

# TEMECULA MEDICAL CENTER



## “STRUCTURAL SYSTEM OPTIMIZATION”

IMAGE COUTESY OF THE HKS INC.

THE DEPARTMENT OF ARCHITECTURAL ENGINEERING  
AT  
THE PENNSYLVANIA STATE UNIVERSITY

APRIL 13, 2009

SEAN BEVILLE

STRUCTURAL OPTION  
ADVISOR: PROF. BOOTHBY



# PRESENTATION OUTLINE

## PRESENTATION OUTLINE

THESIS GOALS

BUILDING INTRO

STRUCTURAL DEPTH

CM BREADTH

ARCHITECTURAL BREADTH

SUMMARY  
&  
RECOMMENDATIONS

THANK YOU

QUESTIONS

THESIS GOALS

BUILDING INTRODUCTION

STRUCTURAL DEPTH

- STRUCTURE CHANGES
- GRAVITY/LATERAL
- RECOMMENDATIONS

CM BREADTH

- INTRODUCTION
- COMPARISONS
- RECOMMENDATIONS

ARCHITECTURAL BREADTH

- FAÇADE CHANGES
- SUNLIGHT CHANGES
- RECOMMENDATIONS

RECAP & FINAL RECOMMENDATIONS


QUESTIONS



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## THESIS GOALS

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- Analysis existing conditions/surrounding region
- Optimize new steel structure
- Analyze construction feasibility of new system
- Enhance exterior architecture



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## BUILDING INTRODUCTION

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LOCATION

Temecula, California


33.5°N 117.1°W



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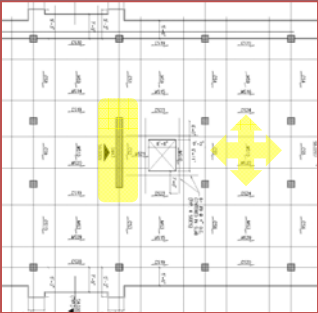
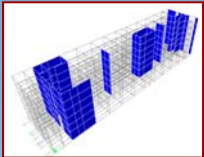
## EXISTING CONDITIONS

### Lateral System

- Concrete Shear Walls 24" Thick
- Compressive Strength  $f'_c$ , 7000 psi

### Floor System

- Concrete Flat-Plate System
- 2-Story D&T Pre-Stressed Double-Tees

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## EXISTING CONDITIONS

### Roof System

- 16 Ga Composite Steel Deck
- 4 1/2" Concrete Slab

### Foundation

- Drilled Piers 42" Diameter
- Spread Footings 5'x5' to 18'x18'


### Columns

- 26"x26" cast-in-place
- Reinforced with #9 and #6 bars

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## BUILDING INTRODUCTION

BUILDING FUNCTIONS – 295,000 sq. ft.

**Floor 1**


- Entrance – ER – Exam Rooms

**Floors 2-3**

- Intensive Care Unit (ICU) – Exam Rooms – Offices

**Floors 4-6**


- Patient Rooms – Offices – Nurse Stations



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## STRUCTURAL DEPTH STUDY

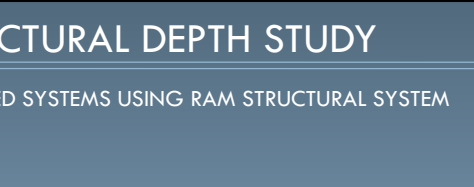
OPTIMIZED SYSTEMS USING RAM STRUCTURAL SYSTEM

**Floor System**

- Flat-plate to composite steel
- Concrete columns to steel columns

**Lateral System**


- Concrete shear walls to steel braced frames



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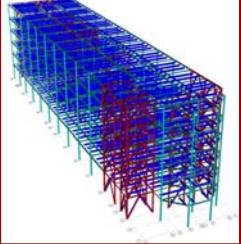
## OPTIMIZED SYSTEMS

### Composite Steel System

- Steel Columns
- 27'x26' Typical Bays

### Lateral System


- Concentric Diagonal Bracing
- Moment Frames
- HSS Steel Shapes



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## FLOOR LAYOUT

### Typical Layout


- W18 Girders, W16 Joists
- 6" Slab (4" above deck)



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## COLUMN LAYOUT

Typical Layout


- W10x33 → W12x79
- Limited to W10 when possible



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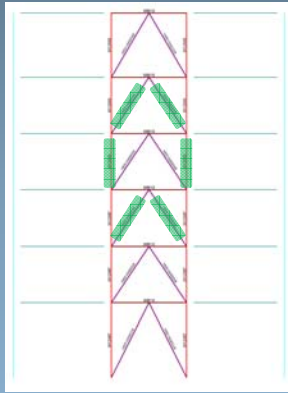
## LATERAL SYSTEM

Diagonal Bracing

- HSS 14"x6"x3/8"
- Concentric

Moment Frames


- W12 x 50/87



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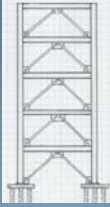
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## LATERAL SYSTEM

Typical Chevron Bracing

- Consistent member contribution
- Adequate deflections < 3.3"




Story	X-Direction		Y-Direction	
	Story Drift	Displacement	Story Drift	Displacement
6	0.68	3.12	0.51	2.79
5	0.64	2.51	0.48	2.23
4	0.64	1.95	0.48	1.71
3	0.61	1.39	0.45	1.19
2	0.52	0.86	0.37	0.71
1	0.49	0.41	0.31	0.32

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## LAYOUT MODIFICATIONS


Typical Floors

- Floor-to-floor heights increased by 12" 
- Column sizes smaller = more space 
- Thinner lateral-structure 

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## RESULTS & RECOMMENDATIONS

### Floor System

- Explore slab – joist combinations
- Non – composite system

### Lateral System

- Eccentric bracing
- Fewer/larger steel braces

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# CONSTRUCTION MANAGEMENT BREADTH

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QUESTIONS

## MATERIAL TAKEOFFS

### Existing System

- R.S. Means estimates
- Typical concrete construction

### Steel Re-design

- RAM Structural System
- Weight takeoffs



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# CONSTRUCTION MANAGEMENT BREADTH

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## MATERIAL & LABOR COSTS

R.S. Means – 2008

Assumptions

- Steel - \$0.50/lb


Takeoffs from 4 Groups

- Columns
- Slabs
- Shear walls – Diagonal Bracing
- Crane/Equipment

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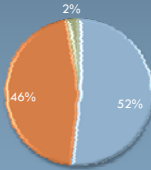
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## COSTS

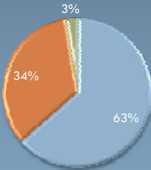
### Concrete Original



Materials:	1,990,893
Labor:	1,756,787
Equipment:	99,763

TOTAL – \$3.8 Million

### Steel Redesign



Materials:	1,473,226
Labor:	779,298
Equipment:	62,283


TOTAL – \$2.3 Million

TOTAL SAVINGS – \$1.53 Million  
\$5.2/sq. ft.

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## CONSTRUCTION MANAGEMENT BREADTH

SCHEDULING

Concrete Existing

261 Days

Steel Re-Design

208 Days

↓

Savings

53 Days

2.7 Months

@ \$60,000/Month = \$198,000 in scheduling savings

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## CONSTRUCTION MANAGEMENT BREADTH

CONCLUSIONS

**Total Savings**

- \$1.53 Million (\$5.2/sq. ft.)

**Additional Savings**

- Scheduling impact
- Early move-in, Foundations

**Disadvantages of Steel**

- Lead time
- Increased height
- Staging area

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# CONSTRUCTION MANAGEMENT BREADTH

CONCLUSIONS & RECOMMENDATIONS

- ✓ Composite Steel Is Viable
- ✓ Flexible Savings
- ✓ Further Investigation Recommended


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# ARCHITECTURAL BREADTH


OPTIMIZED SYSTEMS

Existing Condition

- Plaster façade
- Minimal window coverage

Re-Design

- Predominantly glass
- Extensions for shade



LIFE SCIENCES BUILDING


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OPTIMIZED SYSTEMS

## Glass Façade Re-Design

- Regional architecture
- Sun study
- Penn State study




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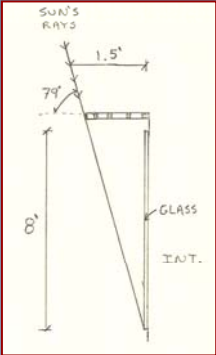
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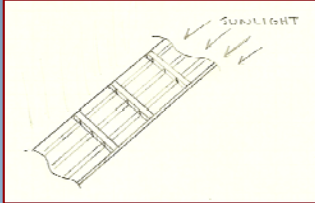
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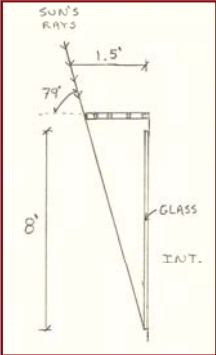
OPTIMIZED SYSTEMS

## Glass Façade Re-Design

- 79° sun angle
- 8' windows








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## ARCHITECTURAL BREADTH

CONCLUSIONS AND RECOMMENDATIONS

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SUMMARY & RECOMMENDATIONS

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QUESTIONS

- ✓ New architectural approach for region
- ✓ Increased sunlight → heat
- ✓ Less efficient than original design
- ✓ Further investigation not recommended

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## SUMMARY & RECOMMENDATIONS

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**SUMMARY & RECOMMENDATIONS**

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QUESTIONS

- ✓ Analysis existing conditions/surrounding region
  - ✓ Existing conditions explored and verified
  - ✓ Systems studied for comparison
- ✓ Optimize new steel structure
  - ✓ Re-designed steel member sizes determined
  - ✓ More efficient lateral system
  - ✓ Further investigation recommended

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QUESTIONS

### GOALS

- ✓ Analyze construction feasibility of new system
  - ✓ Steel system very efficient
  - ✓ Lower final costs and construction times
  - ✓ Further investigation recommended
- ✓ Enhance exterior architecture
  - ✓ Adds appeal to region
  - ✓ Allows more incoming light
  - ✓ Original design – more efficient operating costs
  - ✓ Further investigation not recommended

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QUESTIONS

Special thanks to

HKS Inc.

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Prof. Parfitt

Prof. Holland

Prof. Boothby

Friends and Family

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# QUESTIONS

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## QUESTIONS?



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