MIAMI VALLEY HOSPITAL

HEART AND ORTHOPEDIC CENTER

DAYTON, OHIO

nbbj

A NEW CHAPTER ON EFFICIENCY

Using Lean design principles and Lean construction methods, the new Center challenges the assumption that there must be a trade-off between time, cost and quality.

MIAMI VALLEY HOSPITAL
HEART AND ORTHOPEDIC CENTER
Dayton, Ohio

CLIENT **VISION**

As demand at Southwest Ohio's busiest cardiac care center continued to grow, Miami Valley Hospital sought to increase capacity and consolidate operations into a single state-of-the-art facility. The transformation would redefine the patient experience, embrace advanced methods of care, and position the hospital as an accessible and engaging community landmark.

DESIGN **BREAKTHROUGH**

NBBJ drew on experience from vastly different building types to drive innovative solutions. For example, the patient floor design took a page from corporate offices with a double-loaded corridor and modular, centralized caregiver stations. This resulted in reduced travel times and increased visibility into the rooms.

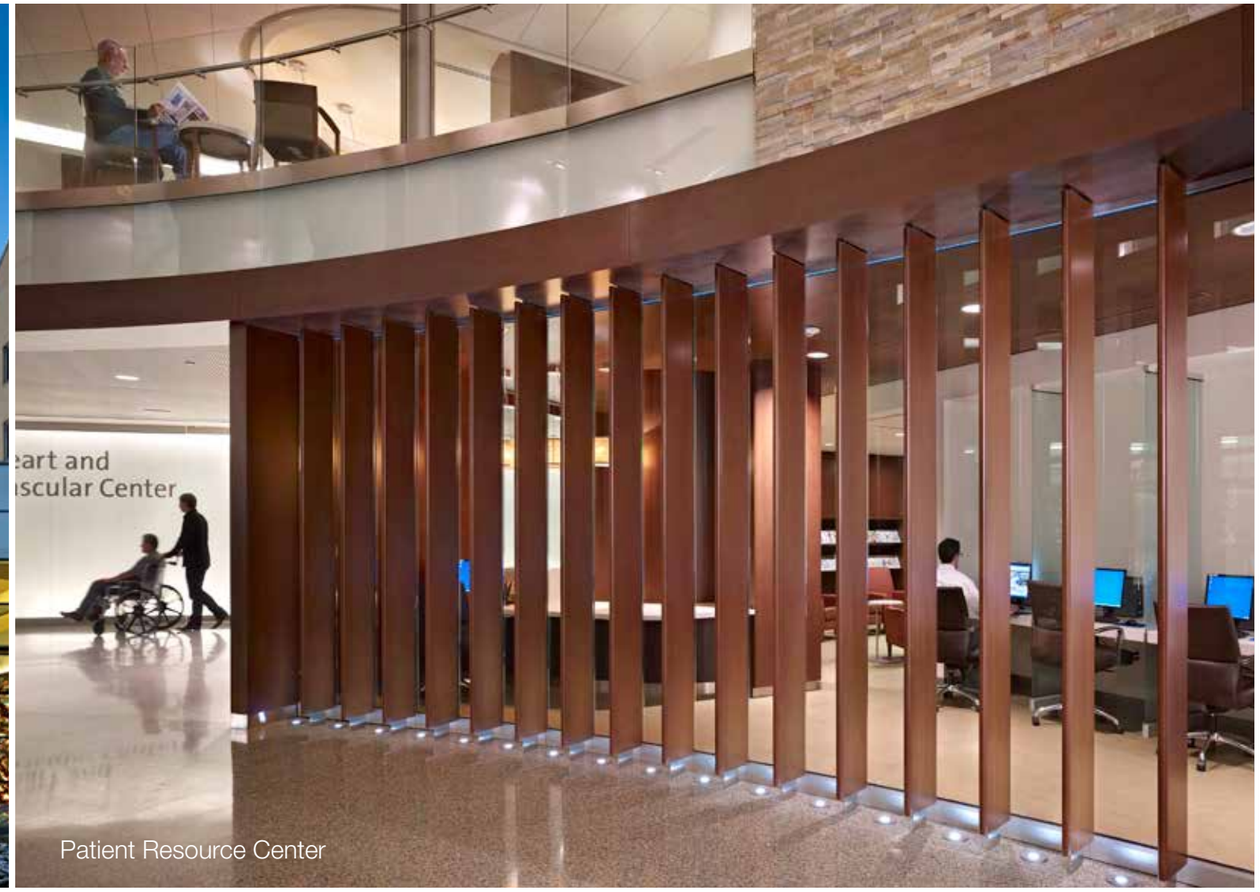
ORGANIZATIONAL **VALUE**

The use of Building Information Modeling (BIM) to test new ideas for patient experience and a Lean construction approach resulted in a savings of over $1 million and a two-month reduction in schedule. Applied research on patient room configurations reduced patient transfers by 66%, and increased the time clinicians are able to spend with patients.

SPRINGBOARD **INSIGHT**

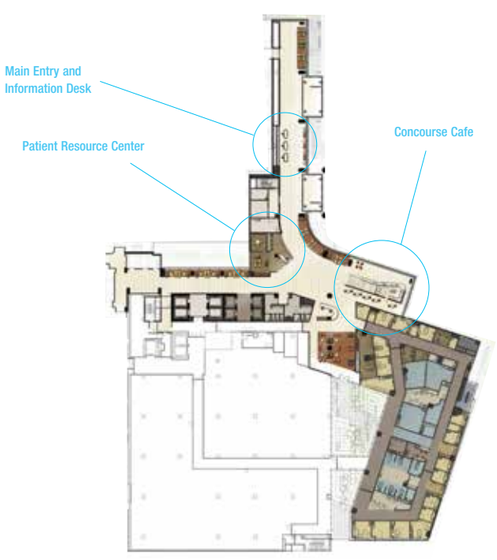
When the facility and delivery process are designed together, they better reveal and support client goals.

Main Entry



Patient Resource Center

Information Desk



A WELCOMING GESTURE

As Dayton's busiest cardiac care center, Miami Valley Hospital struggled to deliver advanced care in three 1970s-era facilities. Premier Health Partners was eager to integrate state-of-the-art practices into the hospital's daily operations and, at the same time, manage costs and minimize waste when it sought to add a new tower. NBBJ seized on the opportunity to rethink patient floor design and flows, pursue a collaborative prefabrication strategy and green the campus.

The tower addition is designed with a flexible and clear circulation system. An improved lobby experience, new entries, exits and traffic protocols were created. Previously, all people and material flowed through the front door: doctors, staff, arriving acute care and discharged patients, food, flowers, lab results and more. With a new loading dock for commercial traffic, a dedicated entry for doctors and staff, and separate exits for dischargED patients, the main entrance lobby—now with a fireplace, lounge and café—is dedicated to patients, family and visitors.

The existing central courtyard which had been congested with vehicular traffic was significantly increased in area and developed into a pedestrian-friendly park. Vehicles were removed from the center of the court, and the existing front drive was transformed into planted gardens with stone pathways, a waterfall and rolling brook.

PROTOTYPING AND TESTING

The $137 million facility is the first major hospital project in the U.S. to use components prefabricated off site within a field-built hospital structure. Prefabrication yielded higher quality construction, a safer work environment and a faster construction schedule.

Already a well-established practice in Europe, prefabrication is on the leading edge of Lean design and construction trends in the United States, with interest growing among architects, engineers, construction managers and owners. In the right hands, prefabrication is an innovative method offering potential for an accelerated project schedule, increased quality, increase safety and reduced construction waste at a reduced cost.

1: BIM IN THE DESIGN PHASE

Image A:
NBBJ initially used Building Information Modeling (BIM) to investigate the feasibility of prefabricating the patient room as an entire portable volume.

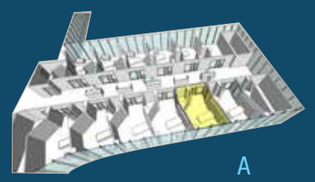
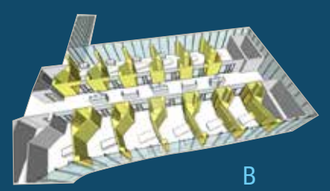
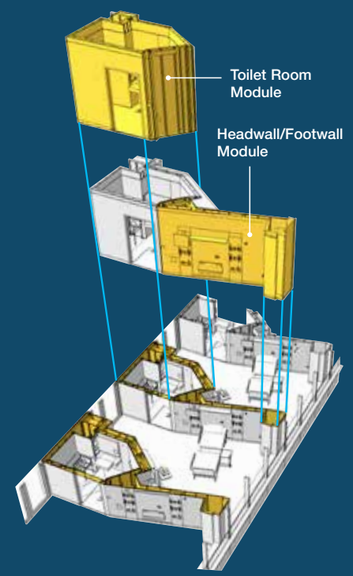


Image B:
This first approach was quickly replaced by a more efficient and cost-effecitve concept that explored the prefabrication of individual room components.



2: COMPONENT-BASED PREFABRICATION

The design team broke apart the patient room into four modules that could be prefabricated individually: a toilet room module, a headwall/footwall module, a casework module and an MEP rack module.

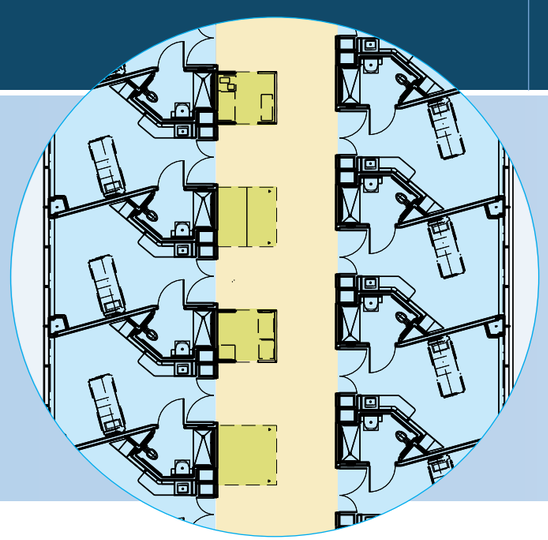


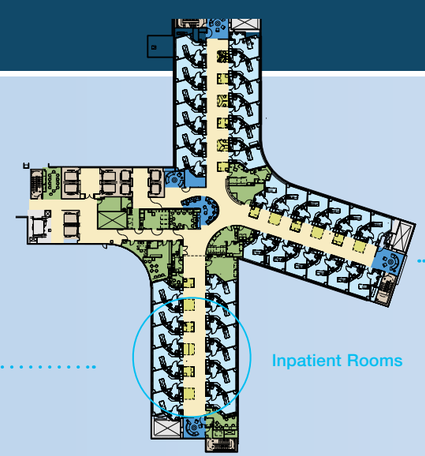
3: LARGE SCALE PROTOTYPING

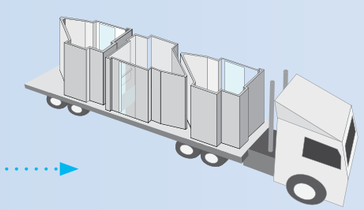
To further refine and test the design, the team built mock-ups of rooms and spaces so that they could test, in real time and at full-scale, how they functioned.

4: USABILITY TESTING

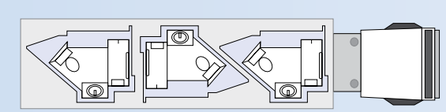
The full scale prototype was also built to allow clinicians to experience the physical form and evaluate how it worked or didn't. As a result, certain fixtures were repositioned to make patient care and maintenance easier.







In order to save the cost and time that would have been spent securing special permits for oversize loads, all components were designed to fit like interconnecting puzzle pieces onto a standard flatbed truck.



PREFABRICATION TO CONSTRUCTION

Components built off site in a warehouse afforded a higher quality construction environment, which allowed for tighter tolerances, less waste, no injuries and lower labor costs. One hundred and seventy-eight patient rooms and 120 overhead MEP racks (mechanical, electrical and plumbing assemblies) were constructed virtually in BIM and then assembled in a warehouse before being transported to the worksite. This approach had several advantages: the prefabrication process was up to three times faster as the small crew of workers could cut, weld, and inspect at ground level without exposure to weather.

5. DEMOLITION

Image A
Two buildings on campus needed to be demolished, requiring a pedestrian bridge to allow hospital traffic to continue between buildings on either side. The construction of this bridge would have normally created 4 to 6 months of disruption to entry traffic and cost an estimated $2.1 million.

Image B
The team came up with an alternative solution. A bridge, manufactured for airport jetways, was constructed offsite, and installed in three days with no disruption in foot traffic, at a cost of $980,000.

6. PREFABRICATION

The BIM-designed patient rooms and overhead MEP racks were assembled in an empty furniture warehouse less than three miles from the hospital before being transported to the work site.

The overhead racks could be fabricated on the floor, rather than on a ladder, which allowed for 360 degree inspection of work. System leaks were also easier to detect and repair.

7. DELIVERY

With little room at the construction site to store components, workers employed just-in-time delivery of the modules from the prefabrication warehouse to the hospital.

8. ON-SITE CONSTRUCTION

The construction schedule was de-sequenced, which allowed interior subcontractors to work at full speed before ironworkers had completed the structure. This new approach reduced the overall schedule by over two months.

Ductwork, dampers, sprinkler piping, medical gases and offshoots to patient rooms were constructed and positioned identically on each floor. In the future, maintenance personnel will know exactly where to work on them.

COST SAVINGS AND INCREASED

300% INCREASE IN PRODUCTIVITY

On a conventional job site, a plumber's installation quota is 200 feet of pipe per day. Plumbers in the warehouse shop were installing 600 feet of pipe per day.

0 SHOP INJURIES

Worker safety was greatly improved by the clean, well-lit, temperate warehouse environment where the fabrication took place.

2% SAVINGS ON BUILDING COSTS

Prefabricating key components sliced 2% off the building cost.

$1.3 MILLION IN SAVINGS

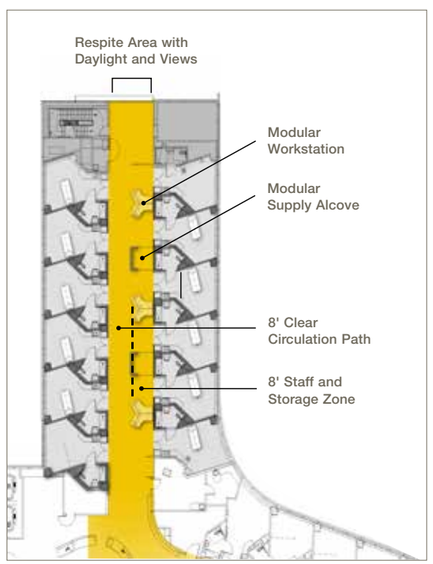
$1.3 million in construction costs were saved by implementing a temporary jetway pedestrian bridge.

14% MORE ENERGY EFFICIENT THAN TRADITIONAL CONSTRUCTION

Materials were ordered to length, significantly reducing waste—less than one dumpster was filled at the warehouse shop.

35% FABRICATED OFF-SITE

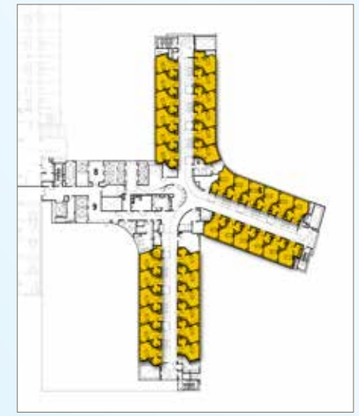
Constructing 35% of the project off-site was three times faster, and helped sliced more than two months from the 30 month schedule.



OPEN CORE NURSING UNIT

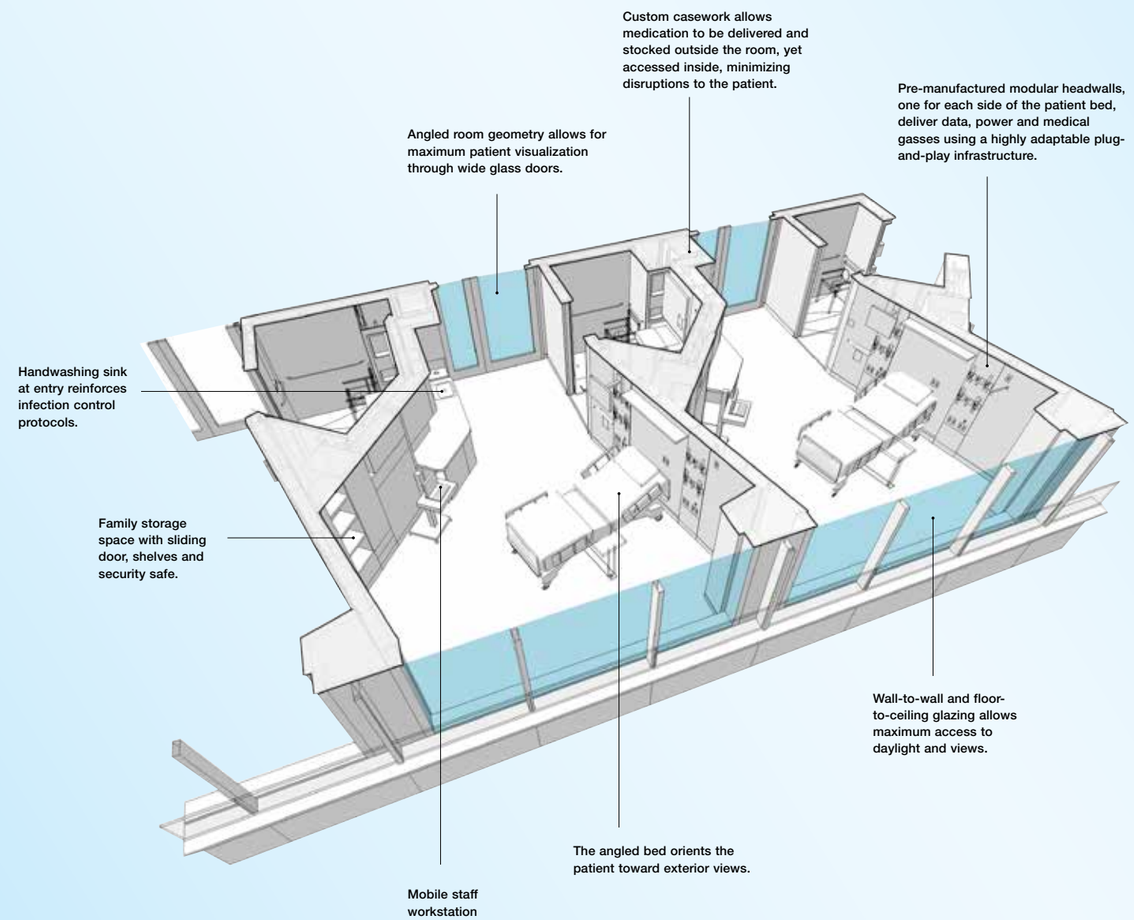
During the planning phase, the client and design team established criteria to increase visibility, access and communication between patients and staff on the inpatient floors. The result was a patient floor design with a flexible open core that departed from the traditional “race track” format. Sixteen-foot wide hallways with patient rooms on both sides turned the entire corridor into a caregiver workspace. Staged supply locations were placed throughout the floor, establishing a distributed core and reducing travel distances.

A MODULAR APPROACH Millwork and sheetrock, the typical solutions for workstations, did not meet the criteria for flexibility. Instead, the design team sourced “corporate” systems furniture for both the caregiver stations and the storage enclosures. Both can be easily reconfigured to the near-term needs of nurses and physicians, and the modular flexibility ensures that they will remain highly functional as staff needs evolve.



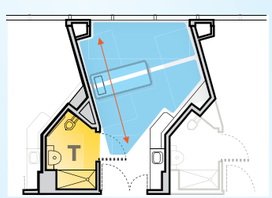
STANDARDIZED PATIENT ROOMS

The MVH bed tower contains 178 identical private rooms on five identical floors. This degree of standardization provides the flexibility to shift functions from floor to floor and reduces the need for patient transfers. Each room is same-handed to ensure patient safety and to streamline staff movements throughout the day.



ACUITY-ADAPTABLE The patient room dimensions, infrastructure and environmental attributes support the broadest range of patient types and clinical activities, making each room capable of flexing from low-acuity use for general medical-surgical functions, to maximum-acuity use for cardiac intensive care units.

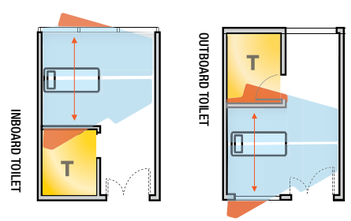
Miami Valley Patient Room



MAXIMIZED PATIENT CARE SPACE

The MVH room geometry maximizes the wingspan of the work zone around the patient's head and chest.

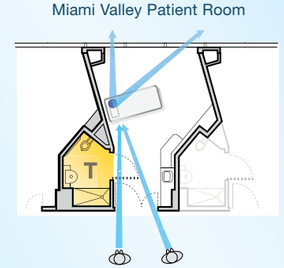
Conventional Patient Room



The traditional right angles of an average patient room configuration reduce the workspace around the patient.

VISIBILITY AND COMFORT Each of the private patient rooms are identical and same-handed for increased efficiency. The angled room geometry maximizes staff-to-patient visibility, while wall-to-wall and floor-to-ceiling windows allow the maximum amount of daylight.

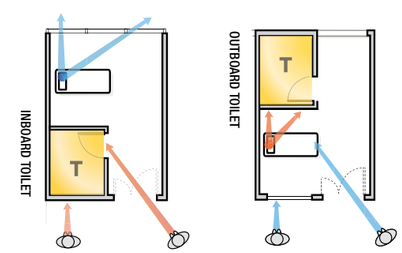
Miami Valley Patient Room



STAFF VISIBILITY AND PATIENT VIEW

The MVH patient room has excellent staff visibility. The bed angle is oriented to the windows for optimal connection to daylight.

Conventional Patient Room

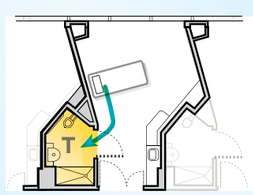


Staff sight lines are compromised in patient rooms with inboard toilets. Alternatively, patient rooms with outboard toilets impede patient views to the outside.

PATIENT SAFETY A 2007 study in *Infection Control and Hospital Epidemiology* showed that 79.5% of falls in hospitals occurred in patient rooms, 11% in patient bathrooms and 9.5% in hallways or exam/treatment rooms. Handrails lead directly from the bed to the bathroom (A, above), greatly reducing the risk of falls.

ACCESSIBILITY Staged supply locations are placed throughout each floor, establishing a distributed core and reducing caregiver travel distances. Custom casework (B, above) allows medication to be delivered and stocked outside the room, yet accessed inside, minimizing disruptions to the patient.

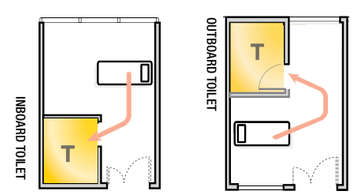
Miami Valley Patient Room



IMPROVED PATIENT SAFETY

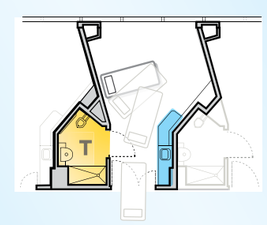
The MVH room geometry minimizes the patient travel distance from the bed to the toilet room, and provides a handrail for support.

Conventional Patient Room



In a traditional patient room, a patient must cross the room to access the toilet room.

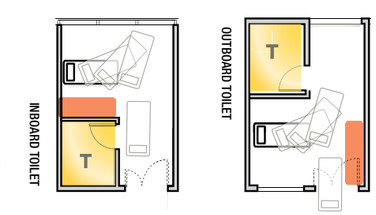
Miami Valley Patient Room



STREAMLINED PATIENT TRANSPORT

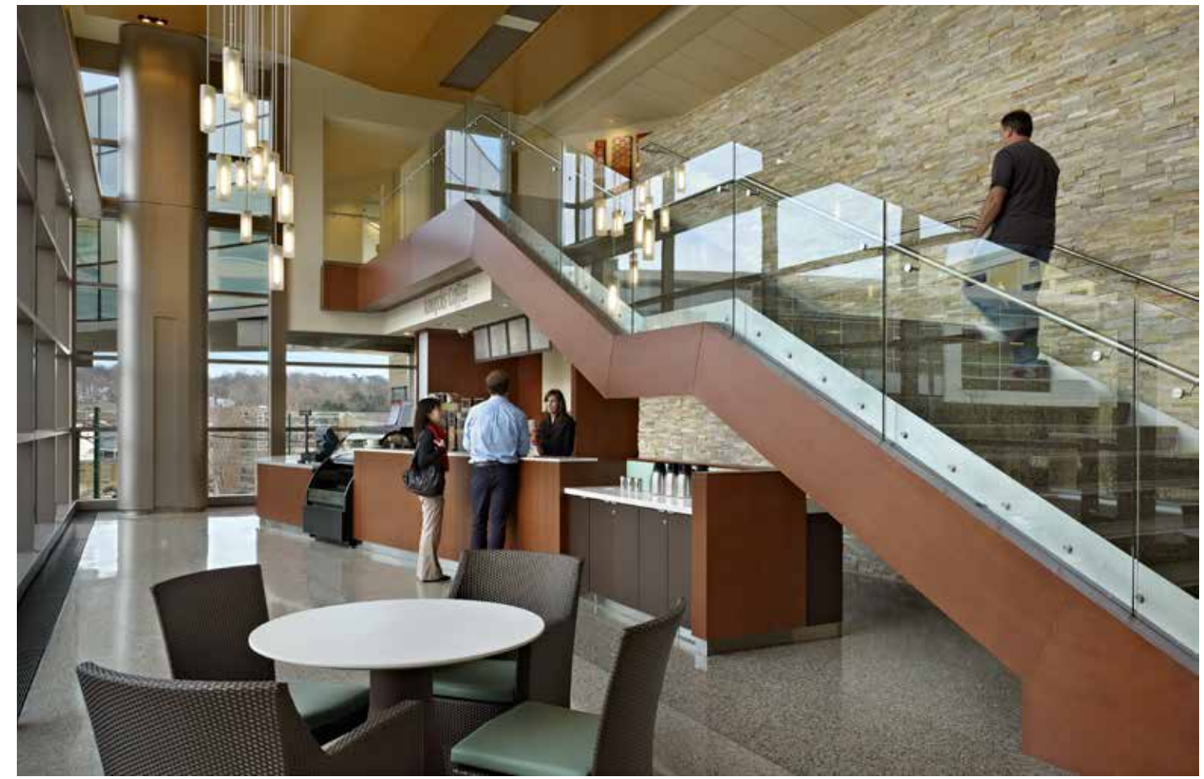
The caregiver station is positioned next to the room entry to allow maximum care space around the patient, and optimal bed maneuverability.

Conventional Patient Room



The caregiver station location compromises the work space around the patient, or the bed maneuverability, in a traditional patient room.

"We call it purposeful design. We are very proud of the number of clinical staff as well as ancillary caregivers who have been involved in the design of the building…Who knows better how to create a workspace to give the very best care?" —NIKKI BURNS, PROJECT DIRECTOR



54%

A 54% increase in campus green space resulted in a patient and visitor experience interwoven with nature.

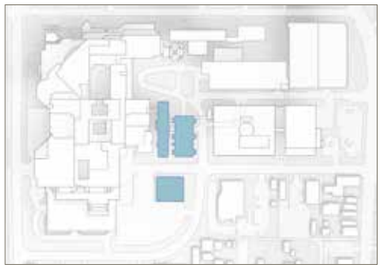
A NEW URBAN AMENITY FOR THE CITY OF DAYTON

The fundamental decision to simultaneously increase density and open the center of the campus was as much a sustainability decision as it was a planning decision. By creating a green space at the heart of the formerly congested campus and replacing existing facilities with a compact high-rise, the project provides a major amenity that connects visitors to nature.

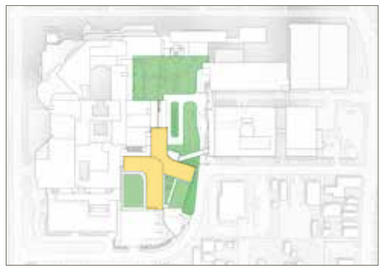
The MVH campus renewal created a destination that is a welcoming setting, open and green. By providing a transparent, open landmark paired with a public green space, MVH renews a promise to the city of Dayton to care for and enhance the lives of its community members.

Green space is woven into the overall experience. A water feature at the main entry provides soothing white noise and a new main entry courtyard greens what was once an asphalt lot. A staff garden located to the side of the new tower provides employees with an outdoor break space.

Before master plan

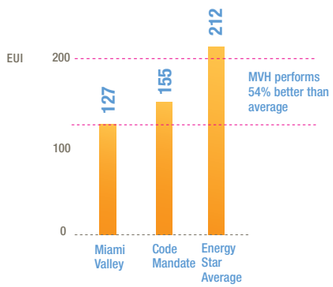


The original campus plan had minimal green space and a congested courtyard. The buildings highlighted in blue were demolished to clear a site for the new tower and green masterplan.

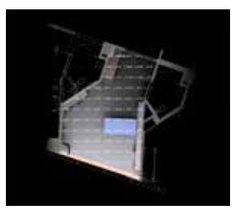


The tower (yellow) provides a new main entry for the campus with minimized vehicular traffic. This maximizes green space and provides a new urban amenity for the city of Dayton.

SOUTHWEST OHIO'S FIRST LEED® SILVER HOSPITAL



1 Energy Use Intensity (EUI) is the total amount of energy used by a building (electricity and/or natural gas) per square foot of floor area, measured on an annual basis to establish a baseline energy use. With an EUI of 127, MVH performs 54% better than comparable hospitals in the region.



2 The patient room model (above) analyzes the amount of light and intensity of exposure.

3 11,000 SF of green roof provides insulation and lowers the building's air temperature.

The sustainable strategies at MVH earned LEED® Silver certification, making it the first hospital in southwest Ohio to perform at this level of resource conservation.

To meet LEED® Silver requirements, the team targeted five key areas: site, energy, materials and resources, indoor environmental quality and water efficiency. Aggressive strategies were developed to drive down energy consumption. The team also tracked to the 2030 Challenge, a nationwide energy benchmark that seeks to achieve a dramatic reduction in buildings' greenhouse gas emissions by improving the way they are planned, designed and constructed.

ENERGY PERFORMANCE TESTING The complex systems of building facades require rigorous testing to determine performance before construction. A full-scale mock up of Miami Valley's facade design (image 4, right) was built and subjected to "real world" performance testing. The result was a building envelope that is 8% more energy efficient than required by code.

Where physical testing was cost prohibitive, typical design details were subjected to computer simulation modeling (image 5, right) of key connection areas. This allowed for the modification of details to correct problems and improve energy performance.

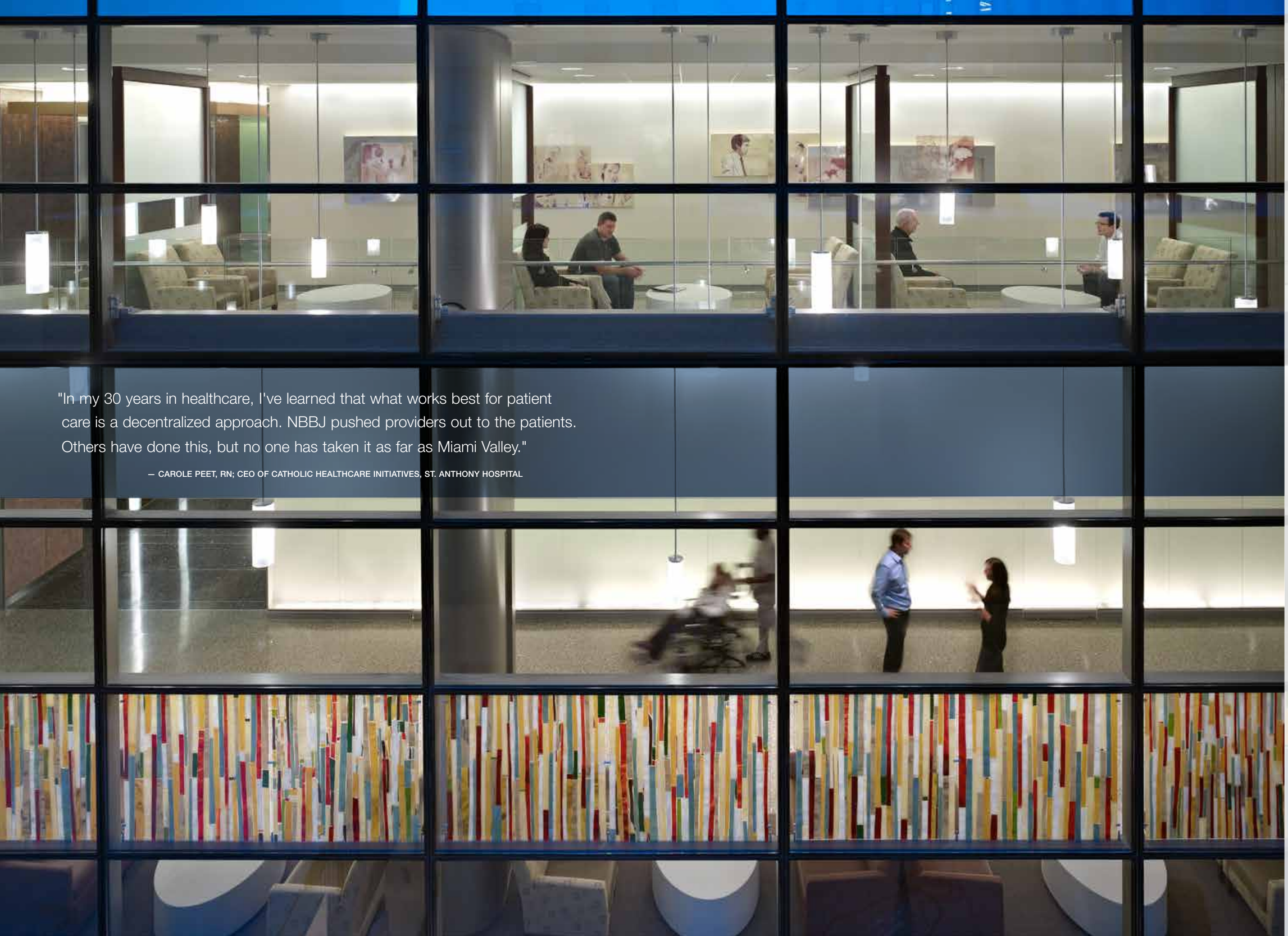
- The new MVH tower performs at an EUI of 127, or 54% better than a comparable hospital *(image 1)*.
- During construction, more than 75% of demolition and land-clearing debris was diverted from landfills and incinerators.
- Daylight harvesting *(image 2)* from extensive windows used in the tower design will reduce electrical lighting use.
- Materials used to construct the tower contain over 35% recycled content.
- Compared to building code, the tower reduces energy use by 18% with help from high-efficiency mechanical and lighting systems.
- The design reduces water use within the building by over 20% and 60% for landscaping.
- An aquifer-cooling system preconditions water for the chillers.
- A LEED "Innovation" point was awarded for creating a green housekeeping program that limits exposure of building occupants and personnel to potentially hazardous contaminants from cleaning products and procedures.
- An enthalpy heat recovery system extracts energy from hot air exhaust, saving energy in the winter and summer months.
- The tower roofs are designed with 11,000 square feet of living plants *(image 3)* that help reduce stormwater runoff.
- 40% of the materials used on the project were extracted, harvested, recovered or manufactured within a 500-mile radius of the project site.

4

A 'test-build' facade allowed contractors to work out kinks prior to construction by identifying and correcting problem areas.

5

The computer thermal analysis image indicates two-dimensional heat transfer, identifying trouble spots where heat could escape from the building envelope.



"In my 30 years in healthcare, I've learned that what works best for patient care is a decentralized approach. NBBJ pushed providers out to the patients. Others have done this, but no one has taken it as far as Miami Valley."

— CAROLE PEET, RN; CEO OF CATHOLIC HEALTHCARE INITIATIVES, ST. ANTHONY HOSPITAL

CLIENT
Miami Valley Hospital

SIZE
484,000 SF; 178 beds

COMPLETION DATE
2010

NBBJ SERVICES PROVIDED
Programming, planning, master planning, full architectural services, interior design, lighting design, environmental graphic design

AWARDS
Innovation in Building, Bentley Be Inspired Awards, 2009

PUBLICATIONS
Building Design and Construction, "Prefab Trailblazer," October 10, 2010

Engineering News Record, "Racking Up Big Points for Prefab," September 8, 2010

Healthcare Design, "How BIM Advances Cost-Saving Planning and Prefabrication," May 2009

SUSTAINABILITY
LEED Silver Certified

ABOUT NBBJ

NBBJ is an award-winning global design and architecture firm focused on helping clients capitalize on the relationship between people and the design of physical space to enhance organizational performance.

The world's leading healthcare providers trust NBBJ to deliver measurable and sustainable improvement in performance and care. Our teams have partnered with some of the leading healthcare institutions worldwide, including nine of the top 14 *U.S. News and World Report* Honor Roll hospitals. Within the architecture industry, NBBJ has been hailed as "Most Admired" by peers in *Interior Design*'s annual Healthcare Giants survey, and ranked as the second largest healthcare design practice in the world by BD World Architecture.

NBBJ's network of offices enables us to deliver quality projects that are regionally and locally appropriate. It allows us to act as a single creative force, leveraging the latest thinking from our NBBJ colleagues in other locations, bringing a rich blend of expertise to each project.

NBBJ SERVICES

Healthcare Consulting
Master Planning
Architecture
Interior Design
Financial Analysis
Project and Cost Management
Graphic Design and Signage
Space Planning
Programming
Land-Use Planning
Construction Administration
Retail Planning and Design
Facility Planning
Lighting Design
Change Management
Workplace Consulting