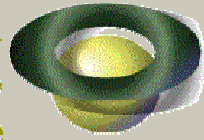
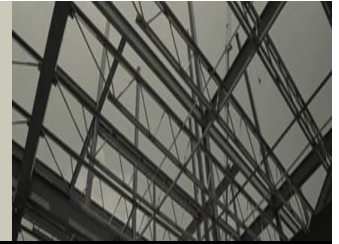




**Virtual
Builder's
Roundtable**



Presentation to
Virtual Builders Roundtable
Seattle Workshop
June 13, 2005



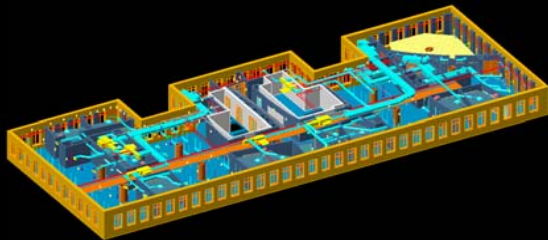
A Case Study of MEP/FP Coordination on a Lean Project Using 3/4D

**Atul Khanzode & Dean Reed
DPR Construction, Inc.**

DPR Experiences Represented

DPR Portland Office Bay Street Emeryville

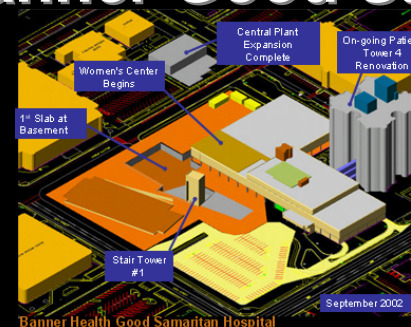
Camino Medical



Letterman (Proposal)



Banner Good Sam



1998

2001

2002

2003

2005

Lessons Learned

- Modeling is early learning
- Model incomplete work early
- Start with blocks in schematics and develop detail as design progresses
- Model to shop drawing level and below
- Integrate models created with different tools
- Model in field to solve coordination problems
- Surround team with 3D images
- Structure work in 4D with subcontractors
- Progress 4D models to use in lookahead planning

Sutter Health's Challenge

Current Program



- \$5.5 Billion (2004-2012)
 - Acute Care Facilities
 - Non-Acute (e.g. Outpatient Surgery)
 - Medical Office Buildings
 - Parking Facilities
 - Remodeling Existing Space



Sutter Health Adopts Lean Project Delivery

Sutter Health Facility Planning & Development's Goal

- Increase reliability that projects conceptually approved and funded in year one are designed and constructed in year five+ . . .
 - on-time or early
 - within budget or less
 - without claims
 - safely (without creating patients), and
 - without burn-out of FPD staff

The Five Big Ideas of Lean Project Delivery for Sutter Health

Move to Lean Project Delivery



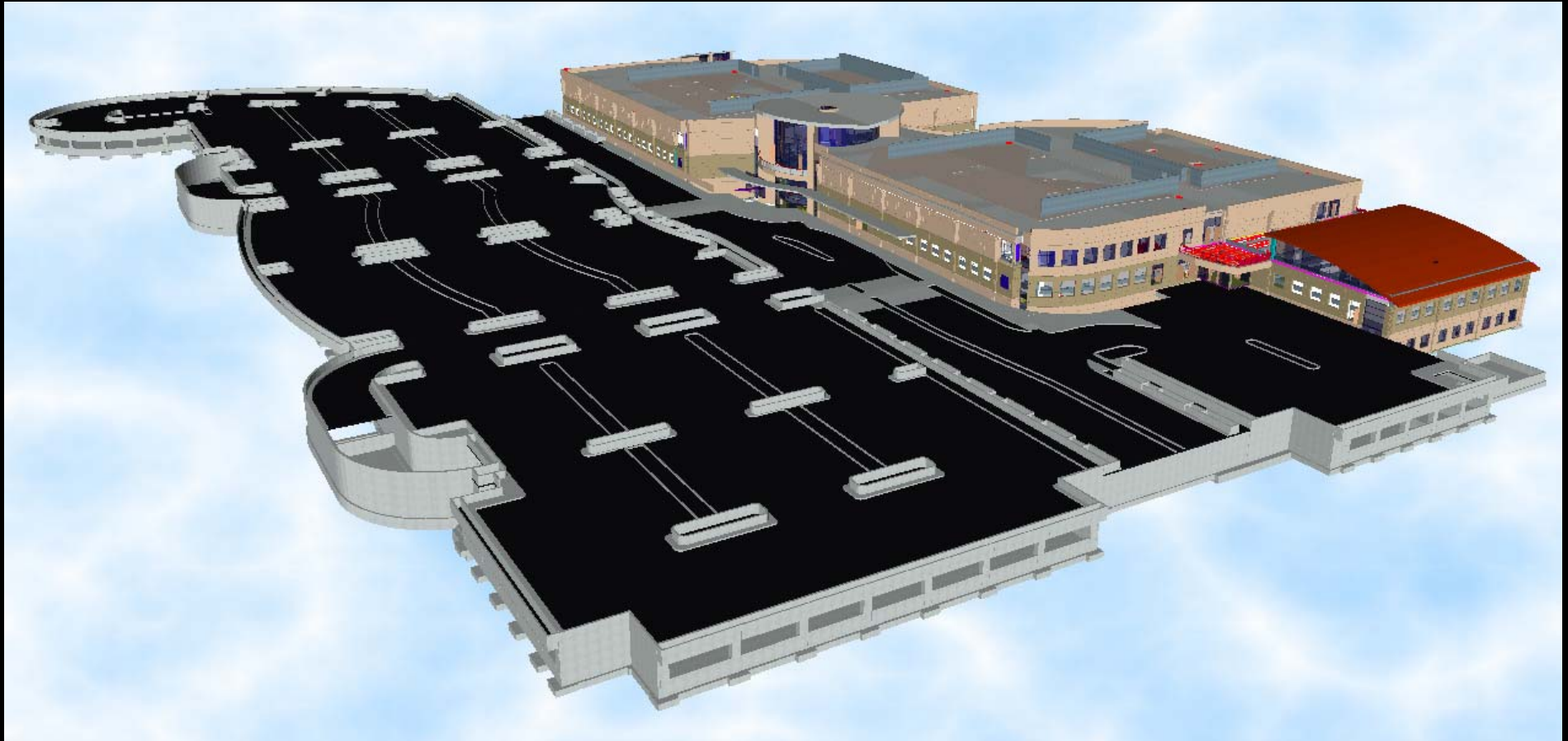
Lean Design & Virtual Building

- **Lean Project Delivery**
 - A process
 - Eliminate waste by designing product (the building) and process (building the building) simultaneously
- **Virtual Building**
 - A technology and process
 - 3D object model of the product
 - Clash detection of multiple 3D object models
 - 4D visualization of construction

The Camino Medical Center

- For the Camino Medical Group (CMG)
- In 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)
- \$100 million in construction costs

Parking Structure & Medical Office Building



Making the Virtual Building Case

Camino Medical Group Mt. View Campus

Schedule Approach

- DPR has worked closely with Stanford University for the past 4 years to implement “virtual construction” to identify design and installation conflicts in time to fix them before they become a problem during construction. We’ve found this to be one of the best risk management tools, well worth the modest expense

•DPR has worked closely with Stanford University for the past 4 years to implement “virtual construction” to identify design and installation conflicts in time to fix them before they become a problem during construction. We’ve found this to be one of the best risk management tools, well worth the modest expense of translating traditional 2D drawings into a 3 and ultimately 4D (3D + time) model. We advocate modeling the Mt. View campus to insure that every party, from the CMG administration and staff to the subcontractors, has a common understanding of the finished product and how it will be built.

Lean Construction Institute. DPR’s Northern California Scheduling Manager is a graduate of Lean Project Consulting’s SHUSA 2 Advanced Lean Implementation and Leadership training program. DPR people are trained in problem-solving through brainstorming and root cause analysis.

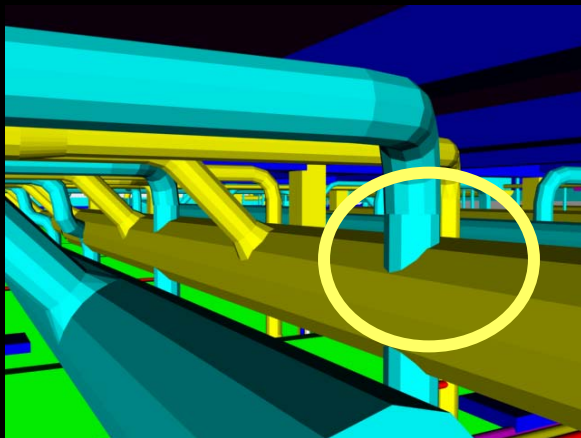
Sutter Health's Expectation

- **Sutter Health / CMG agreed to invest money in early collaboration and virtual building**
 - DRR hired during Conceptual Design
 - MEP/FP, Skin and Steel subcontractors brought on in Schematic Design
 - Architectural and construction budgets increased to pay for additional expense of 3 / 4D modeling and coordination
- **Construction costs will be reduced overall**
 - RFI's will be significantly reduced
 - Change orders due to coordination conflicts will be eliminated

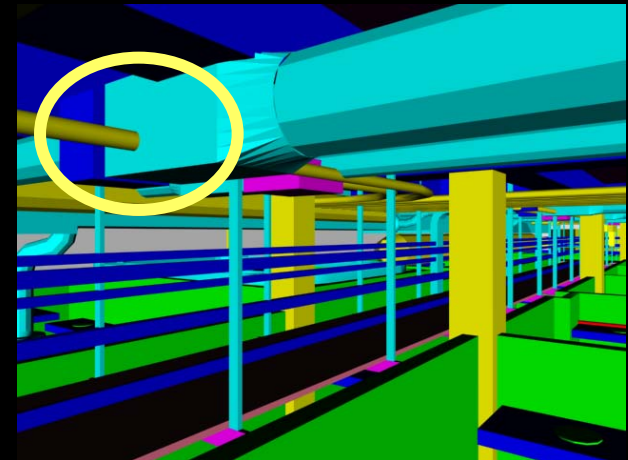
The Vision

Facility Assembled in Computer Before It's Built Onsite

- All important design decisions were made during design phase:
 - No misunderstanding
 - No conflict of systems
 - No change orders



Changes take place during the design phase not during construction



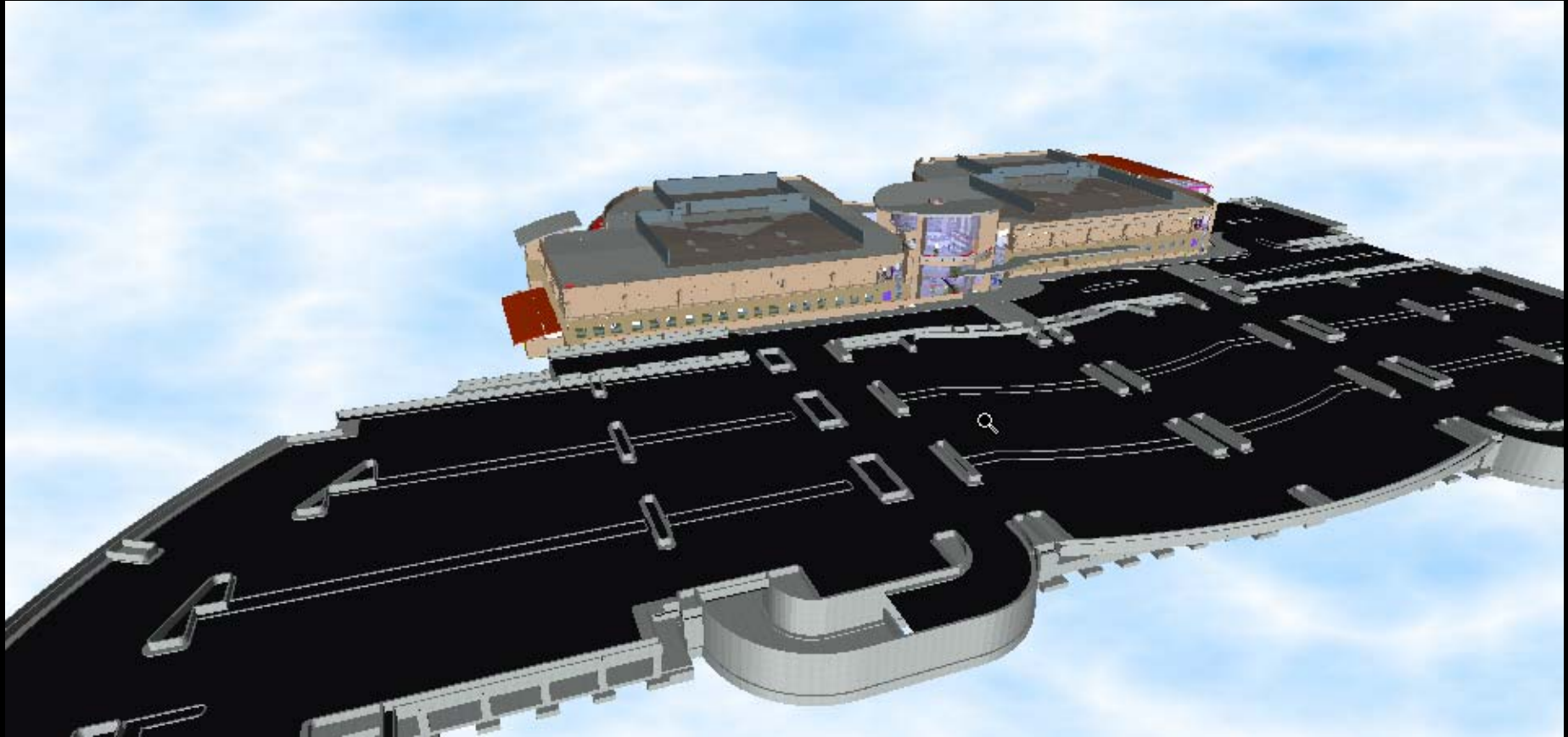
Lean Virtual Building Guidelines

1. Determine authors of architectural and structural 3D object models
2. Define the Virtual - Lean Design Collaboration process
3. Pre-qualify A/Es and subcontractors for Virtual Building capability
4. Determine collaboration and modeling responsibilities
5. Agree on protocol for sharing drawings and models
6. Agree on coordination and conflict resolution process
7. Pull design coordination from construction
8. Sequence trades through interactive construction of 4D models

Authoring the Architectural and Structural 3D Object Models

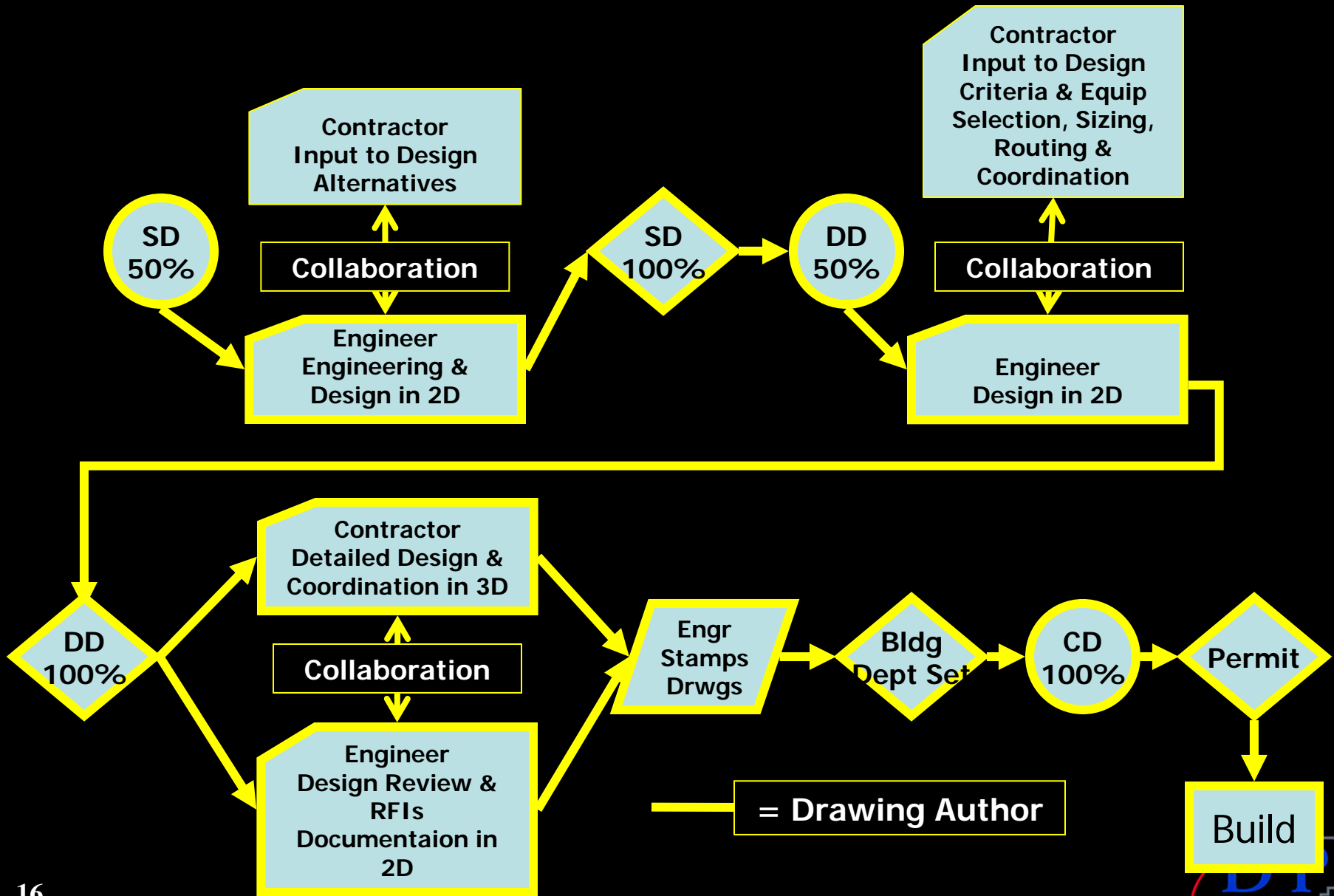
- Hawley Peterson & Snyder Architects had adopted 3D modeling as their standard
- HPS modeled the building interiors and shell in Architectural Desktop
- HPS mentored KPFF – SF (MOB structure) and Watry Design (Parking Structure) in creating their 1st 3D models for this project

Architectural & Structural Model in Design Development



Camino Design Collaboration Process

Defining the Virtual - Lean Design Collaboration Process



Pre-qualifying A/Es and subcontractors for Virtual Building capability

Camino Medical Campus 3D Object Modeling Requirements

Approach

Sutter Health has asked DPR to lead the effort to coordinate detailed construction designs. Each Design Assist and Design Build contractor will be required to create a 3D object model of their design. These models will be brought together into a 3D CAD

Object Modeling

Detailed design will be done in CAD 3D object modeling software, which can create objects having the following characteristics:

- Each object in the model has a unique name or object identifier, and can have attributes attached to it, i.e., geometry info, weight, cost, schedule, procurement info, etc.**
- These objects are either 3D solids or true parametric objects. They are not 2D polygons that are combined to create a 3D object, as is the case in a surface model.**
- The object model is assembled from libraries of predefined parts representing a constructible component or assembly of components.**

All views of the model are depictions of the object properties stored in the database so that a change made to one or more object parameters is reflected in every plan, section and elevation view.

Modeling Responsibilities

Scope	Design Phase 3D Model Created
Architect	Schematic Design
Structural Engineer	Design Development
Mechanical Engineer	No 3D
Electrical Engineer	No 3D
HVAC Contractor	Construction Documents
Plumbing Contractor	Construction Documents
Electrical Contractor	Construction Documents
Fire Protection Contractor	Construction Documents

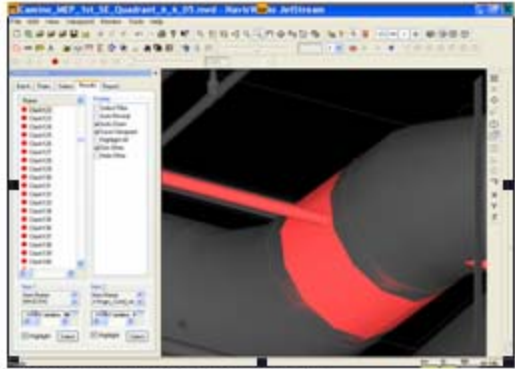
Agreeing on Protocols for Sharing Drawings & Models

- File naming conventions
- Reference point for 3D models
- Protocol for sharing files using FTP site
- Protocol for updating the drawing files
- CAD backgrounds, colors and layer management for the drawings / models
- Protocol for combining drawings in a single NavisWorks model for coordination

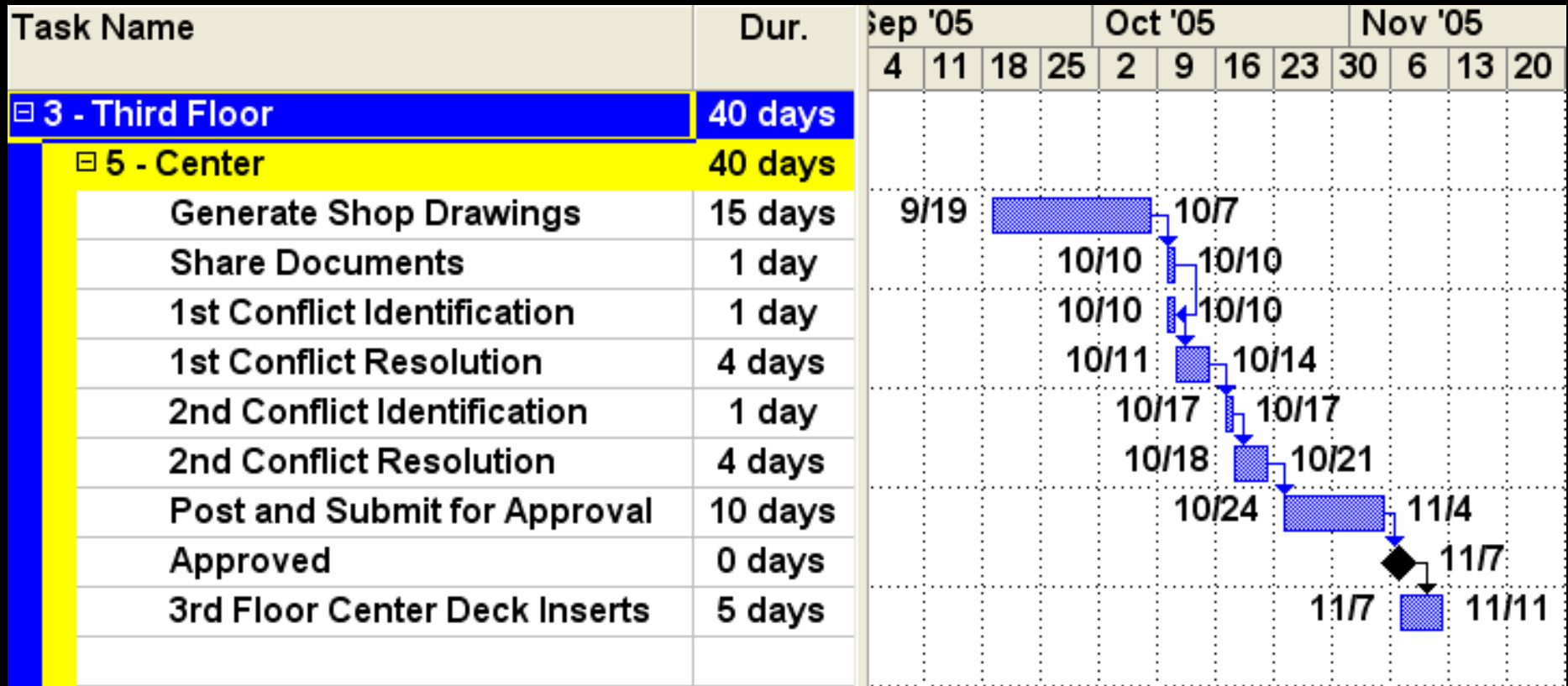
Coordination & Conflict Resolution Process



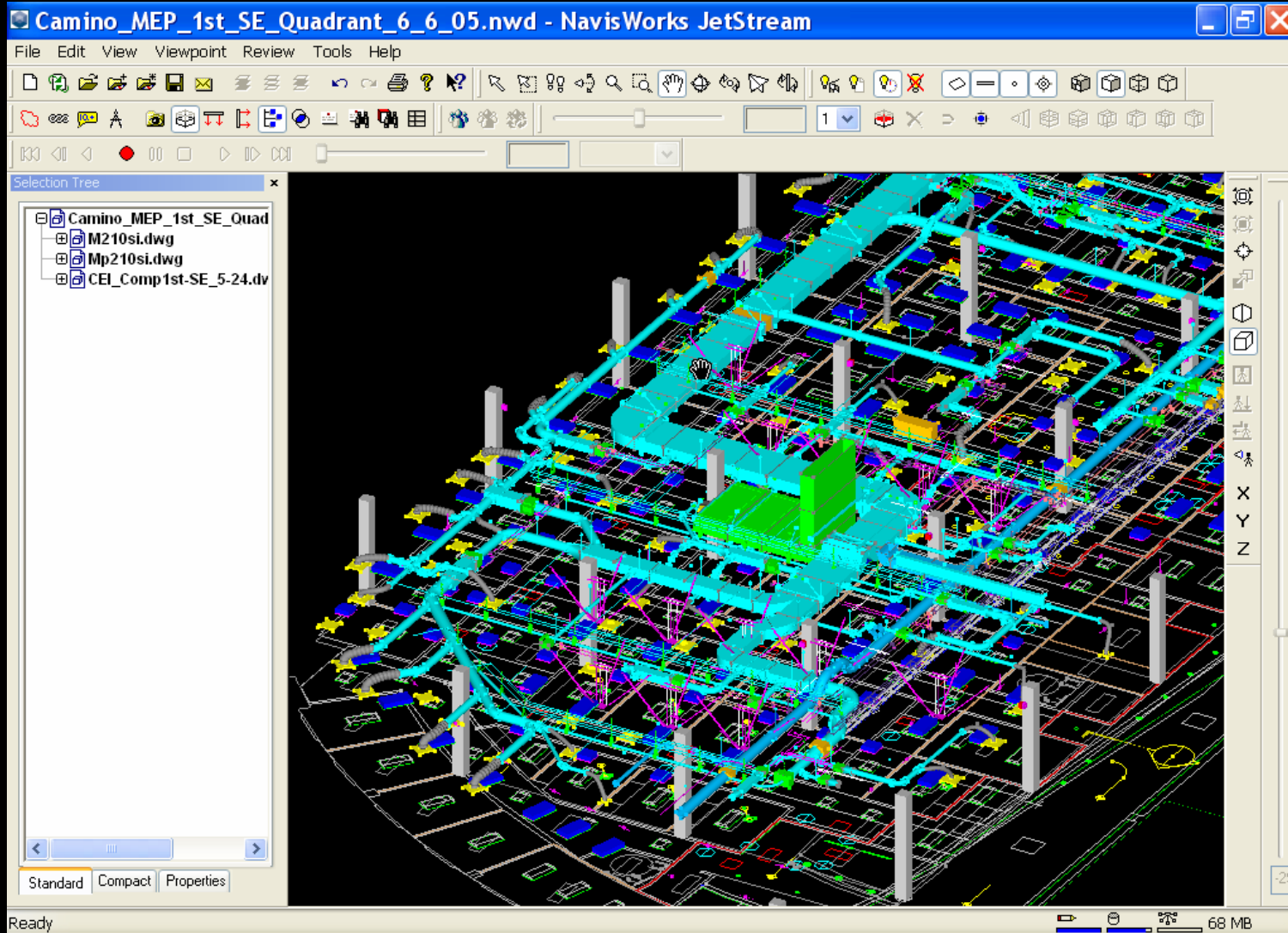
Camino Medical Group Detailed Design Coordination Variance Report

Clash Number	Location:	Issued By:	Meeting Date:
Clash Description:	Model View at Clash:		
Action to Resolve and Responsibility:			
Resolution:	Model View after Resolution:		
Cost / Schedule Impact:			
Potential Value Added:			
Signoff:			

Pulling Design Coordination from Construction



Sequencing Trades through Interactive Construction of 4D Models

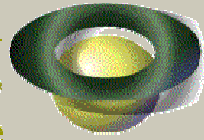


Building a Team to Make the Process Work

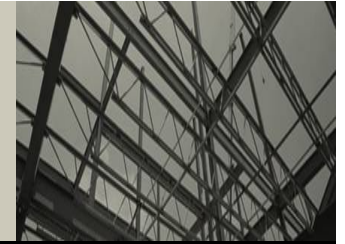
- *Dr. Slavin*
Camino Medical Group
- *Curtis, Henry, David, Gary, Mark, Kevin, Corey*
Hawley, Peterson & Snyder
- *Bryan, Steve*
Capital Engineering Consultants
- *Christina*
The Engineering Enterprise
- *Bruce*
Sandis Humber Jones
- *Blake, Rich*
KPFF – SF
- *Heather, Ken*
Watry
- *Dave C, Dave P, Will, John, Amaya*
Sutter Health
- *Scott, Mark, John, Jerry and Ceasar*
Southland
- *Jeremy, Tim, Norbert*
Cupertino Electric
- *Clint, Ray, David*
JW McClenahan
- *Harry, David*
Northstar Fire Protection
- *Eric, George, Bill, Ian, Tracy, Scott, Ralph, Dan, Eddie, Atul, Dean*
DPR



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Questions & Answers in the Roundtable