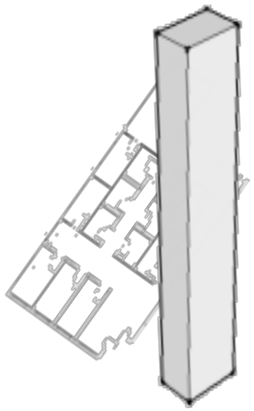
Bringing 5D to the Work Face

- ASAP management impacting project success and cost
- Creating the Flowline version to optimize resource usage
- Production control for hospital construction
- Owner reporting to maximize production data usage

Integrated BIM+Estimating+Scheduling



Column
'Type 1'

Rebar

Formwork

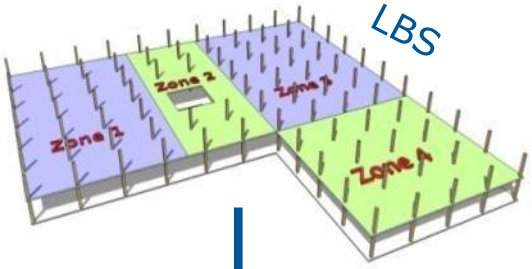
Concrete

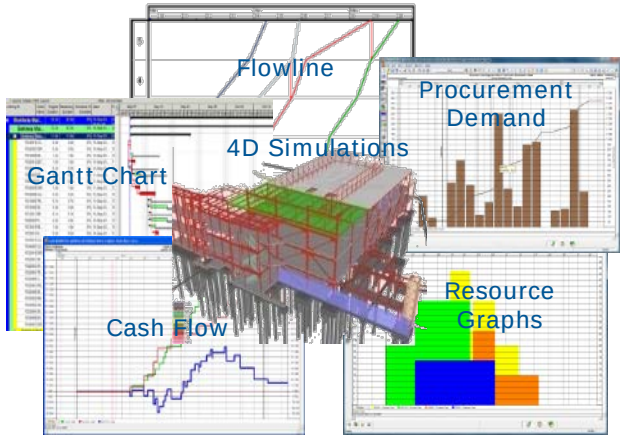
Cladding; Surface Finish

Equipment

Labor

Materials





TOIs
Takeoff Items
$/Qty

TOQs
Takeoff Quantities
$/Qty

Resources
$/Qty

2D / 3D Design

5D Cost

4D Time

What is 4D without 5D?

- Non-integrated process
- Disruptive to efficient workflows
- Different way to plan, schedule and control construction projects:
  - Uses physical locations of work
  - Uses quantities and productivity data to calculate required time by location
  - Resource-loaded based on data
  - Optimizes production efficiency for continuous flow
  - Forecasts based on actual production
  - Flowline as an effective way to visualize work flow

Acute Care Facility in Napa, California

72,000 SF added to existing Medical Center

Includes six Smart Operating Rooms, 20 private intensive care rooms, clinical and pathology laboratories

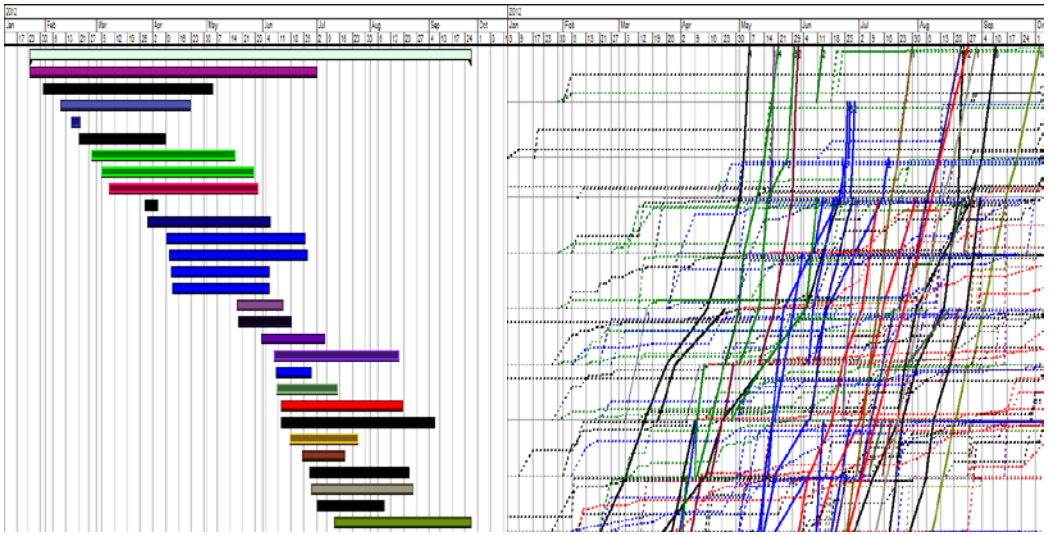
QVMC Herman Family Pavilion

Case Study: ASAP Management

- Wanted to understand Production under current process
- Production Controller and LBMS used for Reporting only
- Schedule was managed using ASAP approach

What we observed in recorded actuals:

- (De)mobilizations
- Waiting Time
- “Blow-fly” effect
- “Flat-lining”
- Cascading delays



Key Benefits

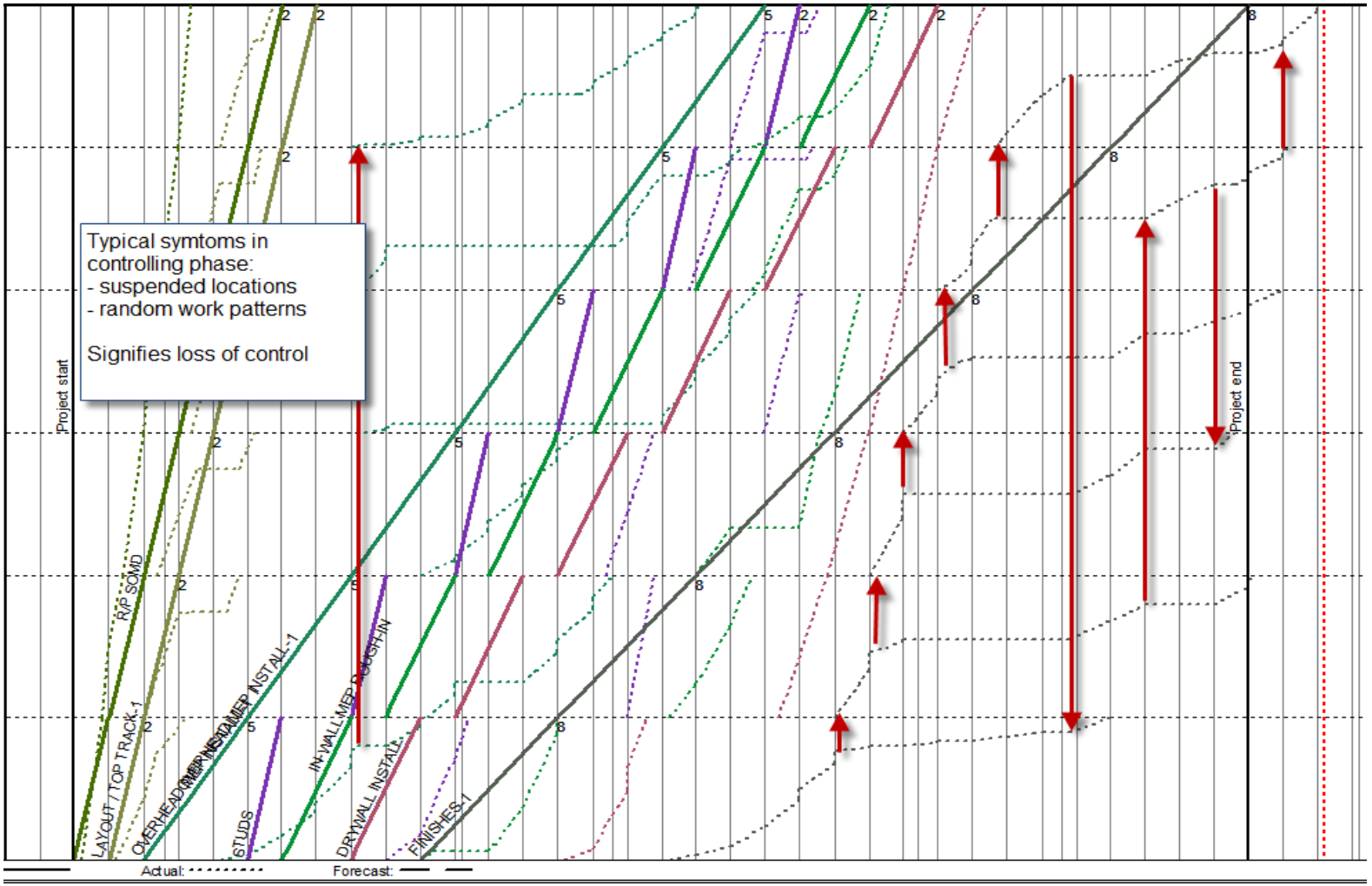
- Understanding what are the opportunities for improving production
- Archive of actual production rates for typical hospital tasks
- Documentation of subcontractor behaviors and patters during operations

What our Client has Learned…

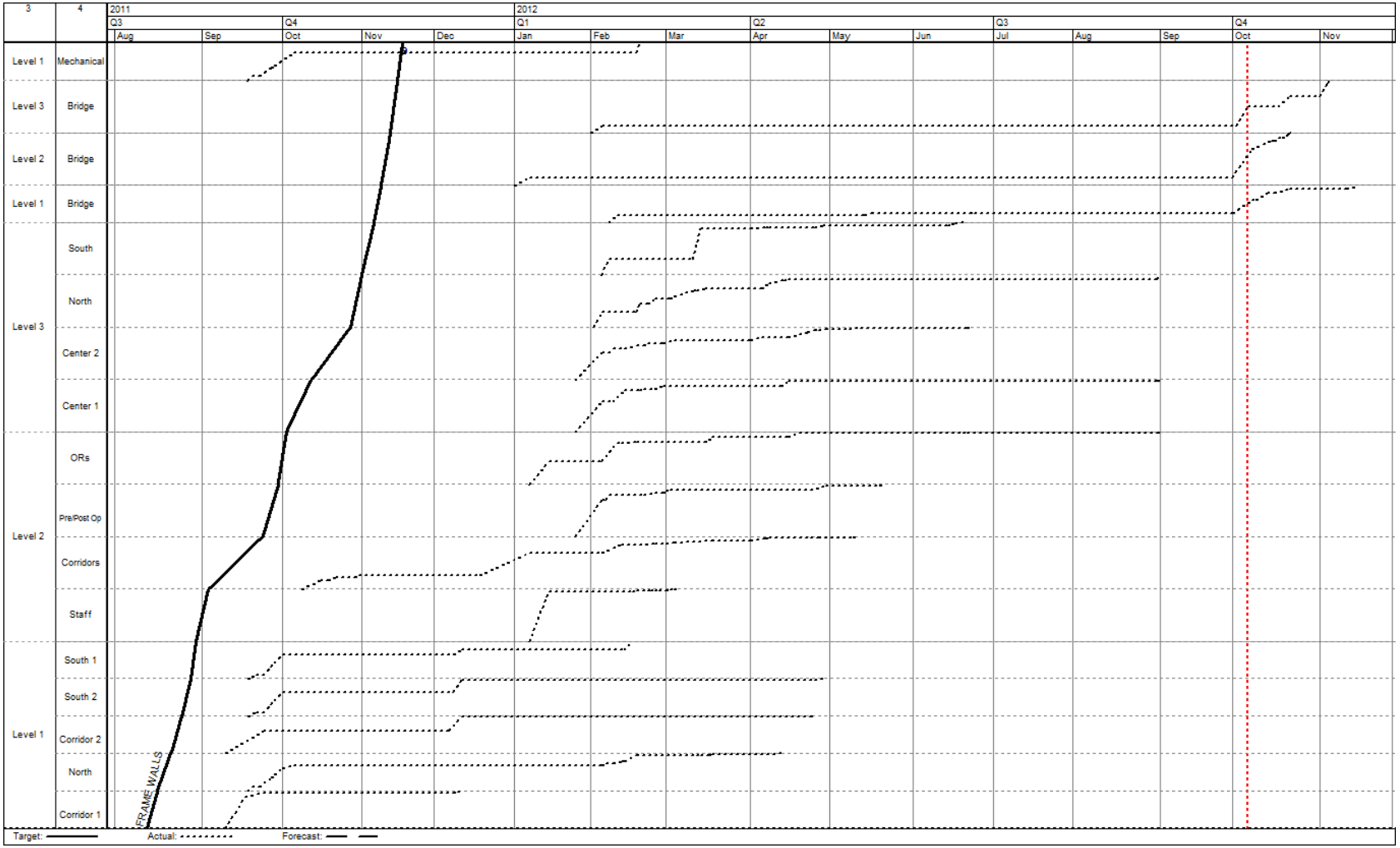
ASAP deployment adds burden to field management process

- Limits forecasting ability
- Impacts workflow
- Once you start working out of sequence it is difficult to reintroduce any amount of “flow”

“Blow-fly” Effect in Controlling Phase



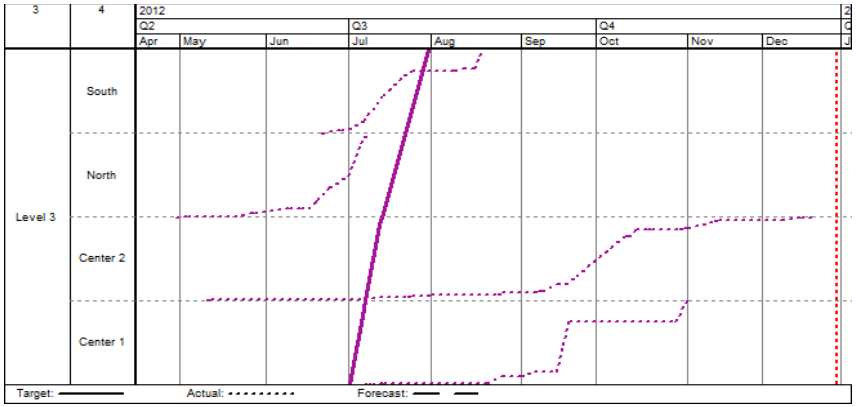
“Flat-line” Effect in Controlling Phase

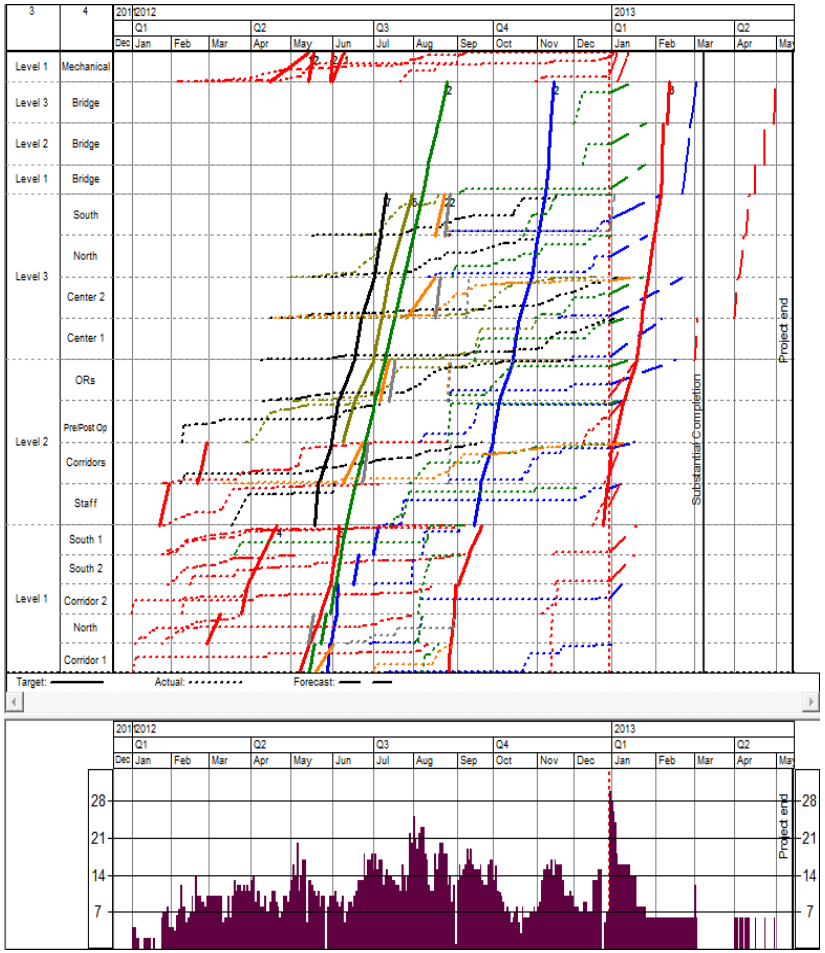


Actual Resource Graph – Electrical

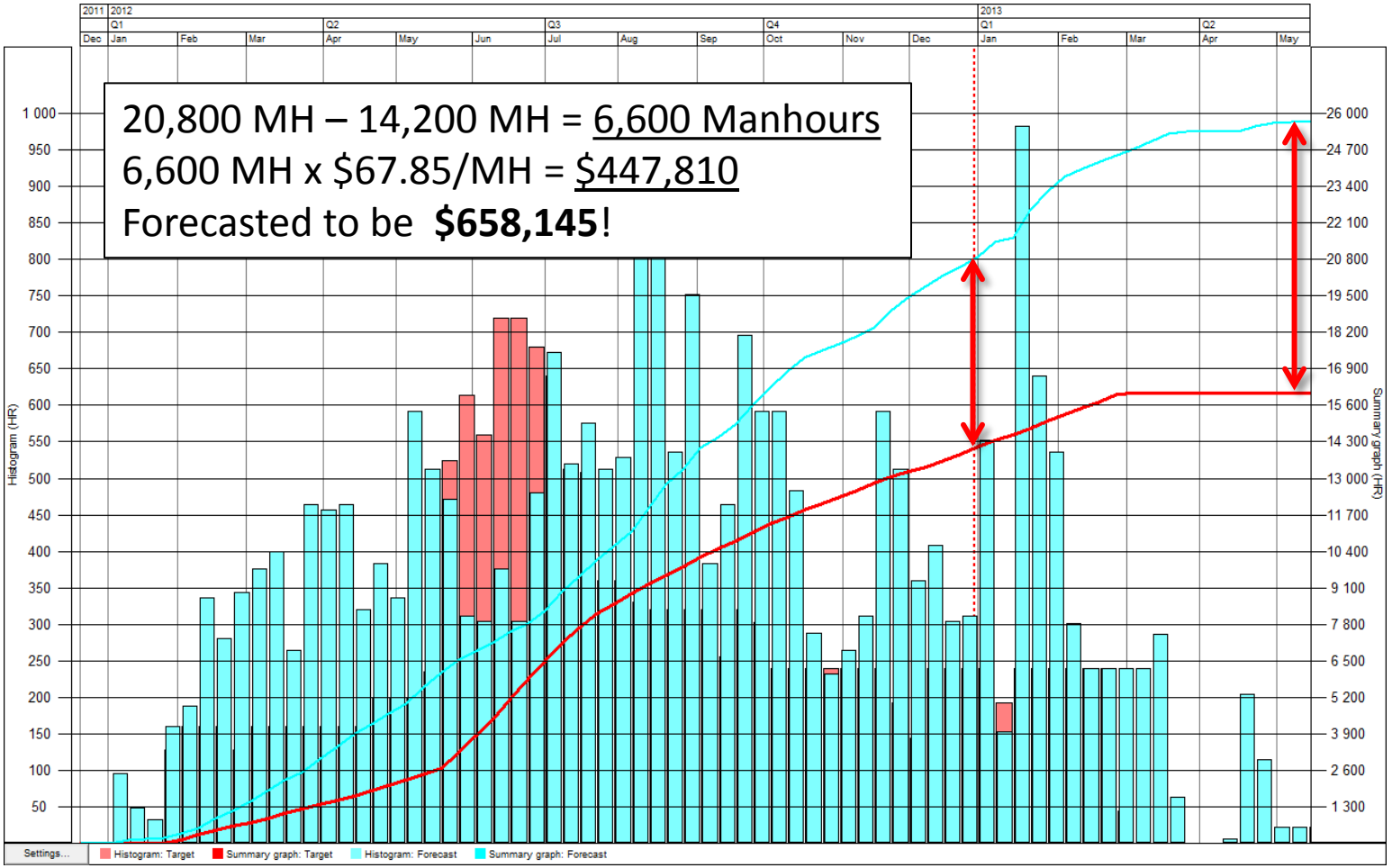
Observed Patterns:

- Early Starts in most locations
- Slower than planned production
- Multiple locations active at the same time
- Working out of sequence
- Smaller than planned crew size





Actual Resource Histogram – Electrical



MOB in Oakland, CA

225,000 SF ancillary support building on new Medical Center Campus

Outpatient services, specialty medicine, Neonatal Post-Operative Care unit, wellness healing gardens

SPECIALTY MEDICAL OFFICE BUILDING

Case Study: Baseline Optimization

- Process:
  - Matched CPM schedule in LBMS; optimized CPM; Implemented change when deemed appropriate by team
- Technology:
  - Selected technologies to support LBMS process
  - Vico Office (Cost Planner, Schedule Planner); MS Office
  - Oracle P3 to export schedule data to satisfy contract
- People:
  - Collaborative work session with GC, Architect, trade-partners and external consultants to agree and implement schedule changes

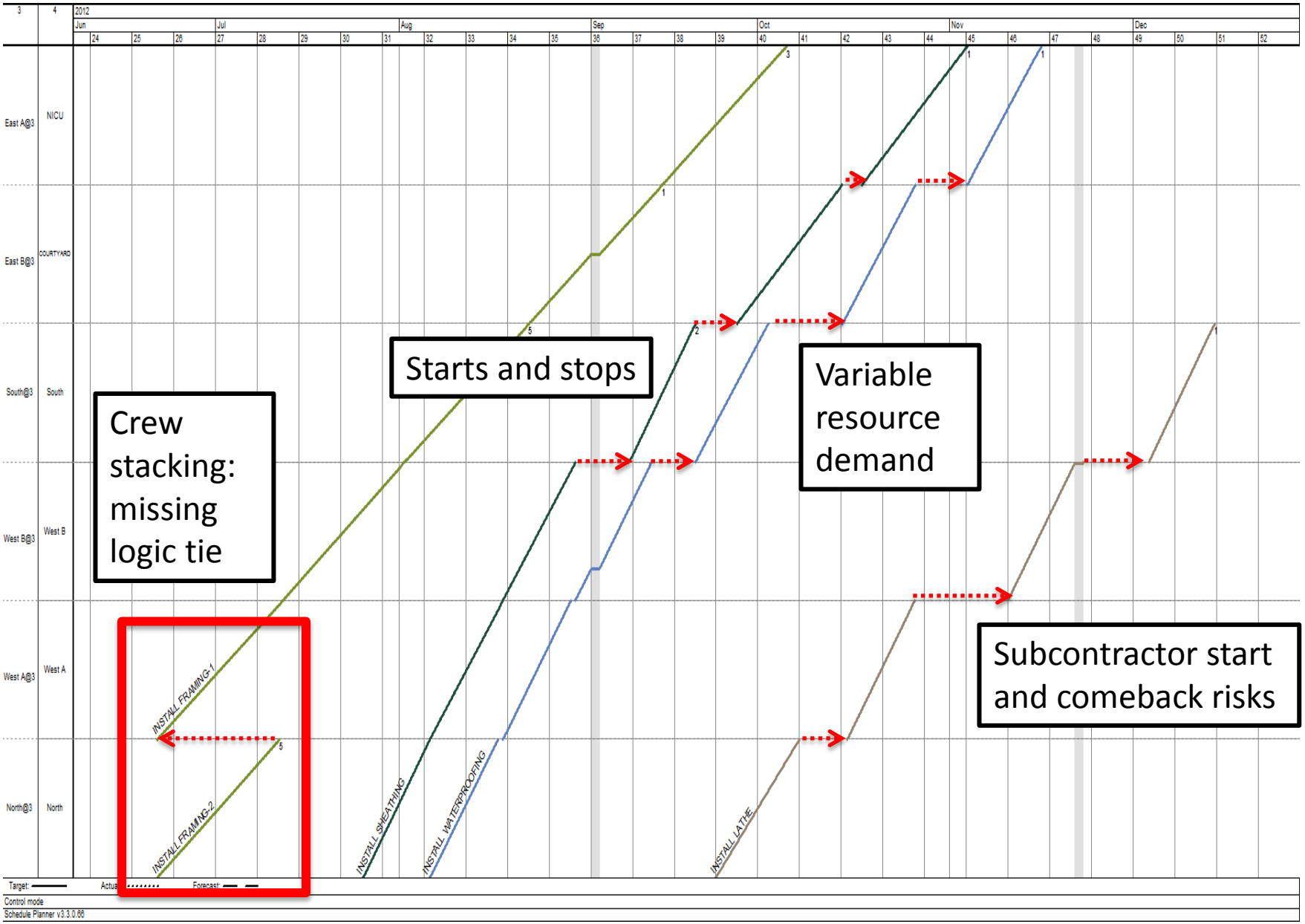
Case Study: Key Benefits

- Graphical review of multiple schedule locations
- Flow analysis
- Detailed understanding of shortcomings of planned CPM dates
- Step by step optimization discussion
- Templatized reports

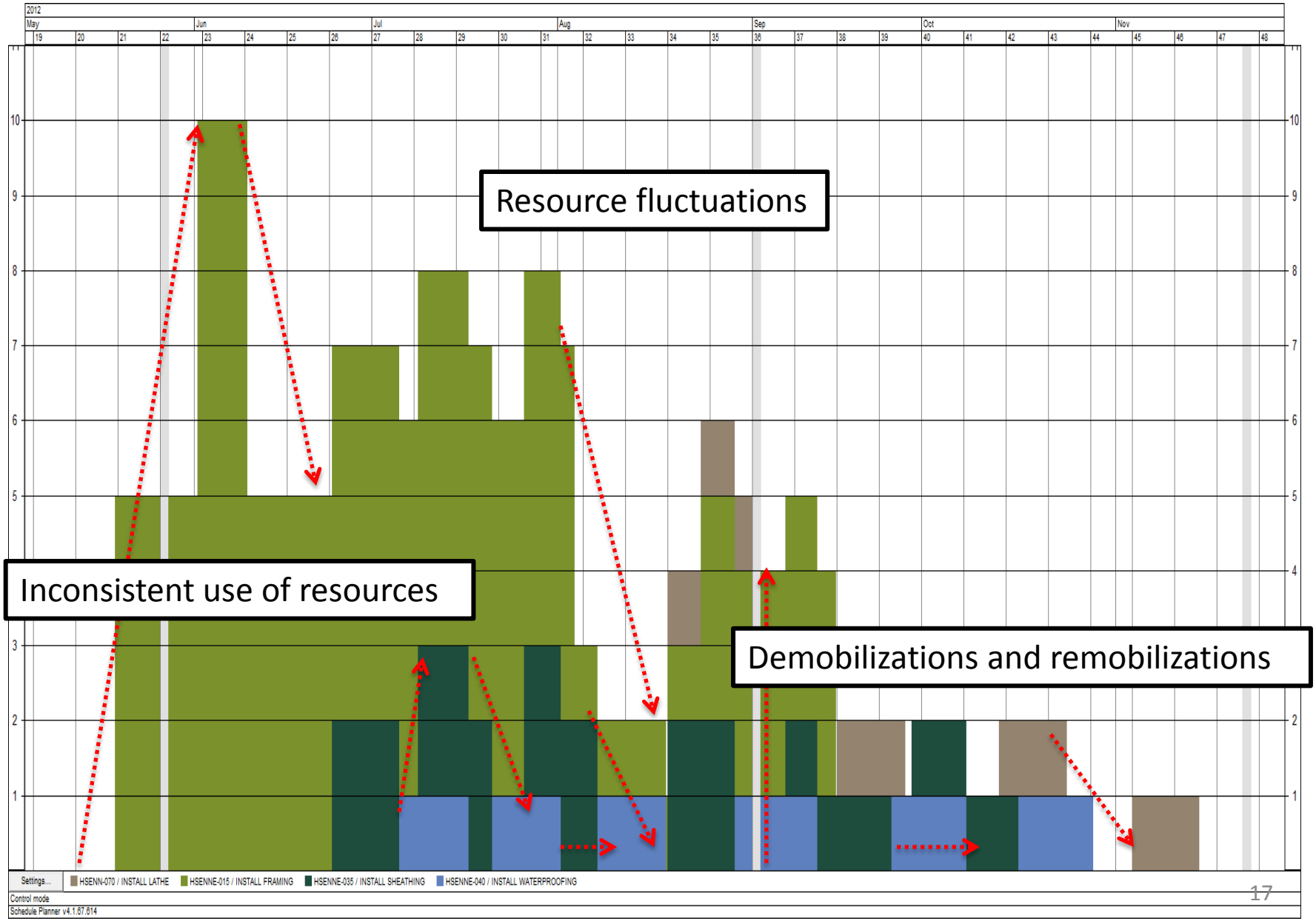
What our Client has Learned…

- Steep learning curve
- CPM denial
- Change from the normal type of analysis
- Sub-contractor buy-in process
- Adjusting the CPM to show LBMS

CPM Schedule Alignment



CPM Resource Analysis

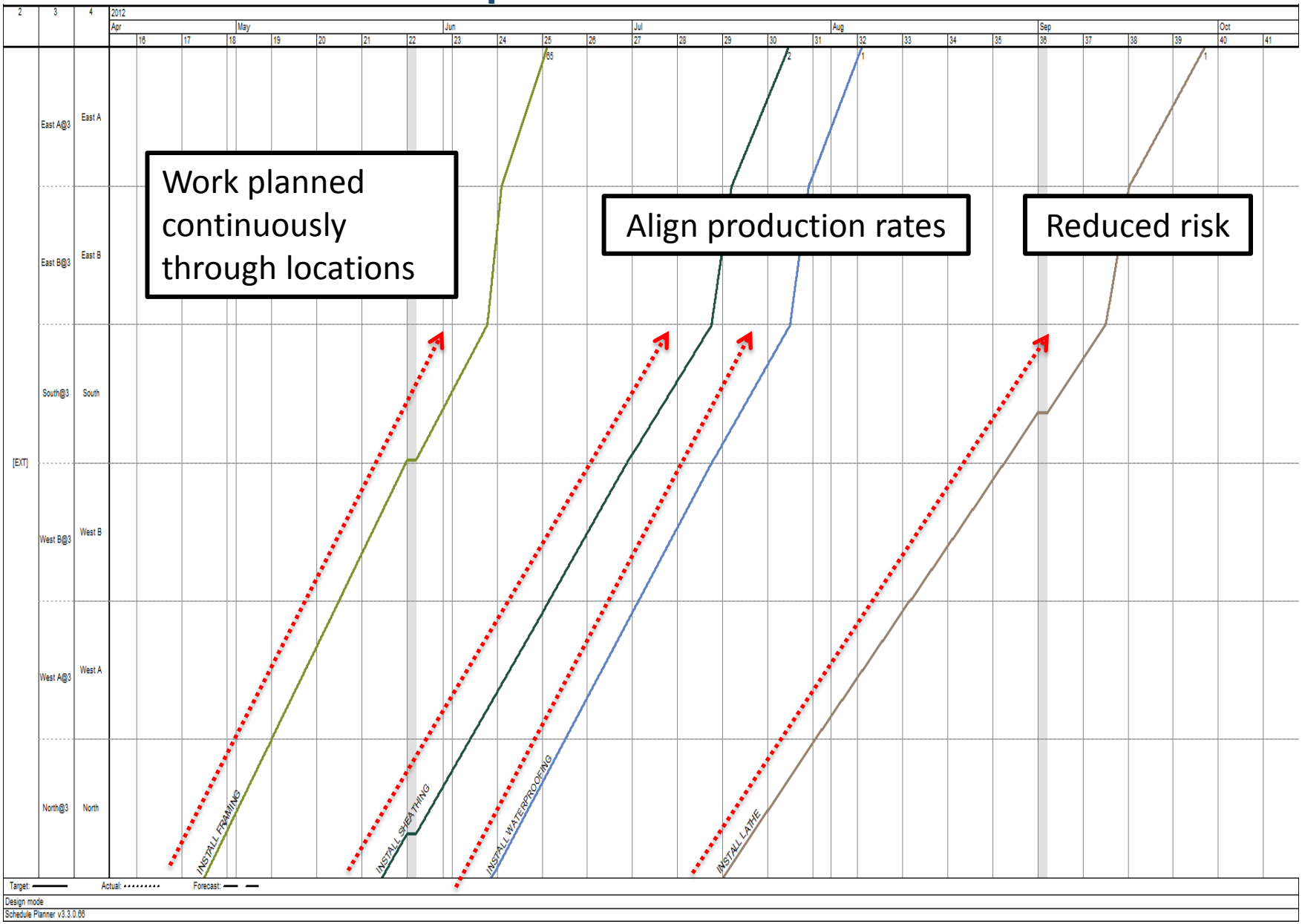


ES EF Date Analysis

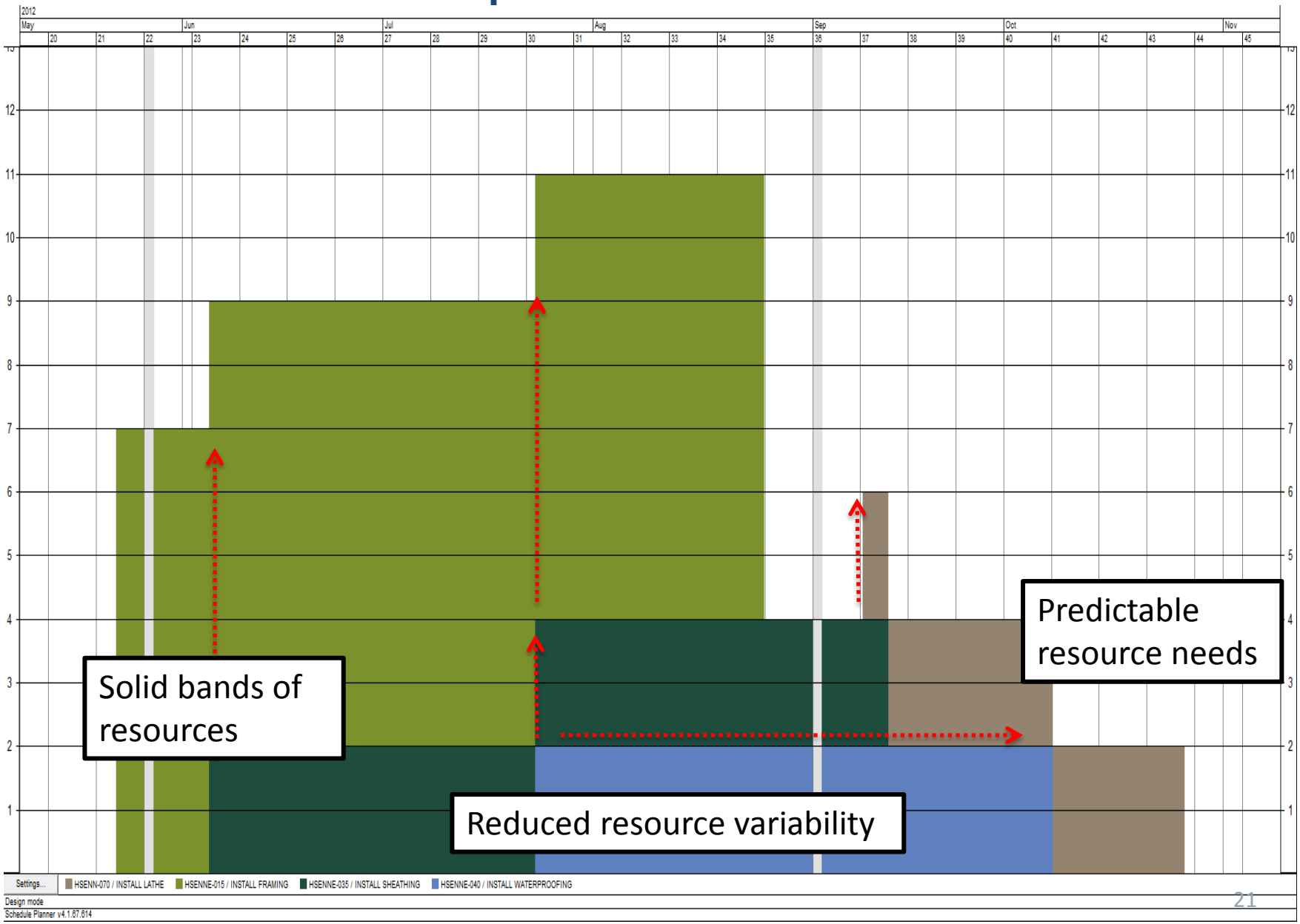
Act Code	Act Name	ES	EF	P3 Start Δ
HSENN-035	INSTALL SHEATHING NORTH ELEV	07/27/2012	08/07/2012	
HSENNW-011	INSTALL SHEATHING WEST ELEV A	08/08/2012	08/17/2012	-1
HSENSW-035	INSTALL SHEATHING WEST ELEV B	08/20/2012	08/29/2012	-3
HSENS-035	INSTALL SHEATHING SOUTH ELEV	09/10/2012	09/19/2012	-12
Act Code	**Act Name**	**ES**	**EF**	**P3 Start Δ**
HSENN-040	INSTALL WATERPROOFING NORTH ELEV	08-Aug-12	17-Aug-12	
HSENNW-012	INSTALL WATERPROOFING WESTELEV A	20-Aug-12	29-Aug-12	-3
HSENSW-040	INSTALL WATERPROOFING WESTELEV A	30-Aug-12	12-Sep-12	-1
HSENS-040	INSTALL WATERPROOFING SOUTH	24-Sep-12	03-Oct-12	-12
Act Code	**Act Name**	**ES**	**EF**	**P3 Start Δ**
HSENN-070	INSTALL LATHE NORTH ELEV	26-Sep-12	05-Oct-12	
HSENNW-018	INSTALL LATHE WEST ELEV A	10-Oct-12	19-Oct-12	-5
HSENSW-070	INSTALL LATHE WEST ELEV B	23-Oct-12	01-Nov-12	-4
HSENS-070	INSTALL LATHE SOUTH ELEV	16-Nov-12	29-Nov-12	-15
HSSML-155	INSTALL LATHE	15-Nov-12	26-Nov-12	14
HSNIC-135	INSTALL LATHE-NICU CTYD	03-Jan-13	10-Jan-13	-38

Cost on down time

CPM Schedule Optimization



CPM Resource Optimization



Cost summary and non-impacts

Hospital in Mountain View California

395-bed hospital

Located on a 41-acre campus in the heart of Silicon Valley

HOSPITAL

Case Study: Camino Medical Center, USA

- 240,000 SF medical office building in California
- Proof-of-concept exercise in the US in 2005
- CPM schedule and optimized schedule compared from time, risk and cost angle
- The same duration could be achieved with
  - 20% lower labor cost
  - Lower risk

Case Study: Camino Medical Center, USA

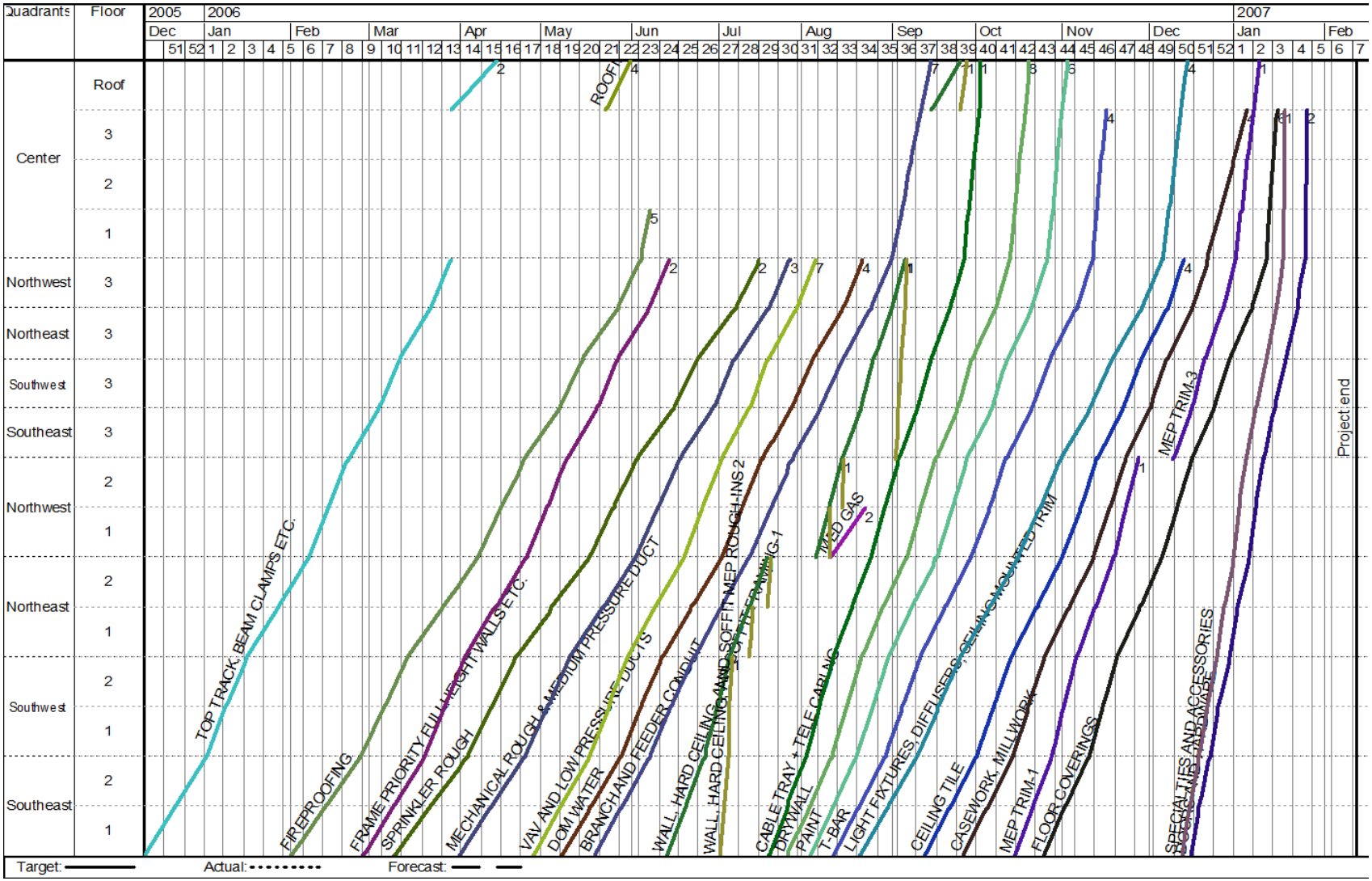
Starting data:

- Quantities for MEP trades (manually measured from 3D model)
- Productivity rates
- Resource limits
- Dependencies
- Labor rates

Outputs:

- Resource-loaded CPM match schedule
- Resource-loaded optimized schedule
- Comparison

Original CPM vs. Optimized LBS



Optimization of 5D Costs

	CPM Schedule				4D-5D Integration			
Subcontractor	Peak Resource Use	Direct Cost ($)	Mobilization / Demobil. Cost ($)	Waiting Cost ($)	Peak Resource Use	Direct Cost ($)	Mobilization / Demobil. Cost ($)	Waiting Cost ($)
Casework	10	$231,680	$7,680	$43,307	8	$185,480	$1,280	-
Ceiling tile	11	$316,320	$12,320	$118,693	12	$262,320	$1,920	-
Doors, frames, hardware	2	$76,000	$3,413	$19,733	4	$38,800	$640	-
Drywall	20	$738,800	$16,960	$245,227	18	$566,920	$4,800	$120,049
Electrical	14	$494,720	$11,840	$123,397	12	$406,000	$2,080	$2,598
Fireproofing	14	$271,040	$2,240	-	10	$291,200	$1,600	-
Flooring	18	$372,480	$12,480	$176,960	12	$228,720	$1,920	-
Mechanical	11	$409,080	$8,000	$90,613	11	$263,400	$3,040	$19,720
Paint	6	$181,760	$5,760	$106,020	6	$126,400	$960	-
Plumbing	3	$109,480	$1,760	$14,133	6	$104,000	$960	-
Specialties	3	$49,640	$1,493	$7,253	1	$8,640	$160	-
Sprinkler	3	$98,000	$1,813	$37,973	2	$59,440	$320	-

What was the result of implementing the LBMS?

How did we focus our effort to achieve success?

IN SUMMARY