Some Results of the use of BIM and Lean Technologies and Processes on the Camino Medical Group Mountain View Project

How did the experience of working on this project impact some of the major members of the design and construction team?
Presentation Outline

- Introduction to Camino Med. Office Building Project
- Architect’s Perspective
  - Henry Mahlstedt, HPS Architects
- Builders’ Perspective
  - Dean Reed, Atul Khanzode, DPR Construction Co. (general contractor)
  - John Mack, Southland Industries (HVAC)
  - David Howard, Synergy Mechanical / formerly with J.W. McClenahan Co. (piping)
  - Clint Blomberg, JW McClenehan Co., Sr. Estimator
Camino Parking Garage and Medical Office Center

- Camino Medical Group - a Sutter Health Affiliate
- Mountain View, California
- Site & Infrastructure development (420,790sf)
- Parking structure (1,110 stalls, 420,000sf)
- Medical Office Building (110 Providers, 250,000sf)
- Urgent Care Center (6,000sf)
- Outpatient Surgery Center (5 Suites, 20,000sf)
- Pharmacy (6,000sf)
- Laboratory and Diagnostics Radiology Center (30,000sf)
- $94.5 million in construction costs
# Milestones for the project

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Date</th>
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<tr>
<td>Start of design</td>
<td>October 2003</td>
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<tr>
<td>DPR engaged</td>
<td>April 2004</td>
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<tr>
<td>Schematic Design complete</td>
<td>November 2004</td>
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<tr>
<td>Detail Design complete</td>
<td>March 2005</td>
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<td>Construction Design (9 packages)</td>
<td>Nov. 2004 – Nov. 2005</td>
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<tr>
<td>Start of Construction</td>
<td>February 2005</td>
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<td>Completion Date</td>
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Goals for Project at Outset

- Create an Injury Free Environment
- Meet Target Cost
- Meet the Schedule
- Meet Quality Objectives
- Build the Project Virtually First
Sutter’s Five Big Ideas
(LEAN THINKING)

1. Collaborate; really collaborate, throughout design, planning, and execution
2. Increase relatedness among all project participants
3. Projects are a network of (reliable) commitments
4. Optimize the project, not the pieces
5. Tightly couple learning with action
BUILD VIRTUALLY
Facility Assembled in Computer Before being Built

- All important design decisions were made during the design phase:
  - No misunderstandings (almost)
  - No conflict of systems (almost)
  - No change orders (almost)

- Hospital administration, staff, doctors can see and understand spaces
- Inform the community
- Phase construction onsite
- Plan logistics and sequence installations (using lean processes)

Changes take place during the design, not construction
Camino Evolved from a Traditional into an Integrated Team
What were the results and how were they achieved?

- Here are some of the highlights
- Use of various 3D modeling tools by team (AutoCAD, ADT, CadDuctPipe, Designer 3D, SprinkCAD) were all downloaded into Navisworks Jet Stream database which was used for clash detection and coordination and planning
- Subcontractors (almost all) worked at job site in one large room to detail HVAC, piping, electrical, etc. – very fast resolution of conflicts and plans
Results - continued

- Lean scheduling techniques linked to model to plan design, JIT deliveries (pull schedule)
- Model used for off-site assemblies: larger assemblies, less clutter at site, reduce field labor, faster and more accurate installation, less waste, increased field productivity (5-30%), almost no rework (41 man-hours out of 36,000 total)
- See BIM Handbook - Case Study 9.3 for all the details
However, there were some problems

- Model not always current, complete and accurate
  - Not all design was done in 3D nor was it converted from 2D in timely and accurate way
  - Changes to design done on paper but the model was not updated (led to additional detailing work when errors discovered)
  - Not all objects were modeled – led to some clashes and extra work
- Architect’s model needed more detail to show doctors how each space would be laid out – led to some design changes after design had been detailed (and in some cases built)
- Some buy-out items missed in budget (which was not linked to model); extra costs came out of contingency funds
Some problems – continued

• Delay of project by OSHPOD* review of Surgery Unit caused significant delay of this space and additional overtime for detailing to try to catch up to schedule (reduced delay by 3 months) and was able to finish on time. Should have submitted design earlier using “pull schedule” techniques, but not sure that OSHPOD review would be required.

• Lesson: Regulatory reviews almost impossible to control; wise to be very conservative and avoid whenever possible.

*California Office of Statewide Health and Planning Development
Post project –

The Architect’s Perspective

• Henry Mahlstedt
  principal, Hawley, Peterson & Snyder
What worked well on Camino project

• Integrated Project Delivery
  • Many benefits of shared knowledge early in project (understanding of design intent, constructability, use of fabricated components)
  • Use of virtual 3D model that could be shared and become basis for detailing, 4D analysis and lean “pull” planning, off-site fabrication
Changes we have made

- Converted from ADT to Revit Architecture
  - Better links to other modeling programs (Revit Structure has excellent links and works well)
  - Better quality drawings that are all consistent
  - Allows earlier integration with other disciplines (MEP at Camino), now want to move on to others (skin, steel fabricators – having trouble finding steel fabricators who can link to model)
- But there are some problems with Revit
  - creating complex forms, creating complex assemblies, creating models that are too large for practical use
  - Revit MEP not ready for serious use by engineers and subs
Changes - continued

- Encouraging owners to support Integrated Project Delivery (IPD) in contracts, share risks and benefits as group to encourage good teamwork
- Use model to help owner experience how spaces and equipment will be used (not just visual impressions)
- Trying to establish metrics to measure improved delivery from IPD
- Extend use of off-site fabrication to wall panels, even rooms (build less at the site, more in a factory with JIT site installation)
- Support “pull schedule” and other lean techniques to drive production of drawings
The Builders’ Perspective

- Dean Reed, Atul Khanzode* DPR Construction Co. (general contractor)
- Lessons learned from Camino Project
  (see BIM Handbook for details)
- Developments since end of Camino Project
  *graciously provided graphics for this part of presentation
Model based Estimating

Autodesk (ADT, Revit)

Innovaya Visual Estimating

3D qtys

Links from Revit objects to Timberline assemblies

Timberline estimate

BIM Handbook Construction Presentation: Paul Teicholz
BIM for Operations

• Shop drawings
Formwork layout quantities

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BIM-Total Station Layout Process

3D Model → 3D model layout Plan → Trimble LM80 Layout Manager → point data → Trimble Total Station

Total station is used for field layout
Details for anchor bolt locations for columns in mat footing (using Tekla BIM system)
Energy Simulation (Riuska*)

- Import model from BIM
  - Geometry
  - Space definitions
  - Doors
  - Windows
- Input data collected
  - HVAC System
  - Area Types
  - Orientation
  - Building location

*Energy simulation software developed in Finland*
Generate Predictive Results

- Energy Usage / Cost
- Temperature / Thermal Loads
- Air Flow for Heating / Cooling
Compare alternative window schemes

Calculated Annual Cost for these energy uses:
lighting, plug loads, heating, cooling, fans, DHW, pumps
Subcontractors’ Perspective

- John Mack, Southland Industries (now a member of a GC and resp. for BIM)
- David Howard, JW McClenehan (now president of his own firm, Synergy Mechanical Contractors—all 3D design/build)
- Clint Blomberg, JW McClenehan, Senior Estimator
Benefits from use of BIM

- 3D model permitted more efficient design, less waste, less labor in the field, more off-site fabrication, higher field labor productivity (30% - 50%), no cutting of pipe in field
- Much greater accuracy, almost no clashes in field (only clashes caused by items NOT in model, or model not reflecting design changes made to drawings)
- Lean scheduling (last responsible moment) very effective – put people on the spot – led to better performance
- GC needs to really believe in use of model by everyone to make it work (model needs to show all rigid material)
- Now teaching use of 3D to our entire organization
Some ideas & problems for the future

- **Navisworks model** (now owned by Autodesk)
  - Could show direction of flow in each pipe so that proper valve(s) could be identified to isolate (empty) a pipe
  - Could be linked to MS Outlook to issue work orders for install teams which contained all data needed for installation that week: procedures, parts, certifications

- Biggest problem: how to educate owners and A/E, GC & subs about benefits of BIM and lean production
  - Need support from industry associations, unions and educators
Conclusions

- BIM coupled with lean production techniques is a revolutionary approach to the design and construction process that is in its early days.
- There are tremendous opportunities for practitioners to adopt these techniques to gain competitive advantage.
- Building owners have the most to gain from insisting on the use of Integrated Project Delivery using these approaches.
- Educators need to support this trend.