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:** 4.65 m (15.25 ft)
- **Floor-to-Ceiling Height:** 3 m (9.84 ft)
- **Raised Floor Plenum:** 1.65 m (5.41 ft)
- **Total Building Height:** 18.6 m (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 CLASSROOMS/MEETING ROOMS

LARGE CLASSROOMS AND SMALL OFFICES
# BUILDING ENCLOSURE SYSTEM

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**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

**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

**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

**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
PRELIMINARY FACADE STRAWMAN SKETCH BY CBPD/STEVE LEE

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