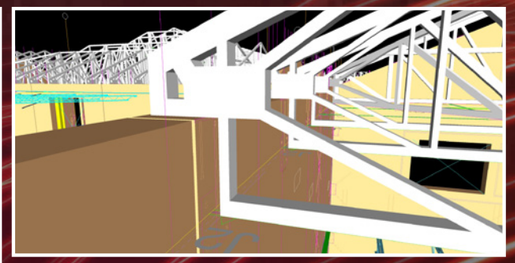
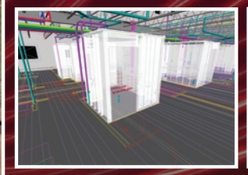
Innovation Speeds Warriors' Road to Recovery

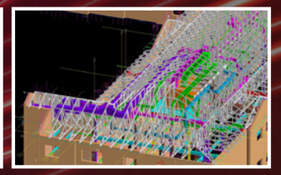
The Warriors in Transition (WT) program is designed to provide a healing and recuperative environment for wounded soldiers returning from combat. Due to limited existing facilities, soldiers were being placed in hotels and other facilities that were not consistent with the WT Unit's mission. The integrated design-build project team quickly understood that there would never be a more important and time sensitive customer for a project than this one. The team developed a "Soldier First" project motto, rallying around a vision that supported those who protect our freedom.

The resulting project design consisted of 80 two-bedroom units housing up to 160 recovering soldiers. The four-story, 96,400-square foot barracks are set up as two-bedroom apartments with shared bathrooms, full kitchens and living spaces. Each furnished apartment has upgraded laminate flooring, solid surfacing counter tops, wood cabinets, walk-in closets, and a washer/dryer. All of the first floor apartments comply with the Americans with Disabilities Act (ADA), while all remaining units are designed as ADA-adaptable units. Other quality of life enhancements include a landscaped courtyard, meditation garden and a large multi-purpose room ideal for group social functions.

Ground breaking for the WT Barracks.







Top: Roof Truss to Precast detail model. Bottom Left: Bathroom module fabrication model. Bottom Right: Roof truss MEP coordination model

The team employed the latest in Building Information Modeling (BIM) technologies during both the design and construction of the project, driving improvements in quality, safety and schedule.

The creative project approach resulted in a project cost well below the construction cost limit, enabling incorporation of numerous additional sustainable design features. A U.S. Green Building Council LEED Gold certification is anticipated.

Project award and design commencement occurred in May 2010. Construction began in August 2010, and was substantially completed in September 2011, **a full 10 weeks ahead of the government's schedule.**

Top left: Model based rendering of courtyard. Top Right: Front Entry 'knuckle' model based design rendering. Middle: Prefabricated Roof Truss on the ground. Middle Right: Prefabricated Roof Truss lifted into place. Bottom Left: Common space- model based rendering. Bottom Right: Bathroom module installation process.

Architect's Statement:

We understood that the success of the project required utmost commitment from every team member, from the owner's representative, contractor, architect and engineers, product suppliers to the foreman at the site. Having an efficient manner to share and update project information with the entire team was paramount to achieving this success. Our team was able to do that through the innovative use of Virtual Design and Construction. Our Building Information Model provided a collaborative platform to be created and used by all team members within a very short period of time, and conflicts were resolved long before they could hinder the construction schedule.

Contractor's Statement:

To address the schedule and quality challenges and risks that were identified early on, the team came up with a design and construction strategy that was centered on an expedited design phase and pre-fabricating many key components of the building. To enable this strategy and ensure that the prefabricated components would assemble seamlessly throughout the construction process, the use of BIM was key.

To reach the team goal we leveraged many elements of VDC, including- site logistics, construction sequencing, phase planning, plan room computer interface, underground utility & MEP coordination. What really set this project apart is the early understanding of the need to implement old concepts (prefabrication) in a new and innovative way. The team not only focused on the need for expedited delivery, but also looked at improving the overall delivery quality to the end user and safety to the construction team.

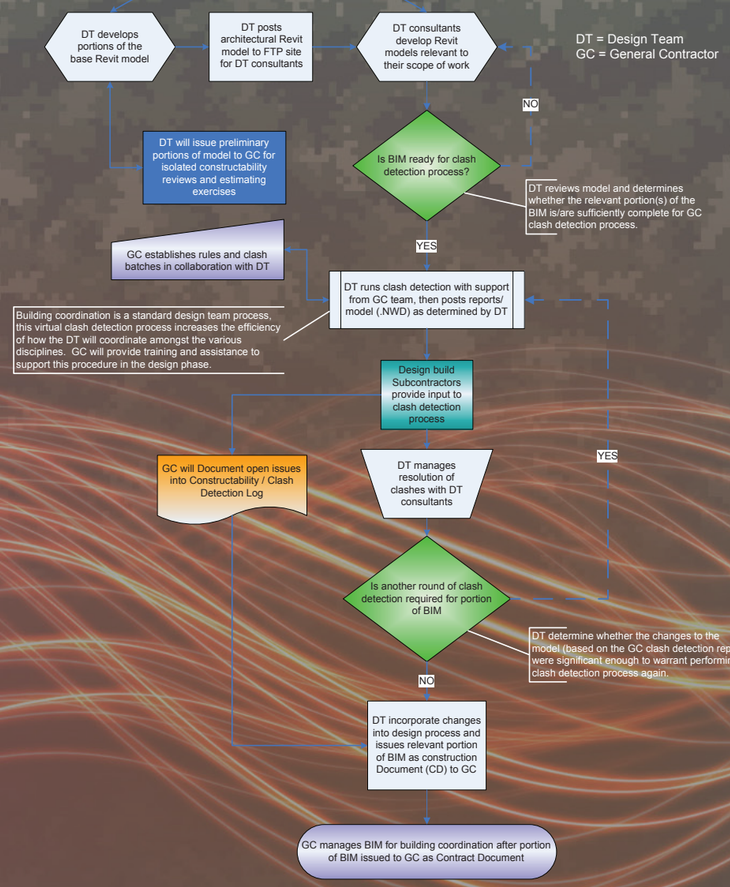
Owner's Statement :

Although creation of a BIM model was a Contract Requirement, the creation of the model proved to be an invaluable tool during both the design of the facility and then into the construction phase. The model minimized conflicts eliminating related change orders, allowing us to leverage cost saving to upgrade the quality of the project. The contractor used new building methods and superior energy-saving design to make this LEED facility a model for others across the Army. The renderings produced from the BIM models were excellent and reflected the true representation of the finished project. They also promoted a real sense of anticipation from soldiers for the completed facility.

Leveraging BIM in Design- main entry (knuckle) model based rendering.

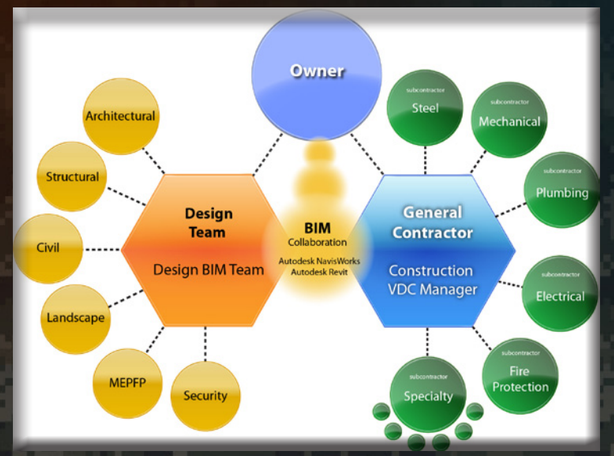
Leveraging BIM in Design- common space model based rendering.

Design Phase Building Coordination Process



Building Coordination VDC Process: addresses clash detection and resolution exercises for major building systems: Architecture, Structure, Mechanical, Plumbing and Electrical. All clash detection will be performed and documented with either Navisworks Manager or Solibri Model Checker.

Quality Tablet Interface



Overall collaboration realtionship

Quantifiable Results - Leveraging VDC Strategies Leads to Real Improvements

Schedule Savings

Design Schedule Savings (Actual vs Typical)

4.5 months

6.5 months

30% Savings

Construction Schedule Savings (Actual vs Contract)

15.5 months

18 months

14% Faster

Typical Plan Room Computer Interface

The WT Barracks saw a 50% improvement in field punchlist vs a comparable Barracks project.

Safety Results

Safety - Recordable Incident Rate
(Project vs Contractor vs Industry Average)

0.83 RIR - WT Barracks

1.36 RIR - Contractor

4.0 RIR - Industry Ave.

39% Improvement

Field Labor Risk Reduction (Drywall/MEP)

.70 - WT Barracks

1.0 - Comparable Project

30% Improvement

Field Punchlist

.50 - WT Barracks

1.0 - Comparable Project

50% Improvement

Sustainability Enhancements

PV Array (added via project savings)
Geothermal Field
Solar Hot Water
Waste Reduction
LED Lighting
Energy Modeling

Waste Reduction

.65 - WT Barracks

1.0 - Comparable Project

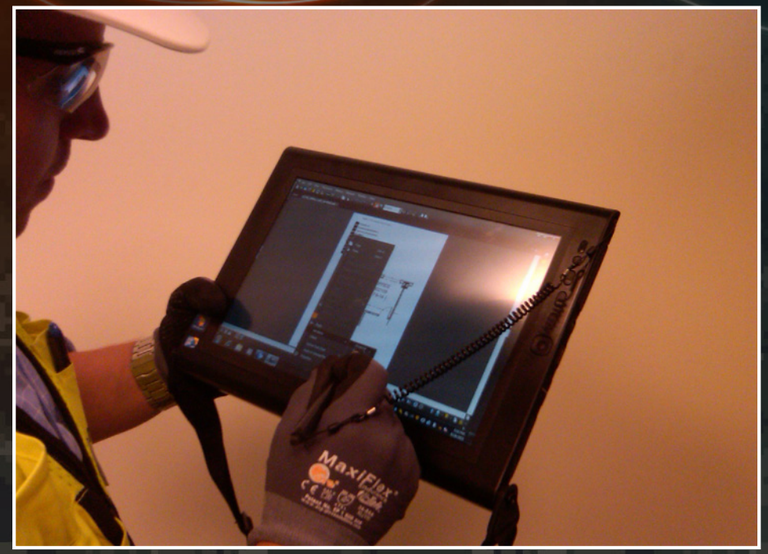
35% Reduction in Landfill Waste

Energy Modeling (Per SF/ Year)

27Kw/h - WT Barracks

50Kw/h - Comparable

46% Improvement



Tablet use- Getting information to the field

Project Narrative

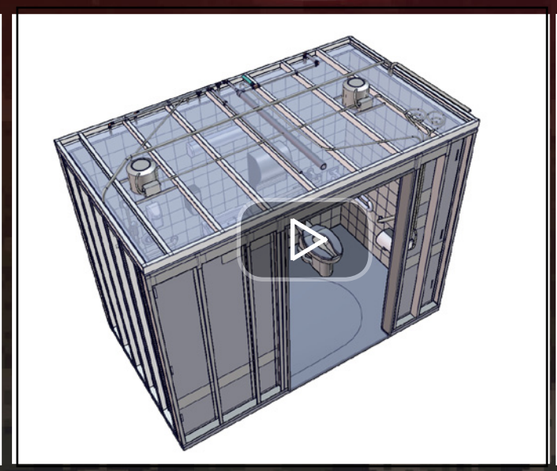
This project exemplifies the team's outstanding use of BIM technologies to facilitate a collaborative project delivery method, while meeting an aggressive design and construction completion schedule. The project was awarded as a design-build contract based on bridging documents provided by the government. The client's program for this barracks facility sought to provide a healing and recuperative environment for wounded soldiers returning from combat, and replace outdated and insufficient facilities currently being used. To meet the rising demand, the team was tasked with the challenge of completing the entire design and construction process within 18 months of project award. Under a traditional construction schedule, **much of the structural frame and exterior closure work would be occurring in the middle of the winter months.**

The team developed a design and construction strategy that expedited design and employed prefabricated key components of the building. To ensure that the prefabricated components would assemble seamlessly during construction, the effective and innovative use of BIM would be key. The following prefabricated components were utilized on the project:

1. **Load Bearing Precast Wall Panels** with internal insulation and integral thin brick and masonry. Incorporation of the thin brick masonry within the panels helped the team save significant site construction time and general condition costs by not having to field lay masonry during the winter months.
2. **Pre-Assembled Roof Truss and Deck Sections.** Large sections of the sloped roof trusses and metal decking were prefabricated on site during structural steel erection. This approach **reduced the overall schedule and safety risk** associated with working at heights on the roof.
3. **Pre-Fabricated Modular Bathrooms**. The team decided to use completely pre-built bathroom pods manufactured off-site in a controlled environment, which **reduced the construction time and provided superior quality.**

Due to the high percentage of prefabricated components used on this project, it was critical that all of the subcontractors and suppliers on the team would be able to provide building information models for their respective components. These could easily be "plugged-in" and accurately merged with the federated building model. At the same time, having this virtual design and construction (VDC) model allowed construction personnel to manage sequencing and activity workflow, resulting in a more streamlined construction schedule.

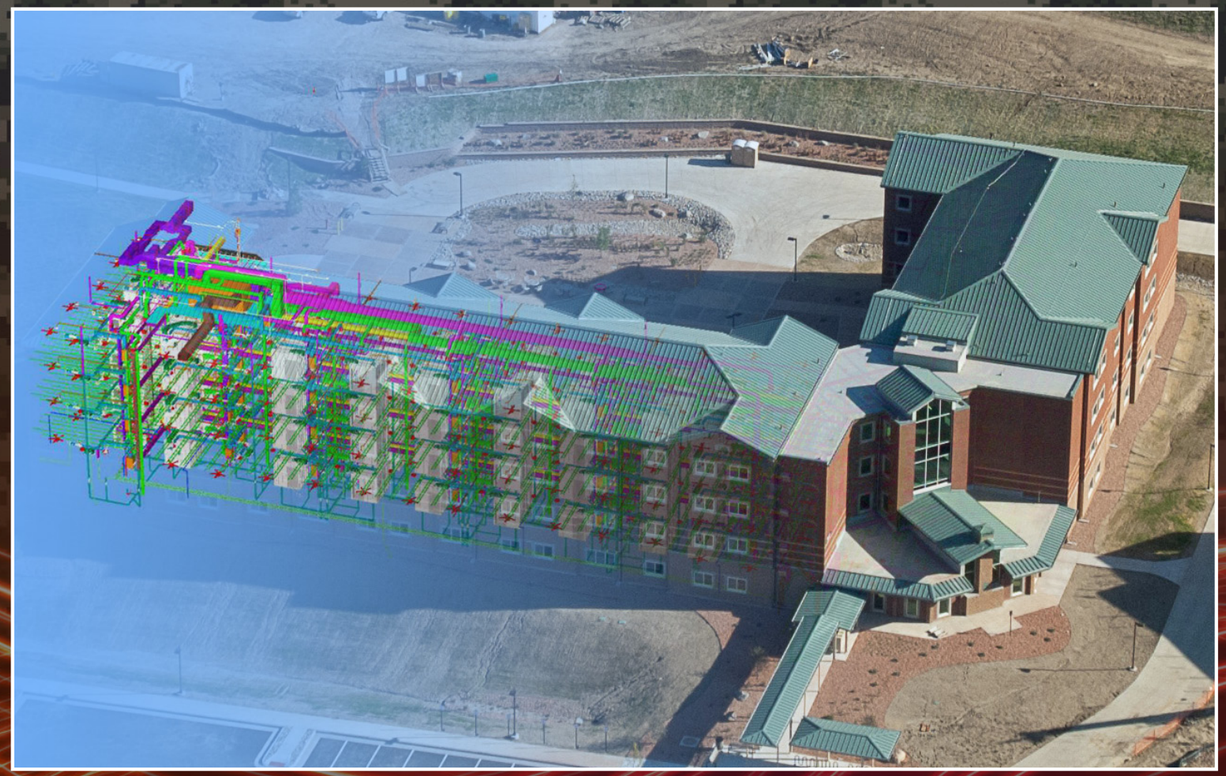
Precast/brick composite panels erection



The video above shows how VDC drives fabrication and the installation planning process.

Bathroom interior delivered as a finished space.

Top: PV Array. Middle Left: Reception desk. Middle Right: Lobby sitting area. Bottom Left: Solar hot water heating system on Mech. Room. Bottom Right: ADA Kitchen Unit/laundry closet.



Birdseye picture of completed project superimposed with MEP and bathroom modules.

The successful use of VDC in developing these designs and planning of prefabricated components provided the project with the following benefits and results:

- A compressed design phase of just 4-1/2 months. A more standard design timeframe would have resulted in a 6-7 month design phase.
- The project was fully enclosed with completed bathrooms in the building just 5 months after foundations were started versus 7-8 months under a more traditional process.
- General conditions costs were saved by not having to enclose and heat for winter masonry work. Savings were used to provide additional scope in the building.
- Project quality was enhanced. The high quality in the bathrooms and in the precast masonry work is readily apparent in the completed project, due in part to the dimensional consistency and controlled work environments that the off-site fabrication facilities afford. The amount of punch list items and time that it took to complete punch list work was reduced by 50% in comparison to traditional approaches.
- Significant labor was transferred off-site due to prefabrication (or from the roof to the ground in the case of the roof truss assemblies), reducing the project's safety risk, resulting in an overall project Recordable Injury Rate of 0.83.
- Overall project waste was reduced due to the efficiency of factory processes vs. job-site processes in the precast panels and modular bathrooms.

Comparing Two Barracks Projects

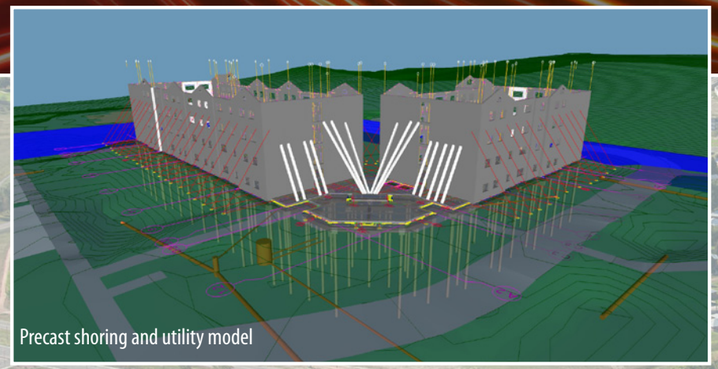
The project team initially intended to utilize prefabrication concepts to achieve schedule compression, improved on-site productivity and enhanced quality control. Other tangible benefits were also achieved. Colorado State University performed a comparative study between the Ft. Carson WT Barracks and a similar barracks project at another port. This study showed that the Fort Carson WT Barracks project used approximately 20% less on-site labor, which translated to significantly reduced risk for both safety and quality incidents. The efficiency of the prefabrication processes **generated 35% less landfill waste than the comparison project.** These types of lean delivery related benefits resulting from BIM enabled prefabrication support today's emphasis on "green" design and construction.

Collaboration was the Key to Success

Our team is extremely proud of the cooperative nature displayed during the execution of the project, the efficiency in the delivery of the project, the number of enhancements made to the program and in the quality of the completed facility. Our team's use of BIM in collaborative project delivery went far beyond meeting the government's requirement to deliver a record building information model and is central to the success of the entire project.

Organizational Impacts

The success of the technology and prefabrication concepts used on this project has had a direct impact on the contractor's organizational philosophy and approach to preconstruction services. Opportunities for prefabrication, technology and productivity advancement are now being modeled around the success of this project.



Precast shoring and utility model

Aerial view of WT Barracks site.