mckinstry oregon headquarters portland or

mechanical option senior thesis presentation







Design Objectives

- Sustainability
- Comfort

• Economy

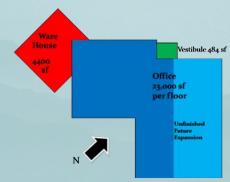
DESIGN OBJECTIVES



Building Overview

Stats

- Total SF: 50,590
- \$11.1 million • \$219.40/SF
- \$1.39 million mechanical cost
- \$27.48/SF



TRODUCTION

SIGN OBJECTIVES

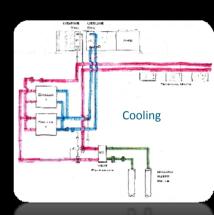
EXISTING CONDITIONS

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ENERGY & CO

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ONCHISIONS



Waterside Mechanical

HEATING Generals

Heating

Boiler

Added

Heat Recovery Chiller

840000 WATER

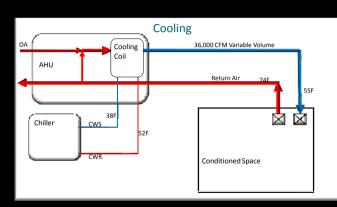
WELLS

VAV System

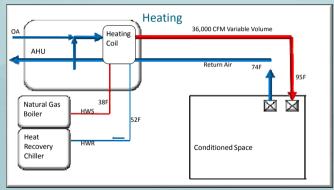
Open

Loop Ground Water Heat Transfer

EXISTING CONDITIONS



Variable Air Volume



INTRODUCTION

IGN OBJECTIVES

EXISTING CONDITIONS

MECHANICA

ENERGY & CC ANALYSIS

ITING REDESIGN

CONCLUSIONS

Mechanical Redesign

- **VAV** • Variable air volume Sensible and
- latent loads

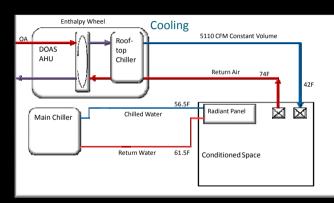
DOAS Ventilation air

• Latent loads

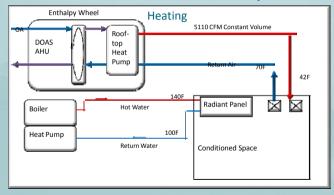
Radiant

Panels

- MECHANICAL REDESIGN



Dedicated Outdoor Air System



INTRODUCTIO

IGN OBJECTIVE

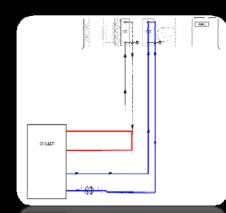
EXISTING CONDITION

MECHANICAL

IERGY & COST

HTING REDESIGN

CONCLUSIO



Central Plant Considerations

- System Split
- Ventilation Air
 - 42F

INTRODUCTIO

IGN OBJECTIVE

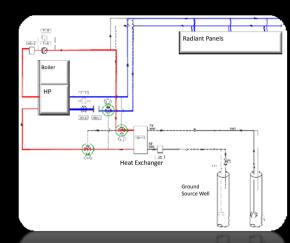
EXISTING CONDITIONS

MECHANICAL REDESIGN

ENERGY &

LIGHTING REDESIGN

HISIONS



Central Plant Considerations

- System Split
- Ventilation Air
 - 42F
- Radiant Panels
- 56.5F

DESIGN OBJECTIV

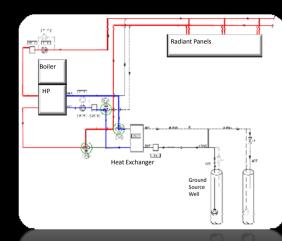
CONDITION

MECHANICAL REDESIGN

> IERGY & COS ANALYSIS

HTING REDESIGN

NCLUSIONS



Central Plant Considerations

- System Split
- Ventilation Air
 - 42F
- Radiant Panels
 - 56.5F
- Hot Water Temperature
- Efficiency vs. thermal stratification
- Raise ΔT

MECHANICAL REDESIGN



DOAS - Comfort

- Proper Ventilation
- No mixed air
- **Humidity Control**
- Latent and Sensible Loads Decoupled

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MECHANICAL REDESIGN

RGY & COST

DESIGN

EDESIGN

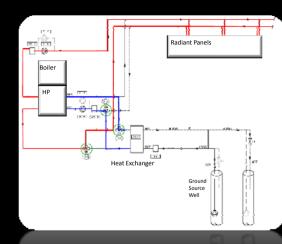
LICIONIC

DOAS - Costs

Added Savings Costs Yearly Energy Radiant Panels Enthalpy Wheel

MECHANICAL REDESIGN

CONCLUSIONS



Piping

- Hot Water
- 45 GPM
- Piping from original design adequate
- Chilled Water
- 225 GPM



RODUCTION

SN OBJECTIVES

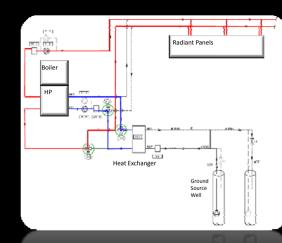
EXISTING CONDITIONS

> MECHANICAL REDESIGN

NERGY & CO ANALYSIS

NG REDESIGN

CONCLUSIONS



Piping

- Hot Water
- \$9,060 savings
- Chilled Water
 - (\$50,070) added

Copper piping PEX Steel

DESIGN OBJECTI

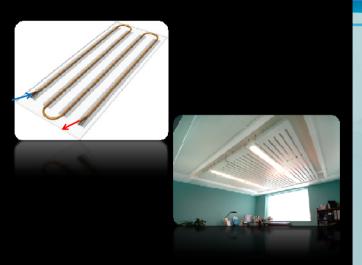
EXISTING CONDITIONS

MECHANICAL REDESIGN

NERGY & CO ANALYSIS

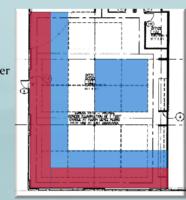
NG REDESIGN

ICLUSIONS



Radiant Panels

- Sensible Loads
- CoolingInterior and Perimeter
 - 42% of ceiling
- 5°F ∆T
- Heating
- Perimeter only
- 40°F ΔT



ODUCTION

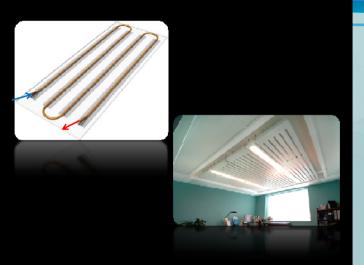
GN OBJECTIVES

EXISTING CONDITION

MECHANICAL REDESIGN

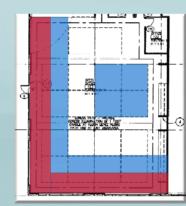
ENERGY & CO

ING REDESIGN



Radiant Panels

- Cooling
 - 17615 SF\$13/SF
- Heating
- 6,316 SF
- \$2/SF additional
- (\$241,620)



JOUCHON

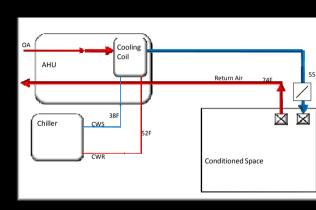
JIGIV OBJECTIV

EXISTING CONDITION

MECHANICAL REDESIGN

ENERGY & COS ANALYSIS

TING REDESIG



Air Side System

- 5110 CFM AHU
 - 15% of original
 - Constant Volume

\$85,000

(\$10,600)

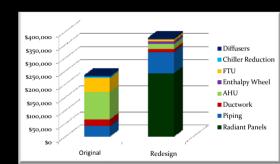
\$15,600

\$44,900

(\$1,500)

- **Enthalpy Wheel**
- 80% efficient Smaller Ductwork
- Terminal Unit Dampers
- **High Induction Diffusers**

ENERGY & COST



First Cost Analysis

	Total Mechanical Cost	Cost/SF	Redesign Savings	Savings/SF
Original	\$1,394,511	\$27.56		
Redesign	\$1,537,814	\$30.40	(\$143,303)	(\$2.83)

RODUCTION

GN OBJECTIVES

FYISTING

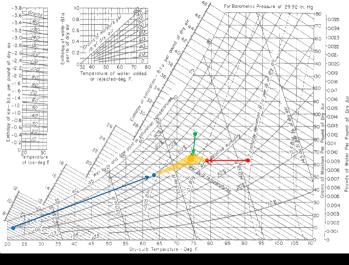
CONDITIONS

HANICAL DESIGN

ENERGY & COST ANALYSIS

REDESIGN

NCLUSIONS



- 1 1 v.n 1
- Enthalpy Wheel Reduced load on AHU Chiller

ODUCTION

EXISTING

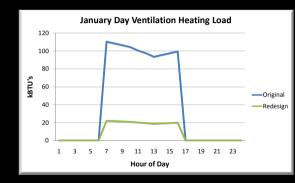
IECHANICAL

REDESIGN
ENERGY & COST

ANALYSIS

LIGHTING REDESI

conclusions



- Enthalpy Wheel
- Reduced load on AHU Chiller
- Yearly Heating: 202,000 kBTU
- Yearly Cooling: 8,900 kBTU

NTRODUCTION

N OBJECTIVES

EVICTING

ONDITIONS

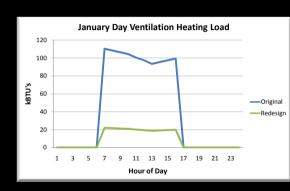
CHANICAL

CHANICAL EDESIGN

ENERGY & COST ANALYSIS

SHTING REDESIGN

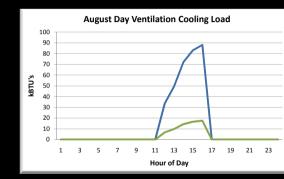
NCLUSIONS





- •15,100 kWh
- \$1,208

ENERGY & COST



- Cooling Load Peak Reduction
- 70,640 BTU/hr Reduces Chiller Size
- 5.9 Tons
- \$5,900

INTROD

OBJECTIVES

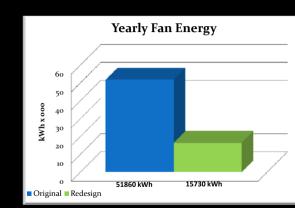
CONDITIONS

MECHANICAL REDESIGN

ENERGY & COST

TING REDESIGN

IG REDESIGN



Fan Energy

- Reduced Ventilation Air
 36,000 CFM → 5,110 CFM
- Yearly Savings
- 36, 130 kWh
- \$2,890

INTRODUCTIO

N OBJECTIVES

CONDITIONS

CHANICAL EDESIGN

ENERGY & COST ANALYSIS

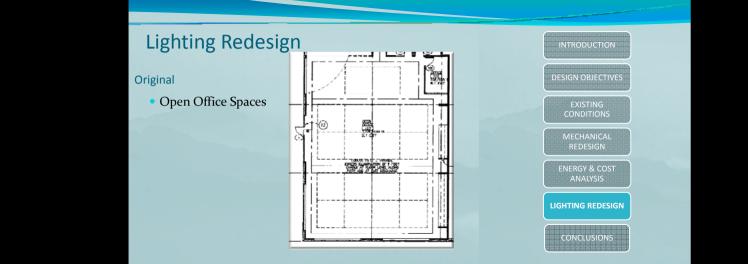
DESIGN

NG REDESIGN

Total Yearly Savings

- •\$4,100 (\$0.08/SF)
- •\$143,300 added cost (\$2.83/SF)
- •35 year payback

ENERGY & COST

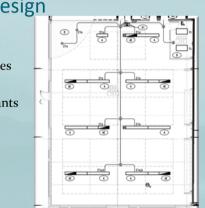


Lighting Redesign

Open Office Spaces

Original

- Suspended Pendants
- 1.02 W/SF

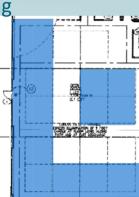


LIGHTING REDESIGN



Tambient Lighting

- Illumination from cubicle
 - Task Lighting
 - Space and Floor



DUCTION

IN OBJECTIVES

EXISTING CONDITION

MECHANICA REDESIGN

ENERGY & CO

LIGHTING REDESIGN

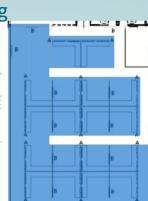
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Tambient Lighting

- Illumination from cubicle
- Task Lighting Space and Floor
- Task and Uplights Uplights





LIGHTING REDESIGN

AGI analysis

5 footcandles on floor

Add 3W task lights

• 30 footcandles on work plane



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SIGN OBJECTIVES

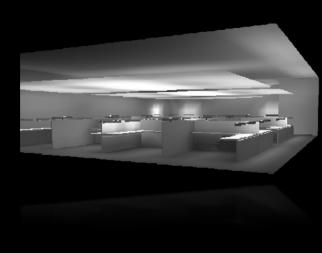
EXISTING CONDITIONS

> ECHANICAL REDESIGN

NERGY & COST

LIGHTING REDESIGN

NICHISIONS



AGI analysis

- .50 W/SF
 - Half original load
- Good Ceiling Distribution

IDITIONS

ANICAL ESIGN

ANALYSIS

LIGHTING REDESIGN

ING REDESIGN

CLUSIONS



Multiple Energy Savings

- Lighting Electricity
- \$3,109/yr Cooling Load
- \$506/yr
- Reduced Chiller Size
- \$3400

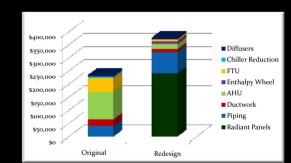
LIGHTING REDESIGN

Adjusted Payback

•35 years → 18.1 years

LIGHTING REDESIGN





Construction Phasing

- Large Costs Reduce
- Radiant Panels
- PipingSavings Upfront
- AHU
- Chiller

INTRODUCTION

GN OBJECTIVES

EXISTING CONDITIONS

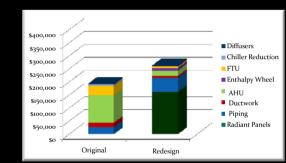
ENERGY & COST

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NG REDESIGN

CONCLUSIONS



Construction Phasing

- Greatly Reduced First Cost • \$139,900 → \$66,100 (\$1.31/SF)
- Slightly Reduced Savings
- \$7,715 → \$5,170 (\$0.10/SF)
- Payback
- •12.8 years

ENERGY & COST



Conclusions

Sustainability • Reduced Energy Usage: 1.91 kWh/SF/yr

- Comfort

 - Better Ventilation
 - Better Humidity Control

- Economy

- Reasonable Payback: 12.8 years

Acknowledgements

- Thanks to:
 - Sponsor: McKinstry
 - Jon, Tom, Aaron, Erik, Phil, Bev
 - Penn State Faculty
 - Professor Srebric and Freihaut
 - Friends and Family
- Brad Sisenwain, Kanis Glaewketgarn Lighting

• Halina, Wojtek, Matt, Chris

CONCLUSIONS



QUESTIONS?

