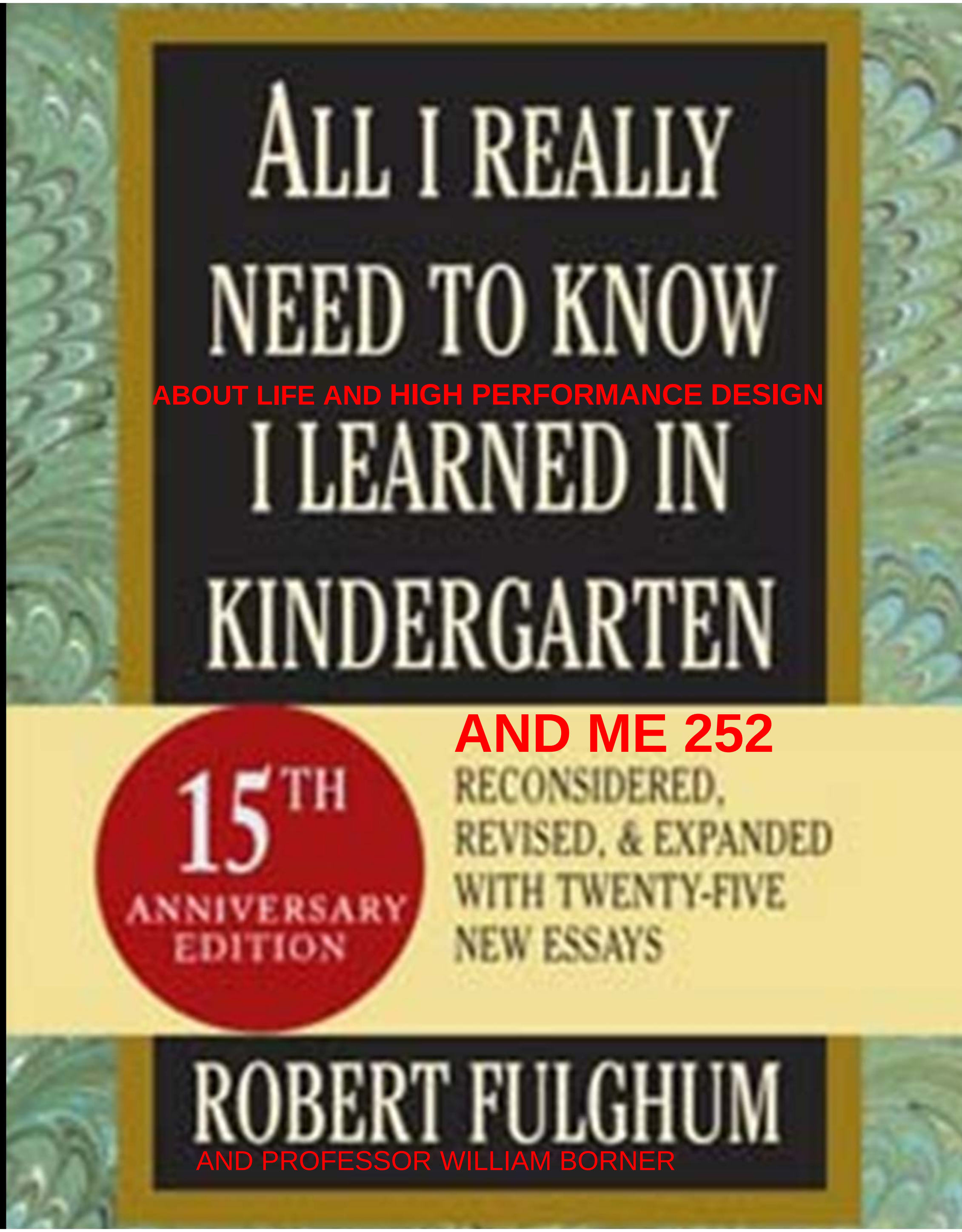

ALL I REALLY
NEED TO KNOW
ABOUT LIFE AND HIGH PERFORMANCE DESIGN
I LEARNED IN
KINDERGARTEN
AND ME 252
15TH
ANNIVERSARY
EDITION
RECONSIDERED,
REVISED, & EXPANDED
WITH TWENTY-FIVE
NEW ESSAYS
ROBERT FULGHUM
AND PROFESSOR WILLIAM BORNER

Thermal Design for Architects: M, T, W, TH 12:00 - 1:00 PM
101 Armory

Instructor: William Borner

Office: 304 Architecture or Building Research Council (Small Homes Council) or Carroll - Henneman Mechanical and Electrical Consulting Engineers, 104 East University, Urbana.

Main Text: Notebook used for old ME 252 course (Notes assembled by S Konzo) You will also be provided with a reading list for supplementary material and to advise you of the state of the art in thermal systems.

Teaching Objectives:

1: To give the architect enough of a background in the engineering science of mechanical systems (nuts and bolts) so as to facilitate easy and meaningful communication between members of the design team and the engineering team.

2: To introduce the architect to the "Air Conditioning Revolution" and hence to show the "design implications in the building shell / mechanical or power systems / and man interface.

Rules for the Course:

1: You will be given a weekly syllabus of the activities planned during that week with the corresponding responsibilities in reading, etc.

2: Every Monday, Tuesday and Wednesday will be scheduled lecture days.

3: Every Thursday at the beginning of class there will be a 20 minute quiz over material covered in class and in reading. You will be allowed to miss one quiz unexcused or I will throw out the lowest quiz grade, but not both. Following each quiz we will have a weekly slide presentation and discussion on thermal design in architecture. You will also be responsible for this material on examinations.

4: Several additional handouts are planned for distribution which will supplement the reading list and the main text. You will also be responsible for this material on the examinations.

L BANK

FINAL EXAMINATION: ARCHITECTURE 241 - THERMAL SYSTEMS.

101 ARMORY BUILDING
Monday January 24 ; 7:00 - 10:00 P.M.

30 Points - 3 hours.

At the time of the final examination you will be given two building type plans which are well worked out such as a theater and a grocery store or an office building, etc.

At that time you will be asked to give two solutions to each building type given. The reason for this is that there are usually two or more HVAC solutions which are equally good, therefore the architect should understand that the engineer also has great variety and alternatives both in his approach and final solutions to HVAC problems.

Therefore there are 4 parts to the exam. weighted as follows for each part: (ONE solution for each building must be an air system.)

2½ (1): Describe the HVAC system you have chosen for the particular building given. Discuss why that system makes sense for this building.

1 (2): Calculate Heat gain and heat loss for each bldg. All "U" values, ETD's, latitudes, types of glass, etc., will be furnished.

1½ (3): Give preliminary sizes of ducts (sensible load only to size these). $Q = 1.08 \times cfm \times 20$ (cooling usually overrides since more cfm used) But check heating also. $Q = 1.08 \times cfm \times 50$. Sizes will be for each zone so designated. You must decide and defend why one is a zone and why another one isn't a zone.

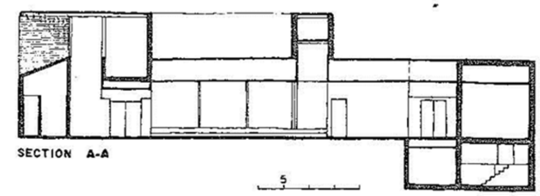
½ (4): Give size of duct near cooling coil for each fan room installation. Maximum velocity of air past the cooling coil = 500 fpm.

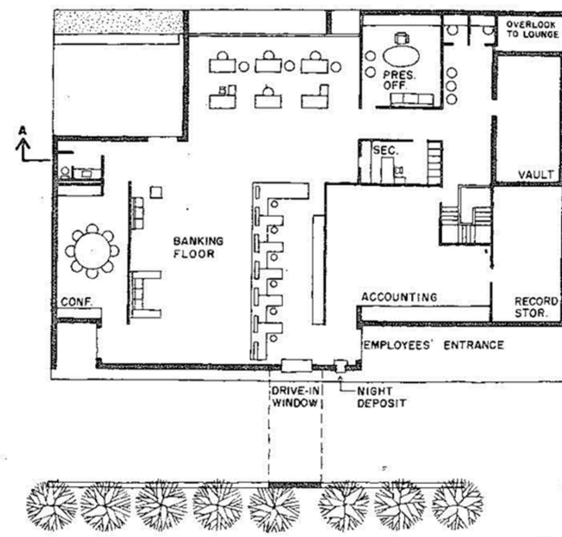
½ (5): Size the outdoor air opening for each fan room installation. Use a code minimum of 1/3 with maximum velocity of 1000 fpm. Use outdoor grille of 50% opaque const. therefore have to double answer to obtain required net free area.

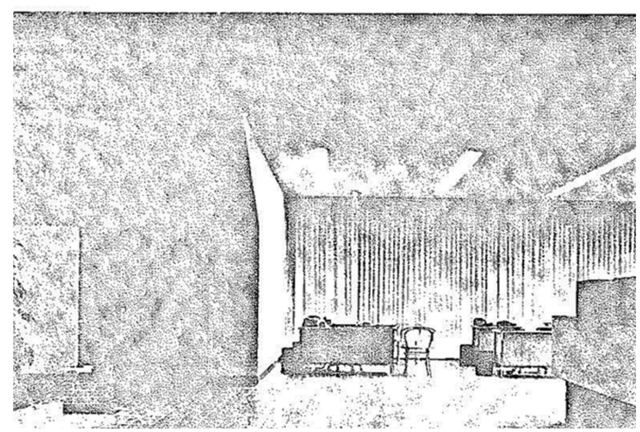
½ (6): Describe the power plant system you have chosen and why it makes sense.

½ (7): Locate major equipment you have chosen on the plan.

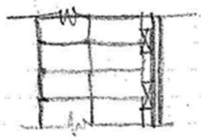
½ (8): Give section through wall, footings, and ceiling - roof assembly. Main emphasis on structural/mechanical integration. Use rules of thumb for structures. Label and discuss points to be made on this section.





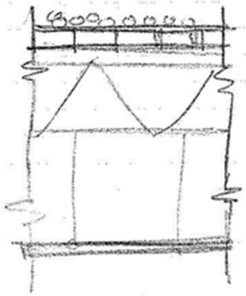


ANDY PIASKOWY
M.E. 252



4" BRICK FACE
4" COMMON BRICK
METAL LATH & 3/4" PLASTER ON FURRING

U = .28



3/8" BUILT-UP ROOFING
2" RIDGID INSULATION
18 GA METAL DECK

STEEL JOIST
SUSPENDED CEILING ✓

U = .115

GLASS INSULATING U = .55

ROOF - 6046 SQ.FT.

	WALL	GLASS
NORTH	1225	350
SOUTH	1575	0
EAST	1125	0
WEST	1380	120
TOTAL	5305	470

TEMP. DIFFERENCE

INSIDE 75°F 85°
OUTSIDE -10°F

6495 DEGREE DAYS

HEATING

ROOF = 6046 (.115)(85) = 59,000
WALL = 5305 (.28)(85) = 126,000
GLASS 470 (.55)(85) = 21,900
FLOOR = 5975 (.1)(20) = 11,900
EDGE LOSS 40 BTU/HR LIN.FT. (340) = 13,600

INFILTRATION

30 (10 CFM/PERSON) = 300 CFM

1.08(85)(300) = 27,500 AIR INTAKE

DESIGN HEAT LOSS

ROOF	59,000
WALL	126,000
GLASS	21,900
FLOOR	11,900
EDGE LOSS	13,600
AIR INTAKE	27,500
TOTAL	259,900

COOLING

95° OUTSIDE 50% R.H.
75° INSIDE 50% R.H.

	WALL		GLASS	
NORTH	1225 (8)(.28) =	2740	350 (25) =	8750
SOUTH	1575 (17)(.28) =	7520	0	✓
EAST	1125 (13)(.28) =	4100	0	
WEST	1380 (13)(.28) =	5030	120 (190) =	22,800
TOTAL		19,390 BTU/HR		31,550 BTU/HR

INFILTRATION 300 CFM (4.5)(14.8) = 20,000
PEOPLE 450 BTU/HR)(30) = 13500
ROOF
6746 (.115)(56) = 43,400 BTU/HR

LIGHTING 30 FOOT CANDLES
FLUORESCENT
7.5 BTU/SQFT. × 5975 = 44,800 BTU/HR

HEAT GAIN

WALL	19,390
GLASS	31,550
ROOF	43,400
AIR INTAKE	20,000
LIGHTING	44,800
PEOPLE	13,500
	172,640 BTU/HR = 14.4 TONS

SYSTEM ONE

POWER — GAS. (ASSUMING AVAILABILTY)
GAS PROVIDES AN ECONOMICAL AS WELL AS PHYSICALLY PRACTICAL SOURCE OF POWER - ALL THAT IS NEEDED IS A TAP INTO GAS COMPANY LINES

HVAC — ALL AIR PACKAGE ROOF TOP UNIT, GAS FIRED, HOWEVER, EXCEPT FOR THE EXTRA COST ELECTRICITY WOULD PROVIDE AN EQUALLY SATISFACTORY SOLUTION. what kind of system + controls NAME OF SYS ?

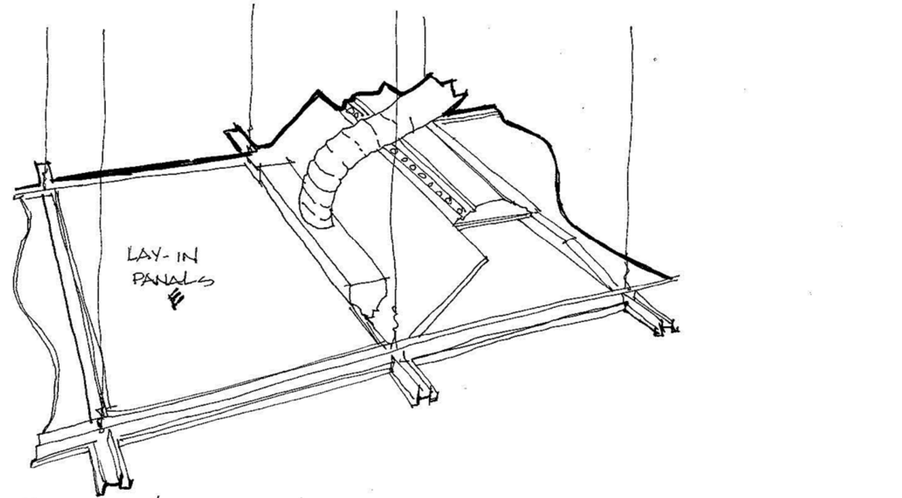
SINCE THE BUILDING IS USED DURING THE DAY SAY 7:00 AM TO 6:00 PM. POSSIBLY 9:00 PM ON FRIDAYS AND SATURDAYS THE SYSTEM WOULD BE SHUT OFF OR DOWN LOW ENOUGH TO AVOID FREEZING PROBLEMS. AN AIR SYSTEM WOULD CONDITION THE SPACE FASTER THAN A HYDRONIC SYSTEM. THE NOISE FROM THE SYSTEM IS NOT CRITICAL EXCEPT FOR THE PRESIDENTS OFFICE OR CONFERENCE ROOM. THE ROOFTOP UNIT WOULD BE PLACED FAR ENOUGH AWAY FROM BOTH AREA TO CAUSE A MINIMUM OF DISTURBANCE. IN CONJUNCTION WITH THE ROOF-TOP UNIT ALL AIR SUPPLY AND RETURN IS FROM THE CEILING. THIS FIRST SOLUTION ELIMINATES THE NEED FOR A SPECIAL ROOM FOR MECHANICAL EQUIPMENT HOWEVER REQUIRES A DROP CEILING TO RUN DUCT WORK. THE ROOF-TOP UNIT WOULD BE HIDDEN BY EXTENDING THE PARAPET WALL. APPOXIMATLY 25 TON OF COOLING COULD BE SAVED BY PASSING AIR THRU LIGHTING UNITS AND EITHER RETURNING TO UNIT OR EXHAUSTING.

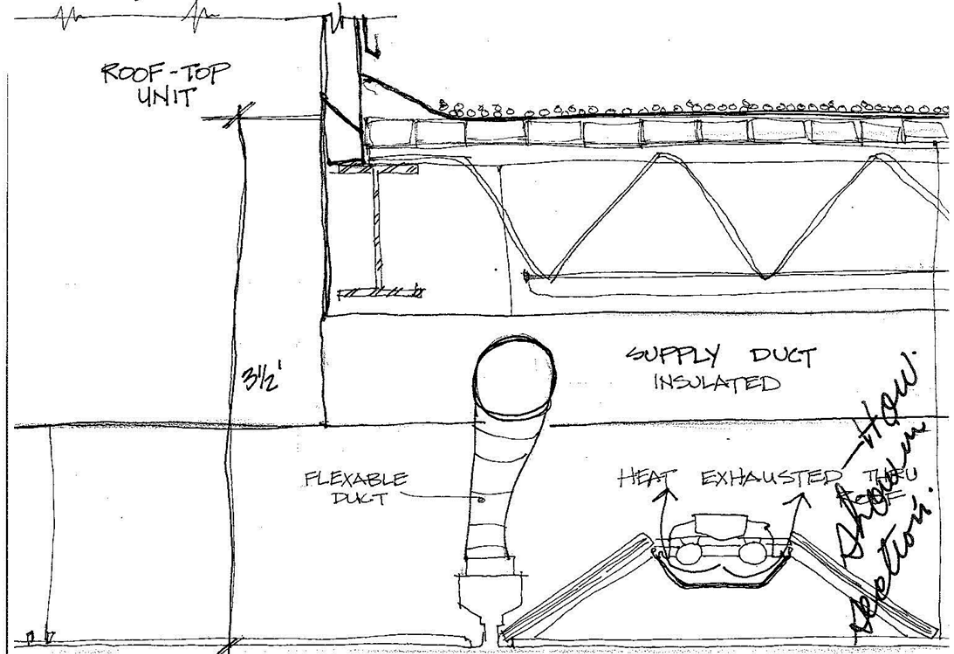
ASSUMING 75% EFF.

.75(44,800) = 33,600

236140 - 33,600 = 192,540 BTU/HR

SYSTEM ONE WOULD SUPPLY HOT AND COLD AIR BY A DIFFUSER WHICH ALSO PROVIDES THE GRID FOR THE SUSPENDED CEILING. RETURN AIR FOR BOTH HEATING AND COOLING WOULD OCCURE IN THE CENTER OF THE BANK ON THE GRID SIMILAR TO THE COOLING SUPPLY.





SUPPLY / RETURN - AT SIMILAR ARRANGEMENT AT CENTER OF ROOM

[redacted]

SYSTEM TWO

POWER - BOTH GAS OR ELECTRICITY COULD BE USED AS EXPLAINED IN SOLUTION ONE IN ADDITION SINCE SOLUTION TWO REQUIRES A MECH. ROOM OIL MAY BE USED ALTHOUGH A FAIRLY LARGE TANK WOULD BE NEEDED FOR STORAGE.

HVAC. - HEATING AND COOLING UNIT SEPARATE OR TOGETHER USING THE SAME SUPPLY DUCTS AS WELL AS RETURN.

I CHOOSE ANOTHER FORCED AIR SYSTEM BECAUSE OF THIS NEED FOR QUICK HEATING AND COOLING. A FORCED AIR SYSTEM HAS THAT QUALITY OF BEING A FAST RESPONDER TO QUICKLY CHANGING CONDITIONS. THIS SOLUTION WOULD REQUIRE DUCTS BE BURIED IN THE FLOOR. IT REQUIRES A MAIN DUCT OF

Doesn't explain type of system used.

HEATING 25.9 = CFM (120-70) = 185(25.9) = 4800 CFM

COOLING 400 CFM (14.4 TONS) = 5760 CFM

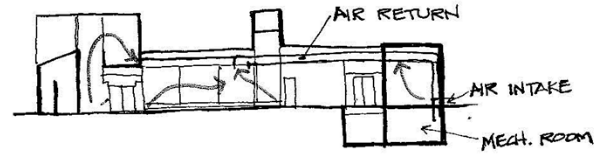
5760 = AV   5760/500 = 11.5 SQ. FT.

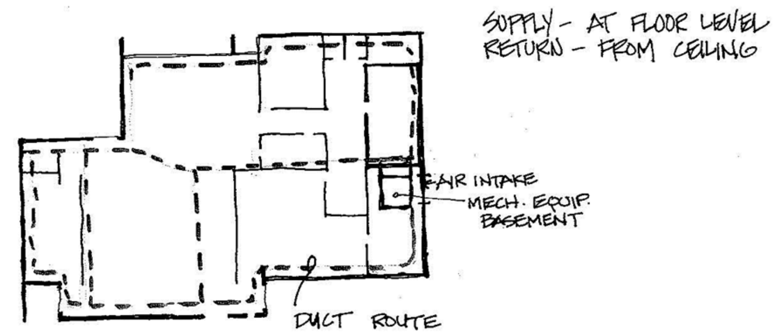
2 MAIN DUCTS 5.75 SQ FT. 2½' □ EACH

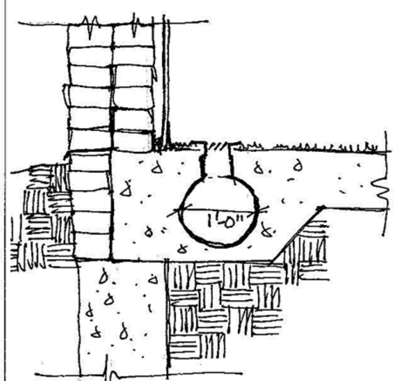
CALCULATIONS APPLY TO SOLUTION ONE AS WELL. MAIN DUCTS IN SOLUTION ONE WOULD HAVE TO BE MORE RECTANGULAR TO CONSERVE SPACE.

OUTSIDE OPENING $\frac{300 \text{ cfm}}{300 \text{ fpm}}$ = 1 × 2 SQ.FT. OPENING

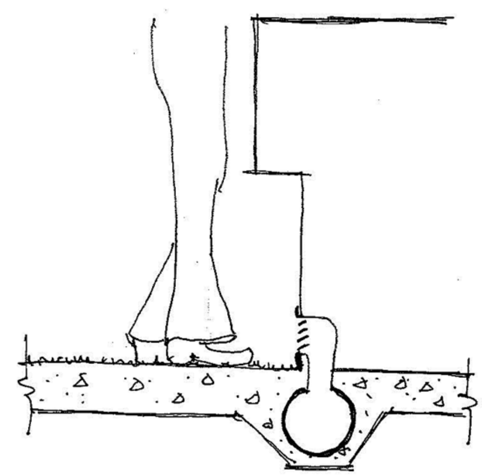
MAJOR DIFFUSERS WOULD BE LOCATED ALONG THE PERIMETER ESPECIALLY UNDER THE WINDOWS.
SINCE THE USE IS A BANK DIFFUSERS COULD BE LOCATED AT THE BOTTOM OF THE TELLARS DESK







PERIMETER SECTION



SECTION AT TELLARS AREA

80% $\frac{24}{30}$.

B

reasonable - but
not exceptional.

ANDY PIASKOWY
ME 252.

"HOW HEAT BEHAVES IN THE BUILDING SHELL SYSTEM"

The Dollar Value of Thermal Improvement:

When you design any heated or air conditioned building for human occupancy, you provide weather protection and the desired indoor climate in two ways: by your design of the building shell and by the capacity of the mech. systems.

Building Shell Versus Building Equipment: Until you "freeze" your design concept, these two possible paths to comfort are open to your free choice.

1: You can design the shell, the walls, glass areas, and roof ceiling constructions, with minimum resistance to sun heat and winter cold, and then provide a fair measure of comfort by using a heating or air conditioning plant of relatively large capacity.

2: Or you can design the shell to be a better barrier to nature's worst behavior and assure your client of equal (or greater) comfort with a mechanical plant of less capacity. You may also want to put into the balance your knowledge that the second path will lead to lower annual operating costs.

When you have balanced the costs of ~~the~~ following one path or the other and have found the one that involves the least cost to your client, you have produced the best thermal design within the limits imposed by your project and the six thermal design decisions mentioned earlier.

What is the "least cost" to the owner varies somewhat with the natuze of the project. If the building is a speculative venture, to be sold by your client as quickly as possible, he may consider the "least cost" to be the initial construction cost only. If your client is a public body, such as a school, or hospital, or church board, that will own and operate the building for many years, the "least cost" is not only the initial cost but also the annual cost of maintenance, operation, repair, and financing, all lumped together as total ownership cost.

HOW HEAT BEHAVES IN A BUILDING:

SIX DESIGN DECISIONS:

In this course we will find that good thermal design:

1: Results in greater comfort;
2: Results in lower ownership costs;
3: Results in preventing damaging condensation of moisture;
4: Results in the building costing less to build, equip, own and maintain;
5: And, in short, then this can result in your having the cake and being able to eat it too - if one applies these principles of good thermal design.

Six design decisions that govern building performance:

Six decisions you will make at the start of almost any building design project determine how the structure will perform - in terms of comfort, suitability, and ownership costs - throughout its useful life. They are:

1: The "indoor climate" and quality of comfort your building must provide.
2: The exposure of the building to sun and wind"; its bulk, height, orientation, and site conditions.
3: The massiveness or "heat capacity" of the construction you select, and tthe color of the wall and roof surfaces.
4: The type of construction and its resistance to heat loss or gain.
5: The amount of glass and the types of glass you will use, and the shading of openings.
6: And, How you design the building shell to prevent damaging condensation within the structure.

DESIGN PRINCIPALS

TURKEYFOOT MIDDLE WAS DIFFERENT FROM CAYWOOD ELEMENTARY IN THAT EVERY DESIGN DECISION WAS DRIVEN BY SAVING ENERGY

POLICY

SCHOOL BOARD

- EMBRACE AND FOSTER A LIFE CYCLE AND SUSTAINABLE CULTURE
- BE WILLING TO COMMIT TAX DOLLARS IN CAPITAL CONSTRUCTION PROJECTS BEYOND LOWEST FIRST COST TO REDUCE BUILDING MAINENANCE EXPENSES AND COST OF OPERATION
- ESTABLISH ENERGY GOALS AND INSTITUTE ONGOING ENERGY MANAGEMENT
- RE-THINK CURRENT PROCEDURES AND ACTIVITIES IN WAYS THAT WOULD USE LESS ENERGY
- ENGAGE STUDENTS IN THE PROCESS

IMPLEMENTATION

ARCHITECT

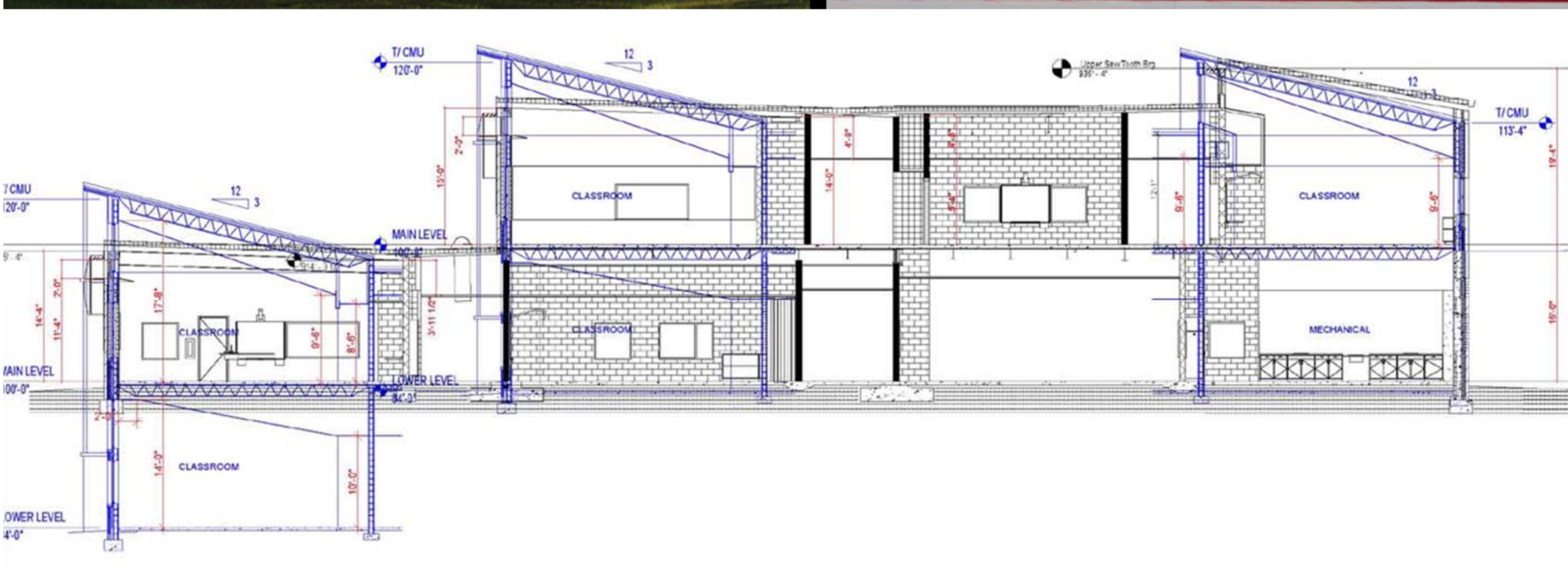
- PLANNING AND SITE DESIGN THAT MAXIMIZES NATURAL DAYLIGHTING OF THE MAJORITY OF A BUILDINGS OCCUPIED AND PROGRAMMED SPACES
- DESIGN A COMPACT BUILDING FOOTPRINT AND BUILDING VOLUMN
- INCLUDE MATERIALS AND DEVELOP DETAILS THAT ENSURE A INSULATED SEALED BUILDING ENVELOPE
- INCLUDE MATERIALS AND FINISHES BASED ON COST EFFECTIVE LIFE CYCLE / RENEWABLE USE

ENGINEER

- DESIGN HVAC SYSTEMS THAT REQUIRE THE LEAST AMOUNT OF ENERGY TO PRODUCE A HEALTHY CONDITIONED ENVIRONMENT
- INCLUDE ENERGY MANAGEMENT CONTROLS TO ALLOW EFFICIENT OPERATION
- UTILIZE RENEWABLE STRATEGIES IN PLUMBING, HVAC, FIRE-SUPRESSION, AND ELECTRICAL SYSTEMS

BUILDING OCCUPANTS

- VIGILENT DAY TO DAY ENERGY PRACTICES


T/CMU
120'-0"
T/CMU
113'-4"
CLASSROOM
CLASSROOM
CLASSROOM
CLASSROOM
CLASSROOM
MECHANICAL
MAIN LEVEL
100'-0"
LOWER LEVEL
84'-0"


KENTON COUNTY SCHOOLS
TURKEY FOOT MIDDLE SCHOOL

"Education is for improving the lives of others and for leaving your community and world better than you found it."

Marian Wright Edelman

Architects can be considered both agent and maker.

As agent they become involved in the problems of others, and attempt to formulate those problems in terms of architectural action. DESIGN

As maker they are responsible for specifying the act and supervising its execution. CONSTRUCTION

The balance between agent and maker can be difficult to maintain.

Architects are told to conform and to innovate at the same time.

Architects cannot be strong advocates if they are practicing risk avoidance.

School administers focused solely on education can suffer from narrow vision when it comes to construction.

The belief that High Performance Design adds to the construction cost is a myth.

It is what I learned in ME 252.

When buildings are constructed with good thermal design they will

COST LESS TO BUILD, EQUIP, OWN, AND MAINTAIN.

"We cannot always build the future for our youth, but we can build the youth for our future"

Franklin D. Roosevelt

PCA

ARCHITECTURE

PSC