SUSTAINABILITY

Introduction
The Veterinary Medicine 3B (VM3B) project is a 118,000 gross square foot (GSF) four-story research laboratory building containing laboratories, laboratory support, research office space, academic and administrative offices, a small-animal vivarium, and centralized service space for research programs.

VM3B provides modern biomedical research laboratories and space for student-faculty research teams in the School of Veterinary Medicine (SVM). Research space is configured in an “open” laboratory floor plan, so that several teams will share each laboratory suite, thus facilitating student-faculty interaction, scientific collaboration, optimizing shared use of equipment and support staff, and providing the greatest flexibility and adaptability for programmatic change over the lifespan of the building.

The project team employed multiple best practices in sustainable planning and design to reach dramatic goals in resource conservation while providing improved environmental quality for occupants and the broader campus community.

Key Building Achievements
- 33% Less Ongoing Energy Consumption*
- 96% of Construction Waste Diverted from Landfill Disposal
- 80% Less Potable Water Use*
*when compared to a similar building built to code

LEED Certification
UC Davis implements Green Building practices under the U.S. Green Building Council’s Leadership in Energy and Environmental Design program (LEED). VM3B is on target to achieve LEED Gold Certification.

Design Approach
Early Integration. Green building strategies were integrated early on in the design process. This began with a critical analysis of the program as well as the site to determine where resources could be conserved and what “free” resources were available.
Demand Reduction in Programming and Design. During the project planning, monitoring of equipment used in existing university laboratory space identified that typical lab cooling requirements would result in oversized cooling equipment for the actual cooling needs of the building occupants. This study validated a reduced cooling demand and ultimately smaller cooling systems while still providing provisions for future capacity increases (i.e. low AHU face velocity, low pressure drop ducts, and chilled water distribution to each floor).

By employing a design using horizontal exits in lieu of exit corridors, the building area was reduced from the programmed 150,000 GSF to 118,000 GSF without sacrificing usable space, thereby reducing not only the amount of material required to build the building, but the total energy demand. This strategy also contributed to the vertical stacking of the program, allowing the decoupling of laboratory heating and cooling systems from that of offices. Personal workspace for lab technicians was moved out of the lab and into open office clusters thereby reducing the lab area that requires high ventilation rates.

Early energy modeling convinced the campus planners to reconsider the building’s original north-south orientation and accept a plan elongated in the east-west direction. Limited windows on the east and west ends of the building limit the uncontrolled entry of early morning and late afternoon summer sun.

After additional modeling and analysis of the sunlight exposure of the north elevation, the west wing was bent northward and vertical fins were added to the east wing to eliminate late afternoon summer sun entering the labs during work hours. Translucent glazing and automatic shades were employed on this façade to redirect the interior lighting back into the space during the late afternoons in winter.

On the south façade, various combinations of window shading elements were studied in a highly iterative process using modeling and sun path studies to balance the daylighting performance, internal gains, visible light transmittance, and glare.

Sustainable Sites
Alternative Transportation. Bike racks and showering/changing facilities are provided at the building. These combined with local bus and campus shuttle stops provide occupants an array of alternative transportation options.

Stormwater and Open Space. The stormwater infiltration basin doubles as both the overflow basin for the reclaimed water system and a dramatic landscape feature at the building entry.

Light and Temperature. Exterior lighting is directed down and/or to the sides, preventing light pollution in the night sky. Paved areas are shaded to prevent excessive ambient heating of the immediate area or “heat island”.

Sustainable Sites

SECTION STUDY OF SHADING FIN

STUDY OF SUN PENETRATION IN LABS
Water Efficiency

Landscaping: The project landscape design focused on maximizing tree canopy shading and limiting lawn area to a small seating area on the north side of the building. The low water use landscaping is designed with native and well adapted plants. In addition to water savings, native plants are adapted to locally available nutrient sources and are resistant to most pests and diseases. Therefore, minimal fertilizers, pesticides, fungicides, or herbicides are used, improving the quality of stormwater runoff.

Efficient Fixtures: All interior water fixtures are optimized for low flow while maintaining user standards. Low flow showers use a nozzle design that increases the velocity to provide similar shower sensation with only 60% of the water. Low flow faucets with automatic sensors are powered by batteries, which are recharged by small turbines receiving energy from the flowing water. These efforts combined with low flow lab faucets and high efficiency toilets significantly reduce building water demand.

Alternative Water Sources. By recapturing the aquatics lab waste water and the lab RO water backwash and combining that with seasonal storm water from the roof in a 3,000-gallon tank, the reclaimed water system can serve the demand for toilet flushing 7 months of the year (80% annual reduction over the base case).

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Energy & Atmosphere

Energy Requirements. Like most buildings, VM3B uses energy for heating and cooling, ventilation, hot water, lighting and equipment. Unlike most buildings, it also uses energy to sterilize lab utensils, to purify lab grade water, and to pump and filter rainwater on site.
Comprehensive Approach. To achieve an exceptional level of energy efficient performance, a comprehensive approach was needed, including:

Demand Reduction

- Research & quantify occupant needs
- Incorporate passive strategies including high performance building envelope, daylighting, natural ventilation & cooling
- Choose high efficiency designs & details
- Choose efficient equipment
- Create control strategies that optimize equipment operational efficiencies

Alternative Sources

- Capture waste energy (recover heating & cooling from exhaust)
- Capture renewable energy (future)

The planning level demand reduction efforts described earlier were supplemented with the following additional demand reduction efforts.

Reduced Energy Demand - Envelope. The well-insulated building skin, including R-20 in the walls and R-30 in the roof, is a passive strategy that reduces energy demands throughout the life of the building. High-performance windows with insulated glass with a “low-e” coating and argon gas in between glass panes, (which reduces heat transfer across the glass) further fortify the building envelope from unwanted heat loss or gain.

Reduced Energy Demand – Lighting. Free daylight is filtered through windows, prompting photo sensors to turn off the electric lights when enough daylight is present.

Reduced Energy Demand – Process loads. In the lab support spaces, ultra low freezers (-80c) are directly cooled from the building chilled water instead of rejecting their heat to the room air. After extensive analysis of occupant needs for lab compressed air and lab vacuum, a centralized distribution system was eliminated in favor of smaller local systems in the locations where these services are needed eliminating distribution losses associated with large systems. The large freezer farm is predominantly cooled using ambient free cooling (taking advantage of the Davis climate’s large diurnal temperature swing) with recirculating fan coils as back up.

Integrated passive/low intensity strategies - HVAC. Operable windows are provided in private offices and shared team spaces to allow for natural ventilation and cooling. The main lobby has a radiant slab, and operable louvers to provide natural cooling and fresh air when the climate conditions allow. The central stair tower is designed to utilize the stack effect to draw warm air from the main lobby and surrounding open office which is exhausted through rooftop ventilators, eliminating the need for additional conditioning in the stair.

Integrated Efficient System Design and Equipment Selection-HVAC. The use of water cooled and heated ceiling-mounted induction diffusers, or “active chilled beams” and radiant panels decoupled the cooling and heating from the ventilation allowing the volume of air delivered to the interior to be dramatically reduced (less air is needed to deliver heating/cooling) which reduced the need
to reheat the air and which allowed the use of 100% outside air in lieu of re-circulated air (see Indoor Environmental Quality below).

A “run around” heat recovery coil carries heat from the lab exhaust to the lab air handler to pre-cool or pre-heat the intake air. The lab air handler is designed with a multiple fan configuration to more efficiently adjust airflow, provide redundancy and reduce maintenance. Open offices, open labs and lab support spaces are cooled and heated with chilled beams. Closed offices are heated and cooled using radiant ceiling panels with ventilation air delivered at the breathing zone. The occupants have partial individual control with thermostats on the local radiant panel valves. The vivarium design utilizes individually ventilated cage racks which provide healthier animal housing and reduces room ventilation requirements.

**Efficient Control Strategies – HVAC.** The lab exhaust system is designed with occupancy sensors to enable unoccupied night setback from 6 to 4 air changes per hour, cutting energy use.

**Integrated Efficient System Design and Equipment Selection - Lighting.** After making use of daylight, light colored walls, ceilings and laboratory counter tops were chosen for their light diffusing properties, which allow lighting power to be reduced while improving visual acuity. A task/ambient strategy for lighting is used in both offices and open labs with LED task lighting and super T8 indirect/direct ambient fixtures. The advanced lighting control schemes with sensors that dim the lights when daylight is present or turn the lights off when rooms are unoccupied were carefully developed balancing user comfort, daylight harvesting and occupancy controls.

**Efficient Appliances.** General appliances such as pantry refrigerators, ice machines, lab coat washer/dryers, etc. were screened and selected based on their energy performance.
Commissioning and Operation. This building has undergone enhanced commissioning, a methodical process to ensure that the building functions as intended and will be checked regularly through ongoing measurement and verification. The University is working with the Cx consultant and design team to define operational tests that optimize the operational settings (combinations of chilled water supply temperatures and humidity control settings, etc.) for energy savings and comfort.

Electrical Generation. Three roof areas are reserved for future on-site photovoltaic (PV) panels and conduit pathways connect them to the main electrical room. The campus is also reviewing dedicating some of the production capacity from the South Entry Parking PV array to serve a portion of the building’s electrical demand.

Materials
Materials have been specified to maximize recycled content, use renewable materials, use regional materials to reduce transportation energy use, minimize embodied energy, eliminate use of toxic materials, minimize off-gassing of chemicals in the building, and increase their recyclability.

Material Reduction through design. Designing components for multiple functions was a prime design goal. The radiant ceiling panel in the closed offices doubles up as the interior light shelf and triples up as the mounting for the direct/indirect ambient light fixture. This combination reduced material usage and improved the performance of both the panels and the light fixture.

Recycled Content. Materials such as paving, concrete (fly ash), steel, and insulation included in the building were selected for high levels of post consumer and post industrial recycled content resulting in over 31% of the construction material (on a cost basis) being recycled material. Material recycling by the building occupants is also well supported with five recycling stations on each floor.

Regional Content. In order to reduce the environmental impacts of excessive transportation of construction materials, regional materials were selected whenever possible. On a cost basis, over 24% of the materials were manufactured and had their raw materials extracted within 500 miles.

Waste Diversion. Diverted construction wastes include all concrete and asphalt from the site clearing, which was crushed and re-used on site, recyclables sorted onsite, which were hauled to a recycling center. This contributed to the project diverting over 96% of the construction and demolition waste from the landfill.

Sustainable Wood. Finally, to ensure that the building supported healthy forestry practices, over 75% of the wood materials used on the project were harvested from sustainably managed forests certified by the Forrest Stewardship Council.
**Indoor Environmental Quality**

**Indoor Air Quality.** High indoor air quality was targeted in the design with higher than typical ventilation rates and good design details that ensure delivery of that ventilation to the occupants. This quality was supported during construction by using products with no or low levels of volatile organic compounds, keeping the ductwork sealed during construction, and flushing the building with outside air prior to occupancy. Carbon dioxide (CO₂) sensors in the seminar room monitor the room occupancy and increase the amount of air delivered to these rooms when the number of occupants increases.

**Daylight.** Daylight, over electrical, is an almost universally preferred mode of lighting and therefore improves the indoor environment. Solar energy in the form of daylight is brought in by perimeter room windows. Strategic building orientation and sunshade design allow the low winter sun to enter perimeter windows. Light shelves with reflective, light colors are located on the interior and exterior of the south facing offices, drawing natural light further into the building.

**Occupant Control.** Careful consideration of occupant needs to adjust their environment to optimize comfort resulted in a combination of operable windows, individual thermostats in the private offices and individual task lights and personal fans at all workstations.

**Innovation**

The project pursued innovations in green building education, green cleaning, and reducing paper use in the construction process through electronic document management which eliminated over 4 acres of paper from the bidding and construction process. The project used Building Information Modeling (BIM) extensively which allowed designing to tighter tolerances, which preserved higher ceilings and contributed to increased daylight in the spaces. The model was also used as the basis for Computational Fluid Dynamics (CFD) modeling of office and typical open lab spaces; it was used to model envelope, daylight and electric lighting alternatives, where attributes of each system were changed and the resultant effect on the other two systems was evaluated.

**References**

- Basic Building Information – *Section 1: General Information*