Winter February 3, 2017

Kevin Roche's University of Massachusetts-Amherst Fine Arts Center and Brutalism's Monolithic Concrete Construction Performance Perception Penalty

L Carl Fiocchi, Jr

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University of Massachusetts-Amherst Fine Arts Center
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Performance Perception Penalty

February 2017
Association for Preservation Technology NorthEast

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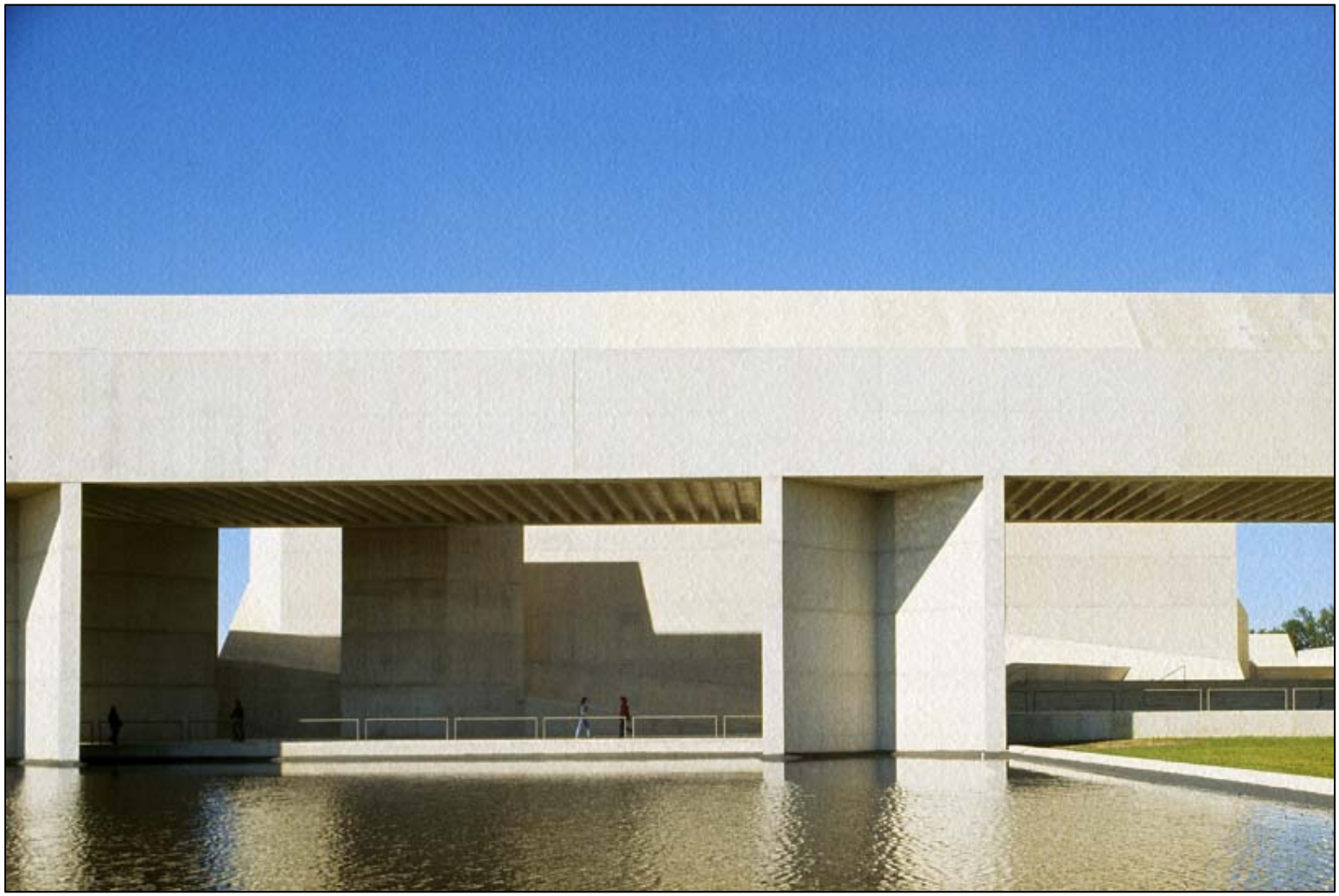
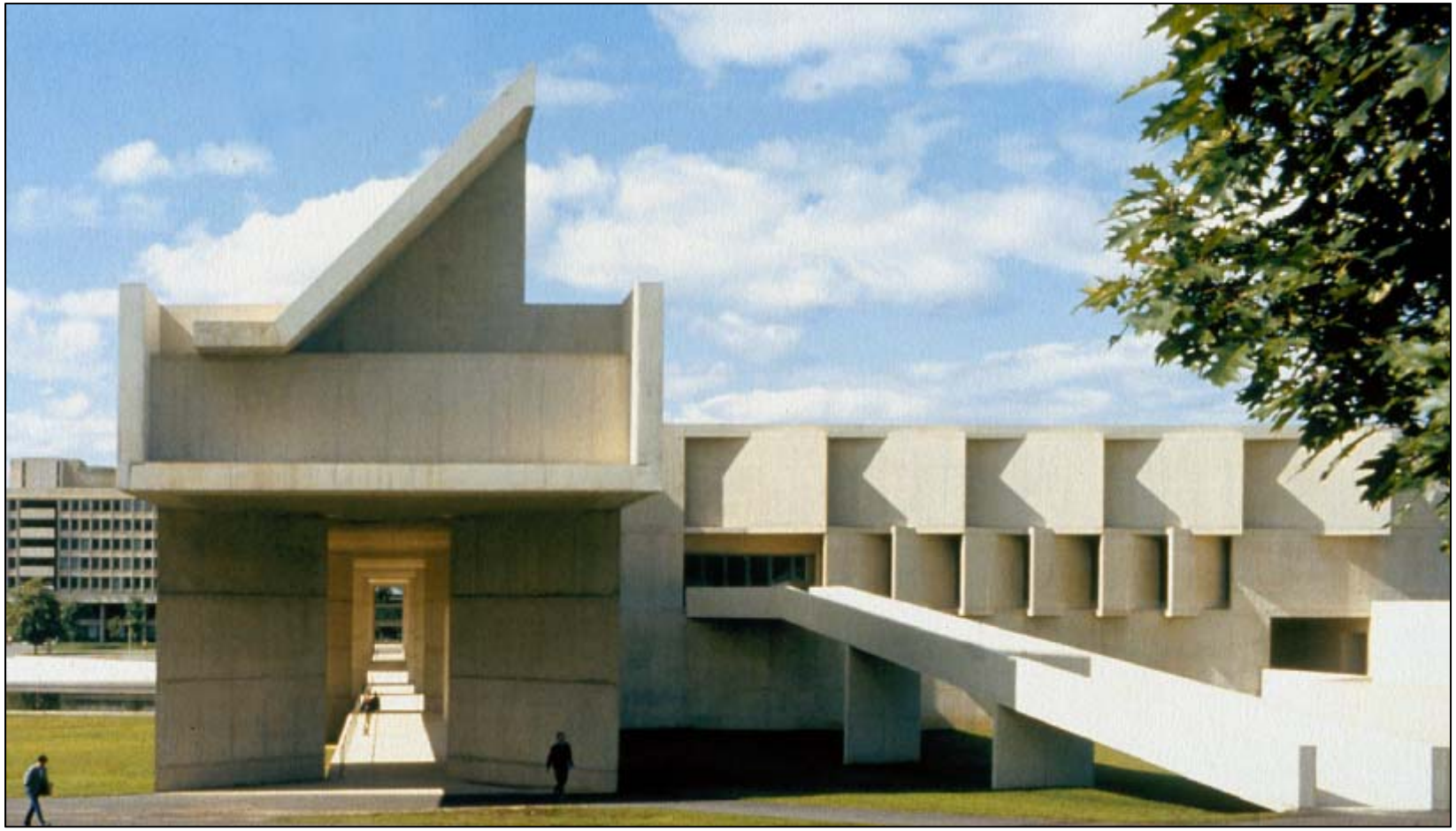
Southern Façade -1975



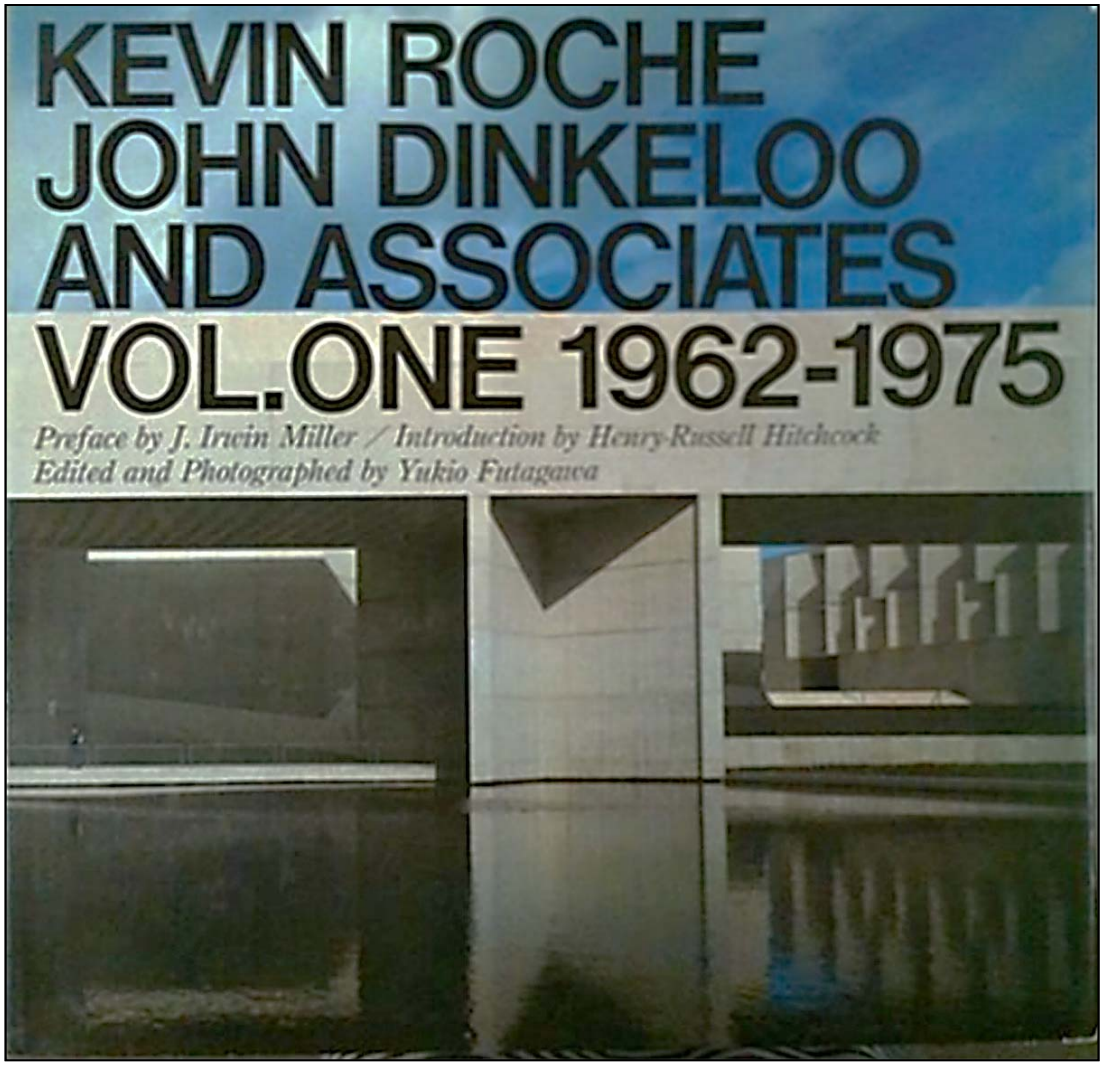
Courtesy of KRJDA

Eastern Façade -1975



Courtesy of KRJDA

Out of Two Hundred



Courtesy of KRJDA

Brutalism’s Perception Problem

The Name

Building Scale

Transparency

Construction Module Scale

Lack of Ornamentation

Maintenance

Concrete

Performance

The Modernist Architects

Personal Life Experiences

Education

Early and Architectural

Three Questions

Did Roche and the rest of the Modernist Masters abruptly jettison their past experiences and education when designing these Brutalist buildings?

Are there any performance enhancing strategies present in the FAC?
And if any are present --- are they effective?

Daylight Maximization

Glare Control

Solar Defense via Self Shading

Siting and Orientation Optimization

Window Direct Solar Gain Defense Strategies

Solar Absorptance Impacts

Thermal Mass Implications

Wind Defense Strategies

What exactly is a monolithic concrete envelope’s impact on performance?

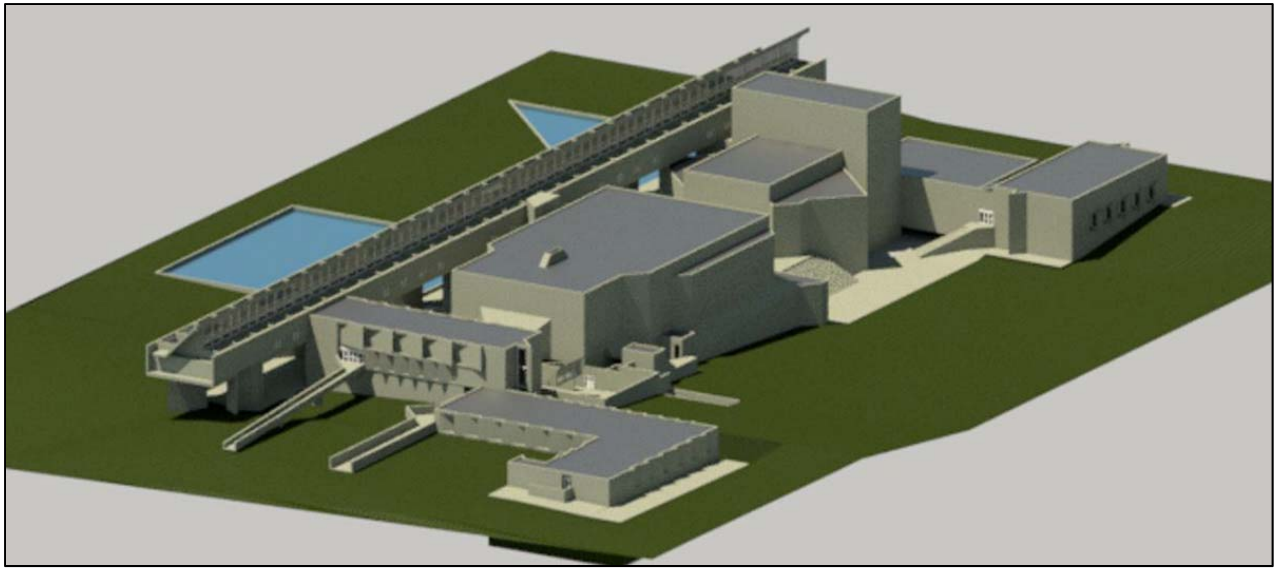
Measuring Energy Performance

Energy Use Intensity

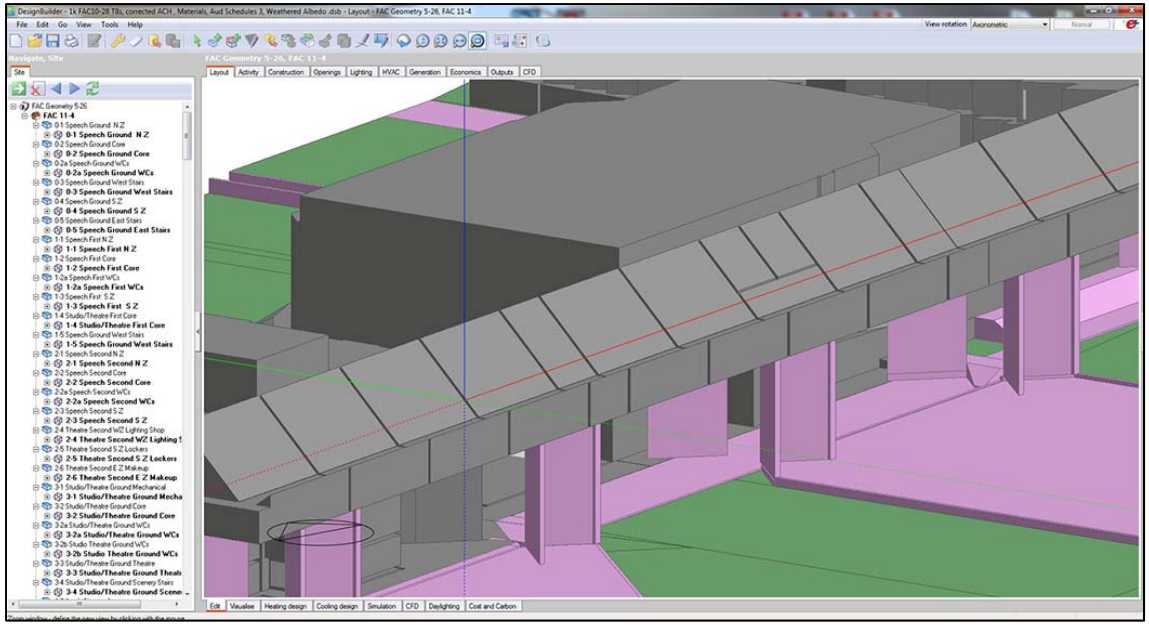
EUI

Commercial Building Energy Consumption Survey

CBECS



Revit



DesignBuilder

Simulation Results

EnergyPlus Output

Temperatures, Heat Gains and Energy Consumption - FAC Geometry 5-26, FAC 11-4

1 Jan - 31 Dec (Zone conditions reported for occupied periods only), Monthly

Student

Room Electricity (Btu/ft2)	76.47	190.33	180.42	207.20	206.53	81.96	61.20	62.33	185.70	208.17	198.79	158.40
Lighting (Btu/ft2)	286.64	656.34	640.86	714.90	717.87	302.17	211.96	217.69	641.76	715.14	682.32	548.78
System Fans (Btu/ft2)	1081.92	978.80	1080.45	1048.60	1083.49	1046.28	1081.73	1081.73	1047.91	1083.25	1047.73	1082.56
System Pumps (Btu/ft2)	387.34	555.16	567.83	798.06	1005.07	871.25	897.74	898.28	986.20	949.94	792.81	554.35
Auxiliary Energy (Btu/ft2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heating (Solid fuel) (Btu/ft2)	11990.48	14549.33	10891.86	8631.80	4434.52	337.41	90.65	212.78	3157.93	5694.03	9947.55	11856.15
Cooling (Electricity) (Btu/ft2)	159.17	683.70	770.51	1315.15	1861.22	1893.54	2011.70	1973.26	1862.00	1698.83	1270.95	593.04
DHW (Solid fuel) (Btu/ft2)	36.31	40.22	37.58	42.60	44.12	33.64	34.64	35.79	40.66	43.37	40.47	40.44
Heat Rejection (Btu/ft2)	0.76	0.52	1.25	3.85	13.72	39.69	51.26	41.73	27.01	11.24	4.23	0.79
Air Temperature (°F)	66.07	67.28	67.40	68.48	69.50	55.76	56.70	56.07	70.08	69.03	68.02	67.52
Radiant Temperature (°F)	53.30	55.07	56.48	60.58	65.05	55.04	57.05	55.82	66.78	63.34	58.92	56.52
Operative Temperature (°F)	59.69	61.18	61.94	64.53	67.27	55.40	56.87	55.94	68.43	66.18	63.47	62.02
Outside Dry-Bulb Temperature (°F)	31.36	29.97	35.64	45.05	55.65	65.67	71.94	68.35	59.96	51.94	41.29	34.69
Glazing (Btu/ft2)	-750.99	-939.80	-871.33	-675.77	-471.80	-186.72	-114.64	-154.74	-335.51	-496.67	-662.83	-776.46
Walls (Btu/ft2)	-6544.17	-7422.66	-6335.38	-4719.80	-2580.59	-243.59	866.42	309.82	-1523.82	-3055.90	-5209.67	-6320.74
Ceilings (Int) (Btu/ft2)	-705.81	-603.37	-480.54	-344.63	-60.35	220.91	415.49	319.16	86.93	-146.79	-444.02	-534.88
Floors (Int) (Btu/ft2)	645.84	552.10	504.67	255.25	29.20	-220.77	-418.68	-298.12	-25.07	197.15	422.57	601.58
Ground Floors (Btu/ft2)	2714.98	1911.65	1650.11	772.55	-226.95	-817.91	-1453.36	-1051.35	-542.63	237.65	1236.84	1998.99
Partitions (Int) (Btu/ft2)	-15.62	-11.45	6.74	-23.42	-7.83	2.37	-3.00	8.97	11.70	21.49	-19.55	28.52
Roofs (Btu/ft2)	-4848.79	-5305.87	-4234.91	-2966.71	-1141.96	588.99	1426.01	892.67	-601.86	-2048.74	-3874.72	-4722.80
Floors (ext) (Btu/ft2)	-248.51	-329.55	-274.77	-244.45	-152.60	-42.64	2.42	-4.37	-75.72	-122.13	-240.27	-223.48
External Infiltration (Btu/ft2)	-1473.10	-1547.95	-1410.10	-978.73	-556.19	-93.61	119.95	0.55	-362.25	-698.99	-1118.67	-1401.33
Task Lighting (Btu/ft2)	1.72	6.00	6.88	6.66	6.89	3.33	1.21	1.21	5.89	6.45	6.22	4.78
General Lighting (Btu/ft2)	284.92	650.34	633.98	708.24	710.98	298.84	210.75	216.47	635.87	708.69	676.10	544.01
Computer + Equip (Btu/ft2)	76.47	190.33	180.42	207.20	206.53	81.96	61.20	62.33	185.70	208.17	198.79	158.40
Occupancy (Btu/ft2)	1016.79	1562.77	1594.26	1648.71	1648.58	947.59	796.36	867.54	1486.75	1659.92	1613.88	1435.86
Solar Gains Exterior Windows (Btu/ft2)	202.11	305.63	526.86	634.60	878.33	847.04	883.21	722.98	562.67	429.68	249.64	156.55
Zone Sensible Heating (Btu/ft2)	9730.50	11055.85	8590.90	5930.47	2344.46	211.29	31.69	76.63	1444.03	3449.13	7275.69	9118.60
Zone Sensible Cooling (Btu/ft2)	-44.40	-26.39	-60.42	-183.58	-579.84	-1407.88	-2473.02	-1756.06	-886.23	-316.58	-54.81	-41.53
Sensible Cooling (Btu/ft2)	-98.33	-593.17	-627.20	-1590.20	-2820.89	-3054.25	-4633.63	-3643.35	-3180.20	-2293.61	-1262.77	-544.84
AHU Heating (Btu/ft2)	364.20	105.86	78.75	15.19	0.00	0.00	0.00	0.00	0.00	4.24	43.11	167.21
Total Cooling (Btu/ft2)	-99.46	-597.58	-631.10	-1593.30	-2918.68	-3648.47	-5158.32	-4150.32	-3544.76	-2336.46	-1266.96	-546.55
Zone Heating (Btu/ft2)	9674.58	12054.90	9055.67	7193.82	3783.58	433.39	234.42	331.12	2761.42	4791.12	8237.21	9710.91
Mech Vent + Nat Vent + Infiltration (ac/h)	0.37	0.38	0.33	0.38	0.38	0.36	0.36	0.37	0.37	0.37	0.37	0.37

FAC EUI vs CBECS 2012

For Buildings in the Northeast	EUI KBtu/sq.ft.	FAC's % Deviations
FAC Model	109.44 (345.01)	0
All Buildings	93.9 (296.08)	+16.55
Building Floor Space: 200,001 – 500,00 sq.ft.	109.7 (345.83)	-0.24
Principal Building Activity: Education	82.1 (258.82)	+33.30
Year constructed: 1970-1979	134.9 (425.27)	-18.87
Northeast Climate Region: Mixed-Humid	104.7 (330.06)	+4.53
Government Owned: State	153.4 (483.59)	-28.66
Predominant Exterior Wall: Material Concrete	101.6 (320.29)	+7.72
Predominant Roof Material: Built-up	113.4 (357.48)	-3.49
Roof Characteristic: Flat	105.4 (332.27)	+3.83
Energy Source: District Heat	143.5 (452.38)	-23.74

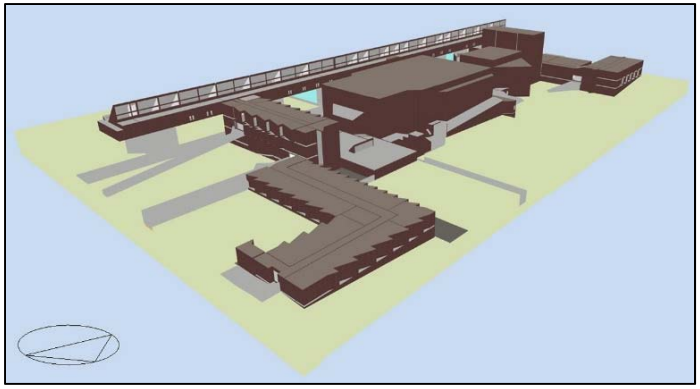
FAC EUI 33.30% Worse than 2012 CBECS

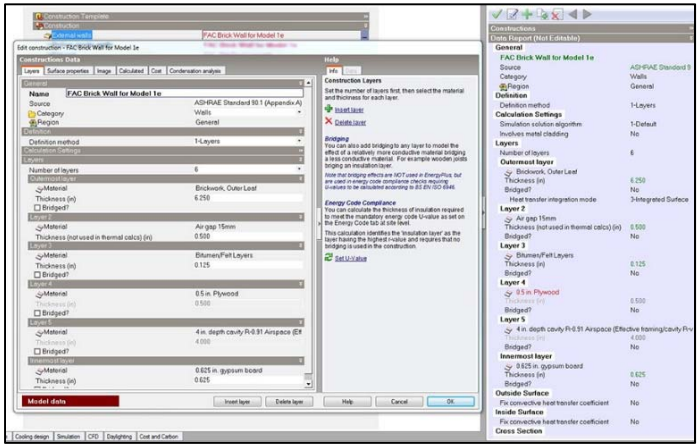
FAC EUI vs CBECS 2003

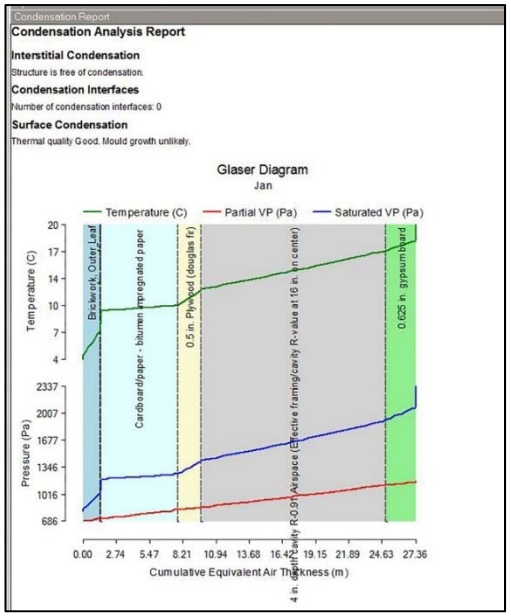
For Buildings in the Northeast	EUI KBtu/sq.ft.	FAC's % Deviations
FAC Model	109.44 (345.01)	0
All Buildings	98.5 (310.72)	+10.00
Building Floor Space: 200,001 – 500,00 sq.ft.	106.3 (335.33)	+2.87
Principal Building Activity: Education	101.6 (320.51)	+7.17

FAC EUI 7.17%Worse than 2003 CBECS

FAC with 1970 Brick Wall Assembly







FAC EUI: CBECS 2012 From 33.30% Worse → 7.18% Better

CBECS 2003 → 25.00% Better

Contemporary Intervention

Change R-value
1.7023 ft^2-F^o-hr/Btu to 12.35 ft^2-F^o-hr/Btu)

Compared to 2012 CBECS

Walls Only (excluding Performance Spaces)
FAC EUI: 33.30% Worse → 0.4% Worse

Ceilings and Walls (excluding Performance Spaces)
FAC EUI: 33.30% Worse → 28.86% **Better**

Architecture 2030 Challenge Goals

FAC EUI with Ceiling and Wall Intervention
58.4 KBtu/sq.ft.

The 2030 Challenge Targets for U.S. National Medians for College/ University Campus Level Buildings.

Year of Compliance	Reduction Percentage	Expected EUI KBtu/sq.ft. (KWh/m^2)
2005	50	52 (163.93)
2010	60	41.6 (131.14)
2015	70	31.2 (98.36)
2020	80	20.8 (65.57)
2025	90	10.4 (32.79)
2030	100	0

http://www.architecture2030.org/files/2030_Challenge_Targets_National.pdf

Inference

There are strategies, concealed within the FAC,
consistent with good performance.

It is their operation and existence,
which contributes to the FAC's respectable EUI,

<u>once</u>

the large negative of the thermal envelope's conductivity is
eliminated from the discussion.

Contributions

Architecture’s Brutalist Scholars, Preservationists, and Stakeholders

Brutalist Critics

Performance Improving Intervention

Image Courtesy of Robert Hallock