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?

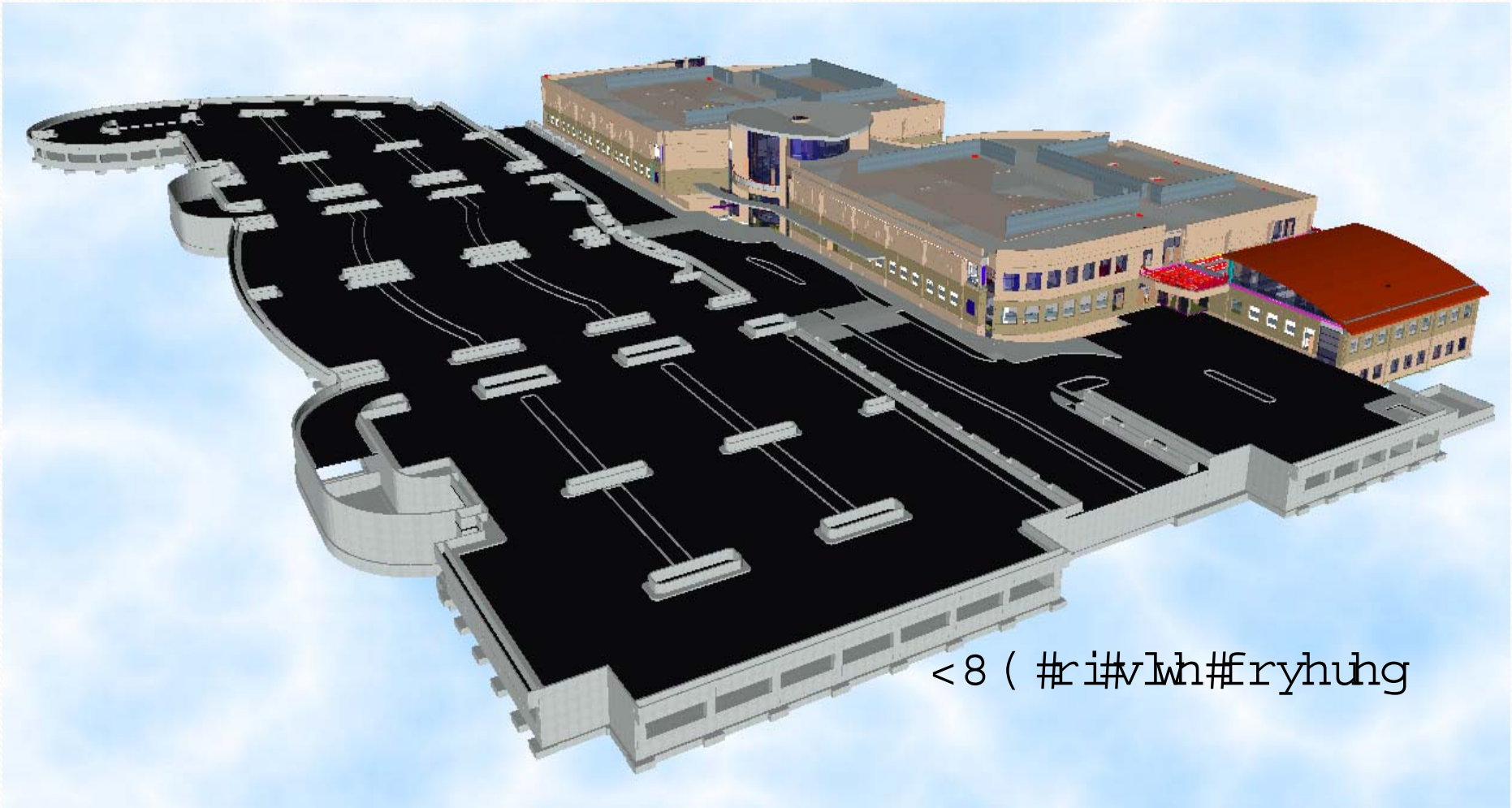
Presentation Outline

- 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

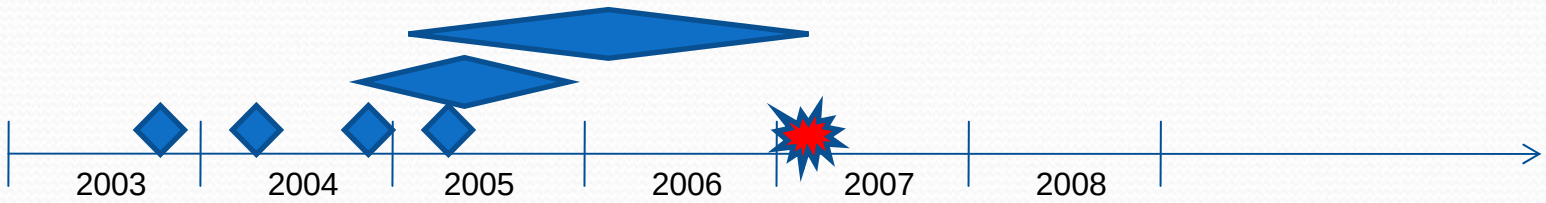
- Camino Medical Group - a Sutter Health Affiliate
- Mountain View, California
- Site & Infrastructure development (420,790sf)
- Parking structure (1,110 stalls, 420,000sf)
- Medical Office Building (110 Providers, 250,000sf)
- Urgent Care Center (6,000sf)
- Outpatient Surgery Center (5 Suites, 20,000sf)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

Camino Parking Structure & Medical Office Building



Milestones for the project

Start of design	October 2003
DPR engaged	April 2004
Schematic Design complete	November 2004
Detail Design complete	March 2005
Construction Design (9 packages)	Nov. 2004 – Nov. 2005
Start of Construction	February 2005
Completion Date	March 2007



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)

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51 Lqfuhdvh#uhodwhgqhvv#dprqj#doo#surmhfw#sduwlflsdqwv

61 Surmhfwv#duh#d#qhwzrun#ri#+uholdeoh,#frpplwphqwv

71 Rswlpl}h#wkh#surmhfw/#qrw#wkh#slhfhv

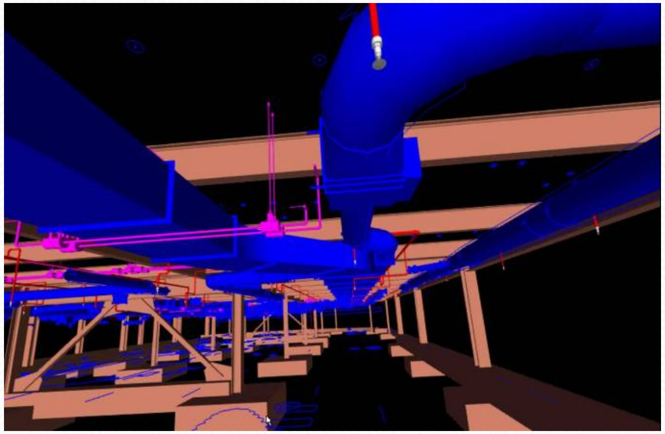
81 Wljkwo|#frxsoh#ohduqlqj#zlwk#dfwlrq

BUILD VIRTUALLY

Facility Assembled in Computer Before being Built

- Doo#lpsruwdqw#ghvljq#ghflvlrqv#zhuh#pdgh#gxulqj#ghvljq#skdvh=
  - Qr#plvxqghuvwdqglqjv#+dopr vw,
  - Qr#frqiolfwv#ri#v|vwhpv#+dopr vw,
  - Qr#fkdqjh#rughuv#+dopr vw,

- Krvslwdo#dgplqlvwudwlrq/#vwdii#dqg#grfwruv#fdq#vhh#dqg#xqghuvwdqg#vsdfhv
- Lqirup#wkh#frppxqlw|
- Skdvh#frqvwuxfwlrq#rqvlwh#
- Sodq#orjlvwlfv#dqg#vhtxhqfh#lqvwdoodwlrqv#+xvlqj#ohdq#surfhvvhv,



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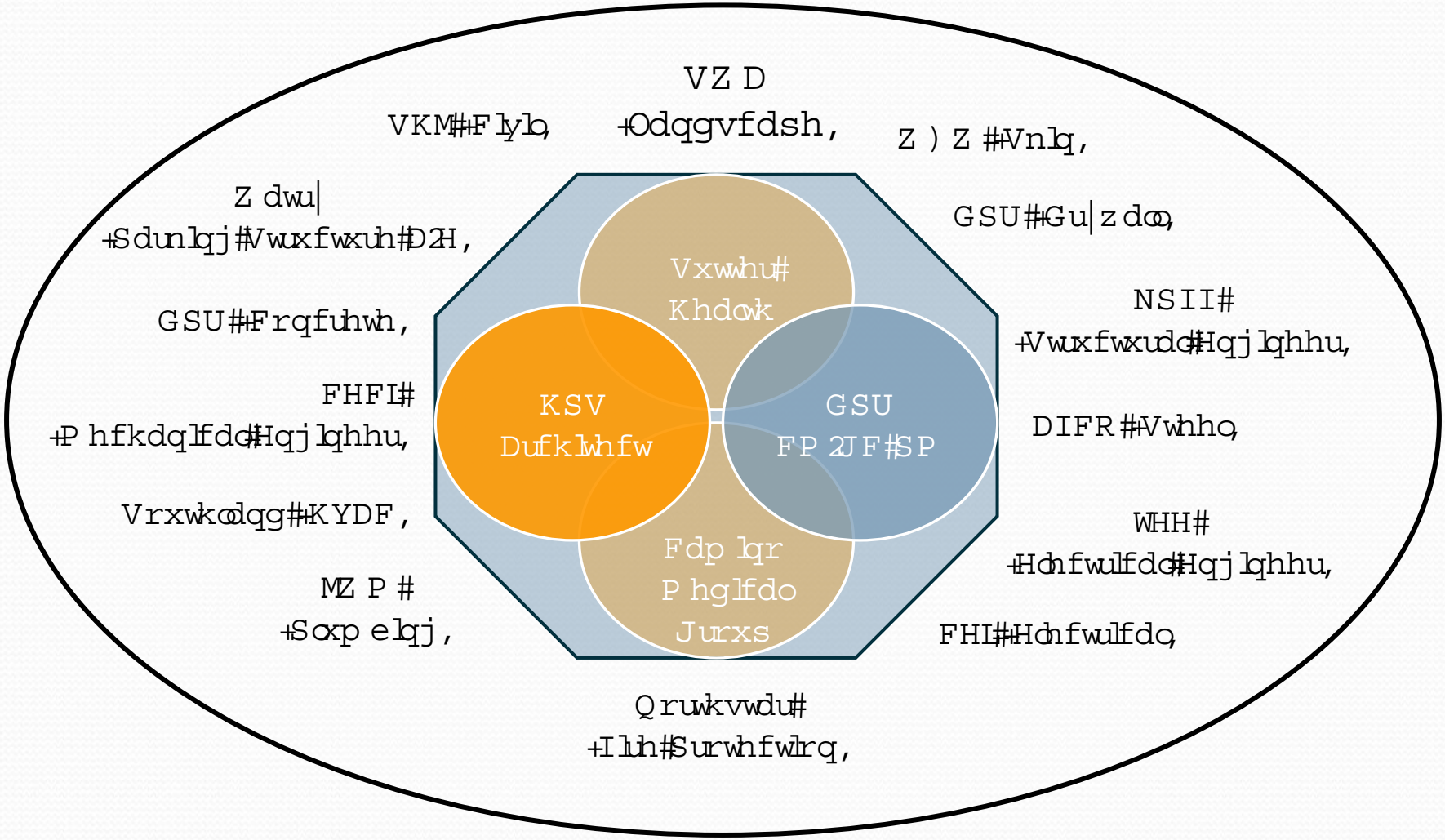
Camino Evolved from a Traditional into an Integrated Team



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 , Kdzch|#Shwhuvrq# #Vq|ghu

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

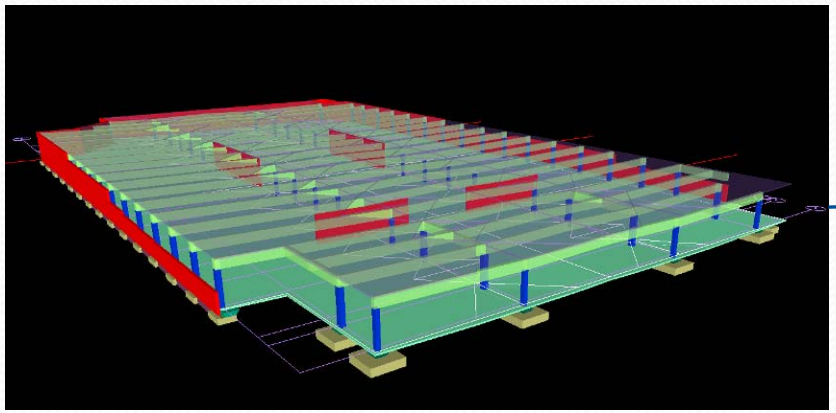
The Builders' Perspective

- 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

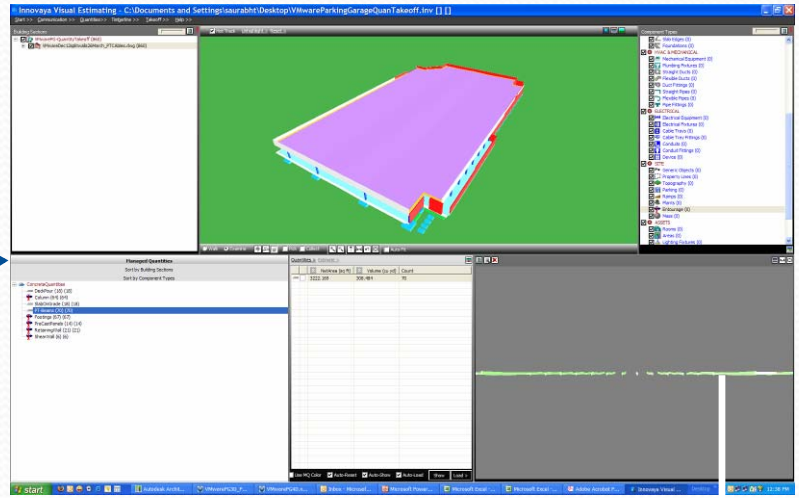
*graciously provided graphics for this part of presentation

Model based Estimating



Autodesk (ADT, Revit)

3D qtys



Innovaya Visual Estimating

Quantities > Estimate > Phase/Item Total $52,004 Show No-link Items Show All Items

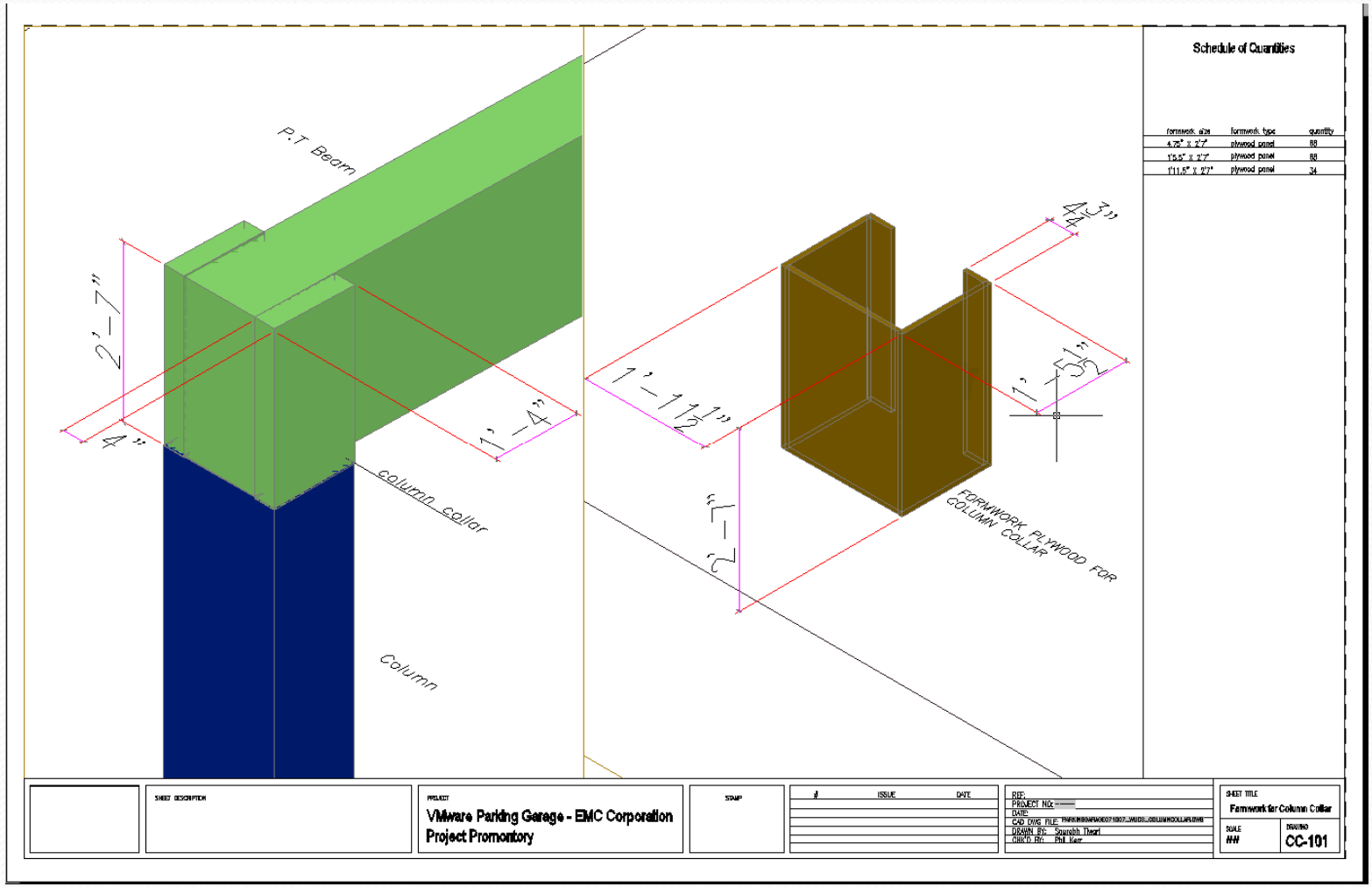
	Phase	Description	Quantity	Unit	Lab	Mat	Equip	Sub	Other	Total
05.00000		SUPERSTRUCTURE								
	05.030004	Flat Slab								
		Slab Concrete, 3000 PSI	59.286	cy	$389	$6,521	$59	$0	$0	$6,970
	05.030000	Concrete Shear Walls								
		Concrete Shear Wall	895.343	sf	$0	$0	$0	$40,...	$0	$40,290
		Shear Wall Concrete 450...	27.652	cy	$726	$3,318	$28	$0	$0	$4,072
	05.030003	Concrete Columns								
		Column Concrete, 5000 PSI	0.951	cy	$50	$118	$1	$0	$0	$169
04.00000		SUBSTRUCTURE								
	04.030001	Slab on Grade								
		Slab Concrete 3000 PSI	2.277	cy	$34	$250	$2	$0	$0	$287
03.00000		FOUNDATIONS								
	03.030001	Spread Foundations								
		Footing Concrete, 3000 PSI	1.781	cy	$19	$196	$2	$0	$0	$216

Timberline estimate

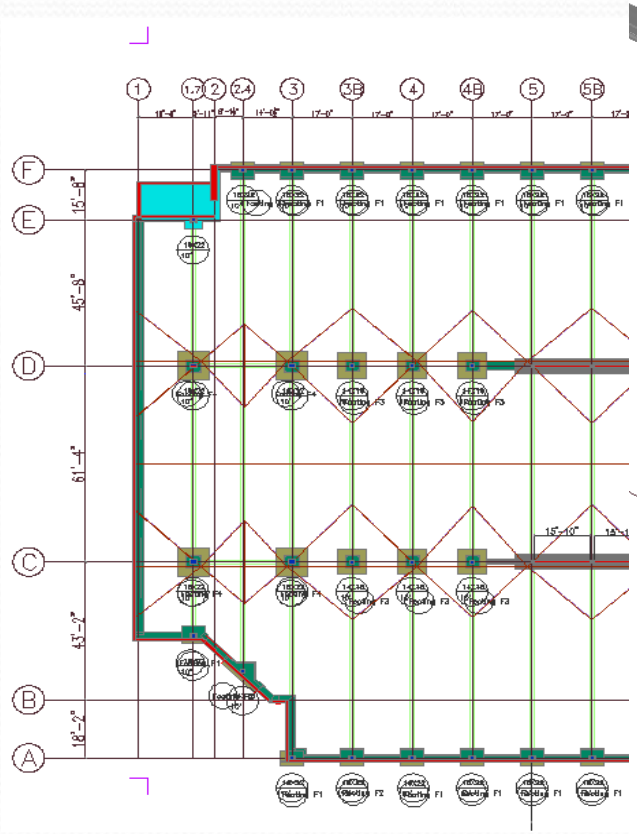
Links from Revit objects to Timberline assemblies

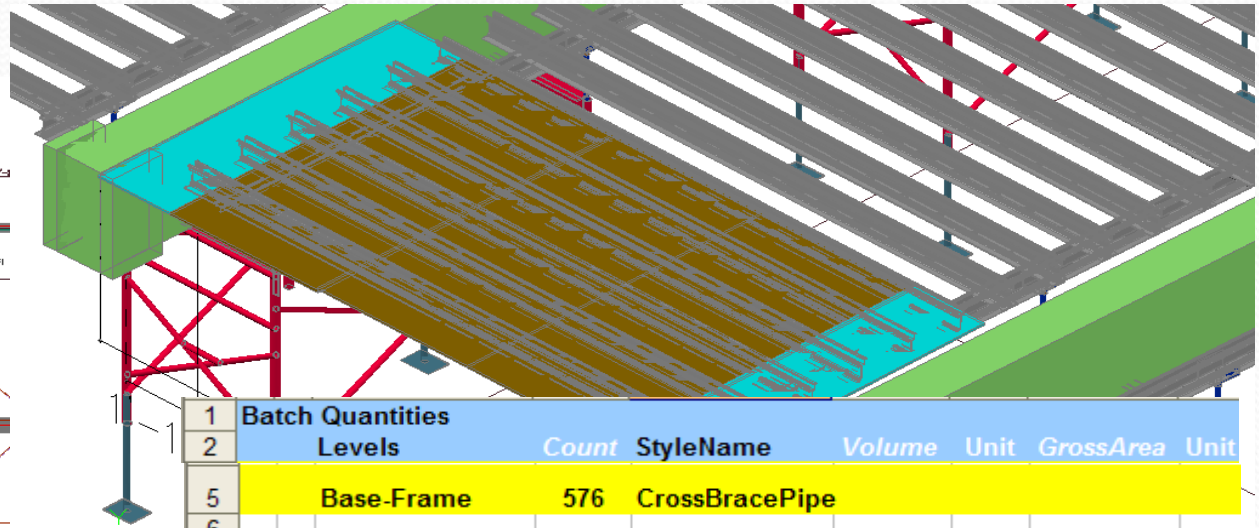
BIM for Operations

- Shop drawings



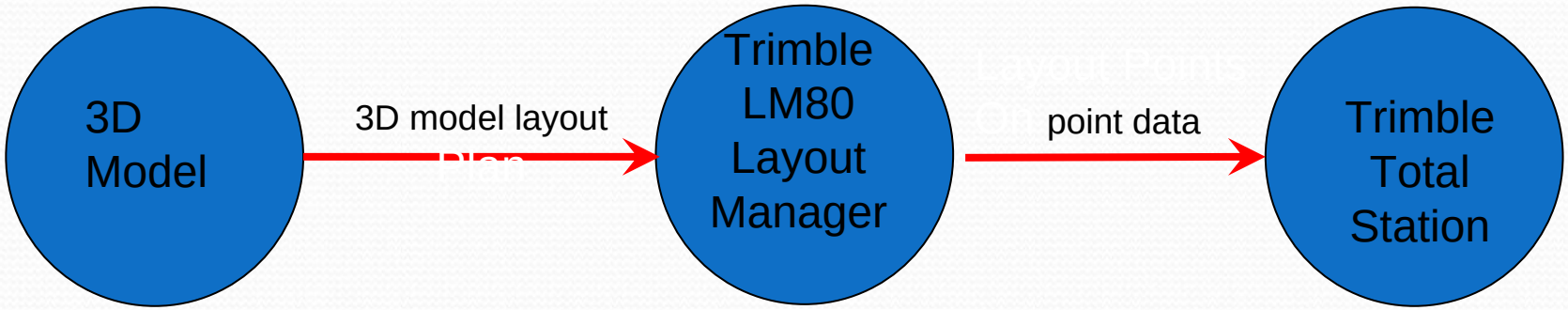
Formwork layout quantities

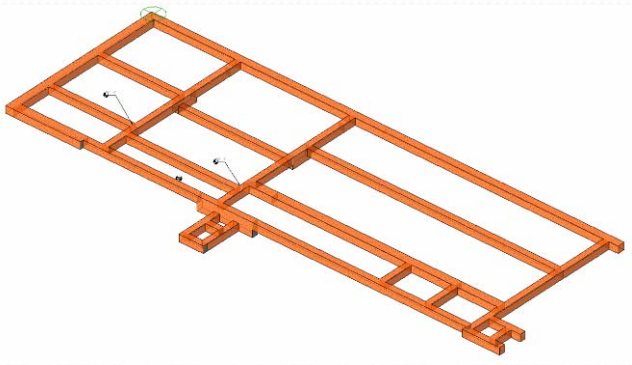




1	Batch Quantities							
2	Levels	Count	StyleName	Volume	Unit	GrossArea	Unit	
5	Base-Frame	576	CrossBracePipe					
6								
7	Base-Frame	288	PIPE2Std					
8								
13	JHead-AdjScrew	288						
14								
15	Steel Stringer	72						
16								
17	Swivel-Type-Plat	284						
18								
19	deckpour3	24	Standard	243.104	cu yd	15,743.18	sq ft	
20								

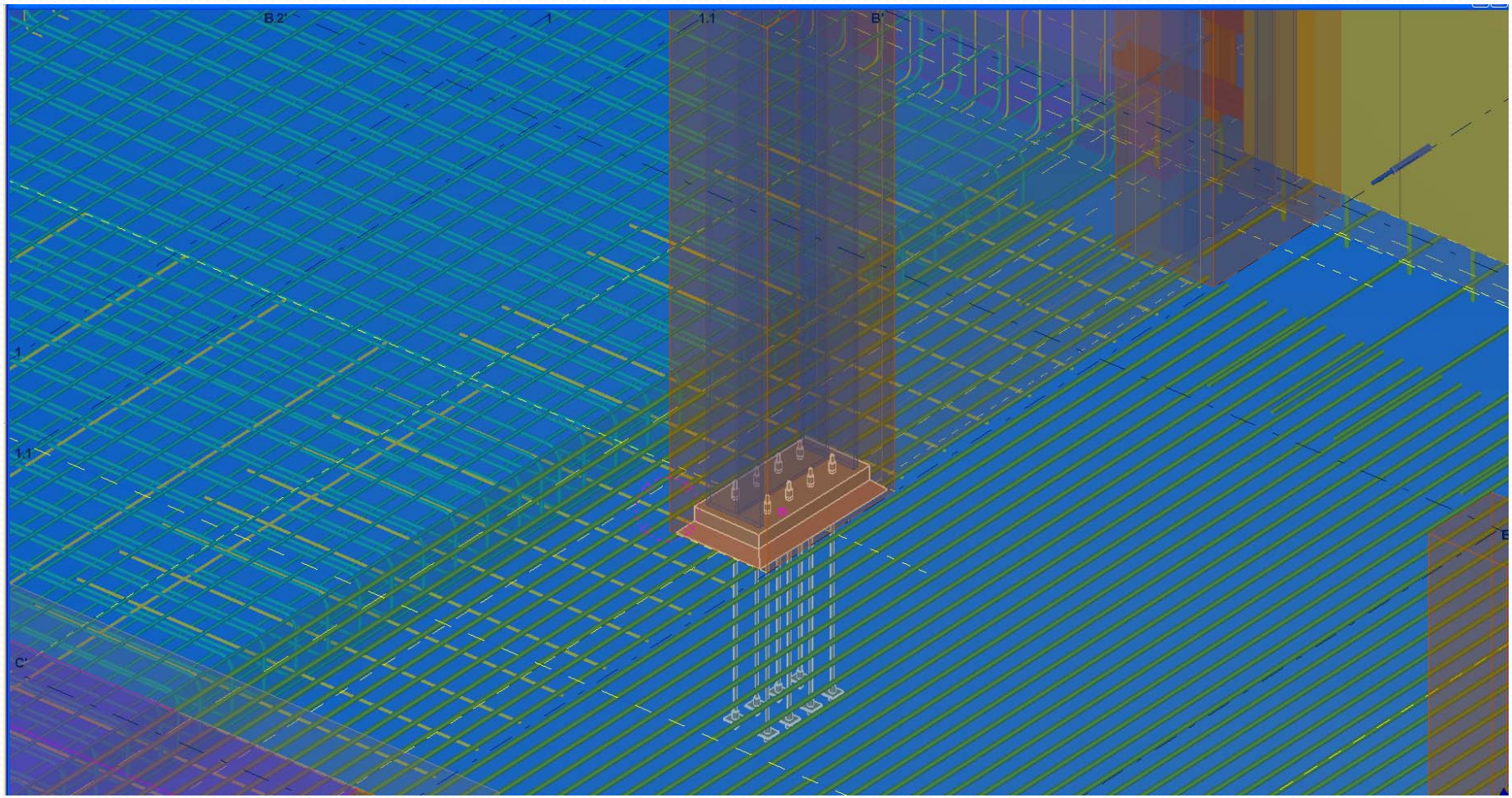
BIM-Total Station Layout Process



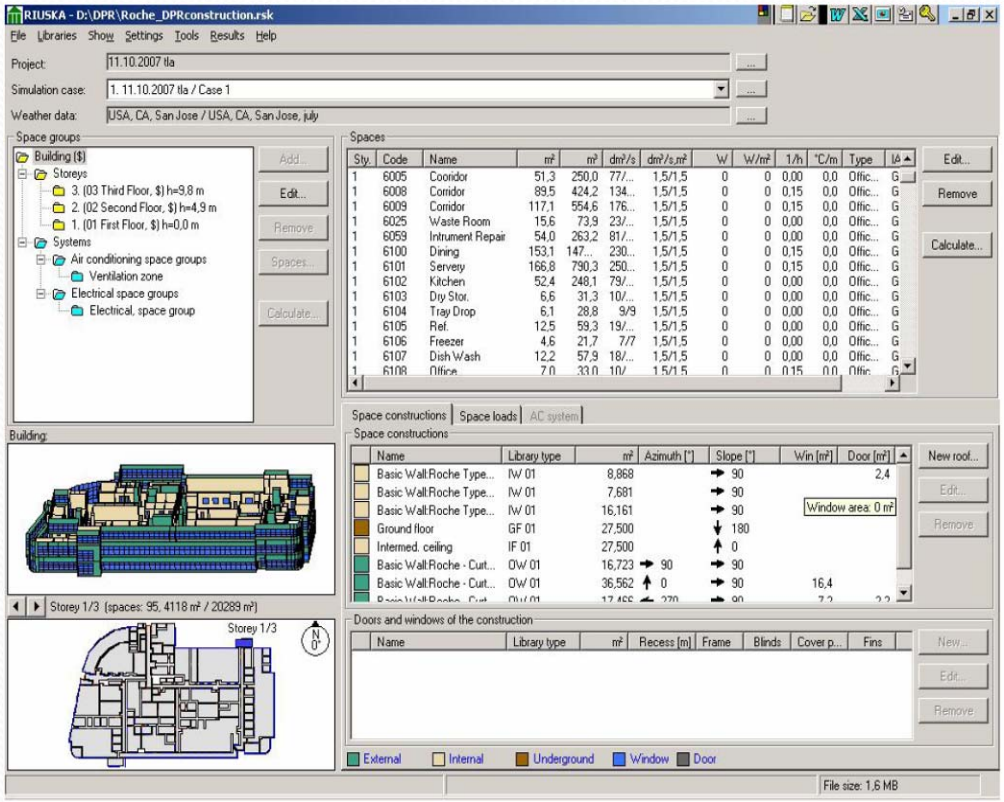


Total station is used for field layout

Details for anchor bolt locations for columns in mat footing (using Tekla BIM system)



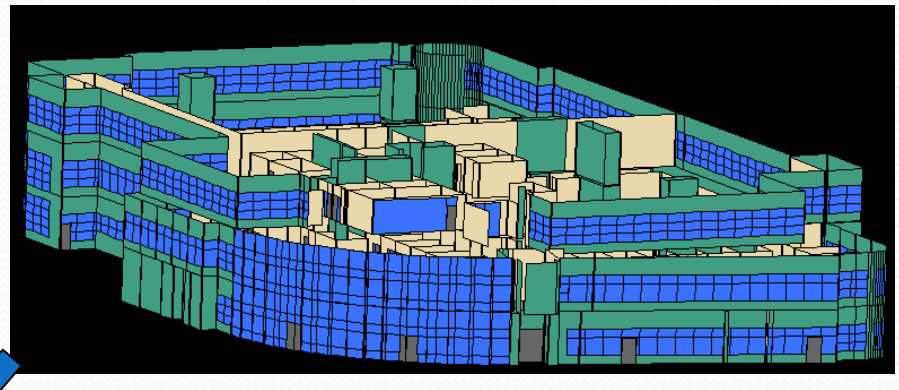
Energy Simulation (Riuska*)



- Ip sruw#p rgh#urp #EIP
  - Jhrp hwu
  - Vsdfh#ghibqlwrqv
  - Grruv
  - Z lqgrzv
- Iqsxw#gdwd#frqfhswhg
  - KYDF#V|vwhp
  - Duhd#W|shv
  - Ruhqwdwrq
  - Exloglqj#orfdwrq

*Energy simulation software developed in Finland

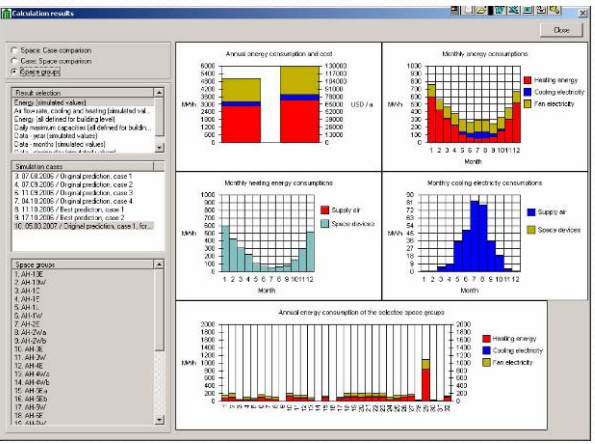
Generate Predictive Results

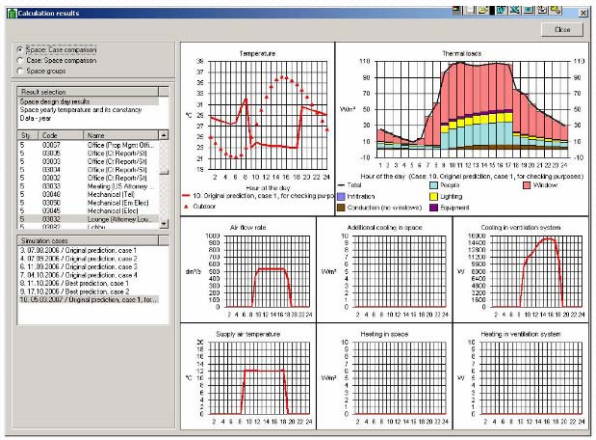


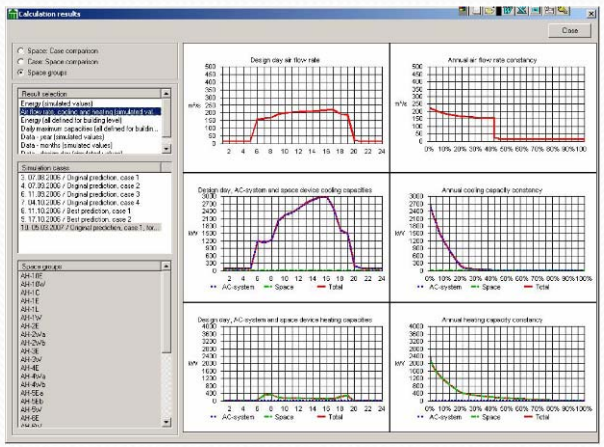
Energy Usage / Cost

Temperature / Thermal Loads

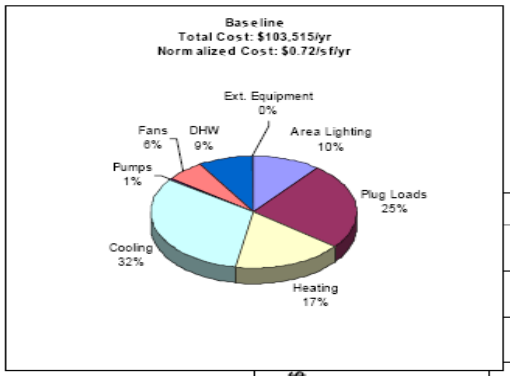
Air Flow for Heating / Cooling



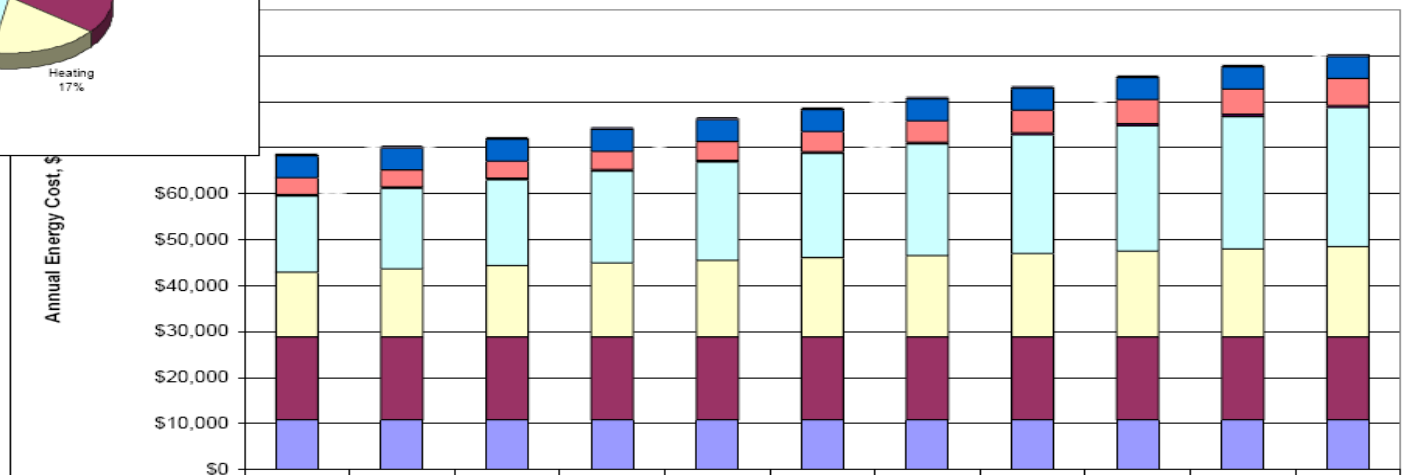




Compare alternative window schemes



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



	Win-0	Win-5	Win-10	Win-15	Win-20	Win-25	Win-30	Win-35	Win-40	Win-45	Win-50
Ext. Equipment	$378	$378	$378	$378	$378	$378	$378	$378	$378	$378	$378
DHW	$4,760	$4,760	$4,761	$4,760	$4,761	$4,761	$4,761	$4,760	$4,761	$4,761	$4,760
Fans	$3,643	$3,663	$3,746	$3,917	$4,091	$4,311	$4,612	$4,914	$5,211	$5,523	$5,835
Pumps	$317	$312	$326	$344	$362	$384	$412	$435	$462	$491	$514
Cooling	$16,570	$17,539	$18,696	$20,023	$21,331	$22,718	$24,259	$25,775	$27,260	$28,754	$30,218
Heating	$14,121	$14,828	$15,511	$16,102	$16,707	$17,267	$17,732	$18,211	$18,703	$19,180	$19,667
Plug Loads	$18,007	$18,007	$18,007	$18,007	$18,007	$18,007	$18,007	$18,007	$18,007	$18,007	$18,007
Area Lighting	$10,844	$10,845	$10,845	$10,845	$10,844	$10,845	$10,844	$10,844	$10,844	$10,844	$10,845

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