

WAR MEMORIAL HALL | VIRGINIA TECH | BLACKSBURG, VIRGINIA

PROJECT DESCRIPTION

Virginia Polytechnic Institute and State University, known as Virginia Tech, was founded in Blacksburg, Virginia in 1872. Considered a legacy building on campus, the headhouse of War Memorial Hall was built in 1924, and an addition was completed in 1972.

220,000 square-foot building houses

- Offices
- Classrooms
- Recreational sports
- Swimming pool
- Gymnasium
- Exercise and workout spaces

DESIGN CHALLENGES

- Maintain the building footprint
- Develop a "Wellness Hub" within the 1924 headhouse
- Introduce natural ventilation with operable windows and other means
- Cohesive facade aesthetic
- Increase building envelope performance by 30%
- Increase daylighting to a minimum of 40% sDA

DESIGN GOALS

- Heart of Campus** - A student destination for connection, collaboration, and a wellness community
- Stewardship** - Stewards through sustainable design that considers community safety, and carbon footprint
- Efficiency** - Mindful design that balance cost, spacial configuration, and energy consumption
- Integration** - Harmonize the unique character of a legacy building with modern technology to provide the best user experience

DAYLIGHTING

Solar Path Study

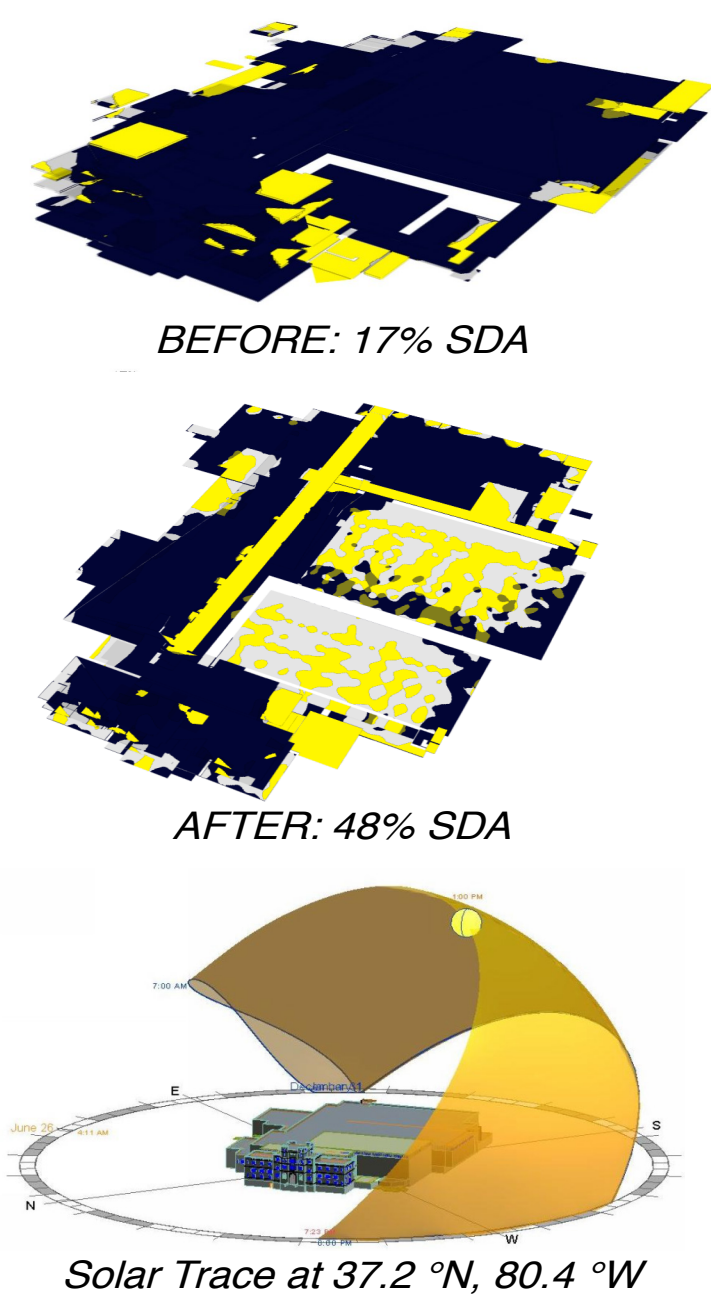
- Understanding how the sun will impact the building throughout the year based on its orientation

Spatial Daylight Autonomy (sDA)

- Existing design had a rating of 17% sDA
- Proposed designs have ratings ranging 43-48%

How Access to Daylight Improved

- Added vertical glazing to spaces on perimeter
- Offices and classrooms were arranged on exterior walls to allow for more windows
- A clerestory was added to the natatorium
- Skylights in the gymnasium



KNOWLEDGE & SKILLS GAINED

SOFT SKILLS

- Communication**
 - Digital
 - In-person
- Collaboration**
 - Decision making
 - Problem solving
- Organization**
 - File management
 - Schedule coordination
- Professionalism**
 - Presentation skills
 - Punctuality
- Teamwork**
 - Group ideation

TECHNICAL SKILLS

- Structural**
 - Software: RISA, Retain Pro, PROFIS Engineering Suite by Hilti, ENERCALC, RSMeans, Microsoft Excel
 - Expansion joints applications with existing structures
 - Braced frame distribution along diaphragms
- Mechanical**
 - Software: Trane, TRACE 700, EnergyPlus, EnergyCAP, Pottorff Acoustic Information Model (AIM)
 - Geothermal loop
 - Water-cooled heat recovery VRF Design
 - Historical preservation and facade development
- Electrical**
 - Software: 3DS Max 2019, AGI32, SKIM Powertools
 - Electrical system design
 - Lighting design
 - Telecommunications and special system design

MULTIDISCIPLINARY PARTICIPATION

STRUCTURAL

- Gravity System**
 - 4.5" concrete over 2VLI19 metal deck
 - Composite steel beam supported by steel columns
- Lateral System**
 - Steel brace frames to prevent story drift
 - Steel moment frame to integrate with architectural layout
- Foundation System**
 - Spread footings and continuous retaining wall footings
 - Helical piles and shallow foundations (another team) to minimize disruption to 1924 structure
- Specialty Items**
 - Redicor stairs
 - Counterfort retaining wall
 - Long span steel trusses
 - Long-span DLH roof joists in gymnasium (another team)
 - Connector Link uses structural stair stringers for movement between different floor elevations in the headhouse and addition (another team)

ELECTRICAL

- Power System**
 - 2500 A 480 V electrical service
 - 200 kW generator serving standby loads and fire pump
- Lighting Design**
 - "Virginia Tech invents the future but does not forget the past" drove the design as the concept
 - Lighting controls for user experience and energy conservation
- Fire Alarm System**
 - IP televisions
 - Two remote annunciators
- Telecommunication Systems**
 - Rack-mounted UPS System
 - Stacked telecommunication rooms for efficient cable usage

MECHANICAL

- Hybrid System**
 - Geothermal primary loop with water source heat pumps
 - Heat recovery water-cooled VRF secondary loop
- Heat Recovery**
 - Condenser water loop
 - Natatorium air handling unit with heat exchanger to pool
- Rain Water Harvesting**
 - Cistern for cooling tower make-up and low flow fixtures
 - Greywater plan for hose bibs, and irrigation (another team)
- Chilled Beam System (another team)**
 - Uses heated and chilled water to condition room neutral air provided by dedicated outside air units for offices and classrooms
- Acoustic Designs**
 - Mitigation of noise and vibration-inducing HVAC equipment
 - Highly absorptive material selection for loud spaces

FACADE PERFORMANCE

Two components improved the building envelope thermal energy performance by 33%.

Phase Change Insulation

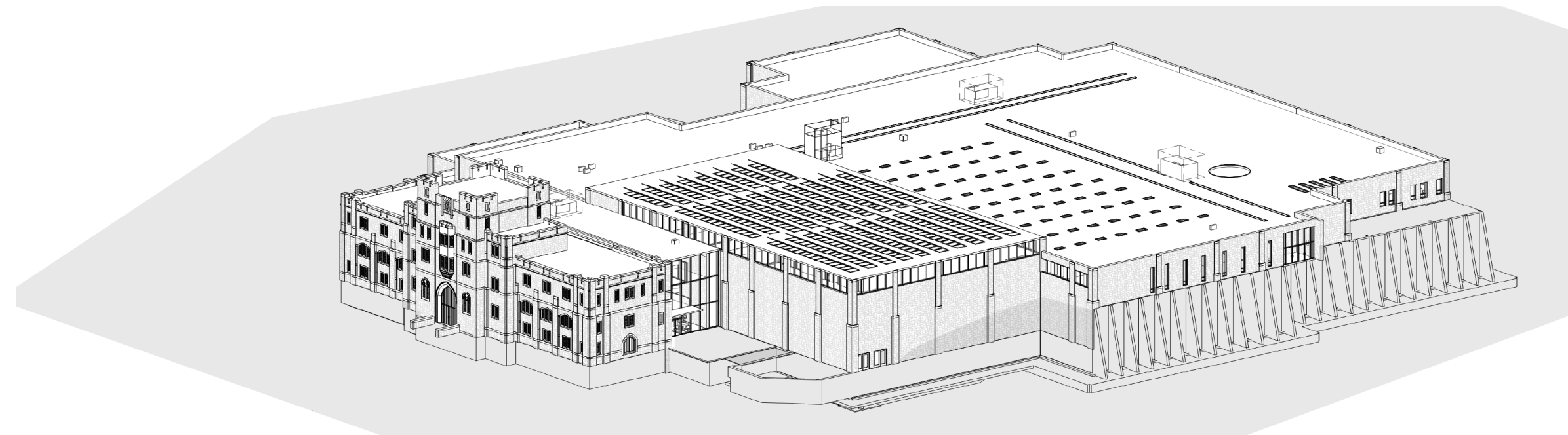
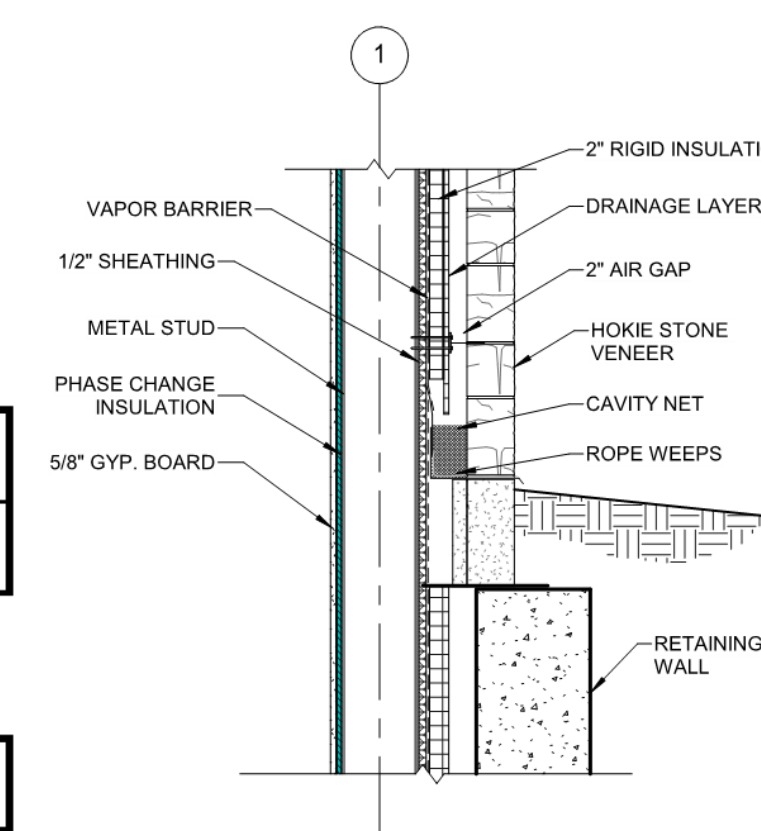
- Reduces energy costs by as much as half
- Increases thermal comfort during occupied hours
- Sourced from non-toxic materials

Honeycomb Glass

- Reduces glare within the Link
- Improves thermal performance with diffused daylight

Type	Profile	Cooling (BTUH)	Heating (BTUH)
1972 Façade (WTWR=0.07)	Window Solar Loads	2770	0
	Wall Transmission	340	2325
2020 Replacement Façade (WTWR=0.26)	Window Solar Loads	449	2742
	Wall Transmission	2577	0
	Window Solar Loads	2577	0
	Wall Transmission	260	1062
	Window Solar Loads	381	1657
	Wall Transmission	381	1657

Performance in Cooling Mode:	11%
Performance in Heating Mode:	66%
Climate Heating Hours:	4150
Climate Cooling Hours:	1154
Year-Round Performance:	33%



NATURAL VENTILATION

Foehn Winds

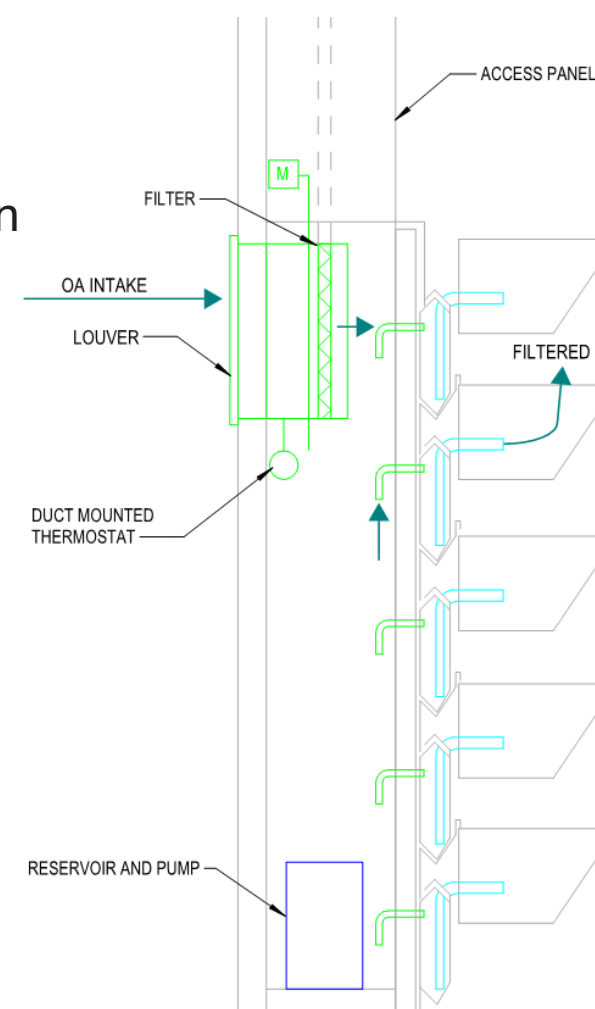
- Strong, warm, dry wind off of the Appalachian foothills
- Adds fresh air to most of the building
- 845 hours of natural ventilation in gym (another team)

Active Green Walls

- Used in highly trafficked areas
- Introduces fresh air while removing carbon

Operable Windows

- All exterior offices and classrooms are equipped with these for individual climate control



INDUSTRY COLLABORATION

Three similar student teams were paired with professionals in allied fields to create a robust collaboration between industry mentors and engineering students to help identify problems early in design, brainstorm solutions and to verify work. Communication occurred in scheduled class time through video conference or in person, at weekly discipline design meetings at the professional's offices, and less-formal e-mails for occasional guidance.

INDUSTRY MENTOR TEAM MEMBERS - 44 by DISCIPLINE

- | | | | |
|----------------------------|----------------------------------|---------------------------------------|---------------|
| Electrical Engineer (8) | Lighting Engineer (2) | Energy Modeling Engineer (1) | Architect (7) |
| Mechanical Engineer (8) | Structural Engineer (8) | Central Plant Mechanical Engineer (1) | |
| Acoustical Engineer (1) | Cyber Security Engineer (1) | Natatorium Mechanical Engineer (1) | |
| Code Review Specialist (4) | Historic Preservation Expert (1) | Mechanical Construction Engineer (1) | |

AE STUDENT TEAM MEMBERS - 29 by ACADEMIC EMPHASIS

- | | | | |
|-----------------|----------------|---------------|-----------------|
| Structural (11) | Mechanical (3) | Acoustics (3) | Electrical (12) |
|-----------------|----------------|---------------|-----------------|

VALUE OF EXPERIENCE

\$950,460

\$2,031,195

\$2,981,665

INDUSTRY PROFESSIONALS

STUDENTS

TOTAL

HOURS WORKED

6,132

21,381

27,513

HEALTH, SAFETY & WELFARE

Community Environment

- Wellness Hub at the Heart of Campus empowers students to live healthy lifestyles
- LEED Silver certification with 55 points from sustainable design elements
- HVAC noise and vibration mitigation
- Considered construction vibrations to reduce disruption

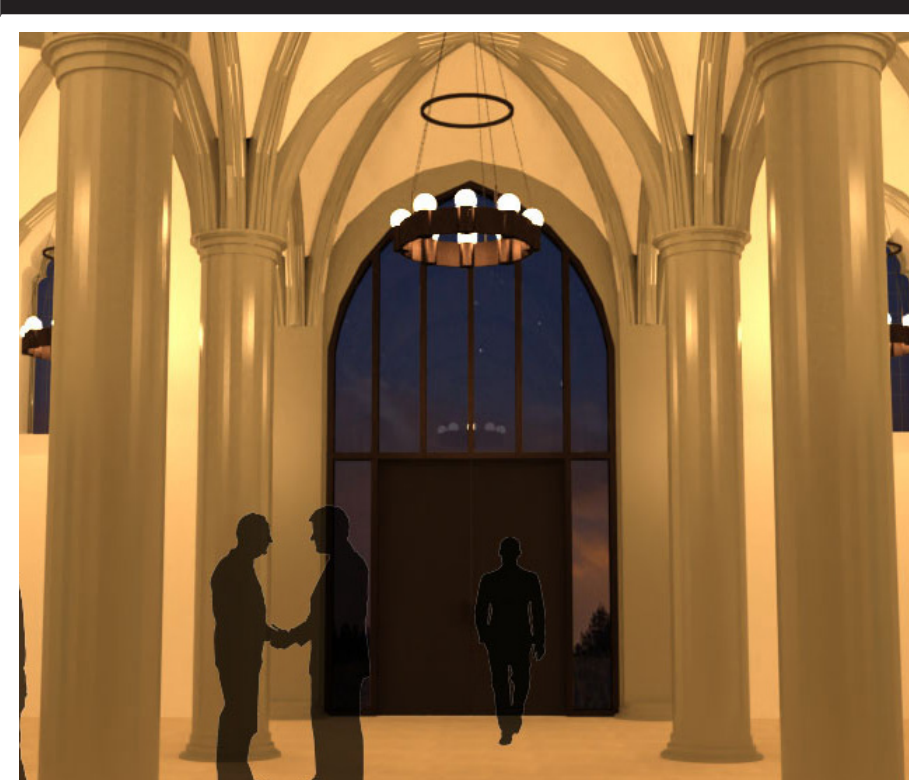
Fire Protection

- Fire wall separating the existing 1924 and newly reconstructed addition (another team)
- Fire pump serve to fully sprinkle the building
- Fire alarm annunciator panels at each main entrance for fire department accessibility

Security & Emergency Conditions

- Active shooter detection system in main corridors and gathering spaces (another team)

LIGHTING RENDERS



MEMORIAL ENTRANCE



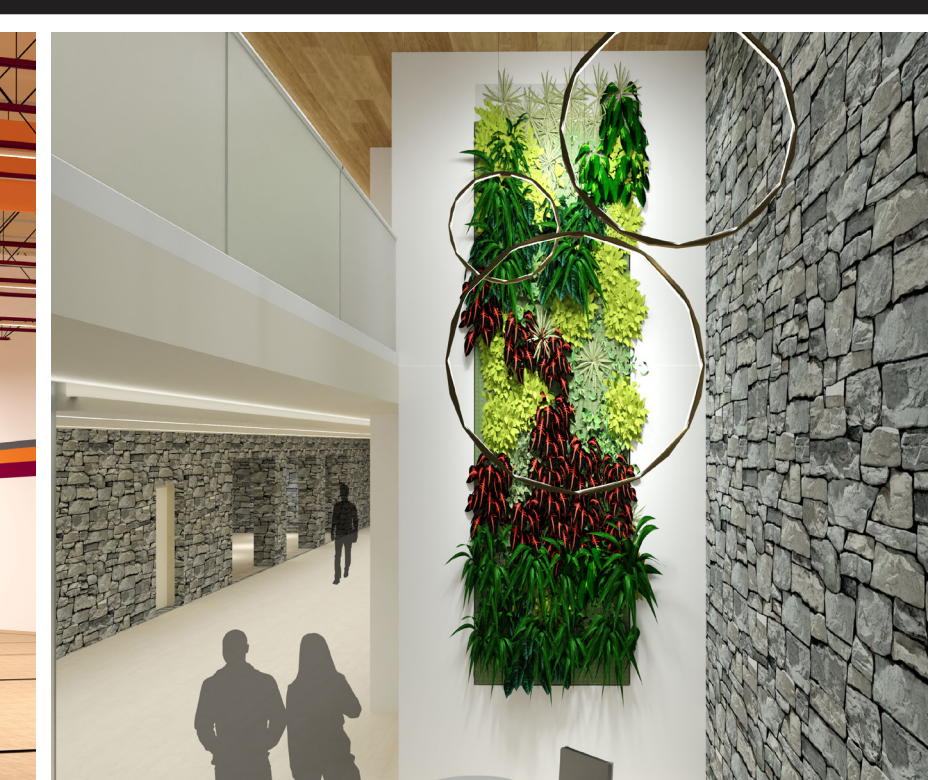
NATATORIUM



FACADE



GYM



GREEN WALL

PROJECT ISSUED

COORDINATION PLAN

CODE ANALYSIS

SCHEMATIC DESIGN

DESIGN DEVELOPMENT 1

DESIGN DEVELOPMENT 2

CONSTRUCTION DOCUMENTS

JULY 2019

AUGUST 2019

SEPTEMBER 2019

OCTOBER 2019

DECEMBER 2019

FEBRUARY 2020

APRIL 2020