UNIFIED SCIENCE CENTER

THE UNIVERSITY OF SCRANTON SCRANTON, PA

DALE E. HOUCK

MECHANICAL OPTION

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- PROJECT SUMMARY
- EXISTING CONDITIONS
- DEPTH STUDIES
- SUSTAINABILITY BREADTH STUDIES
- CONCLUSIONS

DALE E. HOUCK
MECHANICAL OPTION

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INTRODUCTION

PROJECT SUMMARY

OWNER
THE UNIVERSITY OF SCRANTON

ARCHITECTS AND ENGINEERS
EINHORN YAFFEE PRESCOTT A&E, P.C.

CONSTRUCTION MANAGER
QUANDEL ENTERPRISES, INC.

SITE/CIVIL ENGINEER
CECO ASSOC, INC.

LANDSCAPE ARCHITECT
M.L. BAIRD & CO.

PROGRAM

150,000 SF NEW CONSTRUCTION
50,000 SF RENOVATIONS

4 FULL FLOORS, PARTIAL GROUND FLOOR

CONSTRUCTION: MAY 2009 – FALL 2011

$73 MILLION GMP CONTRACT

DEPARTMENTS OF BIOLOGY, CHEMISTRY, COMPUTING SCIENCES, PHYSICS, ELECTRICAL ENGINEERING, AND MATHEMATICS

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INTRODUCTION

PROJECT SUMMARY

ARCHITECTURE

- DESIGNED ACCORDING TO PRINCIPLES OF PROJECT KALEIDOSCOPE
- ENCOURAGES INTERDISCIPLINARY COLLABORATION
- MODERN DESIGN OF NEW CONSTRUCTION SEAMLESSLY INTEGRATES WITH RENOVATION OF EXISTING STRUCTURE

DESIGNED FOR LEED SILVER CERTIFICATION

- STONE FAÇADE SUPPLIED BY LOCAL QUARRY
- RECYCLED MATERIALS
- CONSTRUCTION WASTE MANAGEMENT
- EFFICIENT LIGHTING AND MECHANICAL SYSTEMS
- EFFICIENT WATER FIXTURES

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EXISTING CONDITIONS

AIR SIDE

	Total Fan CFM	Total Supply CFM	Heating Coil Capacity (MBH)	Cooling Coil Capacity (MBH)
AHU 1	52,626	50,000	3430.6	5364
AHU 2	52,626	50,000	3430.6	5364
AHU 3	52,626	50,000	3430.6	5364
AHU 4	52,626	50,000	3430.6	5364
AHU 5	5,746	5,150	323	525.5

Fig. 1a Floors 1 – 4, typ.

Fig. 1b Ground Floor

AHUs 1 and 2 | AHUs 3 and 4 | AHU 5

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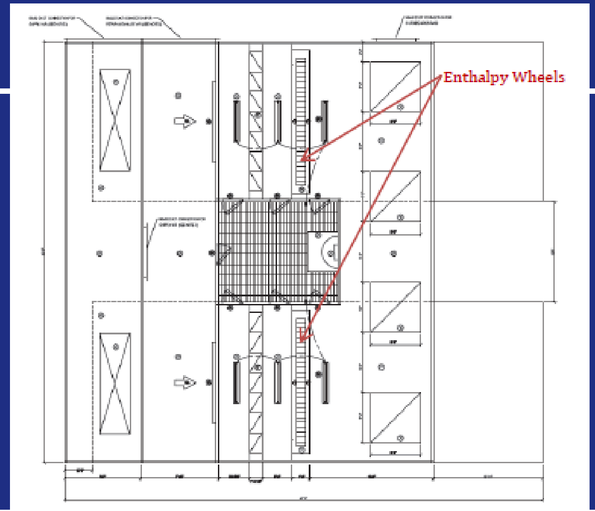
EXISTING CONDITIONS

AIR SIDE

AIR HANDLING UNITS

- VARIABLE AIR VOLUME SUPPLY FANS
- ENTHALPY WHEELS
- VARIABLE FREQUENCY DRIVE FANS



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EXISTING CONDITIONS

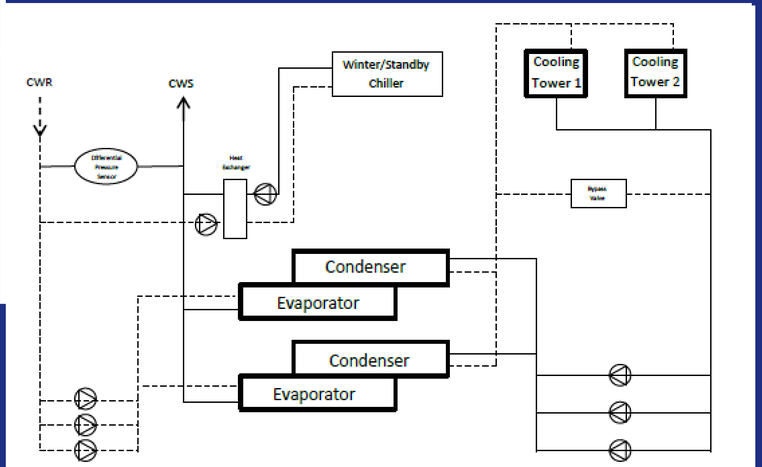
WATER SIDE

Water-Cooled Chillers

	Capacity (Tons)	Efficiency		Evaporator (°F)	Condenser (°F)	Electrical	
		EER (BTU/W-h)	NPLV (kW/Ton)	EWT/LWT	EWT/LWT	MCA	MOCP
CH 1	550	0.548	0.344	56/44	85/95	545	800
CH 2	550	0.548	0.344	56/44	85/95	545	800

Cooling Towers

	Nominal Capacity (Tons)	Design WBT (°F)	EWT (°F)	LWT (°F)	Fan Motor (HP)
CT 1	550	76	95	85	25
CT 2	550	76	95	85	25



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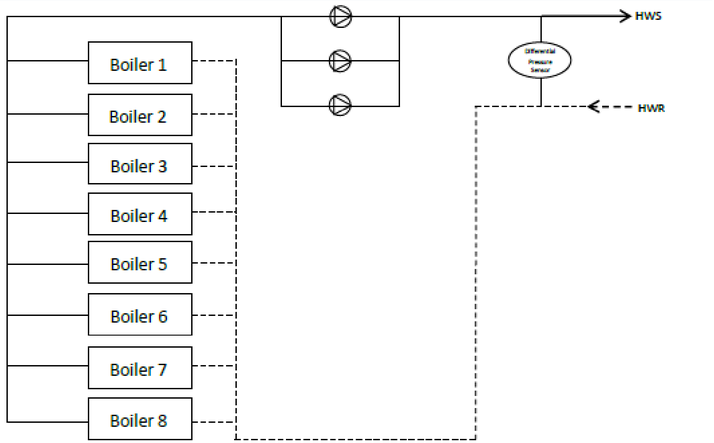
EXISTING CONDITIONS

WATER SIDE

Natural Gas Fired Boilers (typ.)

	Gas Input (MBH)	Net IBR Output (MBH)	EWT (°F)	LWT (°F)	Min/Max Flow (GPM)	Efficiency (%)	Electrical FLA
B-x	1999	1760	150	180	25/120	87	11



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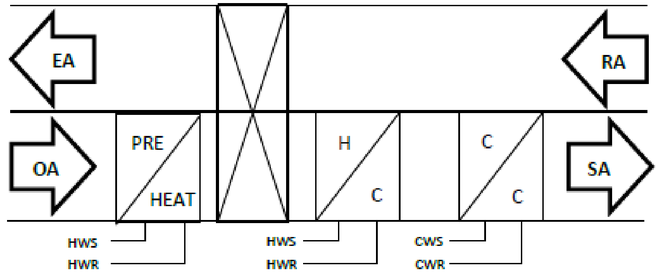
PROJECT DEPTH

HEAT RECOVERY WHEEL

EXISTING ENTHALPY WHEEL TRANSFERS LATENT AND SENSIBLE HEAT BETWEEN EXHAUST AND SUPPLY AIR



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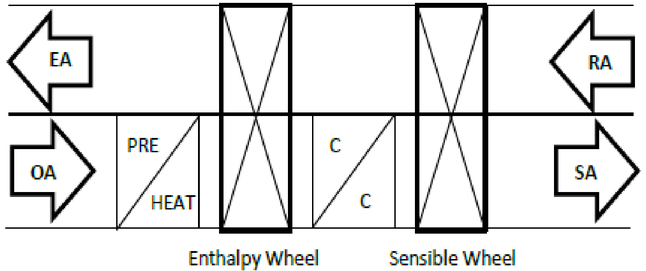
PROJECT DEPTH

HEAT RECOVERY WHEEL

EXISTING ENTHALPY WHEEL TRANSFERS LATENT AND SENSIBLE HEAT BETWEEN EXHAUST AND SUPPLY AIR

ADDITION OF SENSIBLE WHEEL ELIMINATES NEED FOR HEATING COIL



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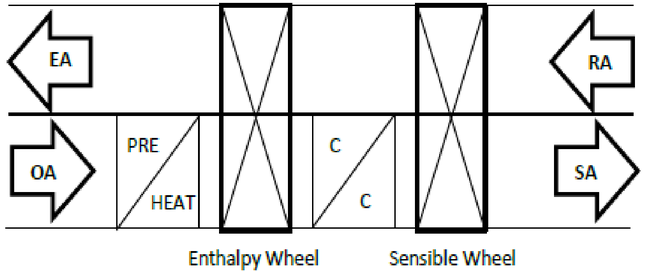
PROJECT DEPTH

HEAT RECOVERY WHEEL

	Cooling Required (Tons)	Reheat Energy Required (MBTUh)
Without Sensible Wheel	168	12,800
With Sensible Wheel	122	7,400
Reduction	27%	42%



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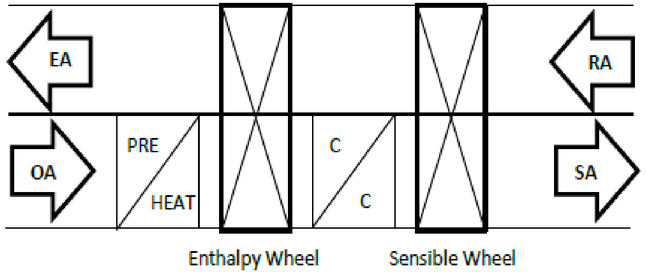
PROJECT DEPTH

HEAT RECOVERY WHEEL

FIRST COST: + $400,000

ENERGY SAVINGS: $45,000/YEAR

SIMPLE PAYBACK PERIOD: 8-9 YEARS



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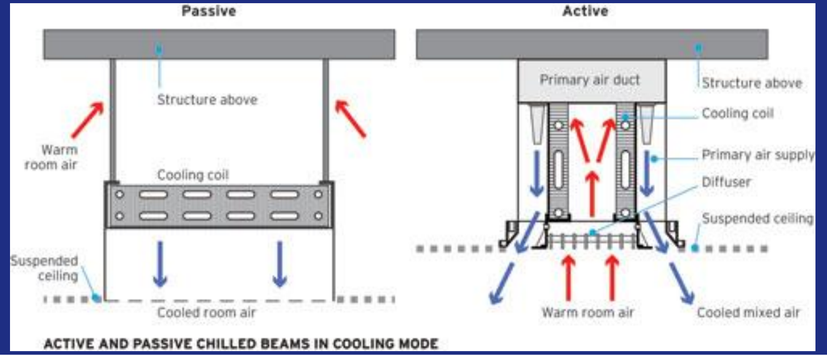
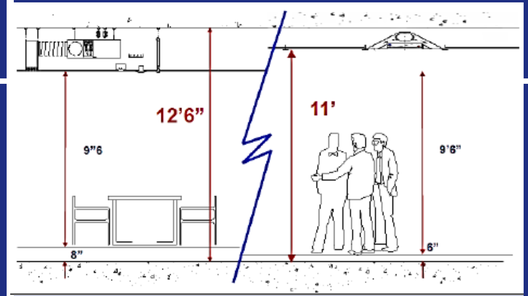
PROJECT DEPTH

CHILLED BEAMS



ACTIVE AND PASSIVE CHILLED BEAMS IN COOLING MODE



Type	Entering Water Temperature (˚F)
Existing Terminal Units	180
Active Chilled Beams	130

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PROJECT DEPTH

CHILLED BEAMS

FIRST COST: +207,200

ENERGY SAVINGS: $75,000/YEAR

SIMPLE PAYBACK PERIOD: 3-5 YEARS

Energy Usage	Current Design	Chilled Beams	Reduction
Natural Gas (kBTU)	24,231,448	15, 935,939	33%
Heating Accessories (kWh)	44,633	22,622	50%
Supply Fans (kWh)	1,024,174	410,261	60%

Equipment	Cost/Unit	# of Units	Savings
VAV Terminal boxes	800	425	340,000
Fan Coil Units	1,100	48	52,800
Chilled Beams	1,000	600	-600,000

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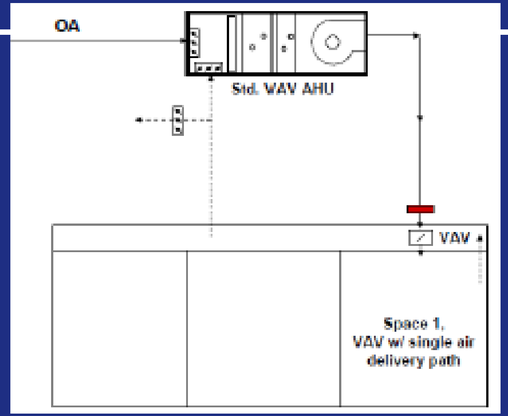
PROJECT DEPTH

TRADITIONAL VAV SYSTEM

- POOR ENERGY USE
- POOR USE OF PLENUM SPACE
- UNKNOWN VENTILATION PERFORMANCE



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PROJECT DEPTH

TRADITIONAL VAV SYSTEM

System	Existing CFM	VAV CFM	Increase
AHUs 1 & 2	100,000	178,400	78%
AHUs 3 & 4	100,000	167,500	68%
AHU 5	5,150	9,200	79%

Load	Existing	VAV	Increase
Heating	64	83	30%
Cooling	168	194	16%

Annual Energy Consumption

Load	Electricity (kWh)		Natural Gas (kBTU)		Water (1,000 gal)	
	DOAS	VAV	DOAS	VAV	DOAS	VAV
Heating						
Primary			21,234,448	28, 241, 815		
Other	127,024	156,921				
Cooling						
Compressor	1,615,573	1,874,064				
Cooling Tower/ Condenser Fans	398,595	458,384			16,550	17,442
Condenser Pump	220,635	258,142				
Auxiliary						
Supply Fans	3,489,151	4,361,438				
Pumps	569,932	683,918				
Other						
Lighting	1,425,080	1,425,080				
Receptacles	820,778	820,778				
Totals	8,666,768	10,038,725	21,234,448	28,241,815	16,550	17,442

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PROJECT DEPTH

TRADITIONAL VAV SYSTEM

FIRST COST: COMPARABLE TO EXISTING SYSTEM

ENERGY COST INCREASE: $200,000/YEAR

- POOR INDOOR AIR QUALITY
- INCREASED MECHANICAL SPACE

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PROJECT BREADTH

LIGHT SHELVES

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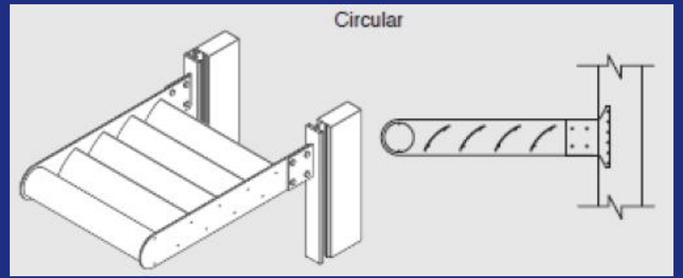
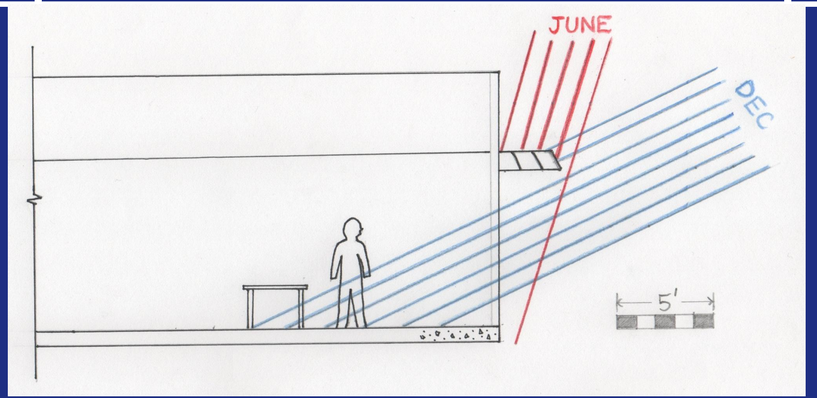
PROJECT BREADTH

LIGHT SHELVES





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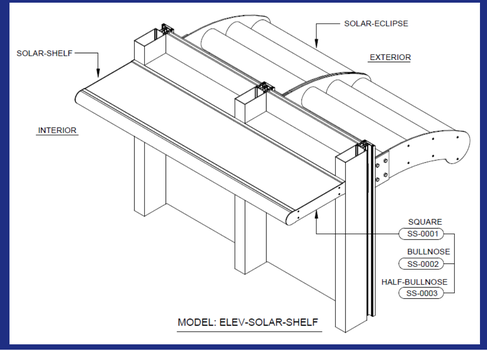
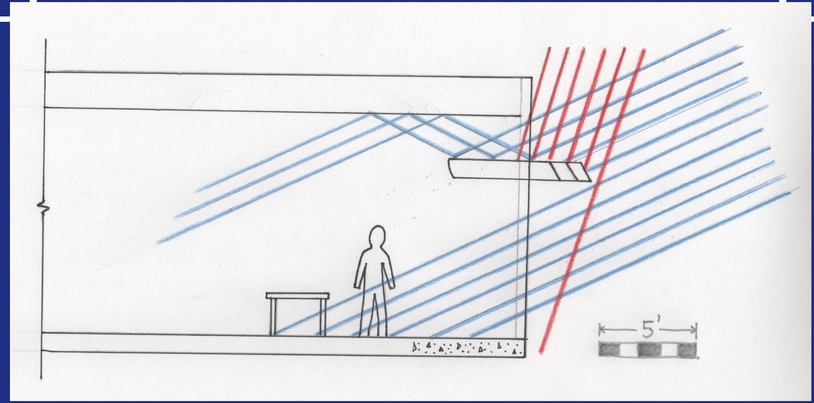
PROJECT BREADTH

LIGHT SHELVES





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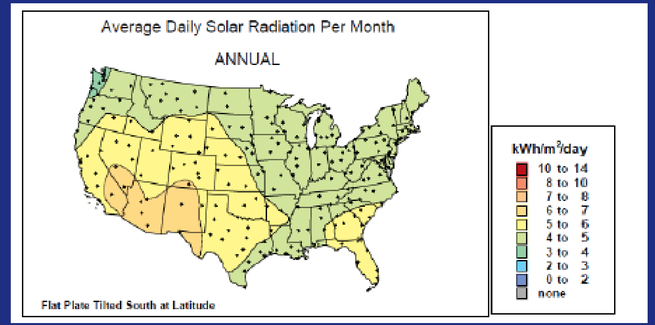
PROJECT BREADTH

SOLAR PANELS



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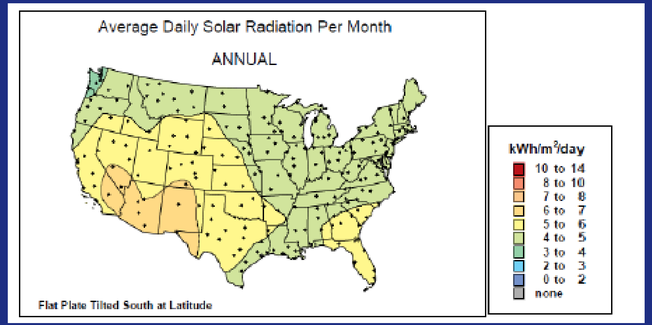
SOLAR PANELS



Month	Solar Radiation (kWh/m²/day)	AC Energy (kWh)	Energy Value ($)
1	2.86	714	68.30
2	3.57	792	75.76
3	4.49	1073	102.64
4	4.75	1064	101.78
5	5.12	1136	108.67
6	5.26	1102	105.42
7	5.31	1125	107.62
8	5.14	1100	105.23
9	4.62	982	93.94
10	4.06	925	88.49
11	2.65	586	56.06
12	2.31	550	52.61
Year	**4.18**	**11150**	**1066.61**

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PROJECT BREADTH

SOLAR PANELS

900 SF 10 KW SOLAR ARRAY:

INITIAL COST: $90,000

ENERGY SAVINGS: $1,066/YEAR

SIMPLE PAYBACK PERIOD: 90 YEARS

Month	Solar Radiation (kWh/m²/day)	AC Energy (kWh)	Energy Value ($)
1	2.86	714	68.30
2	3.57	792	75.76
3	4.49	1073	102.64
4	4.75	1064	101.78
5	5.12	1136	108.67
6	5.26	1102	105.42
7	5.31	1125	107.62
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Year	4.18	11150	1066.61

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PROJECT BREADTH

RAINWATER COLLECTION

11,000 SF ROOF AREA

FIRST COST: $437,500

UTILITY SAVINGS: $2,750/YEAR

SIMPLE PAYBACK PERIOD: 160 YEARS

Month	Average Precipitation (in.)	Volume (ft^3)	Volume (gallons)
January	2.1	1925	14,438
February	2.3	2108	15,813
March	2.6	2383	17,875
April	3.0	2750	20,625
May	3.7	3392	25,438
June	4.0	3667	27,500
July	3.8	3483	26,125
August	3.3	3025	22,688
September	3.3	3025	22,688
October	2.8	2567	19,250
November	3.1	2842	21,313
December	2.5	2292	17,188
Totals	36.5	33458	250,938

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CONCLUSIONS

HEAT RECOVERY WHEELS
- GOOD OPTION

CHILLED BEAMS
- UNCERTAINTY OF LATENT LOADS

VAV SYSTEM
- OUTPERFORMED IN INITIAL AND ANNUAL COST

LIGHT SHELVES
- SUBJECT TO PLENUM SPACE

SOLAR PANELS
- NOT ECONOMICALLY VIABLE

RAINWATER COLLECTION
- NOT ECONOMICALLY VIABLE

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QUESTIONS?