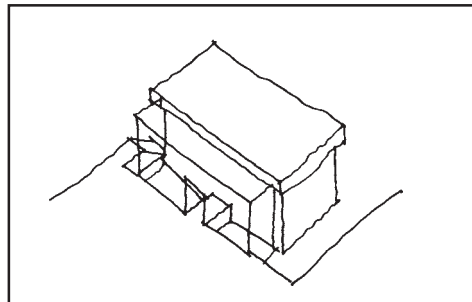


**VOLUMETRIC TRANSPARENCY:
Application of an Improved Double Glass
Facade System to Cowgill Hall, Blacksburg**



Lu Wang

Blacksburg, Virginia
August 21st, 2002

Thesis submitted to the faculty of the
Virginia Polytechnic Institute & State
University in partial fulfillment of the
requirements for the degree of

Master of Architecture

Professor James Jones

Professor William Galloway

Professor Hunter Pittman

Abstract

The initial idea for this thesis involved the design of an addition to Cowgill Hall on the Virginia Tech Campus in Blacksburg, Virginia. This addition, to be constructed with an envelope comprised primarily of glass, would be located on the south side of Cowgill Hall, adjacent to Cowgill Plaza. The all-glass box would add a transparent volume to the existing building, diminishing the barrier between inside and outside. The project would also energize the existing plaza by connecting the activity inside to outside and providing the dynamic reflection of a glass facade. Cowgill Hall would also be given new life by providing a new shared vertical space for dynamic communication and light. Potential problems associated with the all-glass box include high heat loss or gain, glare and noise control. A double envelope system of construction was explored as a means of solving some of these problems and an endeavor on literature review, technical research and design improvement of double glass facade was also made.

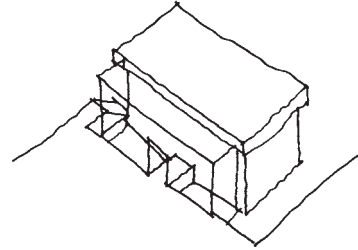
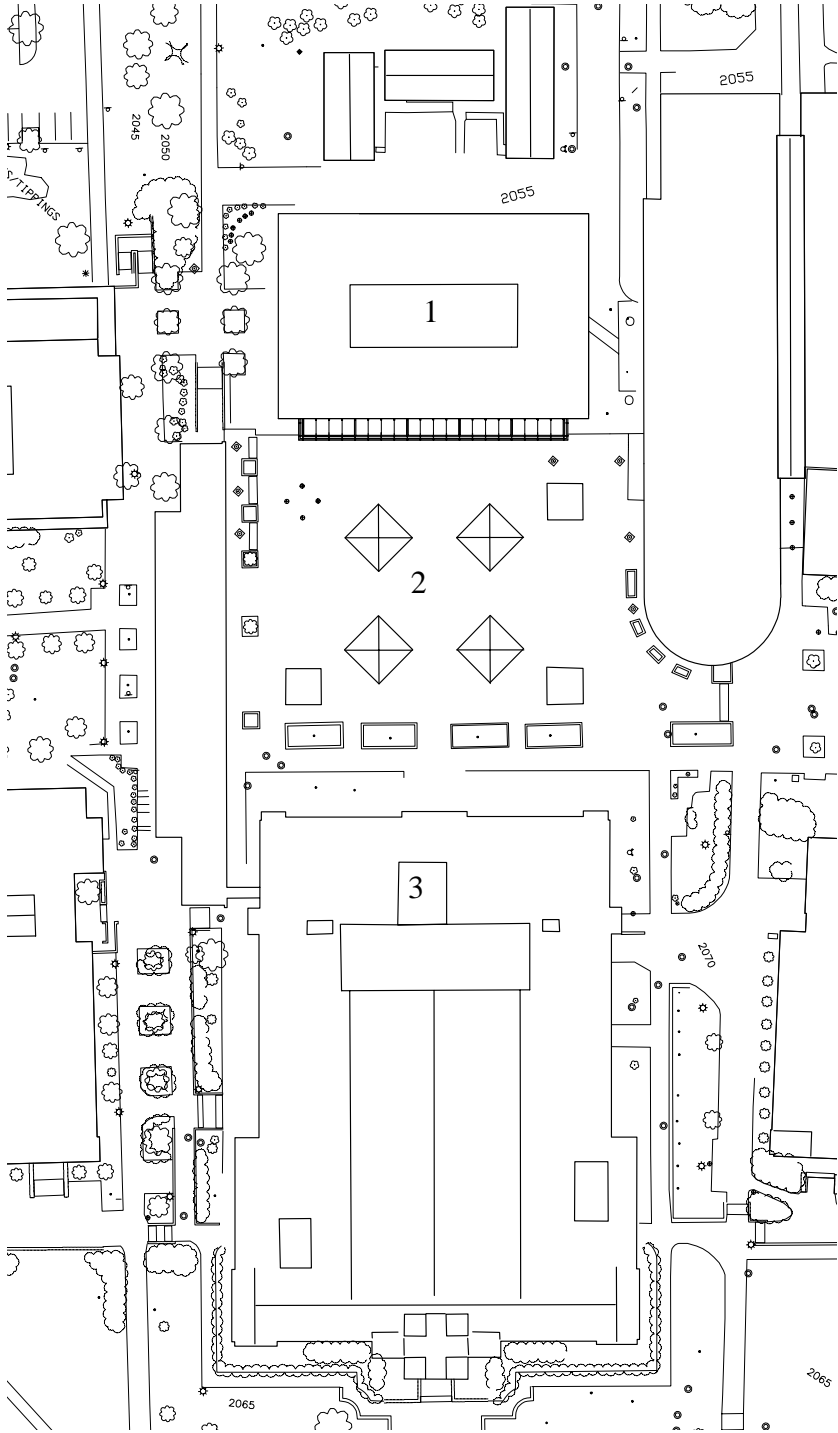



Table of Content

Site	Volume + Transparency	6
	Challenges	7
Structure	Idea Development	8
	Solution	10
	Truss System	12
	Column Clip	14
	Spider & Suspension	16
Transition	Glass meets Ground	18
	Glass meets Roof	20
	Glass meets Existing Corner	22
Space	Floor Plan Rearrangement	24
	Interior	26
	Outdoor	27
Ecology		29
	Definition of double glass facade	30
	Case Study of Double Glass Facade	31
	A closer look at double glass facades, physical characteristics	37
	A closer look at double glass facades, glass property research	42
	Understand Cost Efficient Potential	43
	Key Parameters of Double Glass Façade Properties	44
	Computational Fluid Dynamic	45
	CFD - Model	46
	CFD - Conclusion	48
	Application in Cowgill	50
Conclusion		52
	Reference	53
	Acknowledgment	54
	Vita	55

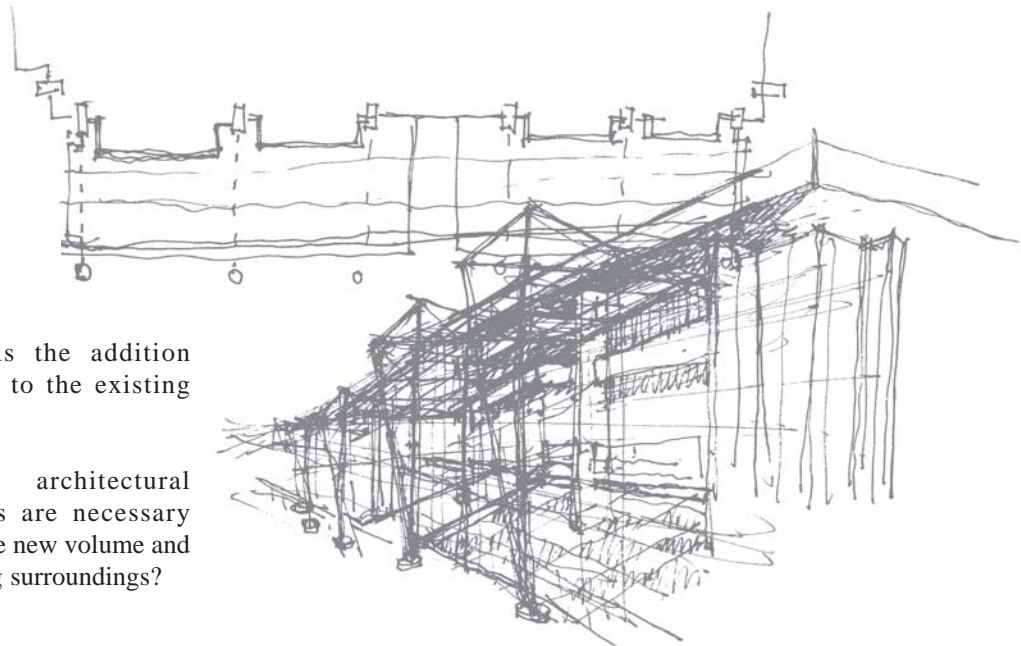
Site

Volume + Transparency



-  NORTH
- 1. Cowgill Hall
- 2. Cowgill Plaza
- 3. Burruss Hall

Site Plan



1. How is the addition connected to the existing structure?
2. What architectural transitions are necessary between the new volume and the existing surroundings?

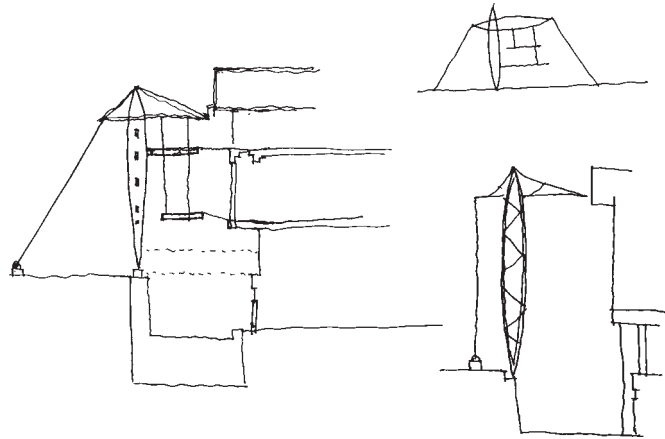
Structure

Idea Development

Structural elegance and Lightness are the primary goals of the atrium addition to achieve volumetric transparency. Several optional structural systems were studied by asking: How are the primary structure, secondary structure and skin as a whole related and what role does each element play toward the goals?

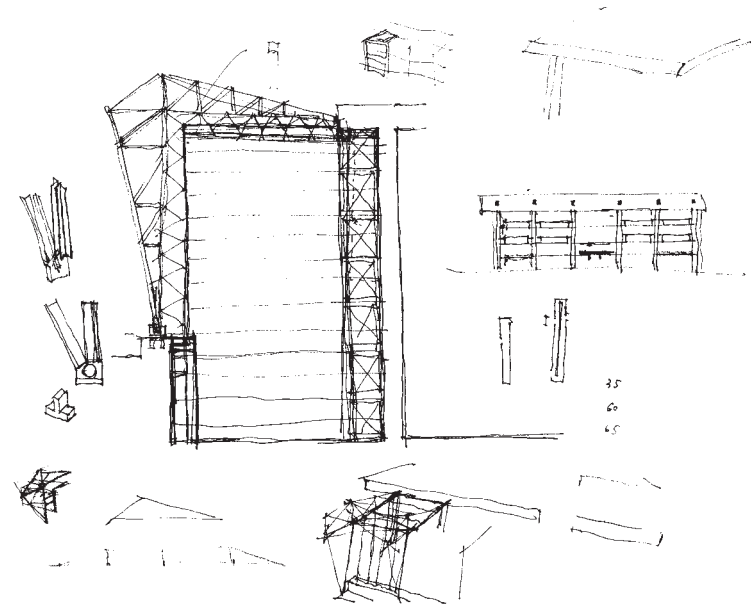
1. Suspension Structural System:

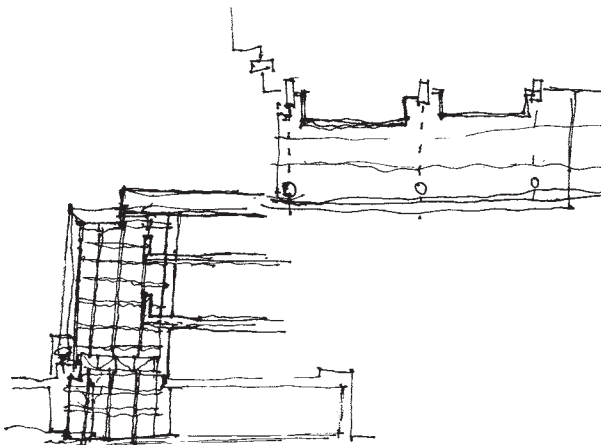
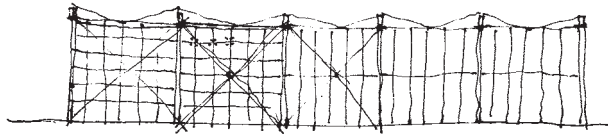
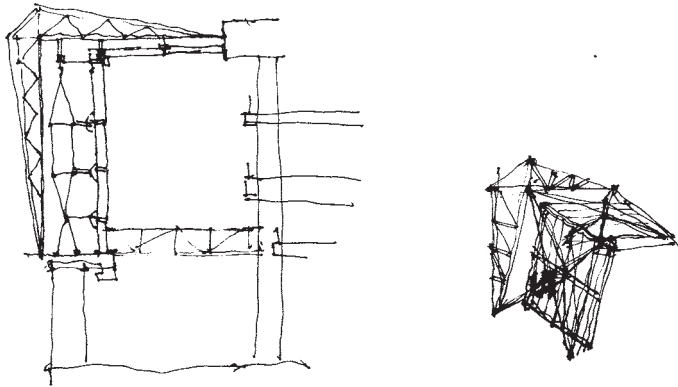
A suspension structural system is very light and elegant. It will also provide the possibility of suspending the floor, which creates spatial benefits by offering usable area at the upper level without intrusive structure at the lower level of the atrium space. However, a steel truss may obstruct and occupy additional space on the plaza, which may make the facade too obtrusive in the plaza. Considering the existing Burchard Hall underneath the plaza, the construction process would be difficult, and the foundations may not be easily accomplished.



2. Truss Structure with Mullion System:

A truss structure may not be as light as a suspension structure, but it is an easier construction method, with fewer conflicts with the existing underground structure. A mullion system can also easily connect the structure and the glass skin. However, the steel truss does not belong to the language of the plaza and the surrounding buildings, which are glass and concrete or stone. A mullion system may also block up to 30% of the facade, causing loss of transparency.





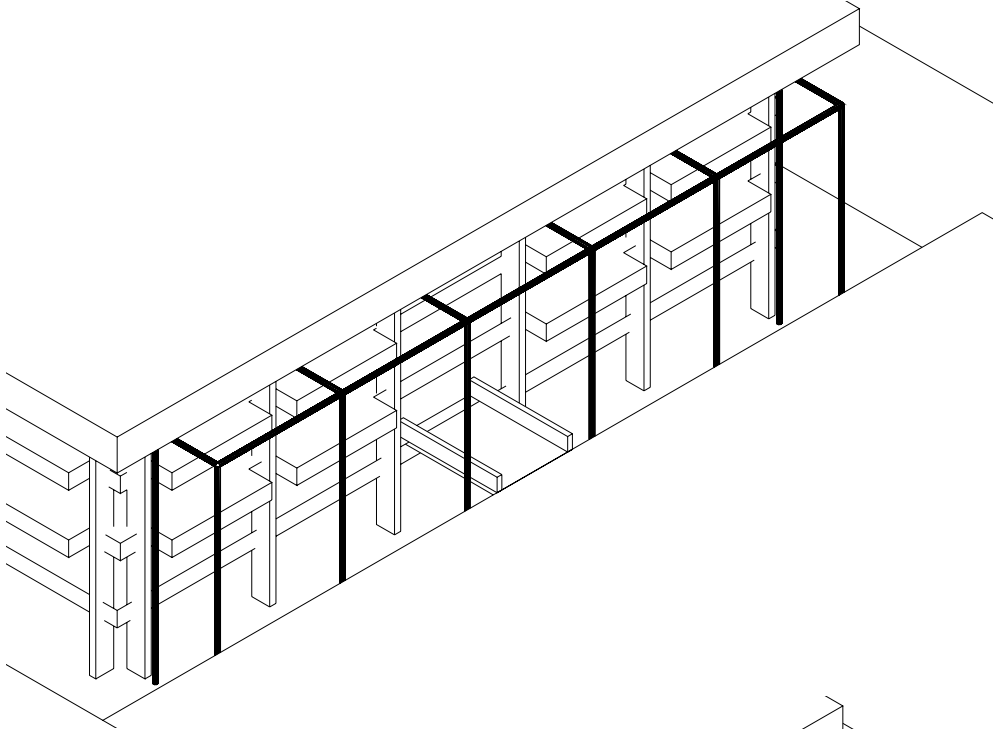
3. Truss Structure with truss suspension system:

Instead of using a mullion system, a truss as a secondary structural system may be used, which can reduce the mass of the secondary structure, thus enhancing transparency. However, in this case, the depth of the steel truss system, plus the secondary truss suspension system, becomes a problem in terms of spatial efficiency because it consumes a relatively large portion of the atrium space.

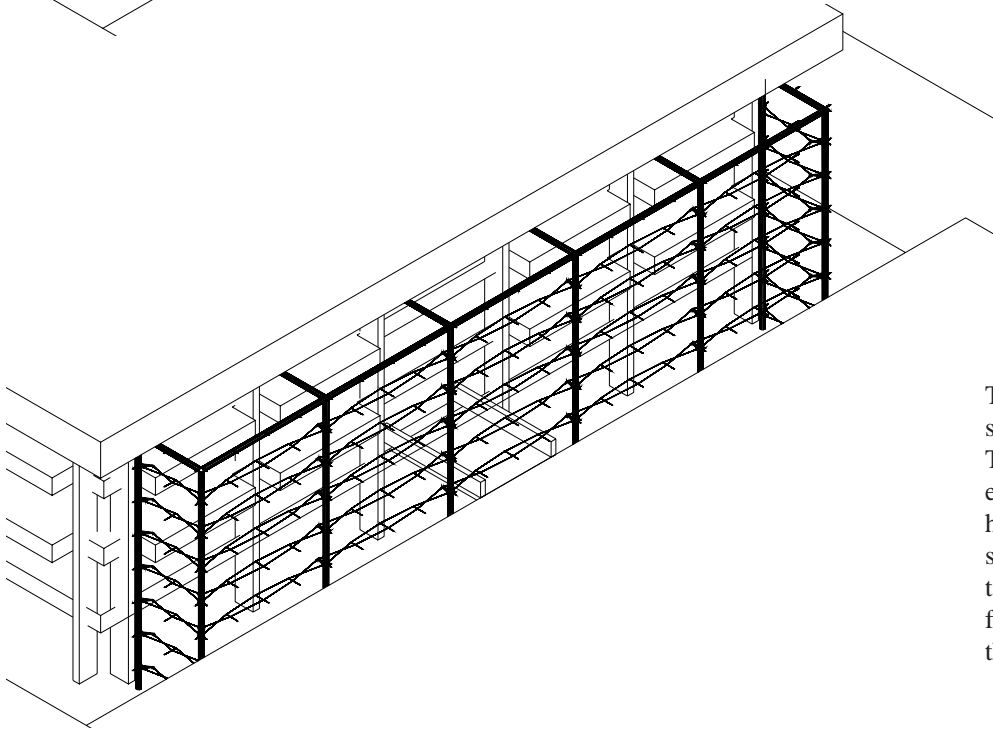
The final solution uses a steel column and beam plus a secondary truss system, which has the best balance of lightness and minimum space usage. The structure is inside, so the facade has a planar appearance to the plaza.

Structure

Solution Steel Column + Truss Suspension System + Spider + Prefabricated Double Glass Unit



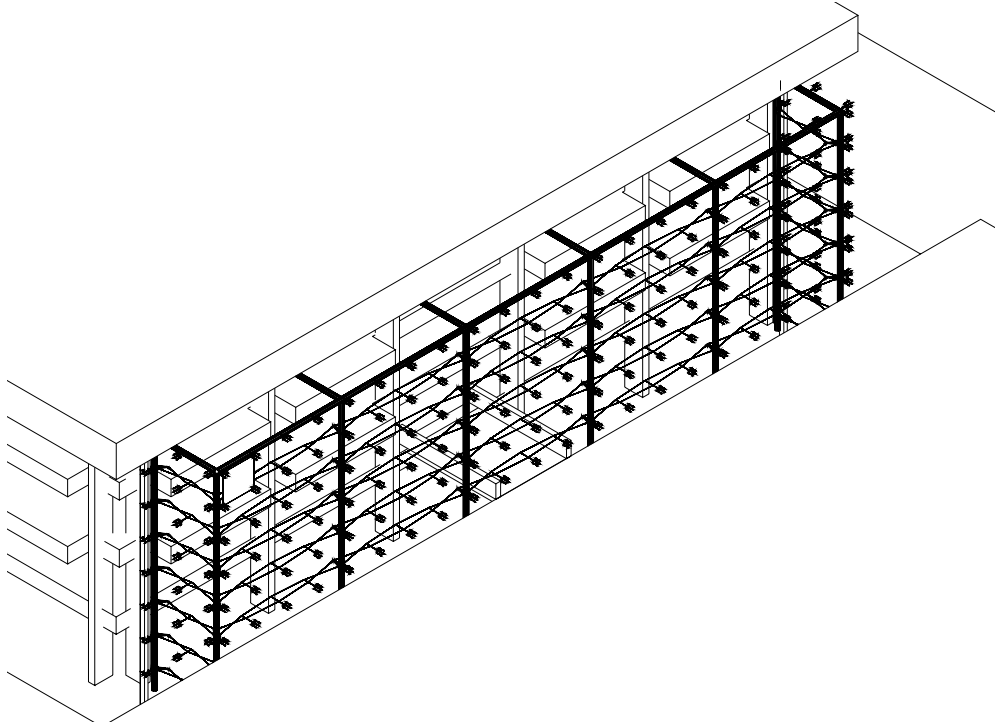
Steel column structure-
The first element in the hierarchy of the structural system.



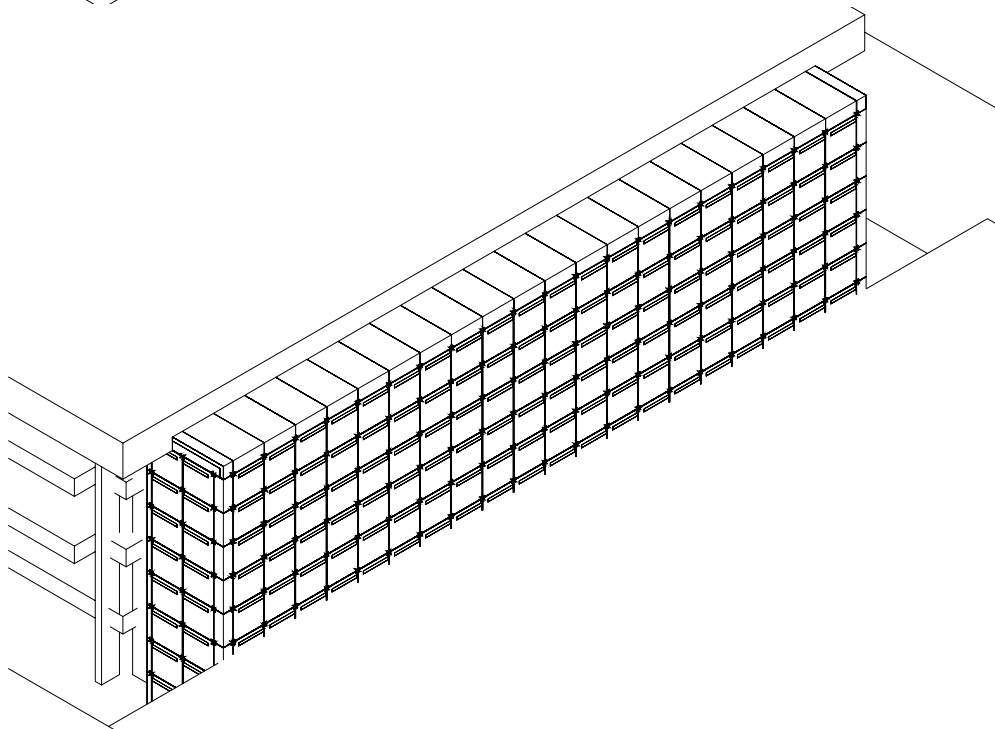
Truss suspension system-
The secondary element in the hierarchy of the structural system, transferring load from the spiders to the columns.

Structure

Steel Column + Truss Suspension System + Spider + Prefabricated Double Glass Unit Solution



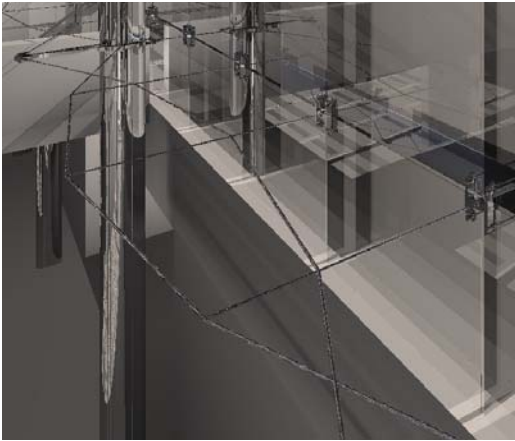
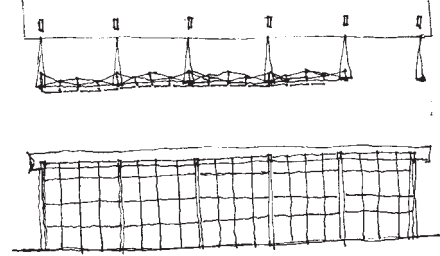
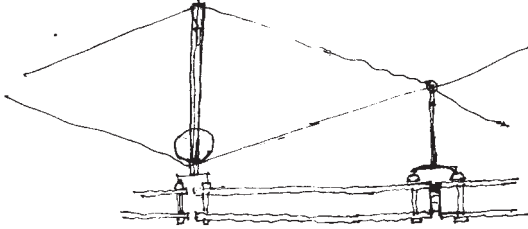
Spider-
The third element
in the hierarchy of
the structure,
attaching the glass
to the truss system.



Prefabricated double
glass unit-
The fourth element
in the hierarchy of
the structure,
attached to the
spider, providing
the enclosure of the
atrium.

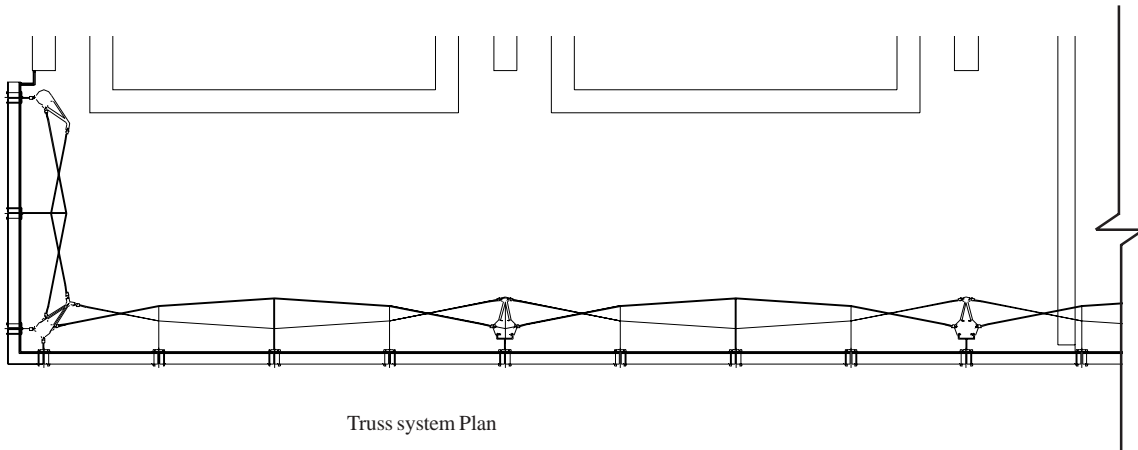
Structure

Truss System



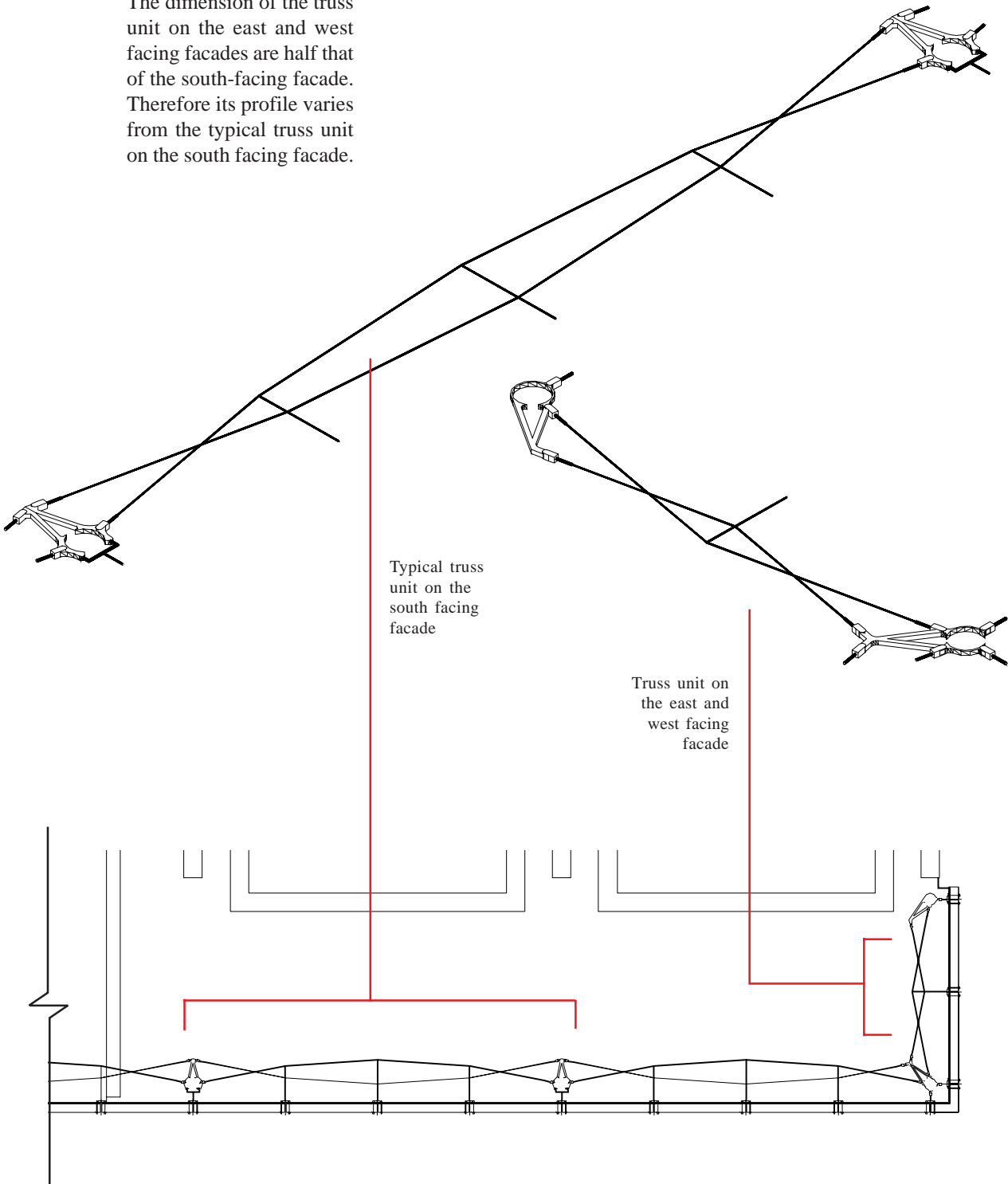
Every truss unit is composed of two pieces of single steel rod. One member primarily resists positive pressure on the glass skin, while the other primarily resists negative pressure.

A truss system is a very light secondary system to support the spiders and glass skin. But it has to have a certain distance between the two members of the truss to hold the horizontal load. In order to save space, the truss system must be tightly integrated with the columns, so they overlap each other in plan rather than occurring as successive layers in the steel truss structure + secondary truss system alternative discussed earlier.



Truss system Plan

The dimension of the truss unit on the east and west facing facades are half that of the south-facing facade. Therefore its profile varies from the typical truss unit on the south facing facade.



Structure

Column Clip



Column clips are used to connect the column and the truss. They are designed to receive the two members of the truss, and grasp the column at the same time. Due to different locations of the columns and different truss types, the column clips need to have three different configurations.

