

# Engineering Centers Building Cleanroom Design



THE UNIVERSITY  
*of*  
**WISCONSIN**  
MADISON

**Dan Christensen**

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Engineering Centers Building  
University of Wisconsin-Madison

# Design Team

- Flad and Associates, Executive Architect
  - Madison, WI
- Kohn Pederson Fox, Design Architect
  - New York, NY
- GPR Planners Collaborative, Lab Planner
  - Purchase, NY
- Affiliated Engineers, Engineering
  - Madison, WI

# Construction Team

- J.P. Cullen & Sons, Janesville, WI
- General Building
  - HVAC -> Downey, Inc., Milwaukee, WI
  - Piping -> Hooper Const. Corp., Madison, WI
  - Electrical -> Staff Electric, Madison, WI
- Cleanroom
  - Cleanroom -> Performance Contracting, Inc, Indianapolis, IN
  - HVAC + piping -> H & H Industries, Madison, WI

# User Team

- State of Wisconsin
  - Division of Facilities Development
- University of Wisconsin-Madison
  - Facilities Planning & Management
- College of Engineering
  - Dean's Office
- Individual Departments
  - Wisconsin Center for Applied Microelectronics

# Building Overview

- 200,000 GSF
  - Student Activity
    - Basement
      - Discovery Center,
      - Innovation Center
    - 1st floor & Mezzanine
      - Auto lab
      - Student Organizations
      - Career Services
      - Technical Communication
      - Auditoriums
- University of Wisconsin-Madison

# Building Overview (cont.)

- Research and Academic
  - 2nd floor
    - Trace Center
    - Bio-Medical Engineering Dept
    - Center for Plasma Aided Manufacturing
    - CVD Materials
  - 3rd floor
    - Micro/Nano Research Labs
    - Cleanroom
    - Research Hatcheries

# Under Construction



## Engineering Centers Building

University of Wisconsin-Madison

# Cleanroom Issues Affecting Building Design

- Column spacing
  - Cleanroom bay width + chase width = column width
- Additional elevator stop in the penthouse
  - Facilitate maintenance of air handlers

# Building Issues Affecting Cleanroom Design

- Had to fit into a multistory engineering building
- Design of student spaces was a high priority
- A&E selection was done and then decision to include a cleanroom in the building
- Located next to residential neighborhood
- Cleanroom funding was not certain
- Building ground floor to be “center-piece”

# Cleanroom Design Approach

- Bay and Chase Concept
  - Most flexible for tool hookup
- Designed for ever-changing equipment
  - Utility hookups flexible and periodic
- Minimize utilities shared with rest-of-building
  - AHU, Exhaust, DI, N2
- Most equipment not “thru-wall”
  - Furnaces the exception

# Cleanroom Design

- 16 ft wide by 40 ft long.
- Located on top floor
  - Air handlers in penthouse
  - Vibration trade-off
- Swing doors not sliding
  - Value engineering

# Cleanroom Bay Design (cont.)

- Door – removable panel
- Emergency exit at building hallway end
- View windows from building hallway
- Air return – under wall (no grill)
- Central housekeeping vacuum with connection in each chase

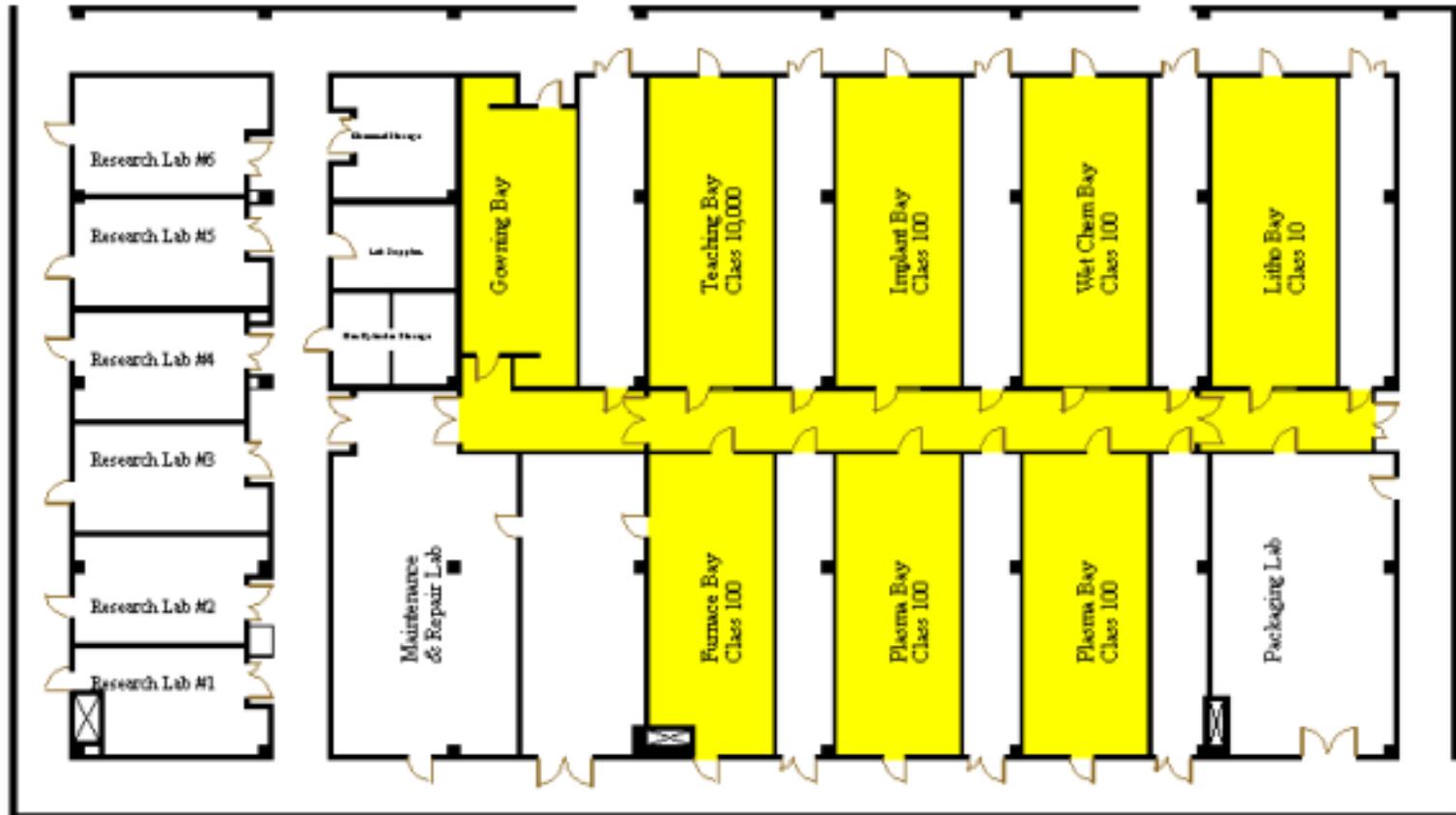
# Cleanroom Data

- Occupy Fall 2002
- Cleanroom
  - Class 10 640 sq. ft.
  - Class 100 3376 sq. ft.
  - Class 1,000+ 2040 sq. ft.
  - Service space 3200 sq. ft.
- Non-Clean
  - Non-clean Labs 960 sq. ft.
  - Support Space 1064 sq. ft.
- Research Hatcheries
  - Six individual labs 1980 sq. ft. (330 sq. ft. each)

# Uncertain Funding Effects

- Alternate bid(s) on increments of the cleanroom
- Cleanroom construction bid separate
  - Resulted in different contractors for cleanroom

# Alternate Bid Plan



# Cleanroom Bay

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# Chase Design Approach

- Size
  - 8 ft. width (reduced from desired 12ft)
  - 16 ft. width for furnace chase
  - Desired space for a vacuum pump on each side plus a central isle to move carts, etc.
- Utilities
  - Uniformly spaced along wall
  - Piping 5 ft. from floor
  - Electrical above piping

# Chase Design Approach (cont.)

- Piping
  - Valves spaced in 4 locations along wall (both sides of a chase)
  - CDA, N2, chuck vacuum, cooling H2O Sup. & Ret., DI Sup & Ret,
  - Spare routes for Hot H2O, Cold H2O, 2 others
- Electrical
  - Outlets spaced in 4 locations along wall (both sides of a chase)
  - 30A, 208 1f, 30A 208 3f, 30A 208 3f 5wire
  - Double duplex

# Chase Piping

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# Chase Design Approach (cont.)

- Communication
  - 2 data and 2 fiber per chase wall
  - Cable tray to connect all chases
- Exhaust
  - Taps 10 each 8”diam. (for gas cabinets)
  - Taps 10 each 4”diam. (for vacuum pumps)
- Drains
  - 1 floor drain in each chase (with trap priming)
- Emergency Exit (into cleanroom)

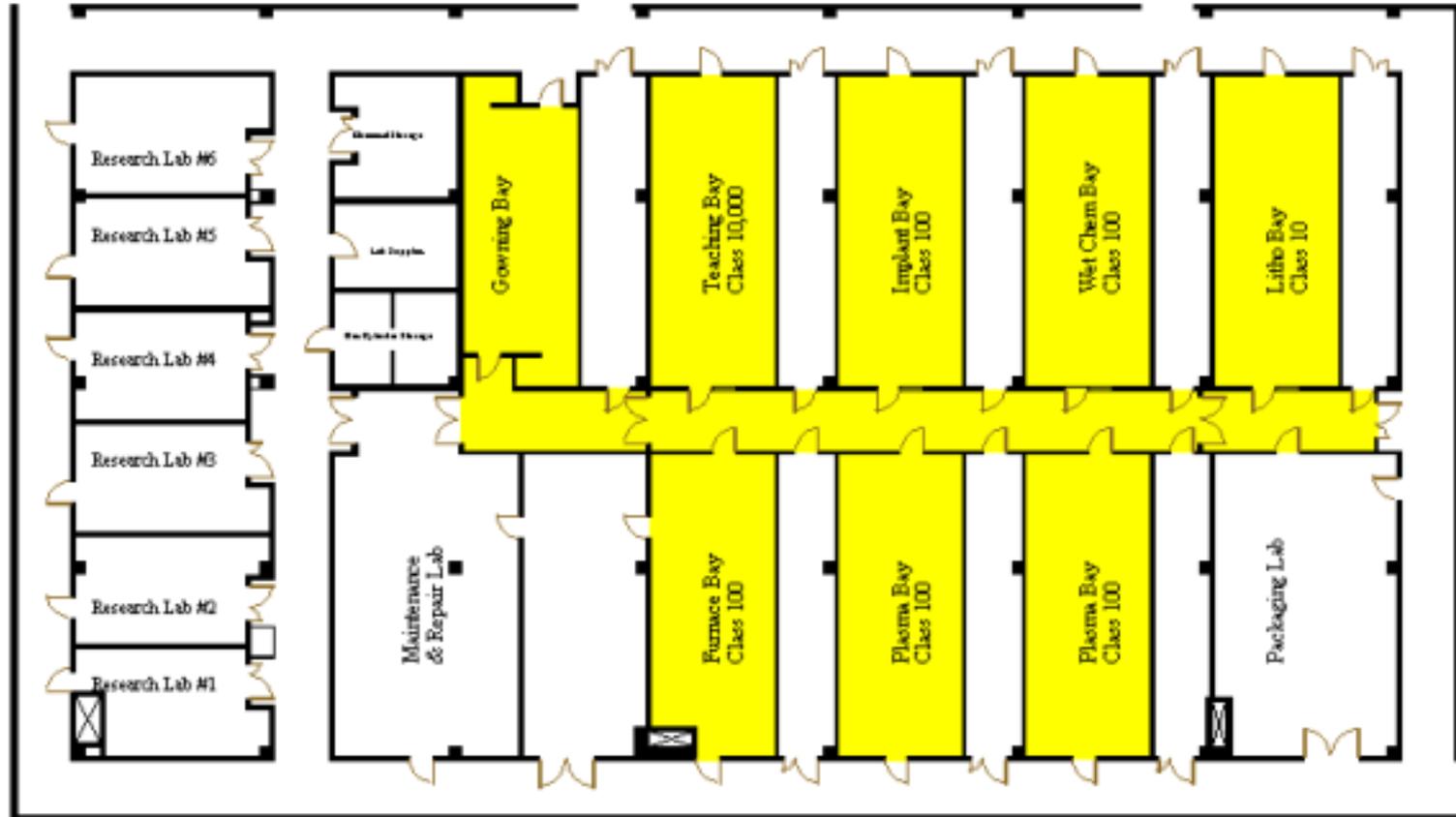
# Alternate Bid Sections

- Support space part of base building
  - Chemical storage, lab supplies, gas cylinder storage
- 1st Bid Section
  - Maintenance & Repair
  - Gowning room C1000, 2 bays C100, 1 bay C10,000, corridor C1,000
  - 5 Utility chases

# Alternate Bid Sections (cont.)

- 2nd Bid Section
  - 3 bays C100
  - 3 Utility chases
- 3rd Bid Section
  - 1 bay C10, 1 (future) bay C100
  - 2 Utility Chases

# Cleanroom Plan



# Exhaust Connections

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# Utilities - HVAC

- 2 each make-up units
  - 40,000 cfm each
- 8 each recirculation units
  - 40,000 cfm each
  - 1/C100 and 1 shared with C1,000+C10,000
- 2 ea solvent exhaust
  - 10,650 cfm
- 2 ea corrosive and general exhaust (combined prior to fan)
  - 28,540 cfm

# Exhaust Ducts

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# Utilities (cont.)

- Exhaust Scrubbers
  - Point-of-use scrubbers on specific equipment
  - Floor space and fit out for future general building scrubbers prior to corrosive fans.
- Acid waste system
  - Stub to each chase wall
  - Dilution with pH probe on outlet
  - Provisions for neutralization in future

# Utilities – DI Water

- Shared conditioning
  - Multi-filter -> water softener -> C filter -> Double pass RO (15 gpm) -> RO system or Pure system
- RO system (for any lab in the building)
  - Storage tank -> 0.2 micron filter -> RO loop -> UV -> return to tank
- Pure Water (cleanroom only)
  - DI beds -> Storage tank -> UV -> DI beds -> 0.1 micron filters -> UV -> .04 micron filters -> PW loop -> return to tank

# Utilities – N2

- LN2 storage tank
  - Gas N2 supply to a tee splits the supply to cleanroom or rest-of-building
  - Check valves (2 in series on each leg of the tee)
  - Single point supply to all of cleanroom with provision for 160L dewars to backup

# Lessons

- Don't build present labs that become future cleanrooms
  - AHU installation issue
  - Air return issue
  - Shell space – yes
- Alternate bid causes some extra design costs
- 10 ft cleanroom ceilings
- Determine gowning protocol prior to gown room design
- Guard the equipment entry size constraints (watch all door sizes and hallway turns!)