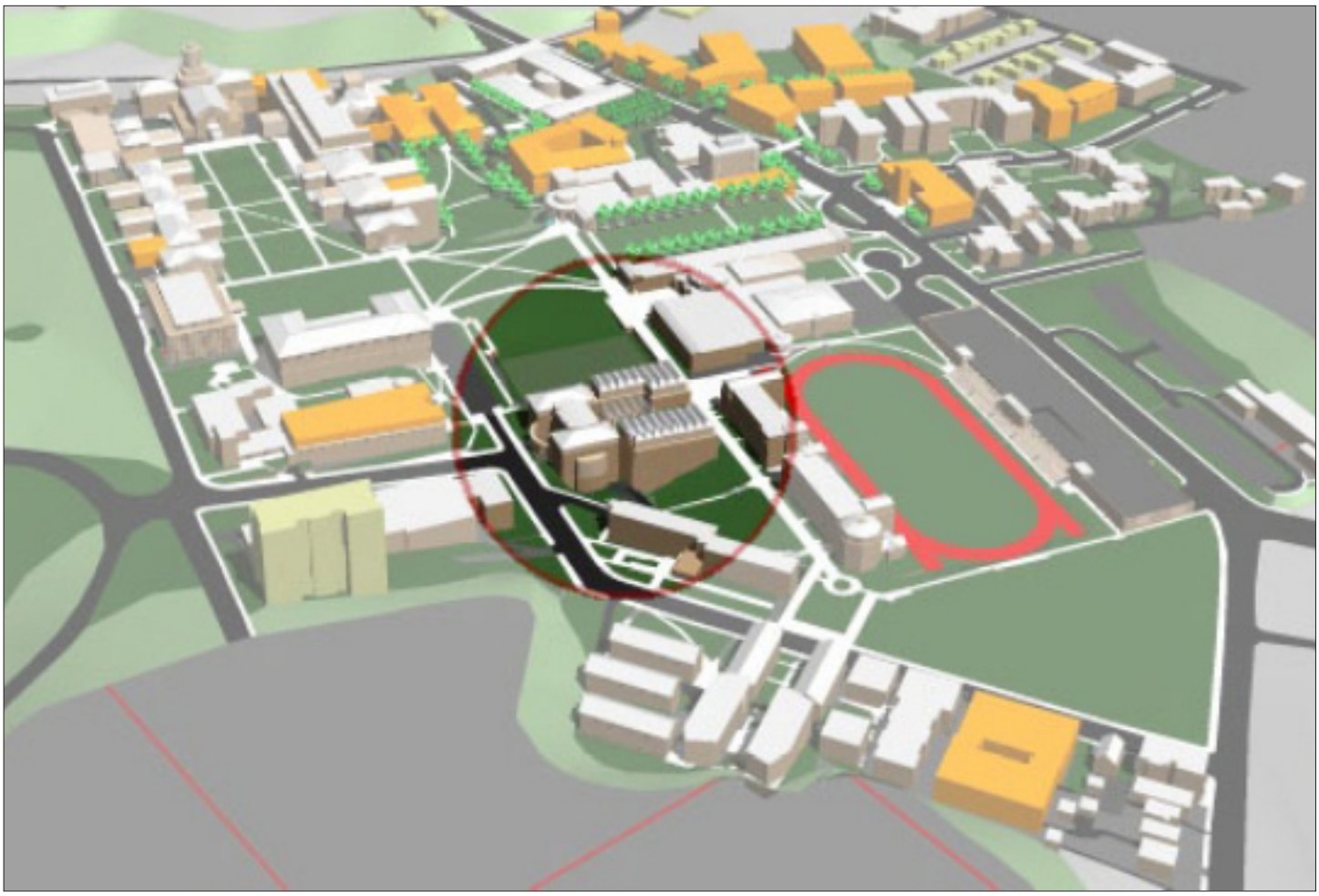
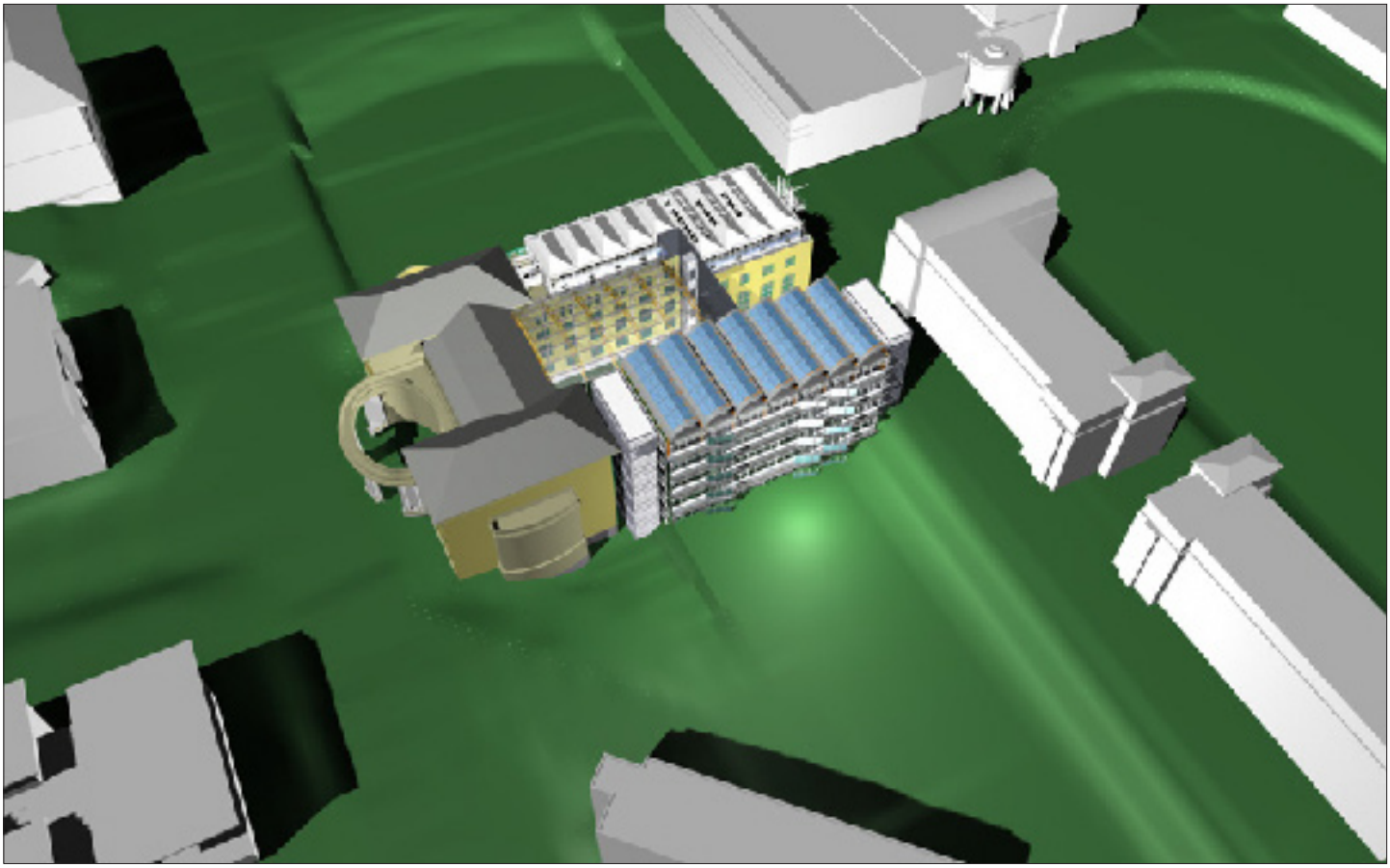


BAPP: BUILDING AS POWER PLANT

INVENTION WORKS

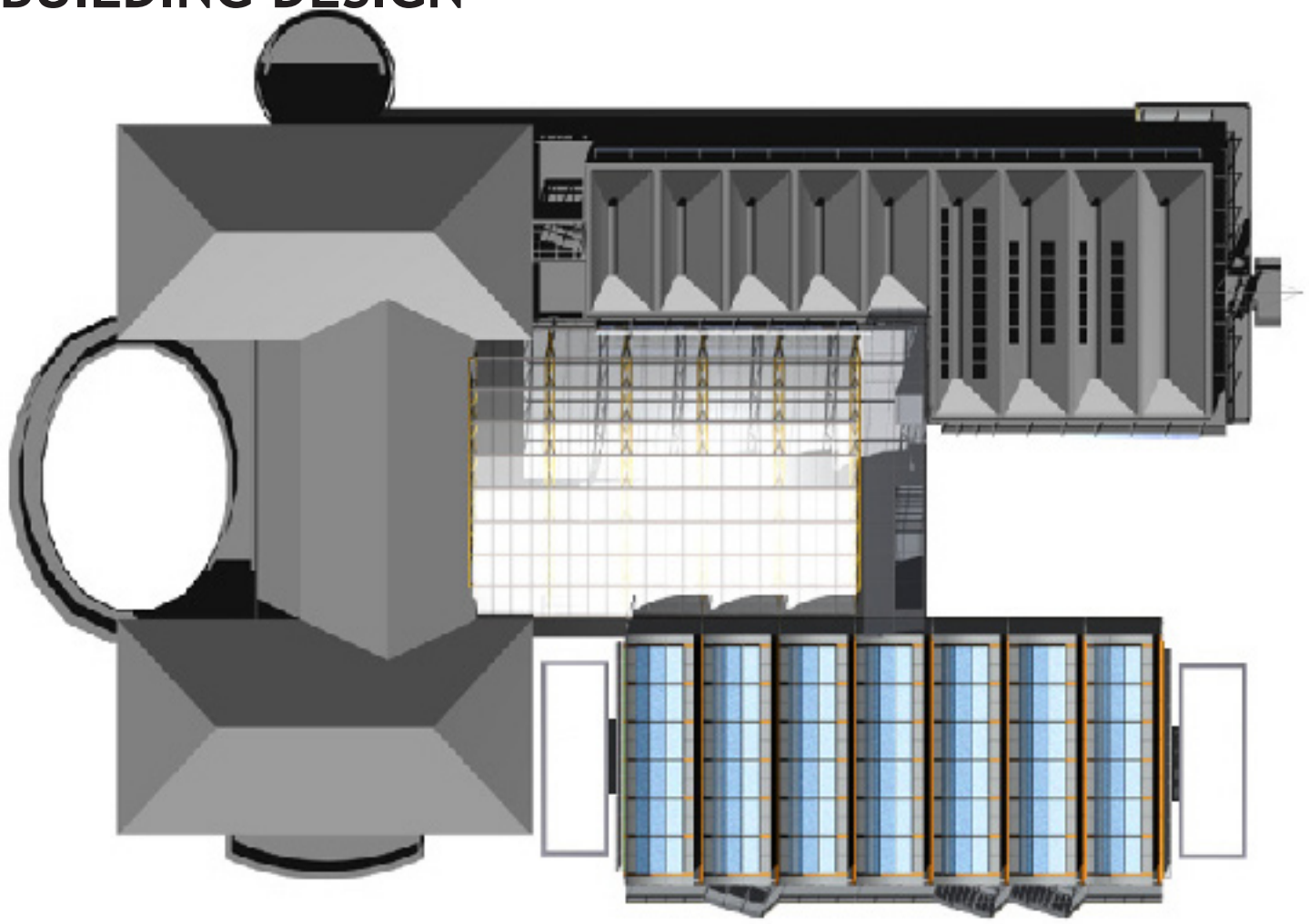
CENTER FOR BUILDING PERFORMANCE AND DIAGNOSTICS
SCHOOL OF ARCHITECTURE
CARNEGIE MELLON UNIVERSITY



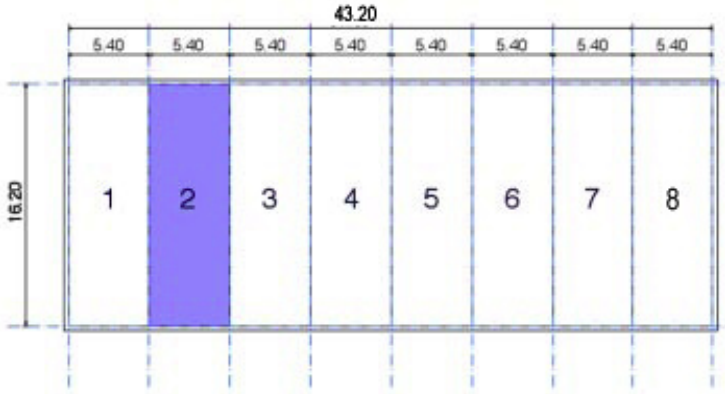
BUILDING DESIGN REQUIREMENTS

- 6 floors, 7,500 square feet each (not including service cores)
- Building's L x W: 43.20m (143.7 ft) by 16.20m (55.12 ft)
- Flexibility for various office layouts, daylight, views and the potential for natural ventilation were goals for this building
- An educational tool as a demonstration of energy efficiency
- It houses classrooms, studios, laboratories, a woodshop, a children's school, and administrative offices
- Underground parking garage for 200 cars
- Built adjacent to an existing historic building, Margaret Morrison Carnegie Hall (MMCH), which is L-shaped and 6 stories
- Connect to MMCH with a 3 story public, central atrium
- The proposed new wing is North-South oriented
- The vertical circulation is designed as modular service cores (bathroom, AHU, PVD closet) that can be plugged into BAPP.

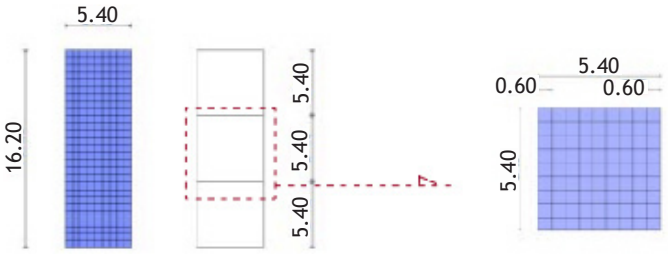
BUILDING DESIGN



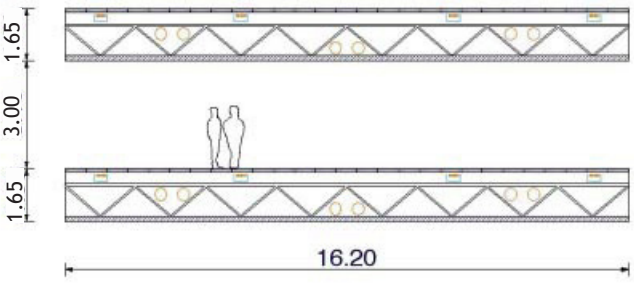
Span:16.20 m (53.15 ft)
Column spacing: 5.40 m (17.72 ft)
Floor Plate: 43.20 m x 16.20 m (143.7 ft x 55.12 ft)
Dimensions of Bay: 5.40 m x 16.20 m (17.72 ft x 55.12 ft)
No. of Bays per Floor: 8
Floor Tiles: 0.60 m x 0.60 m (2 ft x 2 ft)
The floor plan consists of 8 bays



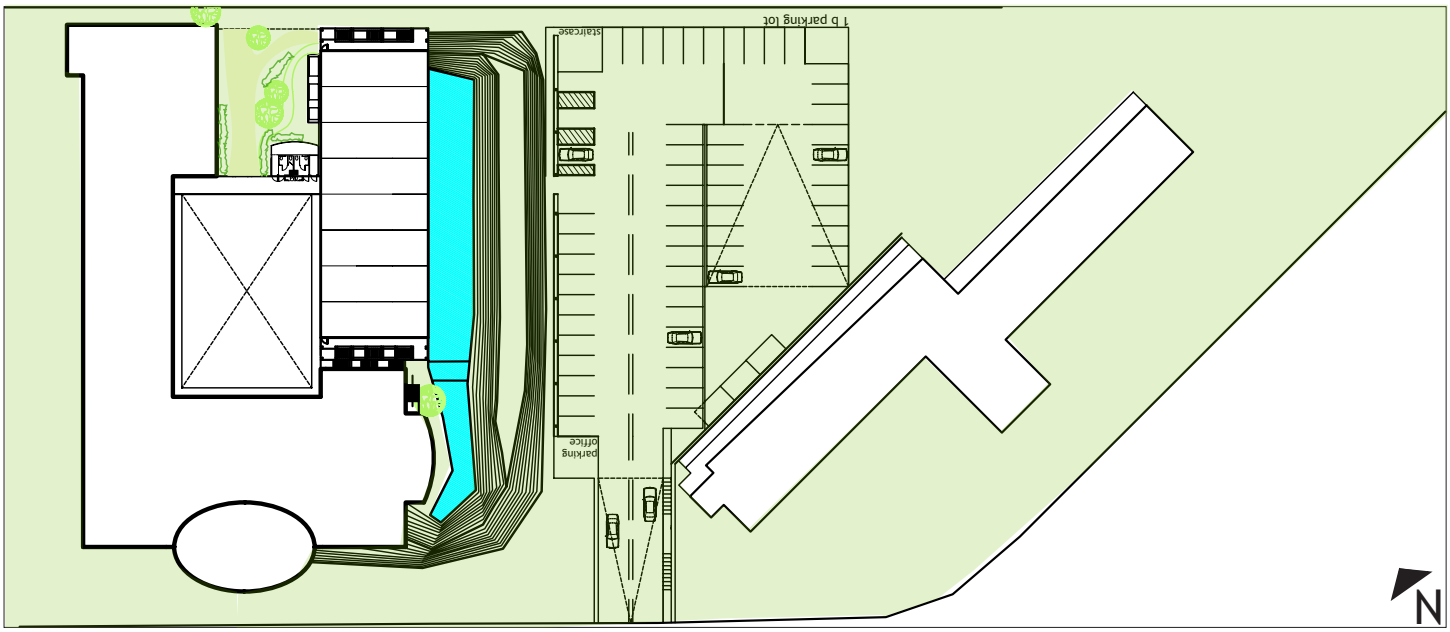
FLOOR TILES

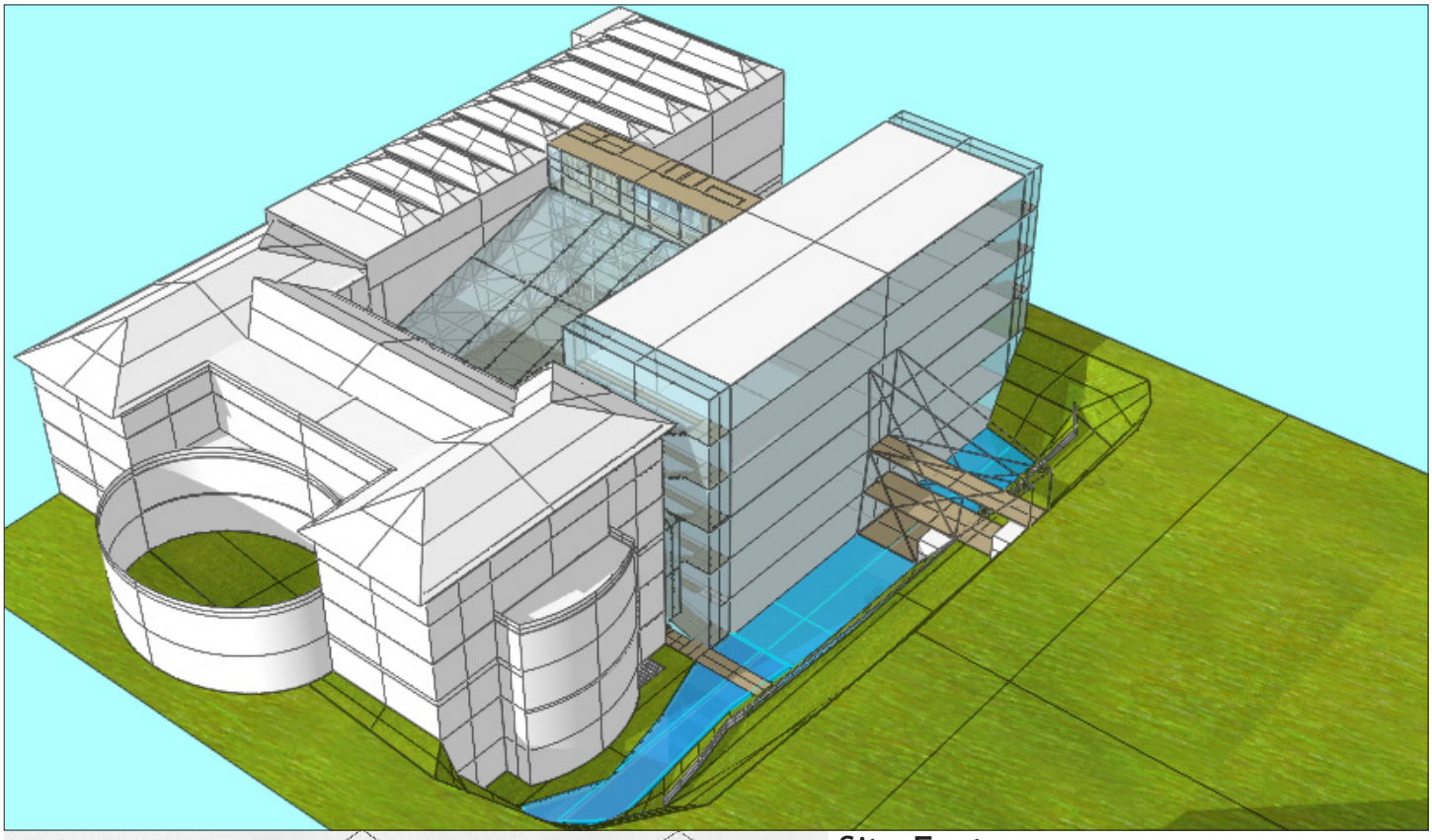


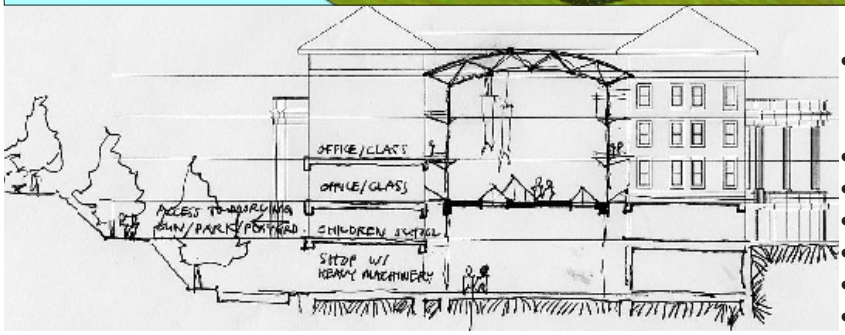
Floor-to-Floor Height: 4.65m (15.25 ft)
Floor-to-Ceiling Height: 3m (9.84 ft)
Raised Floor Plenum: 1.65m (5.41 ft)
Total Building Height: 18.6m (61 ft) above grade (plus roof)



SITE STRATEGIES

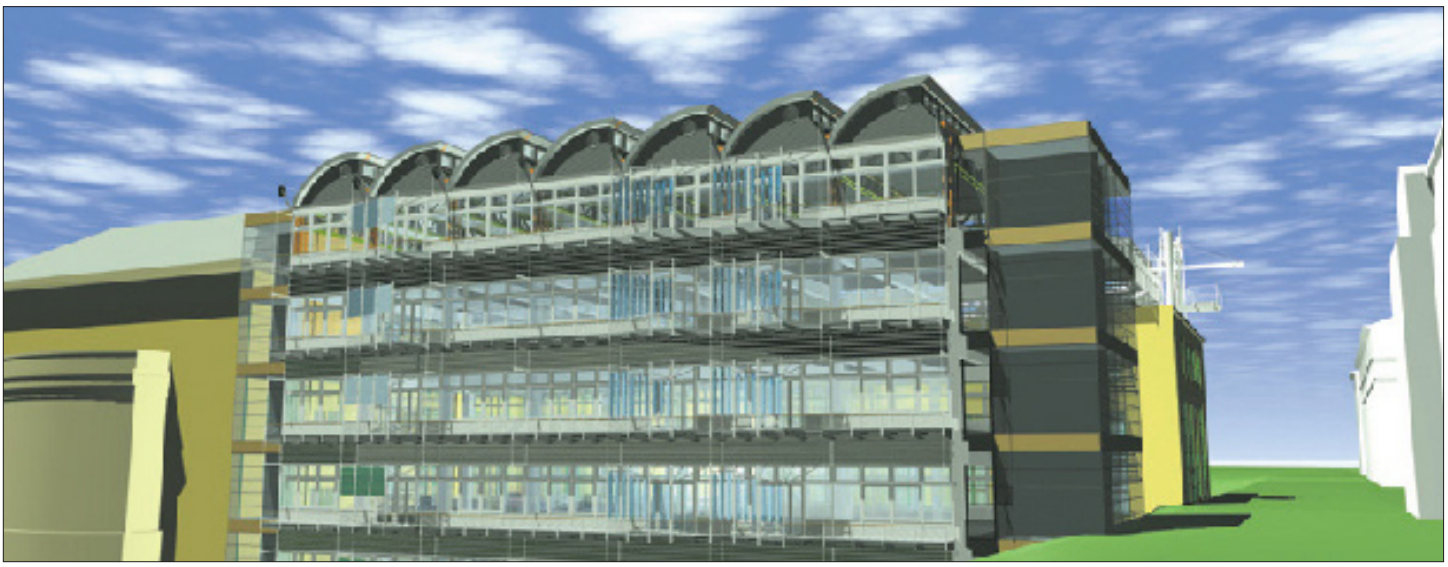


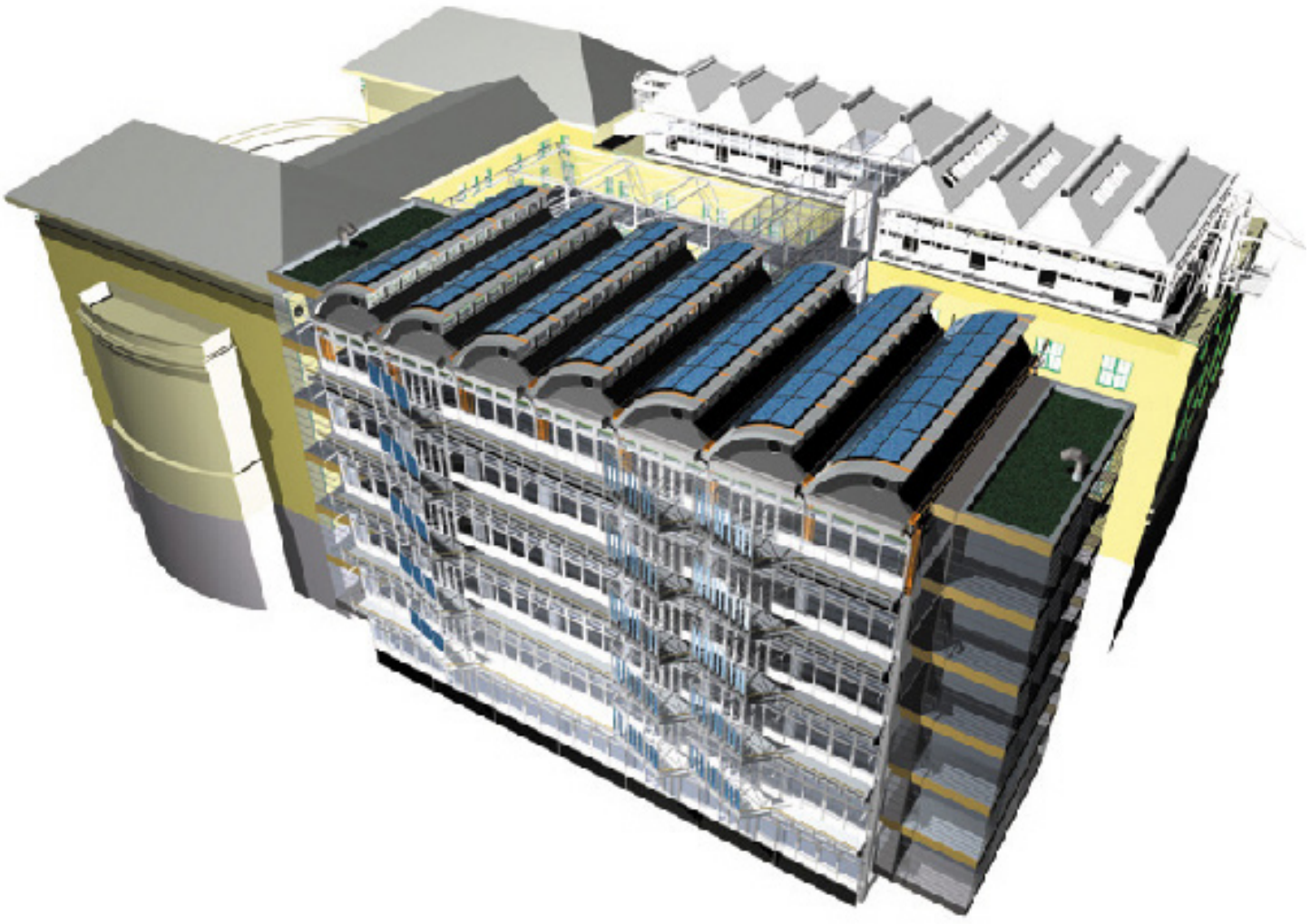


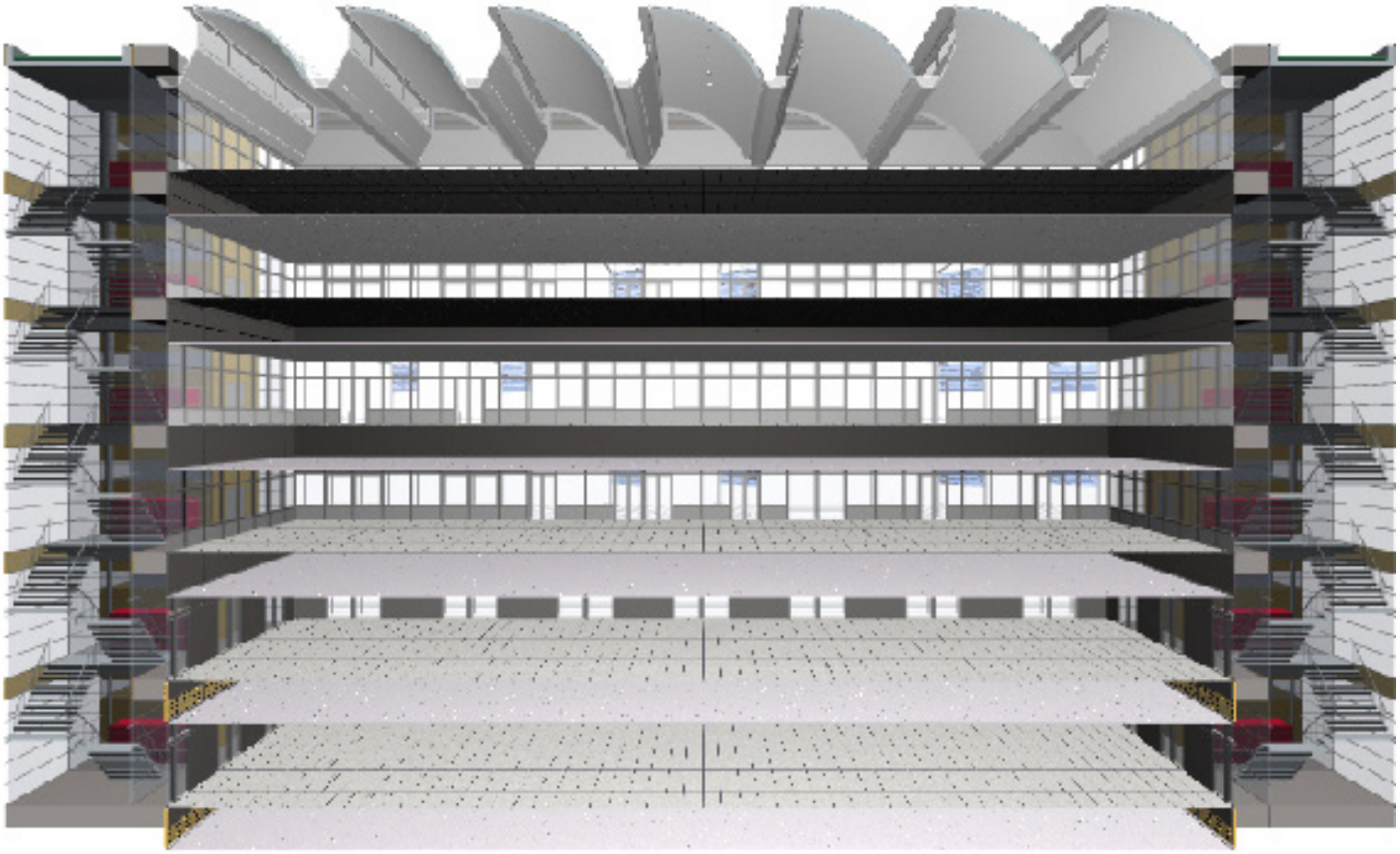


Site Features :

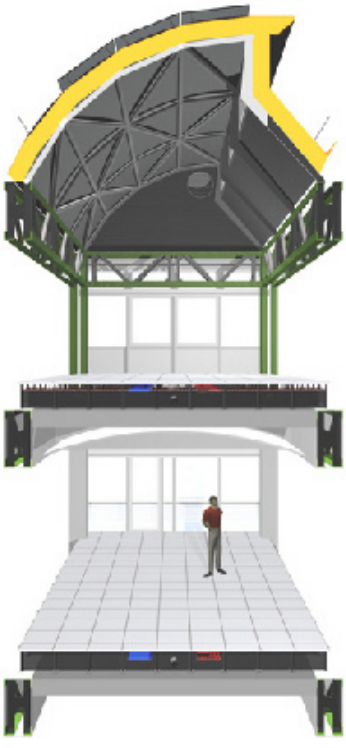
- Stormwater collection
  - Rain-garden water feature
  - Reflecting pool for daylighting
- Solar Decathlon staging ground
- Organic gardening
- Green roof above underground parking
- Protected playing area for children school
- "Energy Cascade" demonstration plaza
- "Living Machine"- On-site bio-gas & compost

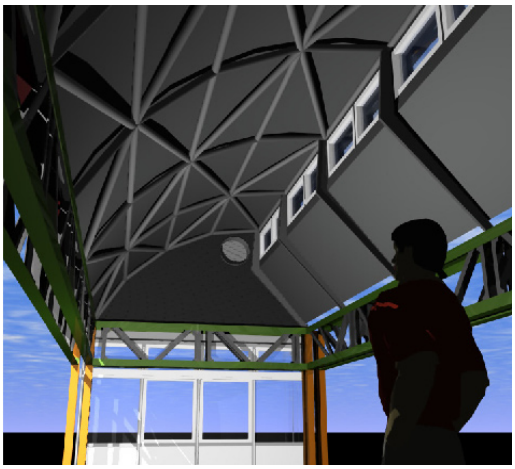


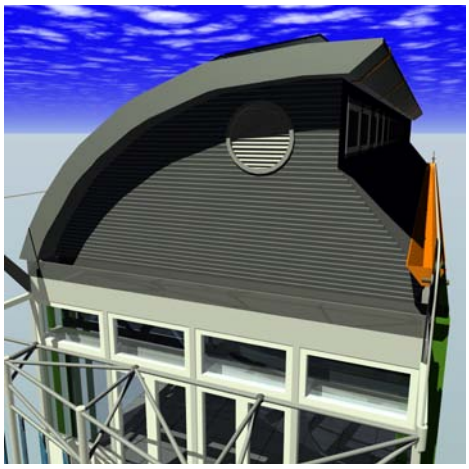


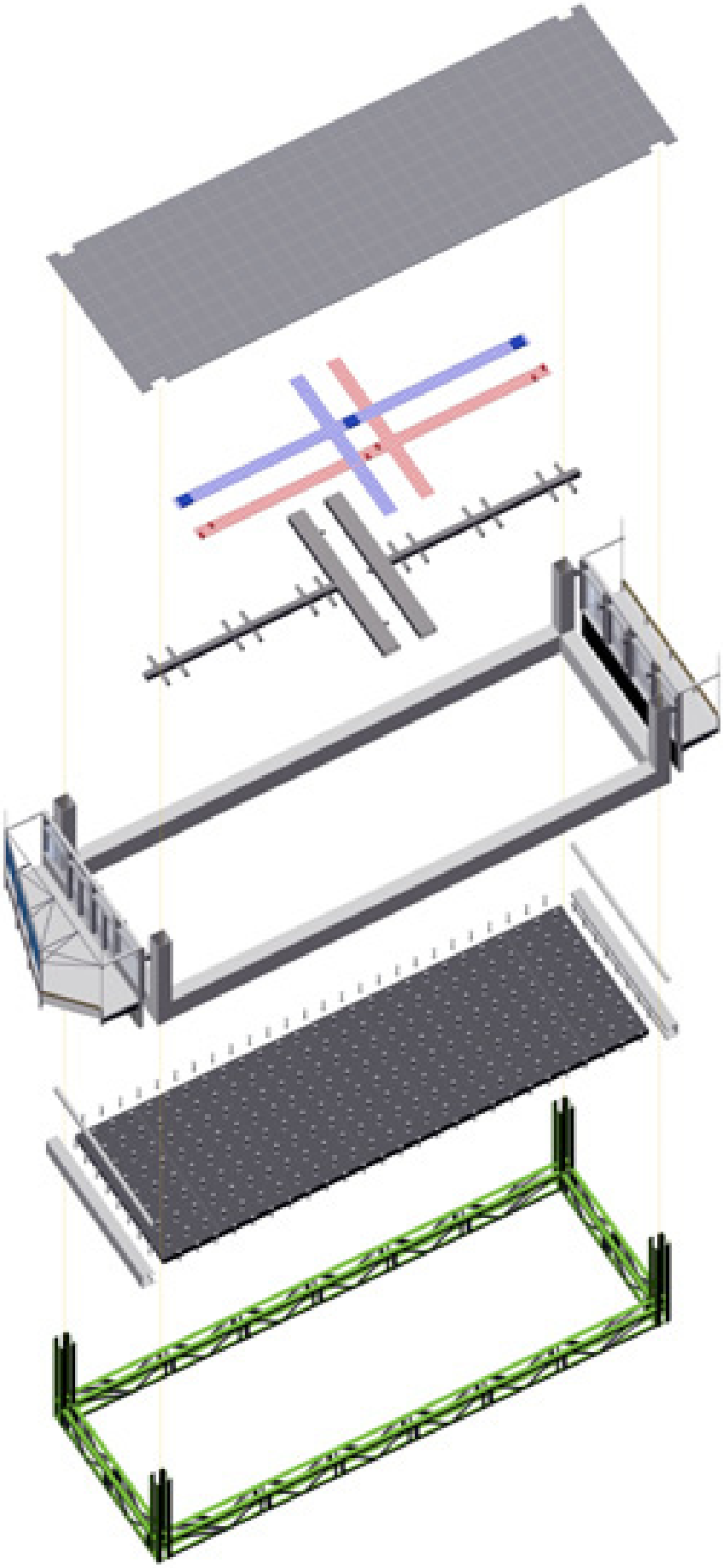


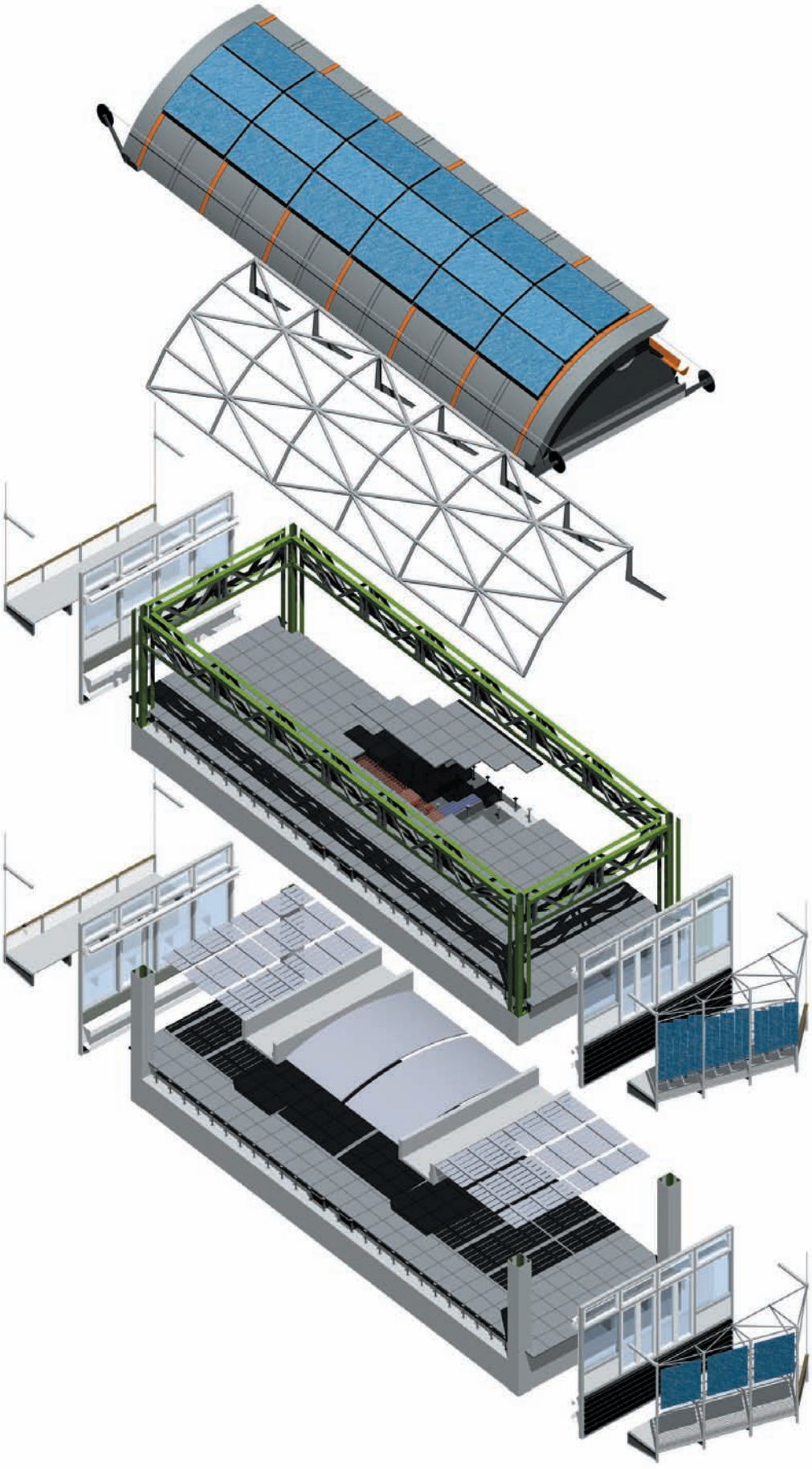
MODULAR BAY



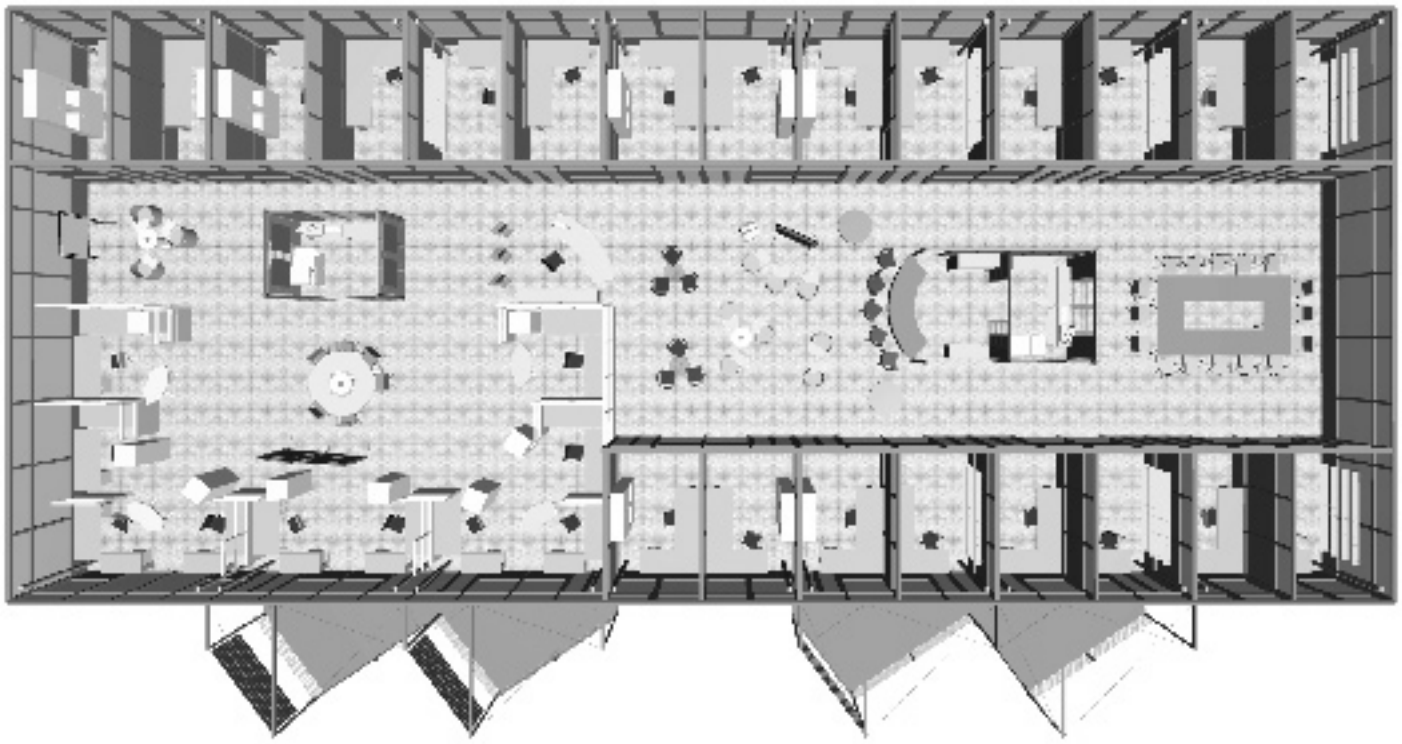




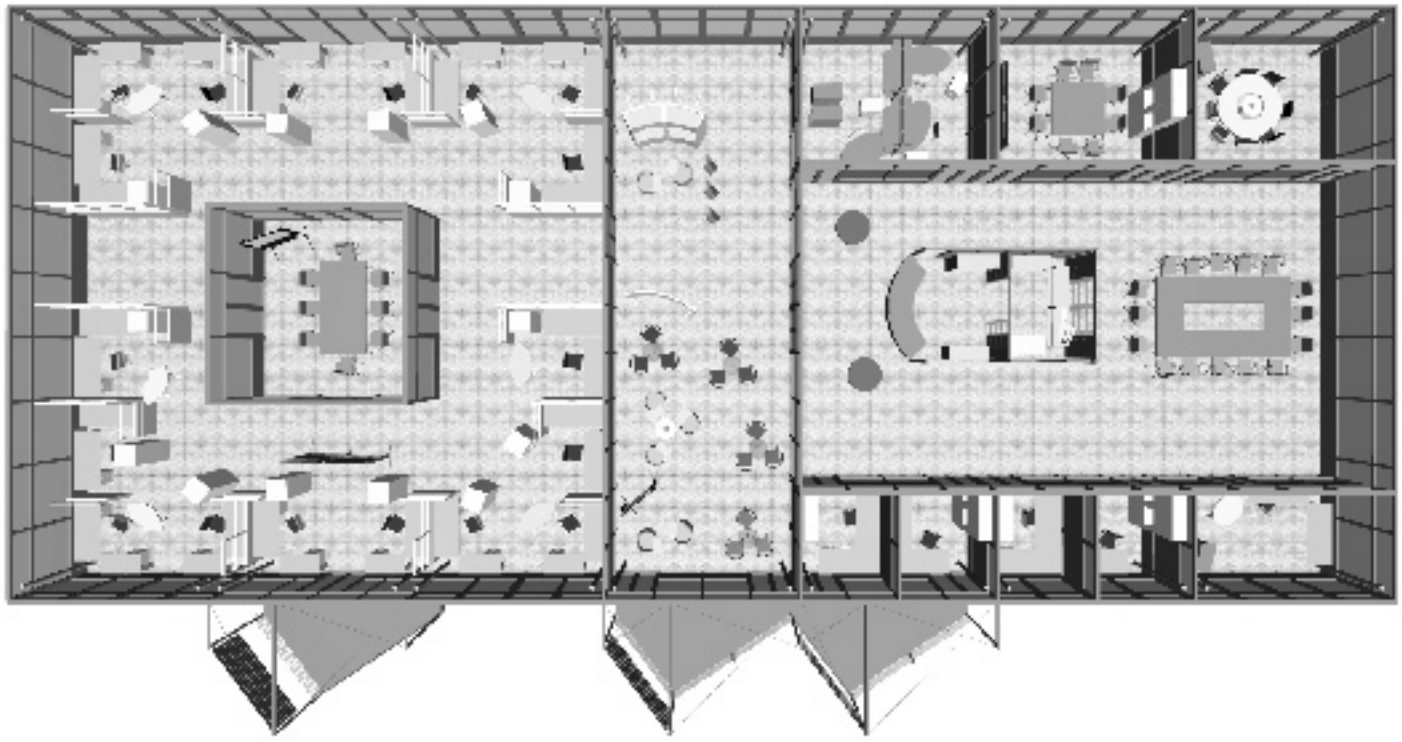




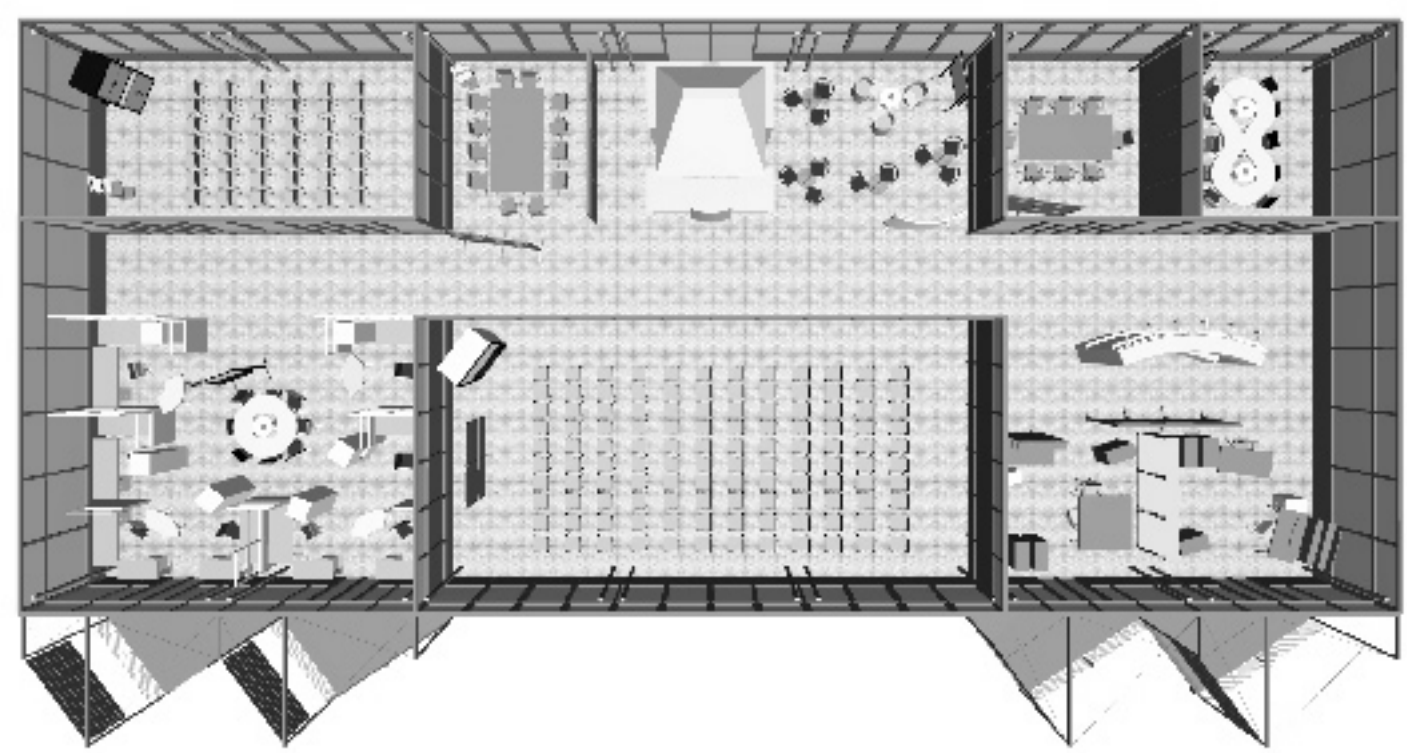
INTERIOR SPACES



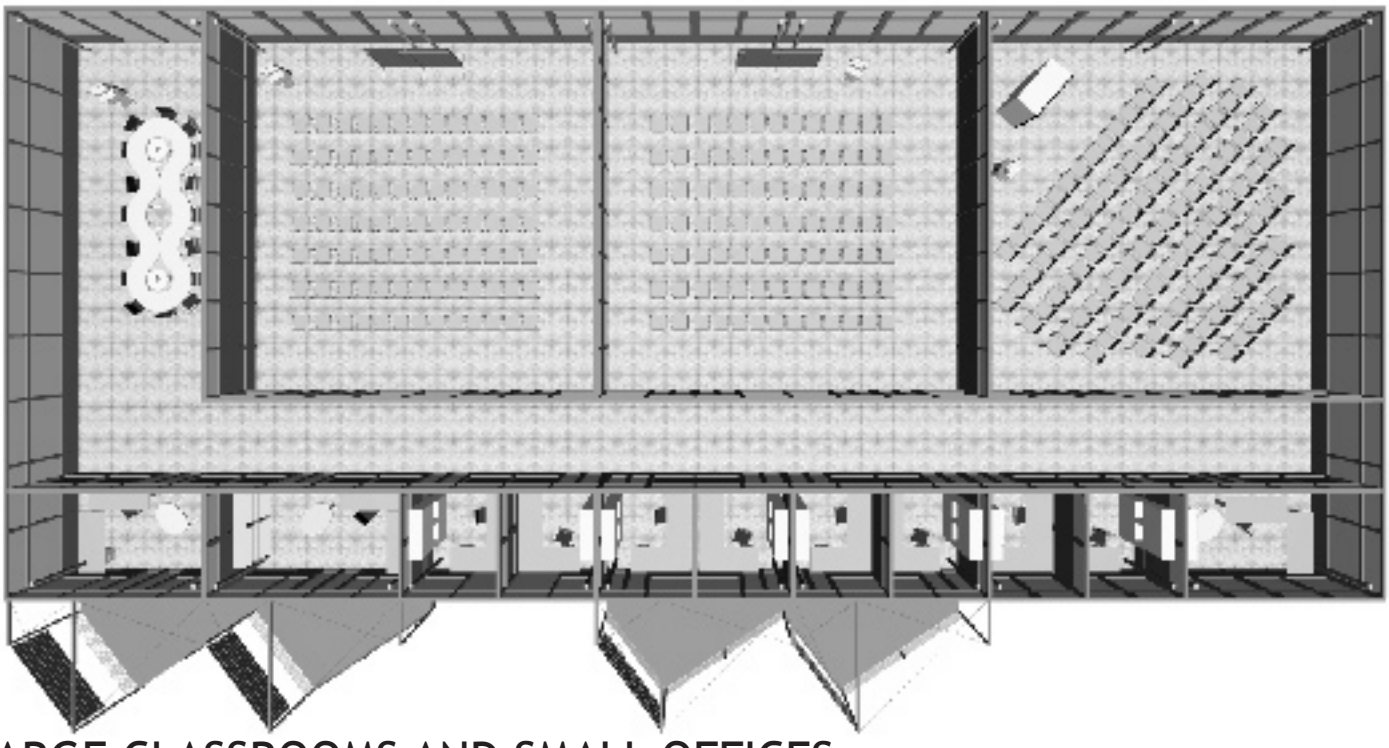
CLOSED OFFICES AND MEETING SPACES



OPEN AND CLOSED OFFICES

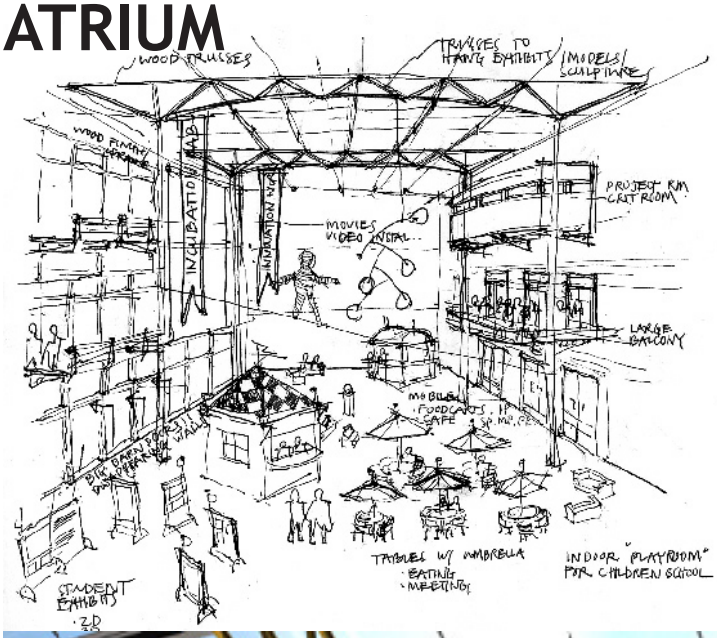


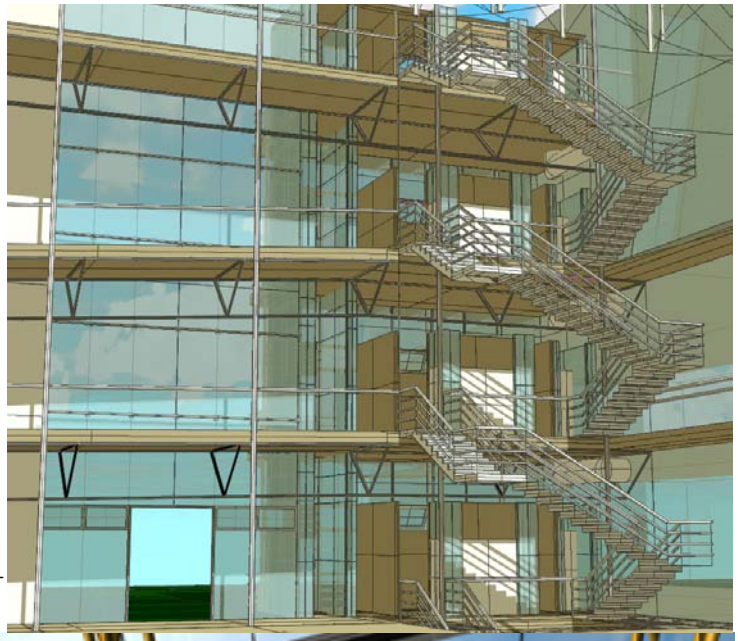
SMALL AND LARGE CLASSR0OMS/MEETING ROOMS

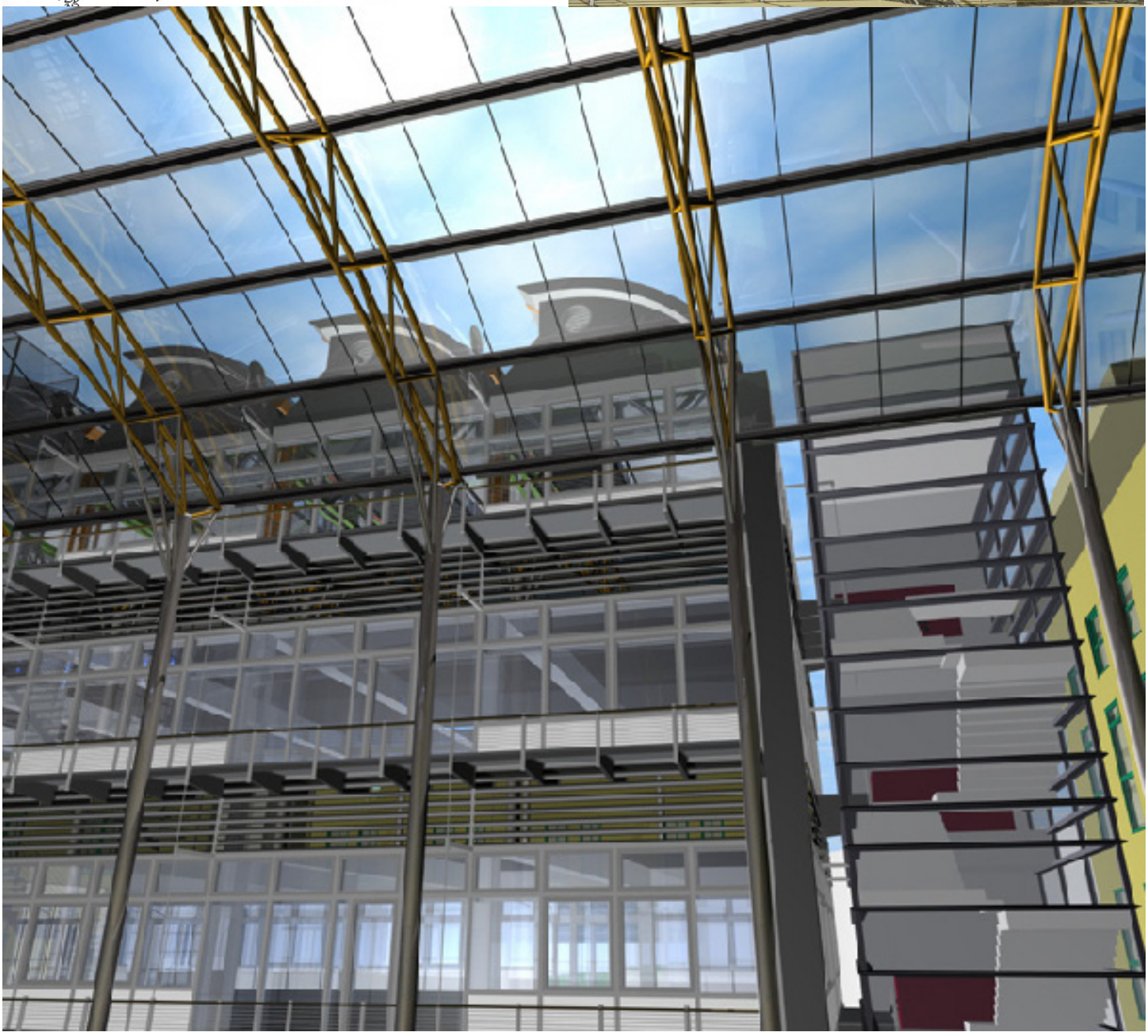


LARGE CLASSROOMS AND SMALL OFFICES

ATRIUM


WOOD TRUSSES
TRUSSES TO HANG EXHIBITS
MODELS/ SCULPTURE
WOOD PANEL WALL
INCUBATOR LAB
INCUBATION LAB
PROJECT RM CRIT ROOM
MOVIES VIDEO INSTAL.
LARGE BALCONY
MOBILE FOOD CARTS
BIG OPEN SPACE
STUDENT EXHIBITS
TABLES W/ UMBRELLA EATING MEETING
INDOOR "PLAYROOM" FOR CHILDREN SCHOOL





BUILDING ENCLOSURE SYSTEM

		INTERIOR	INTEGRAL	EXTERIOR
TRANSOM	ZONE A	A1	A2	A3
VIEWING FIELD	ZONE B	B1	B2	B3
BRUESTUNG	ZONE C	C1	C2	C3
SPANDREL	ZONE D	D1	D2	D3

CATEGORIES FOR ENCLOSURE PERFORMANCE SPECIFICATIONS

Thermal Quality
- Too cold or too hot/ R-value
- Simultaneous heating and cooling/ load balancing
- Diurnal swing/ thermal mass
- Too sunny/ S.C.
- Passive solar/ % glass and mass
- Infiltration/ air tightness
- HVAC Integration - mixed mode
- HVAC Integration – 'reject' heat use

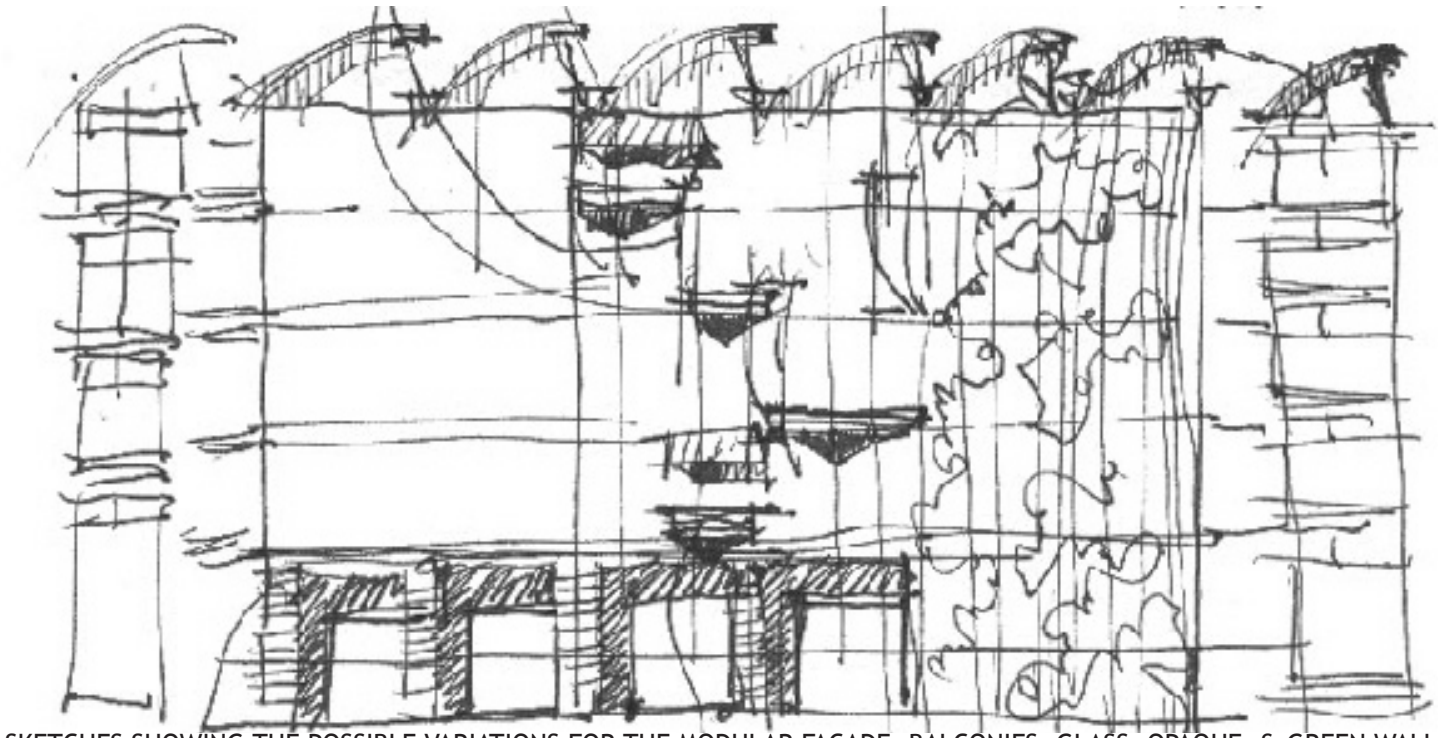
Visual Quality
- Daylight/ transmittance/ % and location glass
- Glare/ diffusion/redirection
- Visual access/ Views and sightlines
- Lighting Integration - mixed mode
- Lighting Integration - split task and ambient

Spatial Quality
- Physical access to outdoors
- Layout flexibility/ module and % glazing
- Structural integration

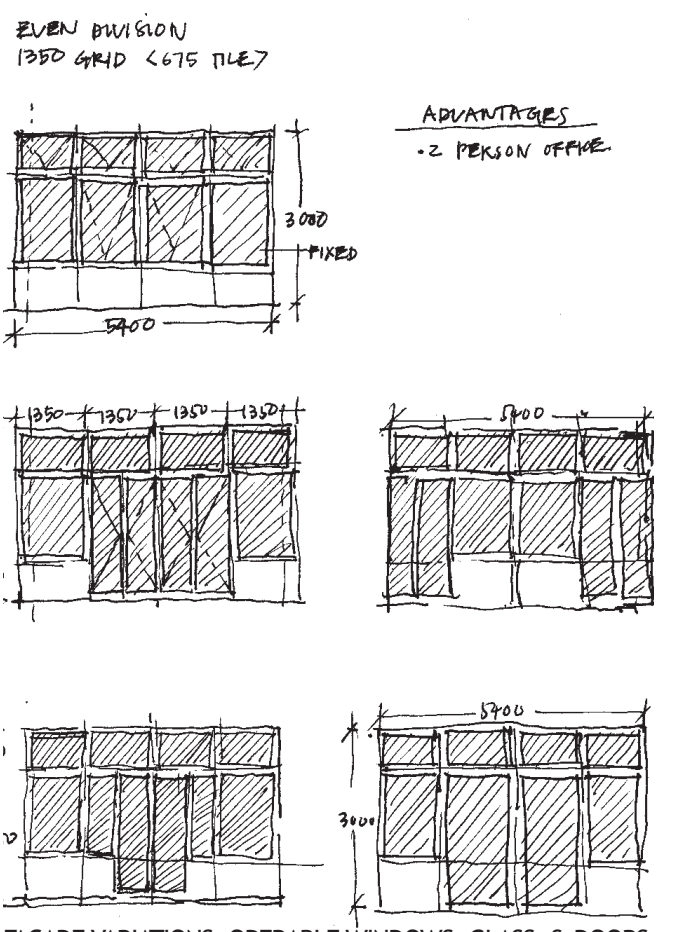
Air Quality
- Ventilation/ pressure induced - A.C., %/ location/ type of aperture
- Ventilation/ thermally induced - A.C., %/ location/ type of aperture
- Ventilation/ solar induced - A.C., height, absorption, mass
- Ventilation/ fan induced
- HVAC Integration - split thermal and ventilation

Integrity
- Rain-proof - type of operation
- Water collection/ plant support
- Material conservations/recyclability

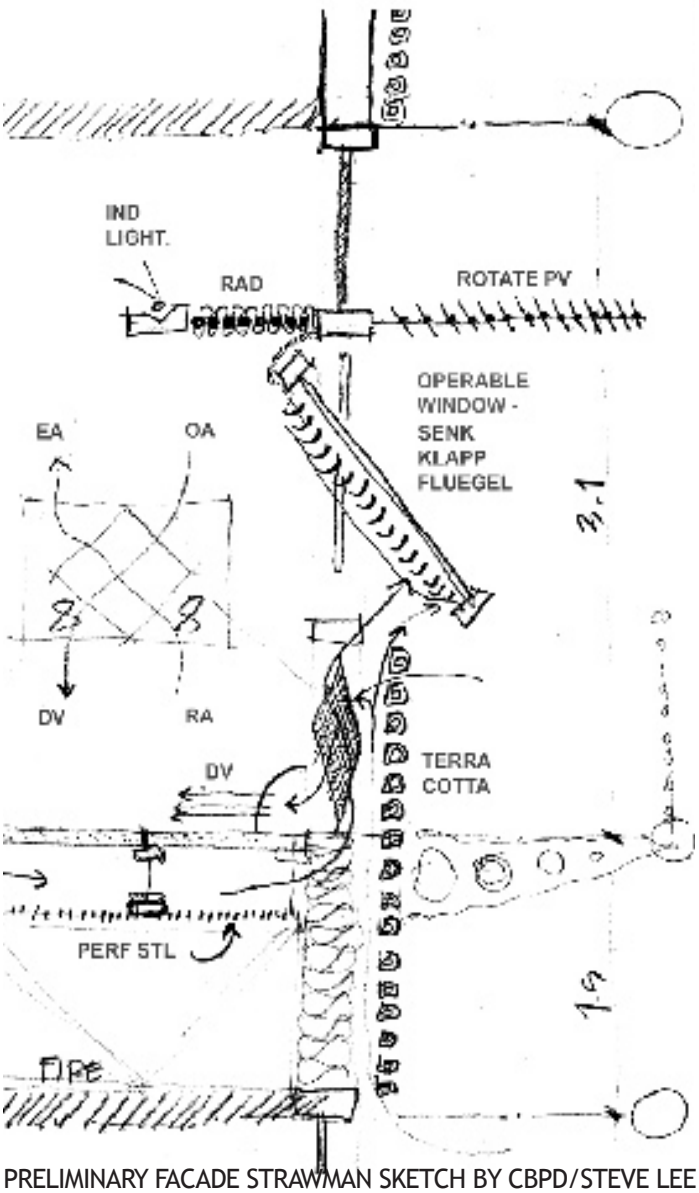
Energy Generation
- PV integration
- Solar Thermal



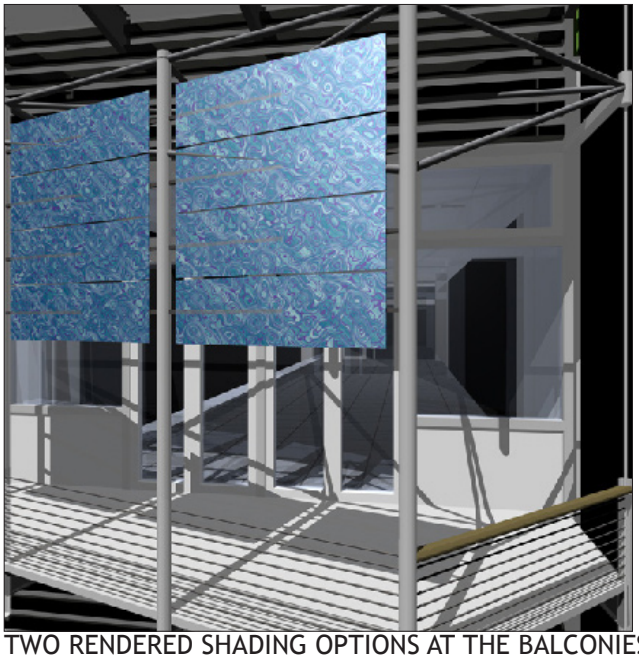
SKETCHES SHOWING THE POSSIBLE VARIATIONS FOR THE MODULAR FACADE: BALCONIES, GLASS, OPAQUE, & GREEN WALL

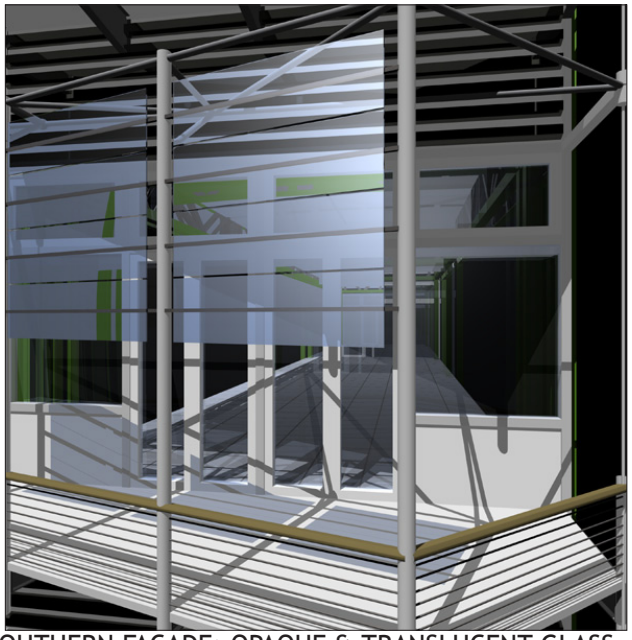


FACADE VARIATIONS: OPERABLE WINDOWS, GLASS, & DOORS



PRELIMINARY FACADE STRAWMAN SKETCH BY CBPD/STEVE LEE



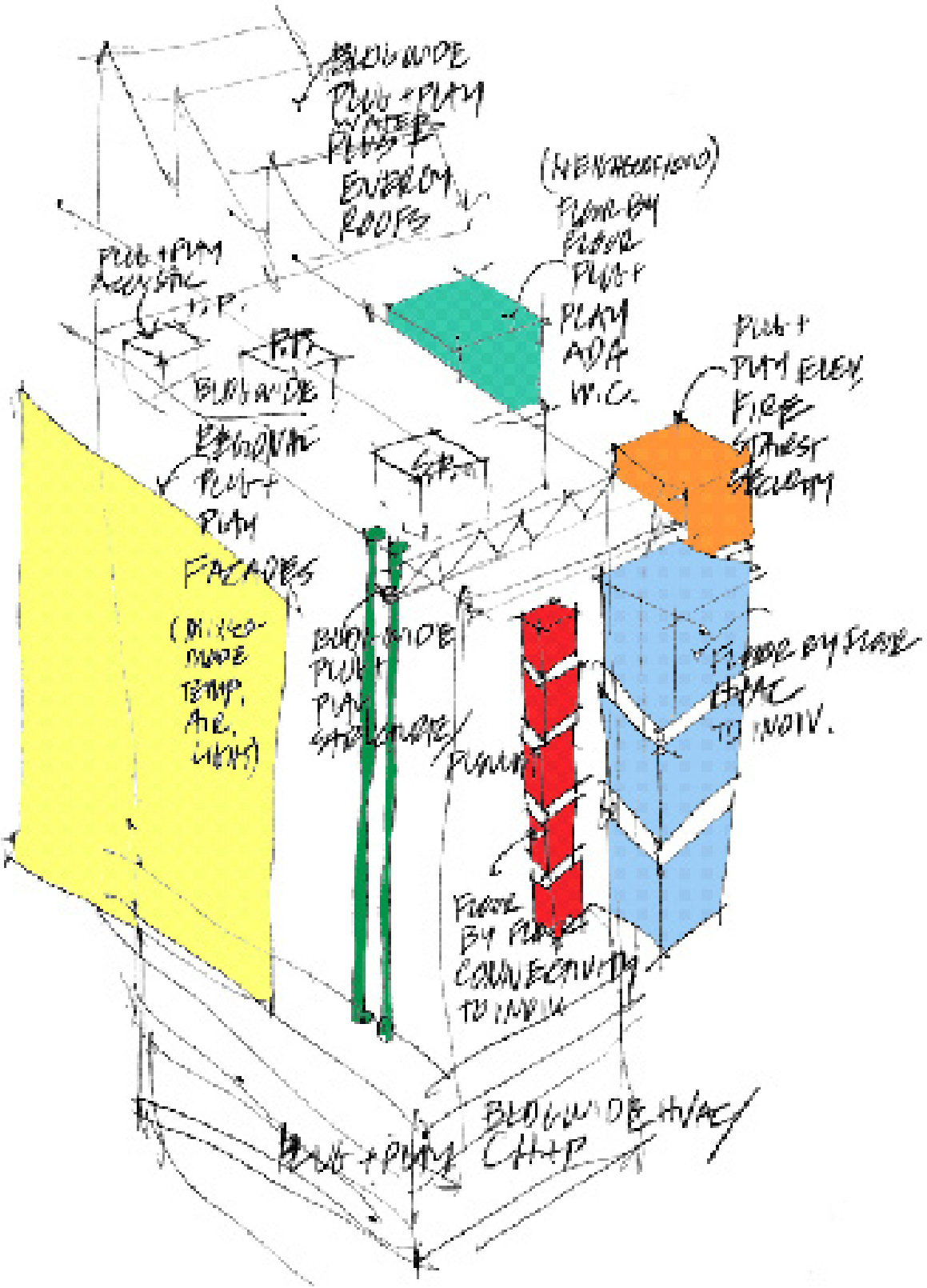


TWO RENDERED SHADING OPTIONS AT THE BALCONIES ALONG THE SOUTHERN FACADE: OPAQUE & TRANSLUCENT GLASS

MECHANICAL SYSTEM

CONCEPT OF PLUG-AND-PLAY TECHNOLOGY

This technology offers: individual comfort and productivity, organizational flexibility, technological adaptability, and energy and environmental effectiveness.



MECHANICAL SYSTEM PERFORMANCE GOALS

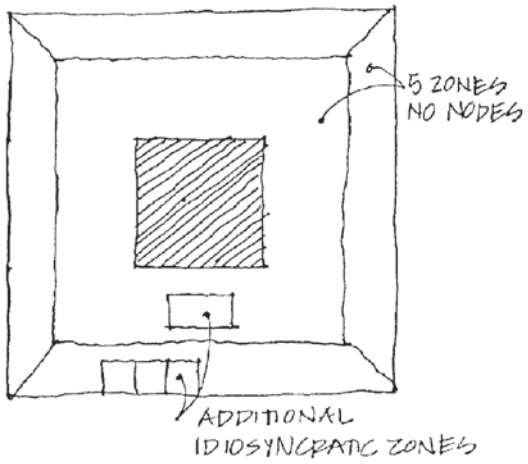
GENERAL REQUIREMENTS

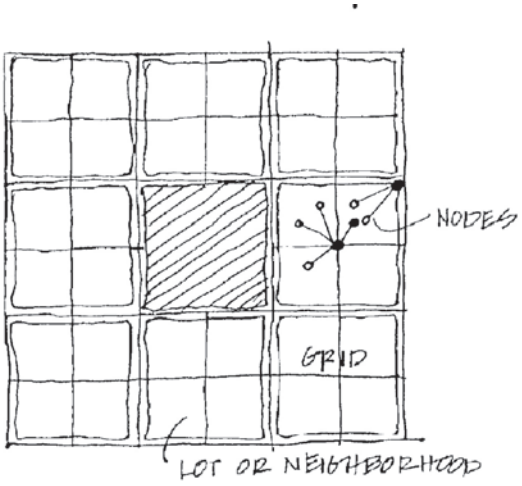
- User-based infrastructures that are modular, reconfigurable and expandable for all key-services- ventilation air, thermal conditioning, lighting, data/voice and power networks
- Flexible infrastructures capable of changing both location & density of services, & supporting reconfiguration of workstations & workgroups
- Ambient-Task Systems, where users set task requirements & the central system responds with the appropriate ambient conditions.
- Central capacities of power, data, voice, cooling, heating and ventilation must be flexible and incorporate add-on capacities
- Modular 'satellite closets' (service cores) connected to accessible vertical distribution
- Distributed local control for dynamic organization with differing equipment and occupant densities
- Predominantly floor-based infrastructures.

HVAC GUIDELINES

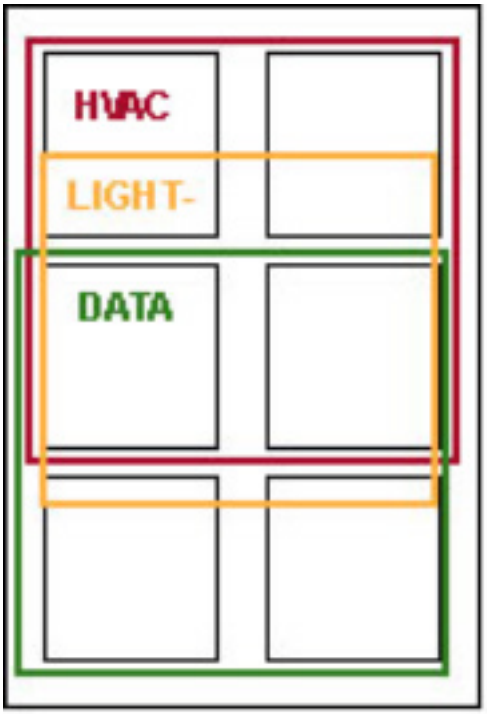
- **Ventilation:** Deliver breathing air independent of thermal conditioning (heating and cooling).
- **Mixed-Mode Conditioning:** Integrate natural & mechanical conditioning systems.
- **Flexibility:** Design a flexible infrastructure that provides user accessibility and control to HVAC end units.
- **Thermal Zones:** Design thermal zones for continuous change in zone size and individual control of local conditions.
- **Load Balancing:** Integrate enclosure and mechanical systems.
- **Energy and Material Conservation:** Select mechanical system components considering energy efficiency, material life cycles, and their service lives.
- **Maintenance:** Provide easy maintenance access for HVAC equipment.
- **Controls:** Create modular, distributed, controls; communicating, modifiable building automation systems.

CONCEPT OF GRID AND NODES

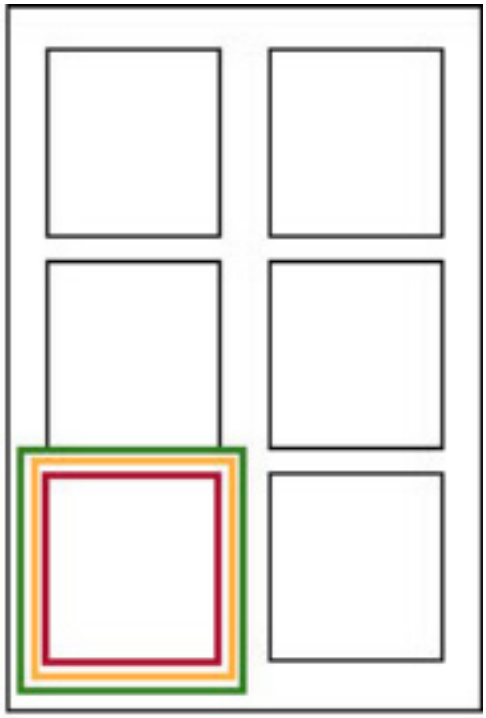




ZONING



Conventional



Desired

HORIZONTAL DISTRIBUTION AND LAYERING