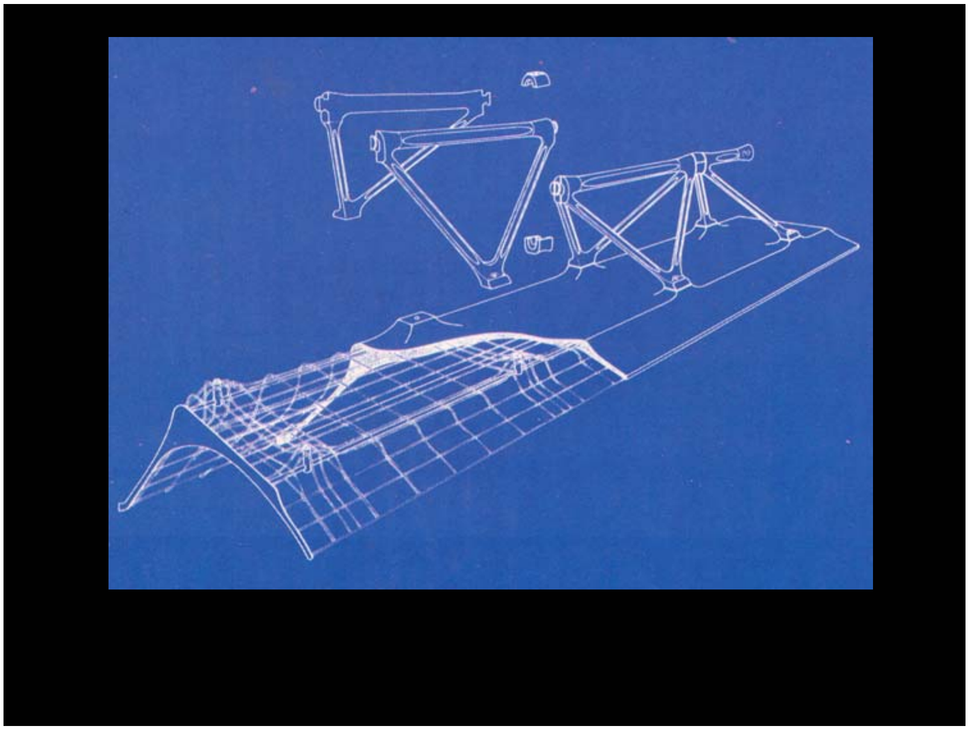
Sidenote, derivation to cypress

Side note: ref: Smolka Pool House and Ruskin House, a Cypress adaptation/derivation of the pressure bar system.

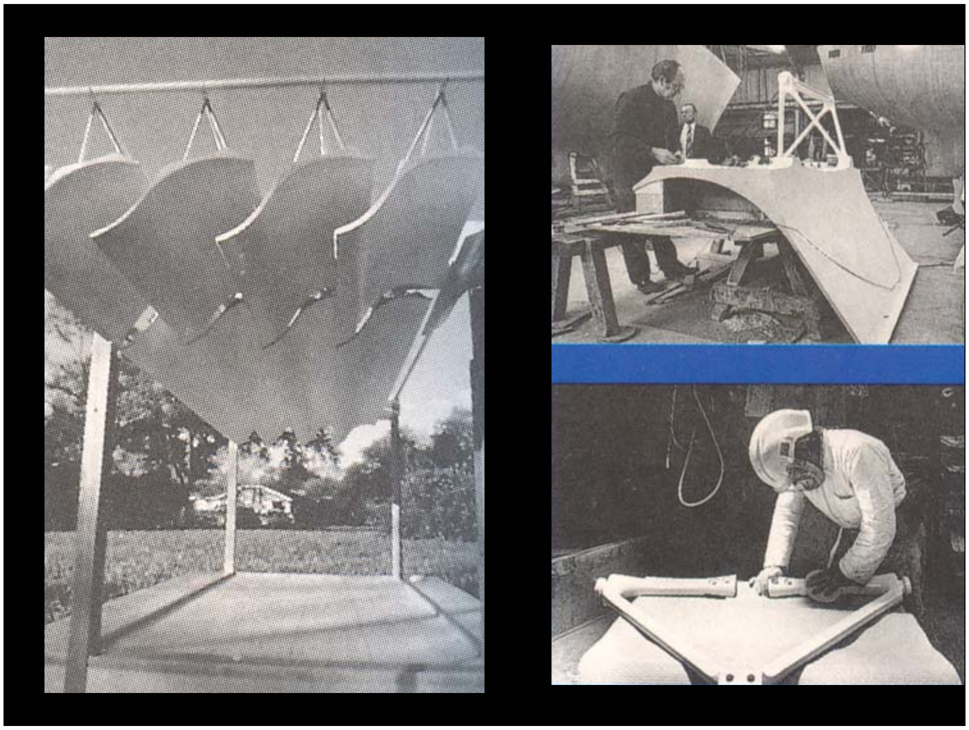
Left: sill plate note the reveal under the sill to keep water from being sucked up into the wood through capillary action. Also note the metal flashing turned up into the lower groove in the cypress and that it does not touch the groove to prevent capillary action once again. The deep notch in the horizontal is for a 1” insulating glass panel. The notch is made on a table saw with a dado blade and may be cut at either ¼’ or 1’ deep to accommodate either a single ¼’ glass lite, or the 1” insulating unit.

Left: The glass panels just set into the notched framing and temporarily held in place with small plywood squares while the continuous silicone bead behind the glass cures.

Right: Finished glass wall with 1x2 caps installed.

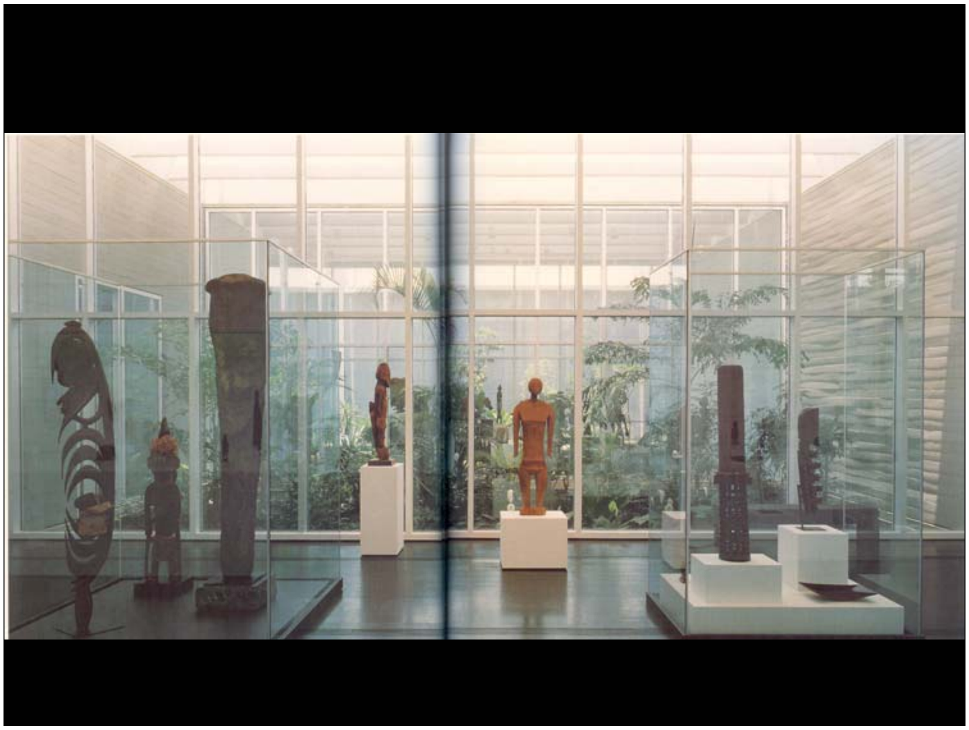


DeMenil: Exploded 3d drawing showing the parts of the system.



Mock ups as part of the testing and design of the systems. The design does not necessarily stop at the paper or when the design drawings are issued but may continue until the project is completed.

The uniformity of the light. The “leaves” are made of concrete and are then painted white. The steel connectors above the leaves are integral to and make a composite beam with the concrete leaves to support the glass system.



The interior garden court seen through a sculpture gallery.

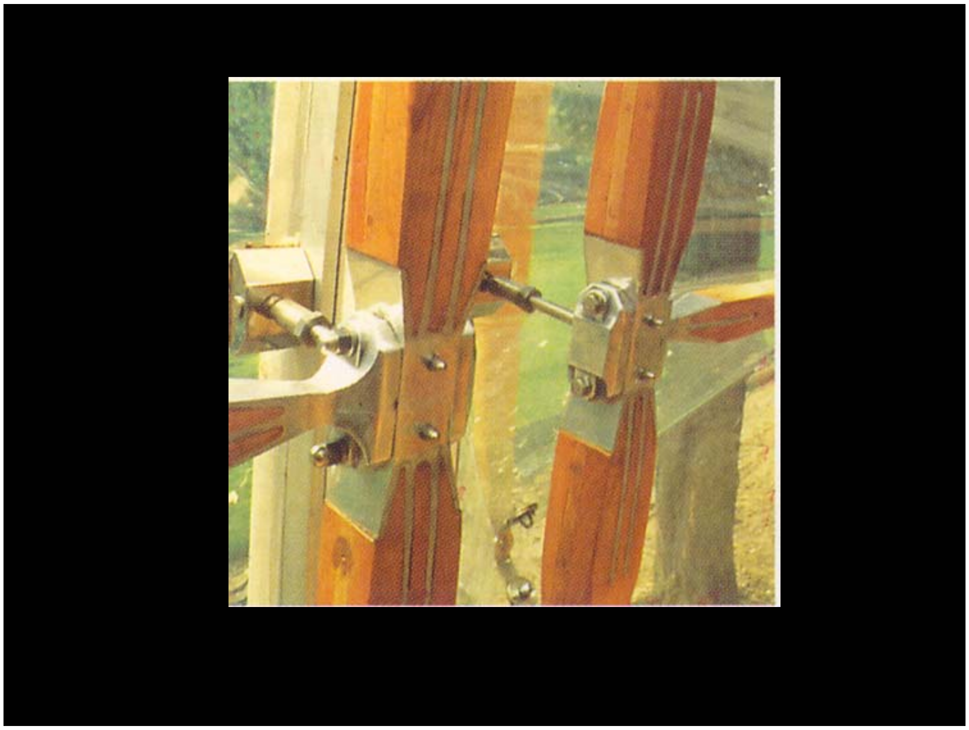
Resultant light quality.

Light quality.

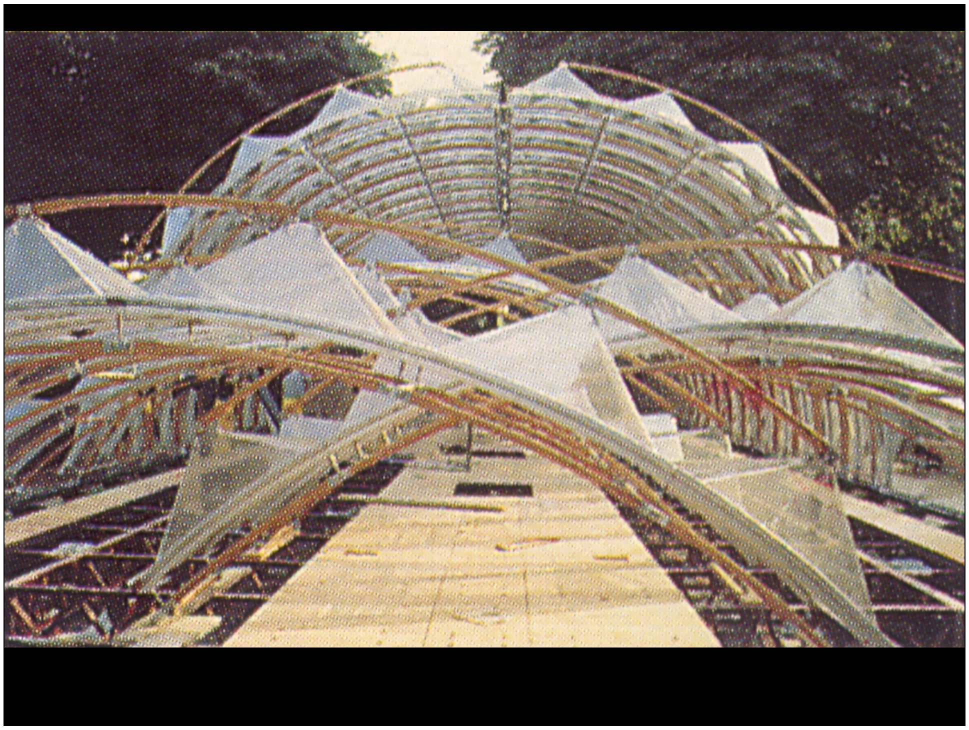
Renzo Piano IBM Traveling Pavillion

Polycarbonate, precast pyramidal units set on wood/aluminum composite arches with polycarbonate being an integral part of the structural integrity of the arch.

Mock up arch to test the process and sequence. The polycarbonate pyramids are joined to the wood and aluminum arch elements with a combination of adhesives and mechanical fasteners.



The wood pieces are laminated of smaller layers and become integral with the aluminum via this sort of finger connection that uses a combination of adhesives (most likely an epoxy) and mechanical connectors (pegs and bolts)



The individual arches in the process of being erected. The structure is in fact a 3 hinged arch where the overall arch is in two halves which are pinned at their base and then together at the peak.

Light quality once again.

Functionality and simplicity.

Aside: the CNC waterjet cut glass panels around the steel truss. The joint is finished by leaving an 1/8" gap between the pieces of glass; ¼" thick glass, 1/8" gap, 2:1 for sealants. The sides of the gap are taped off with masking tape very carefully to the exact edge of the glass on both sides, then silicone is pumped in with sealant gun (caulk gun), then while it is still wet (within about 5 minutes) it must wiped (tooled) smooth (usually just with your finger) and the tape must be removed before the silicone begins to cure and develop a "skin" which will stick to the tape and stretch the wet silicone all over the place and out of the joint. Time is key with the silicone/glass joint that is exposed.