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# MATOAKA ELEMENTARY SCHOOL

## AN EXPLORATION INTO THE INTER-RELATIONSHIPS BETWEEN TECHNOLOGY AND LIVABILITY.

BY

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DEDICATED

TO MY MOM AND DAD

FOR THE YEARS OF CARE AND CONCERN THAT LAID THE FOUNDATIONS UPON WHICH THIS EDIFICE IS RAISED.

AND

WITH APPRECIATION

TO THE FOLLOWING PEOPLE AND ORGANIZATIONS WITHOUT WHOSE HELP THIS THESIS COULD NOT HAVE BEEN ACCOMPLISHED:

JAMES H. LENON
PRUGH & LENON, ARCHITECTS, PC
BOZEMAN, MT

DR. BRYON DUNN
SCHOOL DISTRICT 7
BOZEMAN, MT

MS. NONNIE HUGHES, AND THE FACULTY
MORNING STAR ELEMENTARY SCHOOL
BOZEMAN, MT

Thomas R Wood

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SUBJECT OF THE THESIS

# A DESIGN PHILOSPHY

THE CAPTURING OF WHISPERS
IS THE WAY TO WRITE A SONG,
ITS WHEN YOU GET TO MICROPHONES
THAT THE MUSIC CAN GO WRONG.

THERE WAS ONLY ONE CHOICE
HARRY CHAPIN

# Proposal for Undergraduate Thesis

I am concerned with what I perceive to be an excessive dependence on technological solutions to design problems which result in humanly unlivable buildings. I do not perceive technology as inherently evil, but rather as a Genie out of control, who can and will deliver to mankind anything that he asks for. The essential problem appears to be that mankind is unable to control his own self-desires, and demands the delivery of 'easy living' regardless of his own future, or that of the earth.

I desire to explore this issue of technology and livability in my undergraduate thesis in order to enrich my understanding of their interrelationships, and define 'livability.' The vehicle I propose to use in this exploration is the design of an elementary school, emphasizing environmental design issues and their impact on the daily fabric of life.

My methodology shall be to seek the nature of technology and livability through: 1) research in current technological, psychological and educational literature; 2) a case study of Morning Star Elementary school through construction documents, and by a personal observation of the school as a teaching assistant. Data collection will be followed by analysis and re-synthesis; in effect, to take the data apart for study and comprehension, then put the pieces back together in a manner addressing my concerns about the balance between technology and livability.

TECHNOLOGY, n. [Gr. *TECHNE*, art, and *LOGOS*, word or discourse.
1. the study or science of the practical or industrial arts.

Generally taken to mean advanced electronics, its fastest growing, most visible form, technology is in fact pervasive throughout western society. For the built environment it can mean, for example, everything from the mining, smelting, and production of a nail, to its transport, sale, use, reuse and eventual disposal. For this thesis I shall limit the technological palette to environmental control systems.

The general technology goal shall be to achieve an environmentally satisfactory space with a minimum of mechanical systems, seeking reliance on passive strategies, accepting either active or mechanical systems if the use of the technology is low-grade and sustainable.

LIVABILITY, a. 1. fit or pleasant to live in, habitable; said of house, room, etc.

It can involve a great number of factors, as was expressed by Vitruvius in 'The Ten Books of Architecture' in the terms of 'firm, commodius, delightful.' I shall use a working definition for livability as 'that characteristic of architecture perceived

BY THE LAY USER AS PLEASANT, SUPPORTIVE OF HIS DAILY ACTIVITIES, AND A NATURAL PART OF THE FABRIC OF HIS LIFE.'

LIVABILITY IN THE EDUCATIONAL ENVIRONMENT MEANS SUPPORTING THE CONCEPT OF HOLISTIC LEARNING; BOTH THE TRADITIONAL 3-R'S OF INTELLECTUAL GROWTH, AND SOCIAL/PHYSICAL/EMOTIONAL GROWTH. THE ULTIMATE EDUCATIONAL GOAL IS TO PREPARE THE CHILD FOR A FUTURE HOLISTIC ROLE AS A PRODUCTIVE CITIZEN. THIS CAN ONLY HAPPEN WHEN THE PHYSICAL DESIGN PROVIDES FACILITIES THAT MOVE THE EDUCATION PROCESS BEYOND THE CLASSROOM INTO THE HALLS, PAST THE WALLS INTO THE OUTSIDE WORLD WHERE LIFE OCCURS. IT MUST DO THESE THINGS IN A FACILITY THAT IS ITSELF AN EXAMPLE OF HOW MAN CAN, IF HE DESIRES, CONSTRUCT A BUILT ENVIRONMENT THAT LIVES IN HARMONY WITH HIS NATURAL ENVIRONMENT.

# RESEARCH OF CURRENT LITERATURE AND INTERVIEWS

# TECHNOLOGY

I AM THE CAPTAIN, THIS IS MY SHRINE,
LORD OF THE MANOR, SEE WHAT I LEAVE BEHIND,
RIVERS IN FLAME, CITIES ON FIRE,
I AM THE RELIC TRAPPED IN THE WIRE.

HYDROGEN FUEL, BURNS SO CLEAN,
THROBS IN THE VEIN, MOTHER LOVIN' MACHINE.
SHE IS MY WIFE, HER MECHANICAL HEART,
CONSTANTLY BEATING 'TILL DEATH DO US PART.

THE GLORIOUS WAR DRAWS TO A CLOSE,
THE YELLOW WINDS BLOW,
AND I HAVE TO KNOW,
OH INDUSTRY!
WHATEVER WILL BECOME OF ME?

OH, INDUSTRY!
BETTE MIDLER

THROUGHOUT THIS THESIS THE EXPLORATORY METHODOLOGY WILL BE TO UTILIZE STANDARD PASSIVE ENVIRONMENTAL DESIGN STRATEGIES FOR HEATING, COOLING, DAYLIGHTING, VENTILATION AND DEHUMIDIFICTION; TO OBSERVE THEIR EFFECTS ON THE LIVABILITY OF A STANDARD CLASS-ROOM; CHANGING STRATEGIES AND/OR ADDING TECHNOLOGY AS NECESSARY TO ACHIEVE THE MINIMUM NECESSARY LIVABILITY.

## HEATING STRATEGY

IT IS ANTICIPATED THAT THIS BUILDING WILL PROVE TO BE INTERNALLY LOAD DOMINATED, AND REQUIRE THEREFORE, LESS HEAT INTRODUCTION THAN WOULD OTHERWISE BE NECESSARY.

THE PRIMARY HEATING STRATEGIES WILL BE TO PROMOTE SOLAR GAIN (1, PP 38) AND TO MINIMIZE AIR INFILTRATION (1, PP 46).

PROMOTE SOLAR GAIN. THE DESIGN OF A LARGE FACILITY SUCH AS IS ANTICIPATED FOR THIS THESIS WOULD MEAN THAT SOLAR EXPOSURE COULD CONCEIVABLY OCCUR BETTER IN A NUMBER OF SMALL PLACES RATHER THAN A SINGLE, OR FEW, BIG ONES. THIS WOULD REDUCE THE NECESSITY FOR MECHANICAL DUCTING. AIR SHAFTS COULD BE USED AS WELL TO PROVIDE FOR LOCAL CIRCULATION, AND HEAT RECOVERY. THE USE OF INTERIOR ZONES (POSSIBLY INDIVIDUAL CLASSROOMS) COULD MAXIMIZE HEAT GAIN.

MINIMIZE AIR INFILTRATION. MINIMIZATION OF INFILTRATION WOULD REDUCE LOSS OF THE HEAT THAT WAS GAINED BY SOLAR EXPOSURE. THIS GOAL WILL BE REACHED THROUGH THE CONCEPTS OF SITING, USE OF THE EXISTING LANDSCAPING, AND WOULD BE FURTHERED IN DESIGN DEVELOP-MENT AND CONSTRUCTION BY TIGHT CONSTRUCTION PRACTICES.

## COOLING STRATEGY

COOLING OF THE BUILDING WILL PROBABLY PROVE TO BE AS GREAT A PROBLEM AS ITS HEATING DUE TO ITS ANTICIPATED INTERNALLY LOAD DOMINATED CHARACTER.

THE PRIMARY STRATEGIES WILL BE TO MINIMIZE SOLAR GAIN (1, PP 50) AND PROMOTE VENTILATION (1, PP 53).

MINIMIZE SOLAR GAIN. THE CONCEPTS THAT WILL BE EXPLORED FOR THIS STRATEGY WILL BE: 1) DIRECT SUNLIGHT INTERCEPTION THROUGH THE USE OF SHADING DEVICES, FINS OR OVERHANGS, OR POSSIBLY A SYSTEM OF VARIABLE ANGLE SLATS; 2) CONTROL OF FENESTRATION AREA AND ORIENTATION TO BE ACCOMPLISHED BY A SERIES OF GLAZING SURFACES SELECTED AND PLACED TO ALLOW/STOP SUNLIGHT PENETRATION SEPARATE FROM THOSE SURFACES SERVING FOR VIEW AND/OR VENTILATION.

PROMOTE VENTILATION. VENTILATION WILL BE PROVIDED IN THE

MANNER BEST SUITABLE TO A HUMID CLIMATE, A CONSTANT FLOW OF AIR OVER THE SKIN TO PROVIDE FOR COMFORT. THE ACCOMPLISHMENT OF THIS CONSTANT FLOW WILL BE DONE ATTEMPTED THROUGH INDIVIDUAL CLASS-ROOMS IN AN INITIAL EFFORT TO AVOID MECHANICAL DUCTING. THIS WILL NECESSITATE MOVING THE AIR FROM THE NATURALLY COOL LOWER REGIONS THROUGH THE WARMER UPPER REGIONS TO THE EXTERIOR OF THE BUILDING.

## DEHUMIDIFICATION STRATEGY

DEHUMIDIFICATION IS POTENTIALLY A GREATER PROBLEM THAN EITHER HEATING OR COOLING OF THEMSELVES AS IT UNDERLIES BOTH OF THE TEMPERATURE EXTREMES. THIS ARISES BECAUSE THE SITE IS WITHIN 3 MILES OF THE OPEN OCEAN, AND HAS HIGH YEAR AROUND HUMIDITY LEVELS. (2, CLIMATIC DATA SOURCE)

DEHUMIDIFICATION CAN POTENTIALLY BE ACCOMPLISHED BY LIQUID (GEL) DESICCANTS, WHICH WILL BE REGENERATED USING ELECTRIC HEAT DEVELOPED THROUGH THE USE OF PHOTOVOLTAIC PANELS LOCATED ON THE SOUTHERN SIDES OF THE VENTILATION CHIMNEY. POWER WOULD BE STORED BELOW THE BUILDING USING RECHARGABLE NICAD BATTERIES (3, PP 85.)

## VENTILATION STRATEGY

VENTILATION IS OF FUNDAMENTAL IMPORTANCE TO THE DESIGN AS IT PROVIDES AIR FLOW FOR 1) QUALITY, 2) COOLING, 3) HEATING 4) DEHUMIDIFICATION ABSORPTION AND REGENERATION.

TO PROVIDE ADEQUATE VENTILATION I WILL EXPLORE A CHIMNEY STRUCTURE ATOP THE ROOF WHICH WILL OPERATE ON THE PRINCIPLES OF 1) SOLAR CHIMNEY (4), 2) STACK VENTILATION (1, PP 54/55), 3) AND VENTURI EFFECT (5)(6, PP 98). SOLAR CHIMNEY WILL PROVIDE VENTING FOR THE SPACE BY CREATING A HOT, LOW PRESSURE AREA AT THE TOP OF THE CHIMNEY, CREATING A NATURAL AIR FLOW THROUGH THE SPACE. STACK VENTILATION WILL OPERATE ON THE SAME PRINCIPLE; VENTURI EFFECT, HOWEVER WILL OCCUR DUE TO A LOW PRESSURE ZONE CREATED AT THE CHIMNEY TOP BY THE PASSAGE OF WINDS FUNNELED OVER THE STACK.

## DAYLIGHTING STRATEGY

EXPOSURE TO NATURAL DAYLIGHT IS A NECESSARY COMPONENT OF LIFE FOR THE MAINTENANCE OF BOTH PHYSIOLOGICAL AND PSYCHOLOGICAL WELL BEING. IT ALLOWS A PERSON TO KEEP UNCONSCIOUS TRACK OF TIME AND WEATHER AND GIVES A FOUNDATION TO THE PASSAGE OF DAILY EVENTS. EQUALLY, THE USE OF NATURAL DAYLIGHTING WILL REDUCE BUILDING ENERGY COSTS, ELECTRICAL PRODUCTION COSTS, INTERNAL HEAT LOADS (COOLING SEASON, WHEN GREATER DAYLIGHT IS AVAILABLE).

DAYLIGHTING COULD PROVIDED THROUGH FENESTRATION (6, PP 127, 136), SKYLIGHTS (6, PP 122), OR CLERESTORIES, WITH ALLOWANCE FOR

THE CONTROL OF REFLECTION (6, PP 135) AND GLARE (6, PP 124), AND ARTIFICAL LIGHTING AS A BACKUP (6, PP 150).

# LIVABILITY

REPOSE, CHEERFULLNESS, SIMPLICITY, BREADTH, WARMTH, QUIETNESS IN A STORM, ECONOMY OF UPKEEP, EVIDENCE OF PROTECTION, HARMONY WITH SURROUNDINGS, ABSENCE OF DARK PASSAGES, EVENESS OF TEMPERATURE AND MAKING THE HOUSE FRAME ITS INMATES; RICH AND POOR ALIKE WILL PPRECIATE THESE QUALITIES.

C.F.A. VOYSEY

It is the intent of this thesis to explore the livability concepts of space, light, color and interior micro-climate; to determine if these very human needs can be met through the use of minimal climatic control technology.

## SPACE

The creation of space will search for a balance between the more traditional closed, isolated classroom, and the open free-flowing space touted during the 60's and 70's. The literature currently suggests that both approaches have positive and negative points (7). The balance would seem to be a space that had definite, yet flowing boundaries, with internal flexibility and direct contacts to multiple other spaces. It would provide greater cubic volume (7, pp 447), and both central and secluded, individual spaces (7, pp 447). Smaller, ancillary spaces for teacher seclusion, counseling privacy and lesson preparation would be appended (8, pp 6).

Beyond the immediate classroom, the design should provide spaces for 'activity nodes' (9, pp 7) that are centrally located, easily accessible, in high traffic zones, and with few visual boundaries. In addition, both in and outside the classroom, the spaces must be well differentiated in hierarchy (9, pp 8) to allow increased sense of well being, improved academic and social performance, and participants to change their immediate level and type of interaction.

## LIGHT

The needs of humanity are for the full spectrum of radiation present in natural sunlight. These needs are both psychological and physical. Man needs to be aware of the passage of the day, the state of the weather; he needs the fall of natural light on his skin for physical health, and that his eyes may best respond in acuity and accuracy (10, pp 6, 20).

For these needs to be met within the confines of a building requires that the entry of natural light be carefully controlled. Otherwise the conditions of insufficient or over sufficient illumination, glare, reflectance, low contrast and shadows can result, reducing the advantages of natural daylight (8, pp 25). Another consideration is to ensure that reflectance is darkest at the floor level, lightening up towards the ceiling. (8, pp 27).

Recommended foot candles of illumination, by whatever means, are 50-75 for general classroom use, 60-100 for detailed work (8, pp 26).

At some times natural light will not provide all of the requirements for light, due to inclement weather or time of day. Glass, however, tends to filter out the single greatest missing element in artificial lighting, ultraviolet (10, pp 70). This can be partially remedied by the use of full spectrum fluorescents which research indicates result in greater health and academic performance (8, pp 28; 10, pp 10).

It has been demonstrated that full spectrum tubes, combined with light tinted blue colors resulted in a 56% decrease in aggressive behaviors, a 23% decrease in non-attentive behaviors, and a report by teachers that they were able to get students to complete more work; all within a three week period (10, pp 18). Another test indicated that students studying under 'normal' cool white tubes demonstrated greater lethargy as opposed to the experimental group (11, pp 38).

## COLOR

The current body of literature indicates that color, in both its hue and chroma, affects our behavior. This is an old belief, best exemplified by Knute Rockne's having painted the locker room for visiting football teams blue, while using a bright red in the locker room of The Fighting Irish. Rockne attributed the success of his teams, in part, to this paint scheme (10, pp 17).

A more recent experiment noted the truth of this particular old wive's tale by exposing subjects to red and blue lights of various intensities. The experimenters concluded that, indeed, the red lights promoted tension and excitement, the blues promoted a relaxed behavior (11, pp 39).

The recommendations for classrooms are for light tints of reds, blues and yellows. Further, it is noted, that pastels promote a more accurate sense of time; 'cool' hues are appropriate for routine learning tasks; lighter colors make a space appear larger; neutral colors are suitable for space occupied for long periods of time; vivid colors should be used in areas where student movement is to be encouraged (8, pp 29). Additionally, cooler hues should be used in south facing rooms, warmer colors in north facing rooms (8, pp 18).

## INTERNAL ENVIRONMENT

It has been shown in an Educational Facility Laboratories report that a climatically controlled environment is significant in the learning process. The report indicated a measurable and positive effect in the control group, which exhibited greater maze completion, higher percentage of math solutions, improved reasoning and better clerical tasking (8, pp 33). Another study showed a marked decrease in reading comprehension when the room

TEMPERATURE WAS INCREASED ABOVE 77 DEGREES.

AS A RULE-OF-THUMB: HIGH AMBIENT TEMPERATURES SHOULD BE HELD AT ABOUT 68-70 DEGREES MEASURED 30" ABOVE THE FLOOR; COOLING LEVEL SHOULD BE WITHIN 2-3 DEGREES OF THE HIGH; TEMPERATURE AT 5 FEET ABOVE THE FLOOR SHOULD BE WITHIN 3 DEGREES OF FLOOR TEMPERATURE (8, PP 34).

HUMIDITY LEVELS SHOULD BE HELD BETWEEN 30% AND 50%. HIGHER HUMIDITY LEVELS RESULT IN LETHARGY CAUSED BY SLOW BODY EVAPORATION
RATE, WHILE LOWER LEVELS RESULT IN INCREASED ILLNESS AND LOST SCHOOL DAYS DUE TO INCREASES IN RESPIRATORY PROBLEMS (8, PP 36).

VENTILATION RATES ARE RECOMMENDED AT A MINIMUM OF 40 FEET PER MINUTE FOR NON-MECHANICALLY CONTROLLED BUILDINGS (8, PP 17). ONE SOURCE STATES THAT VENTILATION IS BETTER PROVIDED THROUGH MECHANICAL SYSTEMS THAN THROUGH OPEN WINDOWS (10, PP 25). THIS MEANS THAT THE EXPLORATION OF PASSIVE SYSTEMS WILL REQUIRE PROVISION FOR VENTILATION BY MEANS OTHER THAN 'SIMPLE WIND'. AN IMPORTANT ISSUE OFTEN OVERLOOKED IN VENTILATION PLANNING AND DESIGN IS THE CLEARING OF THE AIR DUE TO INTERNAL POLLUTION, WHICH IS PARTICULARLY IMPORTANT IN THE HIGH DENSITY ENVIRONMENT OF AN ELEMENTARY SCHOOL (8, PP 25).

VENTILATION, AS COOLING AND HEATING, CANNOT BE EXPECTED TO MAKE EVERYONE IN THE CLASSROOM COMFORTABLE AT ALL TIMES. THIS IS BECAUSE CHILDREN, DUE TO A HIGHER METABOLISM, WILL TYPICALLY FEEL WARM OR COMFORTABLE IN THE SAME SPACE WHERE AN ADULT WILL FEEL COOL (8, PP 25).

# CASE STUDY

# OF

# MORNING STAR ELEMENTARY SCHOOL

From the period of 3 September, 1992, until 17 November, 1992, I worked at Morning Star Elementary school to observe the staff and student usage and reaction to the building. In an agreement between myself, Dr. Bryan Dunn of the School District, and Ms. Nonnie Hughes, the principal of Morning Star, I was allowed to assist in four classrooms, much in the manner of an education major para-professional.

I alternated four classrooms, selected to present their only windows to the four cardinal directions. By shifting wings and morning/afternoon periods, I was able over a period of time to observe the natural light of each room at various times of day.

These observations are culled from my rough notes (12).

## TECHNOLOGY OBSERVATIONS

The building is a low energy user due to its high technology HVAC design. It is tightly sealed and has a very efficient boiler plant for heating (rated 98%). Administrative policy is that windows are not to be opened as it will lower HVAC system efficiency.

No mechanical cooling is provided.

Artificial lighting in the classrooms contains three tubes in a fixture, switchable in sets of 1, 2, or 3.

The staff perceives the air supply as temperature controlled but not as refreshed.

## LIVABILITY OBSERVATIONS

In the classrooms, window placement in one corner of each room causes dark pockets of shadow under natural lighting conditions. The relationship between window/AV screen and white marker board is such as to create a bad glare condition, this occurs even in the north classroom. Cubbies are not included for times of desired privacy by the students, who create their own by using the locker space, corners, the corridor columns outside the doors and the 'trophy cases' in the corridors which were left unglazed upon completion of construction. One teacher removed the lower shelving in the locker space storage area to create cubbies for the students.

One parent complained of the high technology nature of the girls toilet; it continually self flushes during use. For smaller girls, K/1, who tend due to their size to sit lower in the seat this means they always get wet. Consequently, there is normally a line of small girls to use the handicapped stall which is manually operated.

Noise control throughout the building was impressive, especially given the hard nature of the wall surfacing materials.

This condition prevailed even in the Gymnasium. All four teachers commented on the condition. Speech, conversely, travelled well in all areas of the school, without reverberation or echo, and without speaking loudly.

Color selection throughout was in keeping with the research that I have just completed. Three of the teachers noted that the students here seemed to be quieter in their behavior than last year at Emerson.

# AN ANALYSIS OF THE DESIGN PROBLEM

# FINDING AND DISCOVERING

IF YOU DO NOT EXPECT THE UNEXPECTED, YOU WILL NOT FIND IT FOR IT IS HARD TO FIND AND DIFFICULT. FOR THE MANY DO NOT UNDERSTAND SUCH THINGS WHEN THEY MEET WITH THEM; NOR HAVING LEARNED DO THEY COMPREHEND, THOUGH THEY THINK THEY DO.

THE REMAINING FRAGMENTS
HERACLITUS

# ANALYSIS

## SITE

The site is located on the west side of the south end of Linkhorn Bay in Virginia Beach, Va., about 3 miles west of the open Atlantic Ocean.

The site is bordered on the north by a service road along the side of US-58, the other side of the highway being dense trees. On the west, there are heavy bushes and hedges, on site, which block views both on and off the site. A street is just beyond the shrubbery. The east of the site is like the west. To the south, the boundary is lined with 30-40 foot trees, backed by 3-story condominiums. The site is therefore essentially removed from the context visually and aurally, and is cut off from light winds at the ground level (13, 14).

Site elevation ranges from 9' at the NW corner to 2' at the SE corner. A steep ditch runs through the trees along the south boundary, it normally only carries water following moderate to heavy rains (13, 14). Groundwater on the site is found at about 1', and varies 1 to 2 feet during the annual cycle of tides and precipitation (15). Water table temperatures achieve steady state at 55-60 degrees at an elevation of about -20/25 feet across the entire site (15).

## CLIMATE

The prevailing climate in Virginia Beach is best described as mild and temperate. Winds and sun are available in abundance throughout the year. The site climatic data indicate 3300 heating degree days, and 1900 cooling degree days. Winds are SW/NE for 11 months of the year. Precipitation, in the form of heavy fog, does exist in sufficient quantities to be noted. Humidity levels are high year around (3).

## PROGRAM

In order to avoid the time necessary to 'make-up' a program for the thesis I have used the Bozeman School District 7 program for Morning Star Elementary School (16).

# INTERRELATING TECHNOLOGY AND LIVABILITY

WHATEVER IS BEAUTIFUL RESTS ON WHATEVER IS NECESSARY.

LOUIS SULLIVAN

# DESIGN GOALS

## GENERAL

Based on the research conducted the design goals that I shall use to explore the technology/livability relationship are those: sustainability, educational layering, after hours community use, minimal environmental technology, and maximum livability as used in the working definition.

## SPECIFIC

### Livability

I shall seek a flexible plan, as a balance between the good and bad points of open and closed planning in the typical classrooms. I will place areas in the classroom that provide for student and teacher privacy to alleviate the overcrowded feeling of never getting away.

Light will be provided by both fenestration and clerestories. All light entry points are to have the capability of darkening to prevent glare, and to allow use of AV equipment. As much natural light as possible will be used to enhance colors and the sense of the passing of the day.

Colors will be selected for hue and chroma to enhance quiet behavior patterns.

Educational layering, a livability issue specific to school design, will be done to promote holistic learning both in and out of the classroom. This layering, in the building, will occur in the circulation spaces; outside it will occur on exterior decks and the playground (18).

### Technology

Technological issues will be addressed by the main concept of minimal. Such technology as proves necessary to maintain the desired climatic conditions will be in addition to the use of the passive strategies discussed earlier.

Heating is to be provided by direct solar gain, ventilation by wind effects; both of these to be housed in the roof of the structure so that all classes, north or south, may have a common means of accomplishing them. I will use the steady state ground water temperature as the primary cooling means, pumping through a system that sends the water through a liquid/air heat exchanger then re-injects up strata so that it may naturally percolate back to the suction well. I have been informed that this concept has recently come into use in the Virginia Beach and Norfolk areas (17). Dehumidification will be through liquid desiccants placed under the building in a volumetrically large plenum (3).

I SHALL TEST AND EVALUATE THE DESIGN THERMALLY USING THE COMPUTER SOFTWARE, SOLAR 5, WRITTEN AT UCLA (19)

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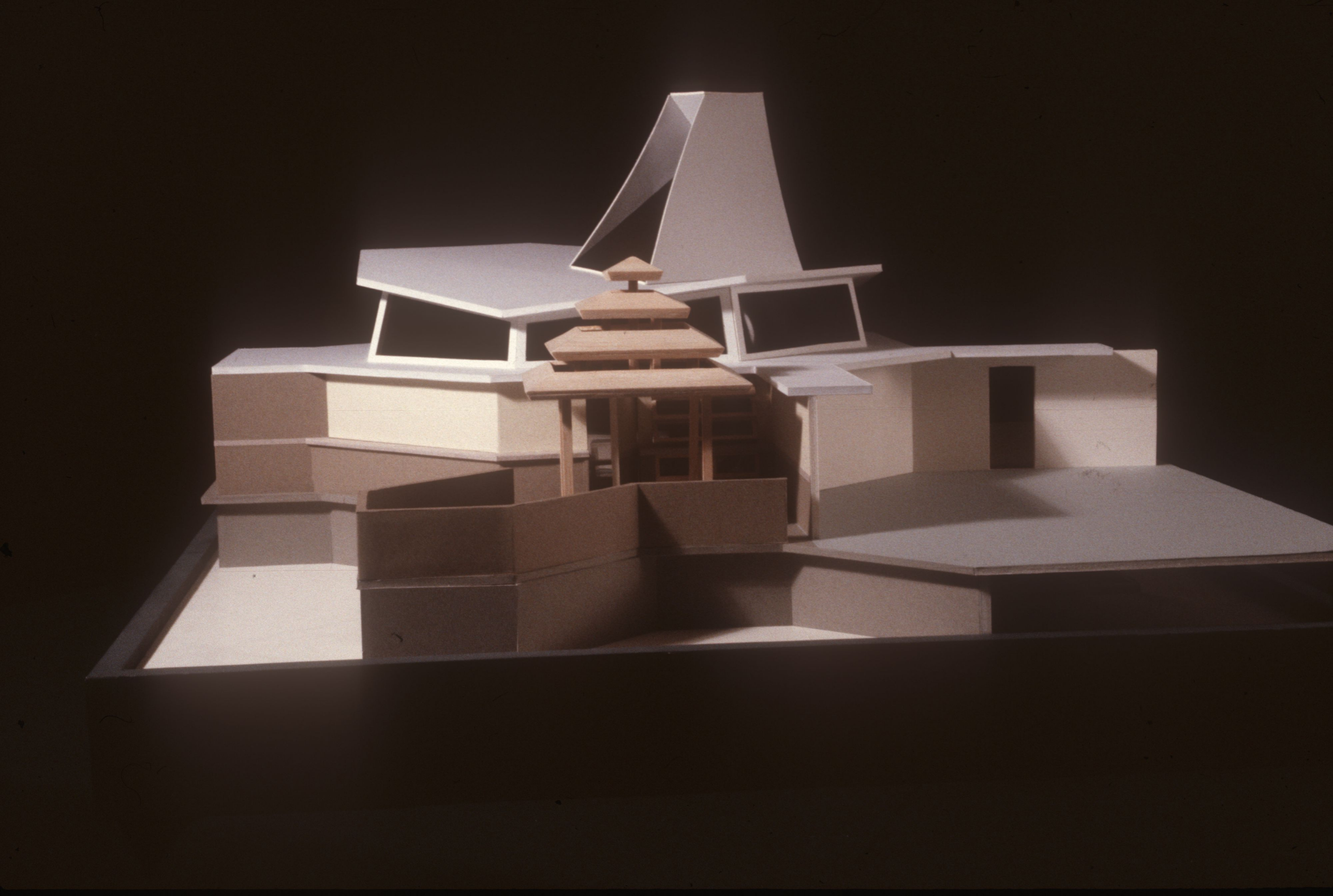
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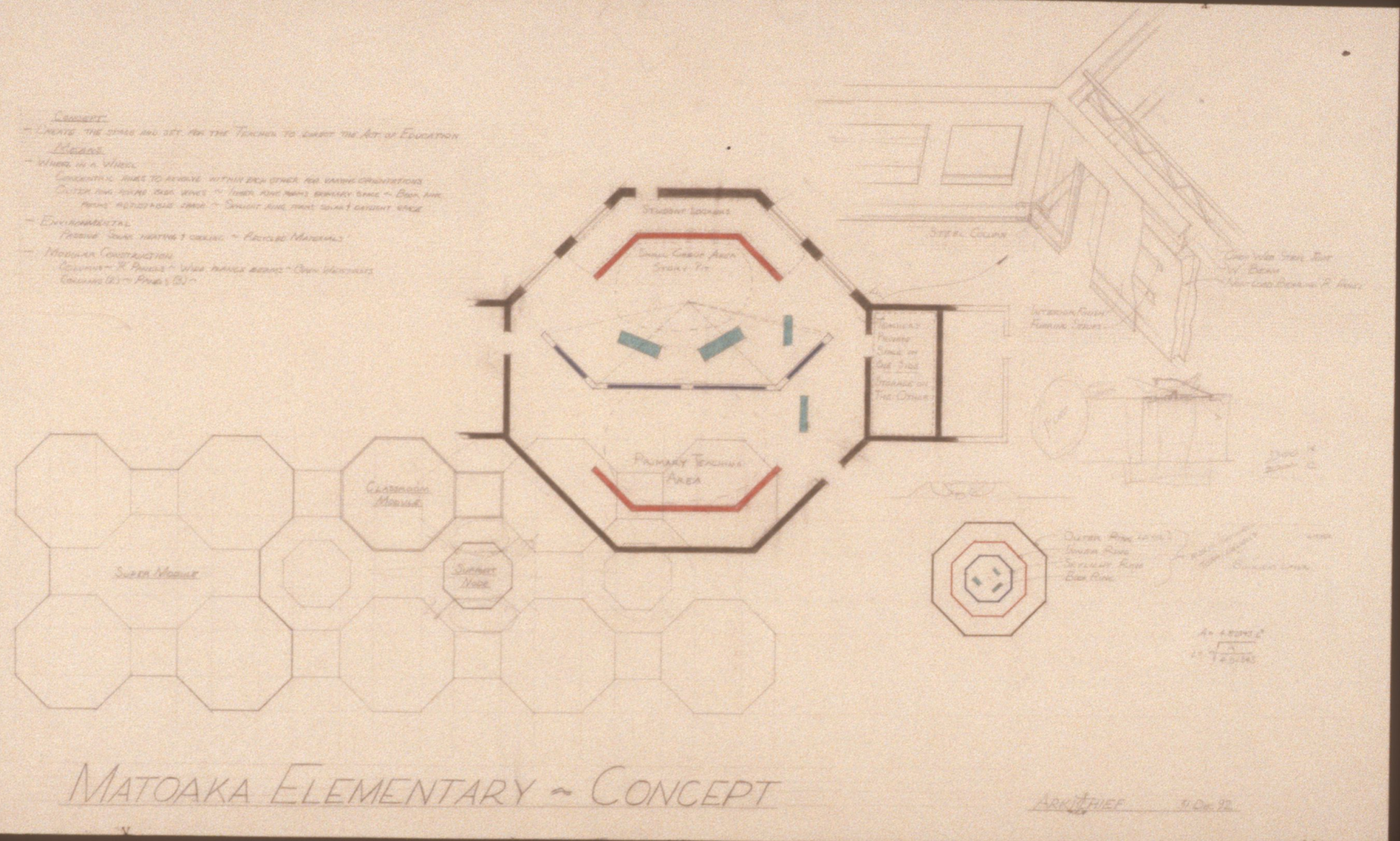

ART

CONCEPT

- CREATE THE SPACE AND SET FOR THE TEACHER TO EXHIBIT THE ART OF EDUCATION

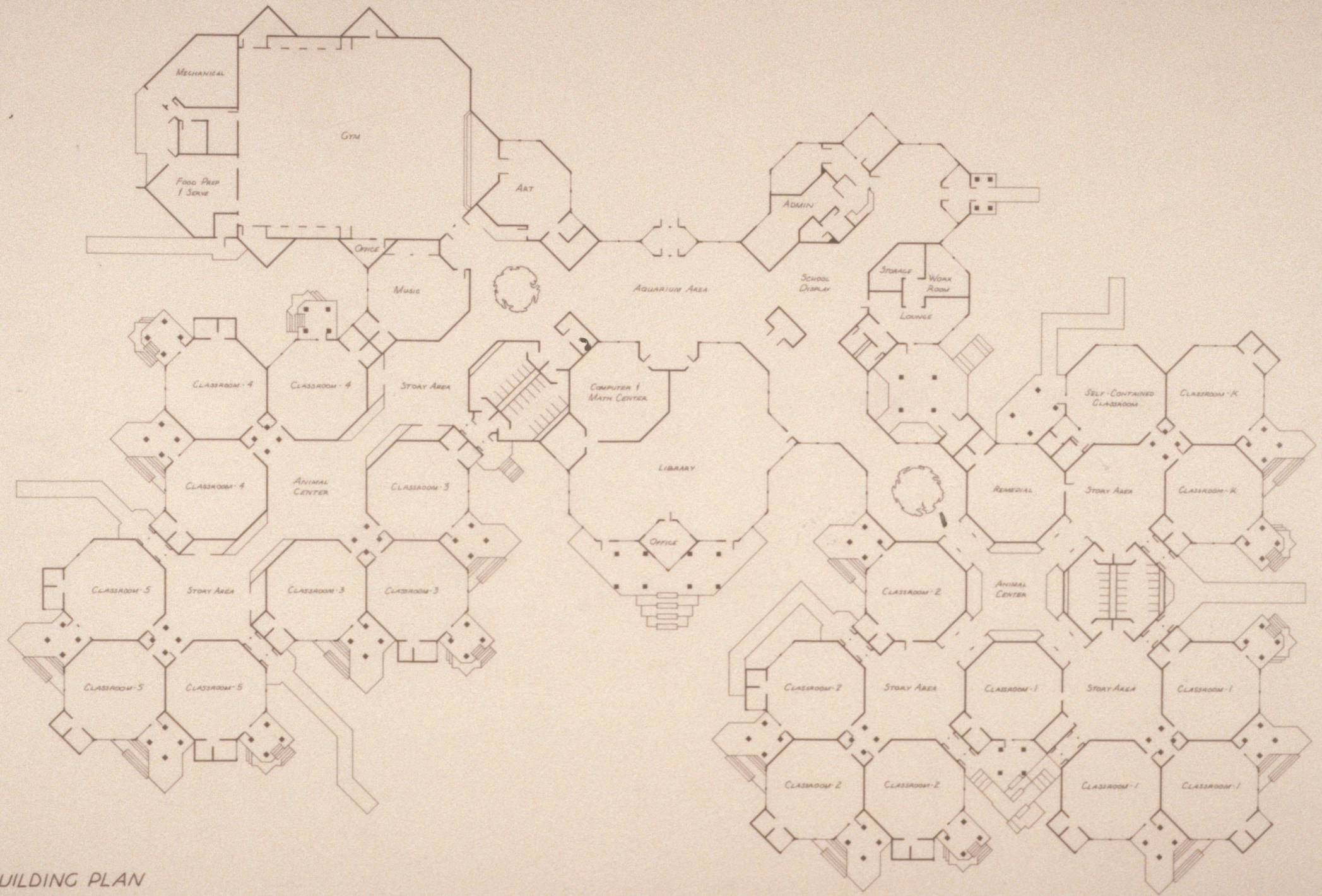
PLANNING

- WHEEL IN A WHEEL
  - CONCENTRIC RINGS TO REVOLVE WITHIN EACH OTHER FOR VARYING CONFIGURATIONS
  - OUTER RING HOUSES BASIC SERVICES - INNER RING PARTS, SECONDARY RINGS - BOOK AND PERIOD ACTIVITIES AREAS - SPOKES ARE FIXED, PARTS WHICH DIVIDE SPACE
- ENVIRONMENTAL
  - PASSIVE SOLAR HEATING & COOLING - RECYCLED MATERIALS
- MODULAR CONSTRUCTION
  - COLUMNS - 8' RADIUS - WOOD, PARALLEL BEAMS - OPEN WEBBINGS
  - CEILINGS (2) - PANELS (3) -




# MATOAKA ELEMENTARY - CONCEPT

ARCHITECT




BUILDING PLAN

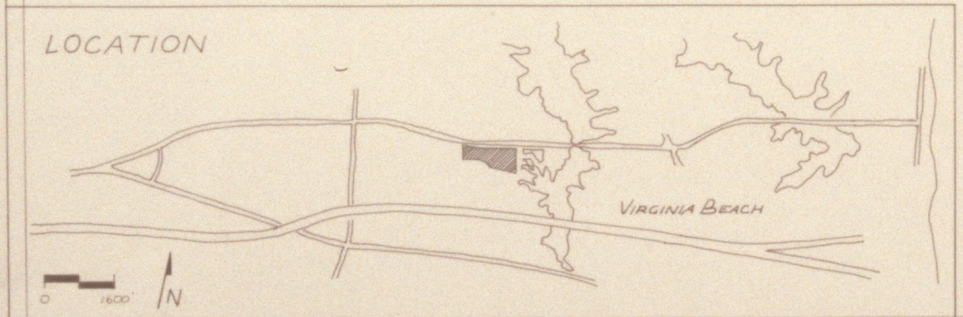
0 5 10 15 25

SITE PLAN

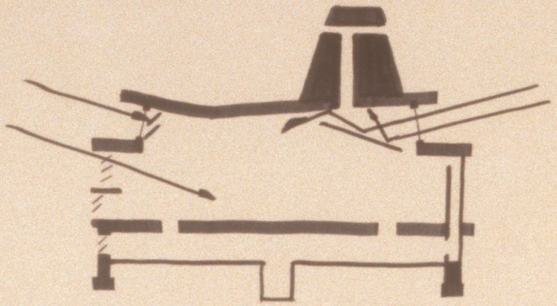
0 10 20 40 100

N

LOCATION

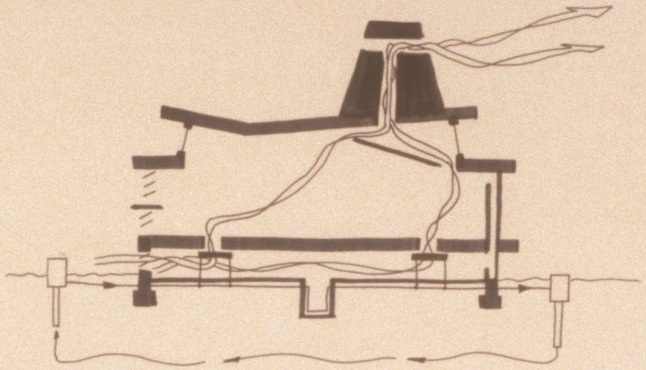


360 Degree Clerestories
Interior Blinds to Control Light



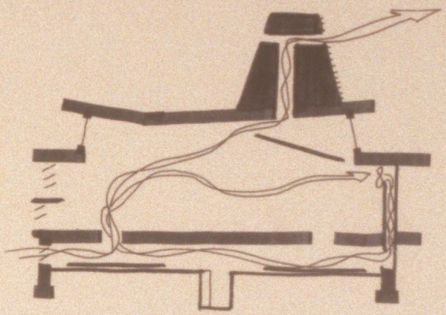
## Daylighting

Cool Air Storage in Plenum
Air Flow Due to Press/Temp Differential
Chill Water From Well - Reinjection Up Strata
Air to Liquid Heat Exchanger



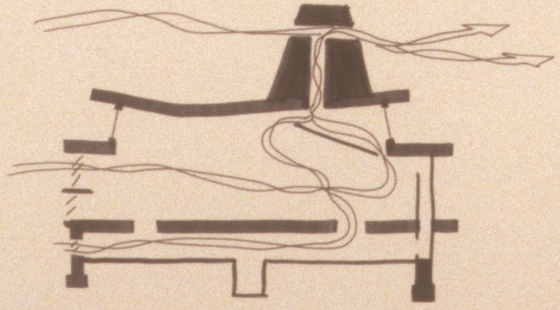
## Cooling

Liquid Desiccant Absorbs Moisture
Chimney Mounted Solar Cells Charge NiCad Batteries



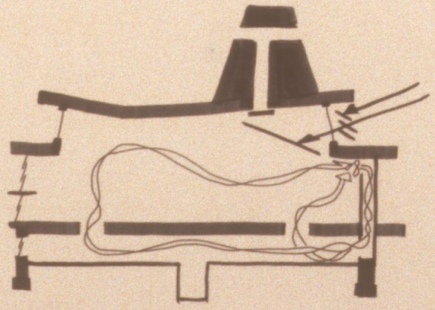
## Dehumid'n (Absorb)

Chimney Height Provides Stack Effect
Chimney Baffles Funnel Wind for Venturi Effect
Chimney Black to Produce Solar Chimney
Intake Through Floor for Cool Air
Intake Through Windows for Ambient Temp Air



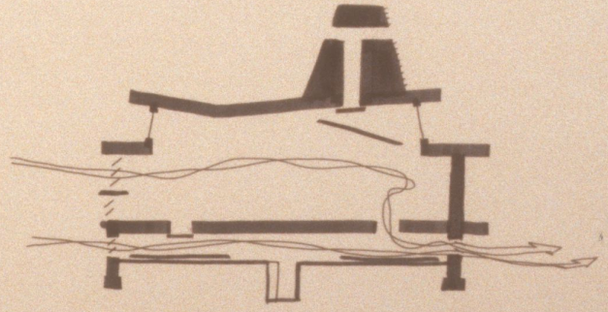
## Ventilation

Direct Gain
Exterior Louvers Control Solar Access



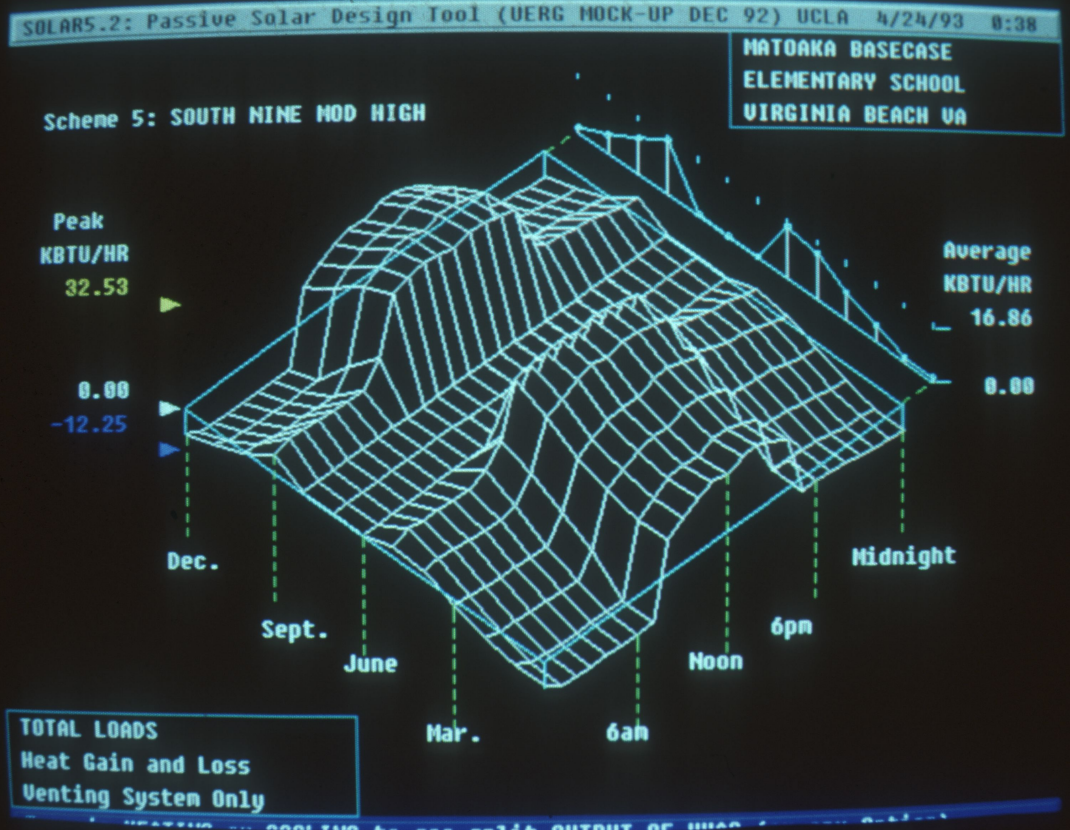
## Heating

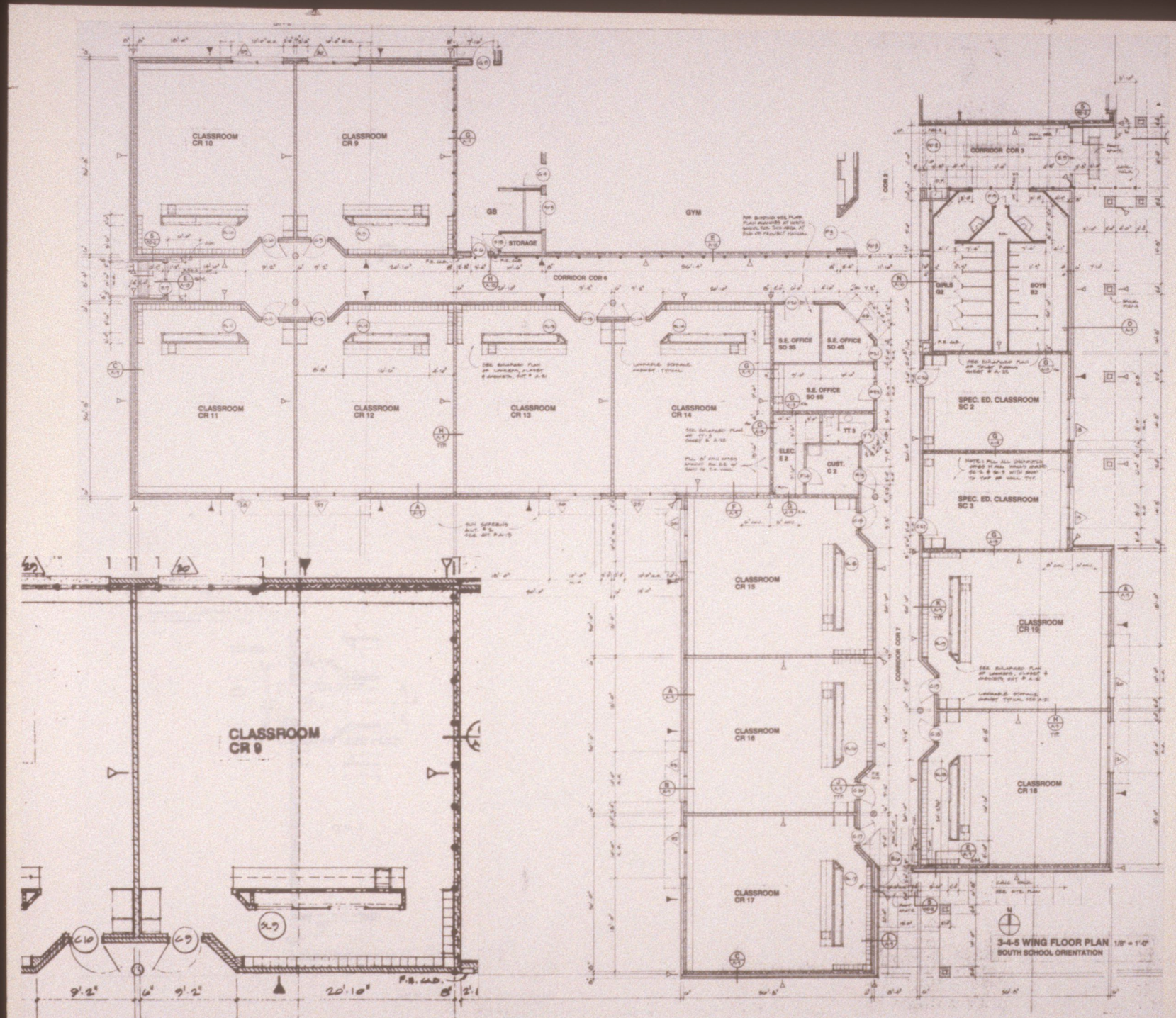
NiCad Batteries Heat/Dry Desiccant
Moisture is Vented out of Building
NiCad Batteries Power Fan



## Dehumid'n (Regen)

| PLEASANT | SUPPORTIVE<br>OF DAILY ACTIVITIES | FABRIC<br>OF LIFE |
|---|---|---|
| COMFORT ~ TEMPERATURE - VENTILATION - HUMIDITY - DAYLIGHT<br>DELIGHTFUL ~ PLEASURE - ENJOYABLE - RESTFUL - PEACEFUL<br>MEMORABLE ~ NOTABLE - WORTHY OF MEMORY<br>SCALE ~ ADULT SIZED - KID SIZED<br>VISUALLY STIMULATING ~ LEGIBLE - CLEAR - SIMPLE | BALANCE ~ HARD/SOFT - STRAIGHT/CURVED - SCIENCE/ART<br>COMMODIUS ~ SPACIOUS - ROOMY - SUITABLE<br>FUNCTIONAL ~ OPERATIVE - PERFORMING AS DESIRED OR NEEDED<br>FLEXIBLE ~ SERVING DIFFERENT NEEDS AT DIFFERENT TIMES IN DIFFERENT WAYS<br>NURTURING ~ CULTIVATE - FEED - HELP GROW AND DEVELOP EDUCATE AND TRAIN<br>SNUG ~ REFUGE - STABILITY - PRIVACY | SUSTAINABLE ~ RECYCLE - MINIMUM MATERIALS - MINIMUM WASTE<br>HABITABLE ~ SUITABLE TO LIVE - DWELL<br>CONTEXT ~ BLEND IN - PART OF COMMUNITY |
| PROVIDE CONTROL OF THOSE THINGS WHICH AFFECT THE SENSES SO THAT THERE IS NO UNDESIRED CONSCIOUS INTERRUPTON OF THE EDUCATIONAL PROCESS. A PLACE WHERE ALL USERS WANT TO BE. | PROVIDE PHYSICAL PLANT TO ENSURE OPPORTUNITY FOR HOLISTIC LEARNING. THIS MUST OCCUR THROUGHOUT ALL PORTIONS OF THE BUILDING AND OUTSIDE TRADITIONAL CONCEPTS OF SCHOOL. | PROVIDE FOR INTERACTION ON INSIDE AND OUTSIDE ISSUES: BUILDING TO SITE; SITE TO CONTEXT; INTERIOR TO EXTERIOR; FRIEND TO FRIEND; TEACHER TO STUDENT. |


SOLAR5.2: Passive Solar Design Tool (UERG MOCK-UP DEC 92) UCLA 4/24/93 0:38
MATOAKA BASECASE
ELEMENTARY SCHOOL
VIRGINIA BEACH VA
Scheme 5: SOUTH NINE MOD HIGH
Peak
KBTU/HR
32.53
0.00
-12.25
Average
KBTU/HR
16.86
0.00
Dec.
Sept.
June
Mar.
6am
Noon
6pm
Midnight
TOTAL LOADS
Heat Gain and Loss
Venting System Only

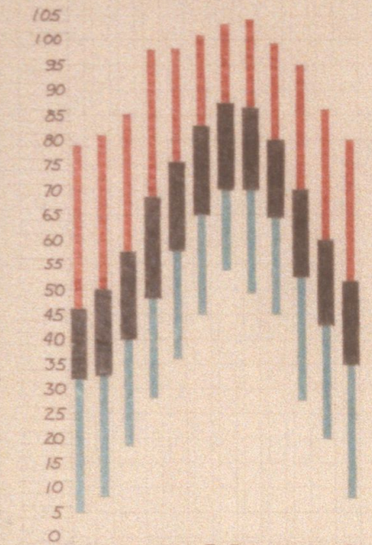

CLASSROOM CR 10
CLASSROOM CR 9
GB
GYM
STORAGE
CORRIDOR COR 6
CLASSROOM CR 11
CLASSROOM CR 12
CLASSROOM CR 13
CLASSROOM CR 14
S.E. OFFICE SO 38
S.E. OFFICE SO 48
S.E. OFFICE SO 49
TT 3
ELEC. E 2
CUST. C 2
CORRIDOR COR 3
GIRLS G2
BOYS B2
SPEC. ED. CLASSROOM SC 2
SPEC. ED. CLASSROOM SC 3
CLASSROOM CR 15
CLASSROOM CR 16
CLASSROOM CR 17
CLASSROOM CR 18
CLASSROOM CR 19
CORRIDOR COR 7
3-4-5 WING FLOOR PLAN 1/8" = 1'-0"
SOUTH SCHOOL ORIENTATION


CLASSROOM CR 9
C10
C9
C11
C12
3L9
3L12
9'-2"
6"
9'-2"
20'-10"

# MATOAKA ELEMENTARY CLIMATIC DATA

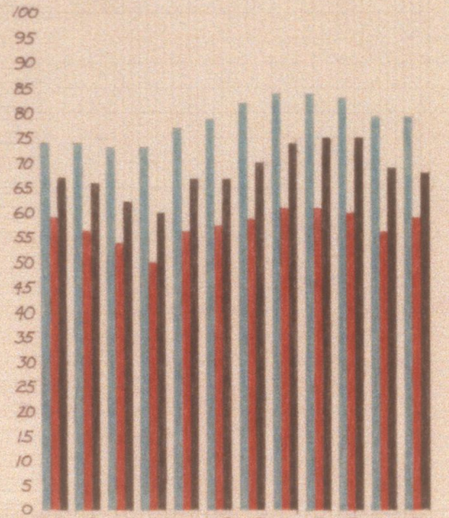
## TEMPERATURE

DEGREES FAHRENHEIT
DAILY MAX ■ RECORD HI ■
DAILY MIN ■ RECORD LO ■



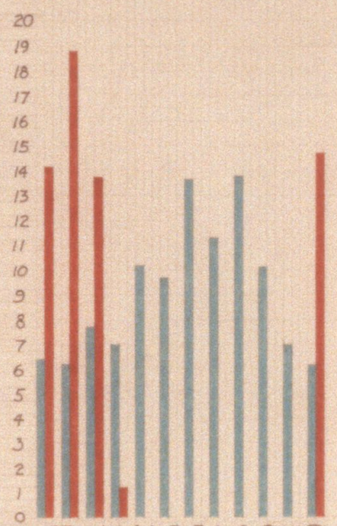

## HUMIDITY

PERCENTAGE
7 AM ■ 7 PM ■
1 PM ■



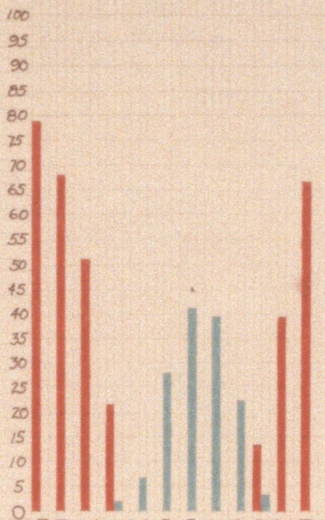

## PRECIPITATION

INCHES
MAX WATER EQUIV ■
MAX SNOW ■



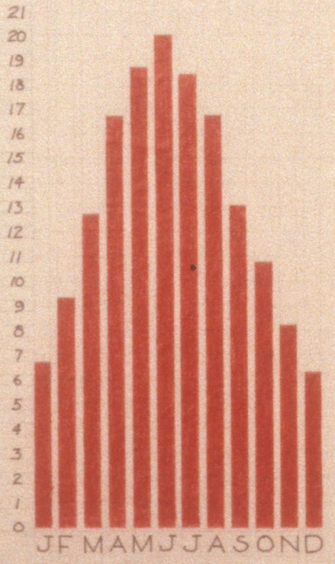

## DEGREE DAYS

BASE 65 DEGS F IN 10's
HEATING ■
COOLING ■



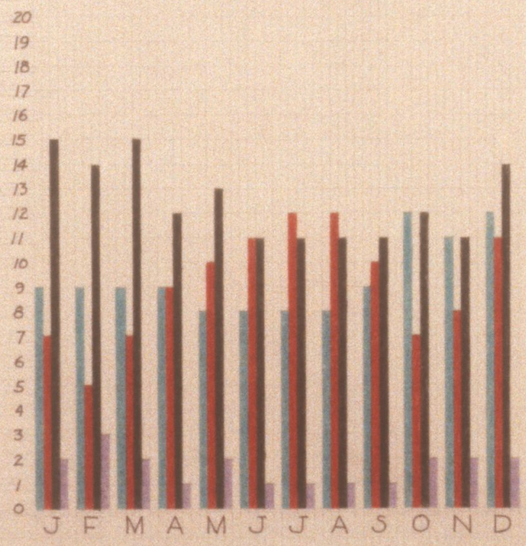

## SOLAR RADIATION

BTU's/FT² ■
IN 100's



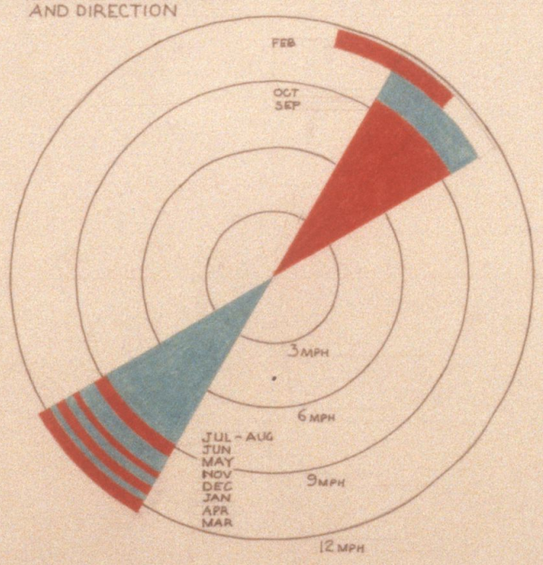

## SKY COVER

MEAN NR. DAYS
CLEAR ■ PARTLY CLOUDY ■
CLOUDY ■ HEAVY FOG (VISBY < ¼ M) ■



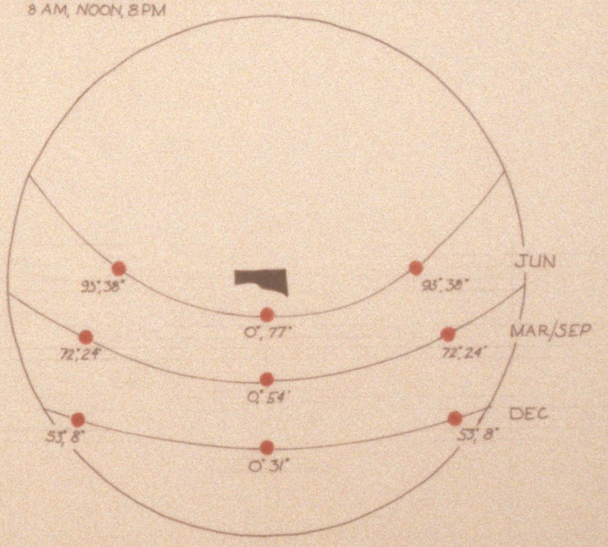

## WIND

MONTHL MEAN SPEED
AND DIRECTION

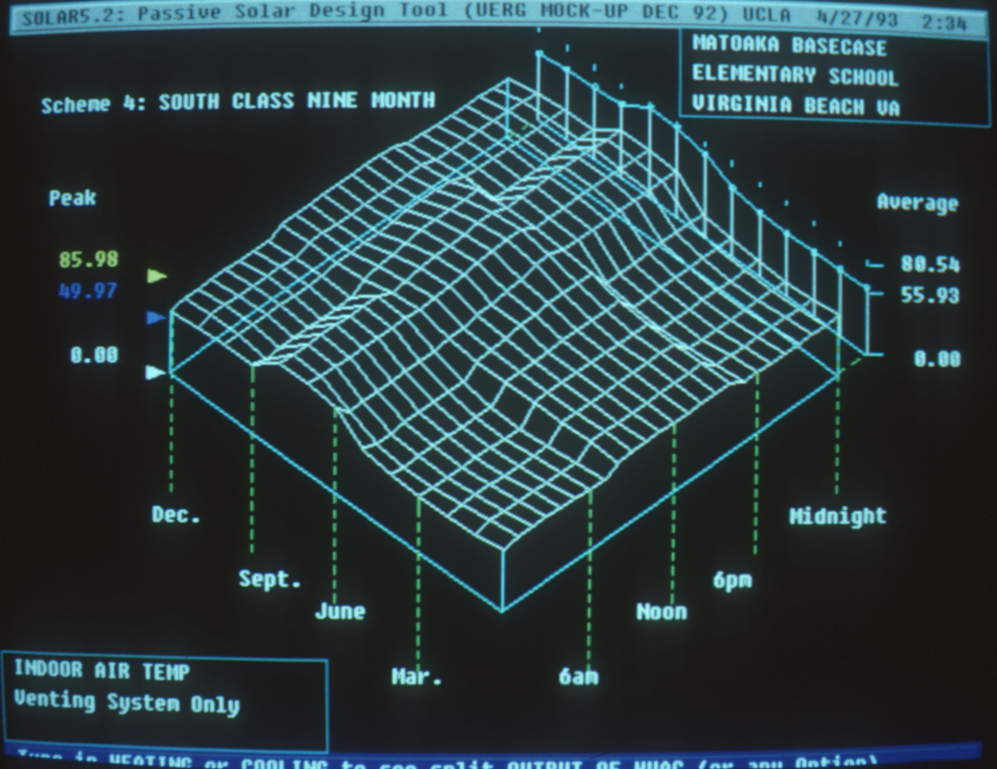


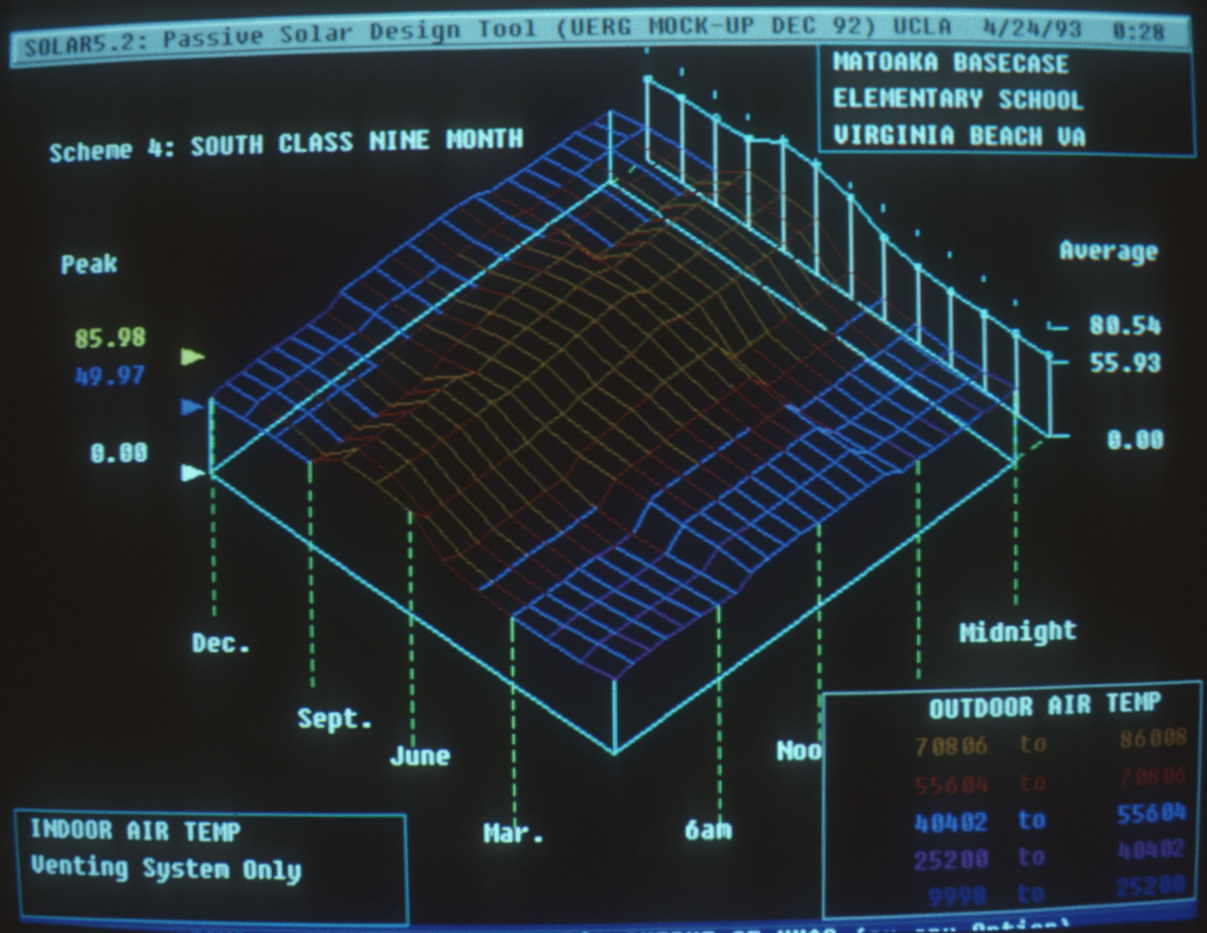

## SUN CHART

BEARING & ALTITUDE
8 AM, NOON, 8 PM






SOLAR5.2: Passive Solar Design Tool (VERG MOCK-UP DEC 92) UCLA 4/27/93 2:34
MATOAKA BASECASE
ELEMENTARY SCHOOL
VIRGINIA BEACH VA
Scheme 4: SOUTH CLASS NINE MONTH
Peak
85.98
49.97
0.00
Average
80.54
55.93
0.00
Dec.
Sept.
June
Mar.
6am
Noon
6pm
Midnight
INDOOR AIR TEMP
Venting System Only


SOLAR5.2: Passive Solar Design Tool (UERG MOCK-UP DEC 92) UCLA 4/24/93 0:28
MATOAKA BASECASE
ELEMENTARY SCHOOL
VIRGINIA BEACH VA
Scheme 4: SOUTH CLASS NINE MONTH
Peak
85.98
49.97
0.00
Average
80.54
55.93
0.00
Dec.
Sept.
June
Mar.
6am
Midnight
INDOOR AIR TEMP
Venting System Only
OUTDOOR AIR TEMP
70806 to 86008
55604 to 70806
40402 to 55604
25200 to 40402
9998 to 25200

SOLAR5.2: Passive Solar Design Tool (UERG MOCK-UP DEC 92) UCLA 4/24/93 0:32

BAR CHART: PEAKS

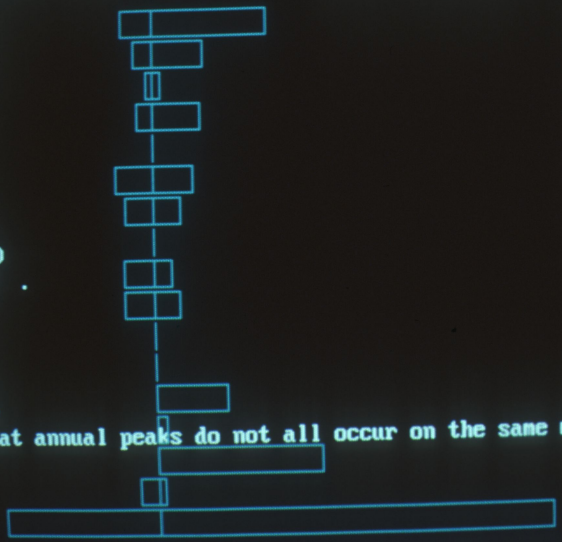
Project Title: MATOAKA BASECASE
Building Type: ELEMENTARY SCHOOL
Climate Data : VIRGINIA BEACH VA

Scheme 4: SOUTH CLASS NINE MONTH

Component Annual Peaks

Units = BTU/HOUR

| | Peak Loss | Peak Gain |
|---|---|---|
| SOUTH WINDOW | -2287.7 | 8375.9 |
| WEST WINDOW | -1302.3 | 3786.7 |
| NORTH WINDOW | -356.7 | 593.8 |
| EAST WINDOW | -1069.9 | 3481.6 |
| SKYLIGHT | .0 | .0 |
| SOUTH WALL | -2700.5 | 2960.0 |
| WEST WALL | -2042.5 | 1999.1 |
| NORTH WALL | .0 | .0 |
| EAST WALL | -2091.7 | 1343.6 |
| ROOF | -2160.9 | 1860.9 |
| FLOOR (RAISED) | .0 | .0 |
| SLAB ON GRADE | .0 | .0 |
| LIGHTING | .0 | 5184.6 |
| EQUIPMENT | .0 | 740.7 |
| OCCUPANTS | .0 | 12000.0 |
| INFILTRATION | -1287.7 | 563.4 |
| ** TOTAL ** | -11522.8 | 28875.6 |



Note that annual peaks do not all occur on the same month and hour

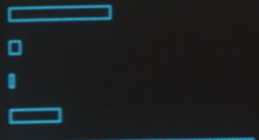
Want to see a Bar Chart for a specific month and hour (Y,N,option)?

SOLAR5.2: Passive Solar Design Tool (VERG MOCK-UP DEC 92) UCLA 4/24/93 0:33

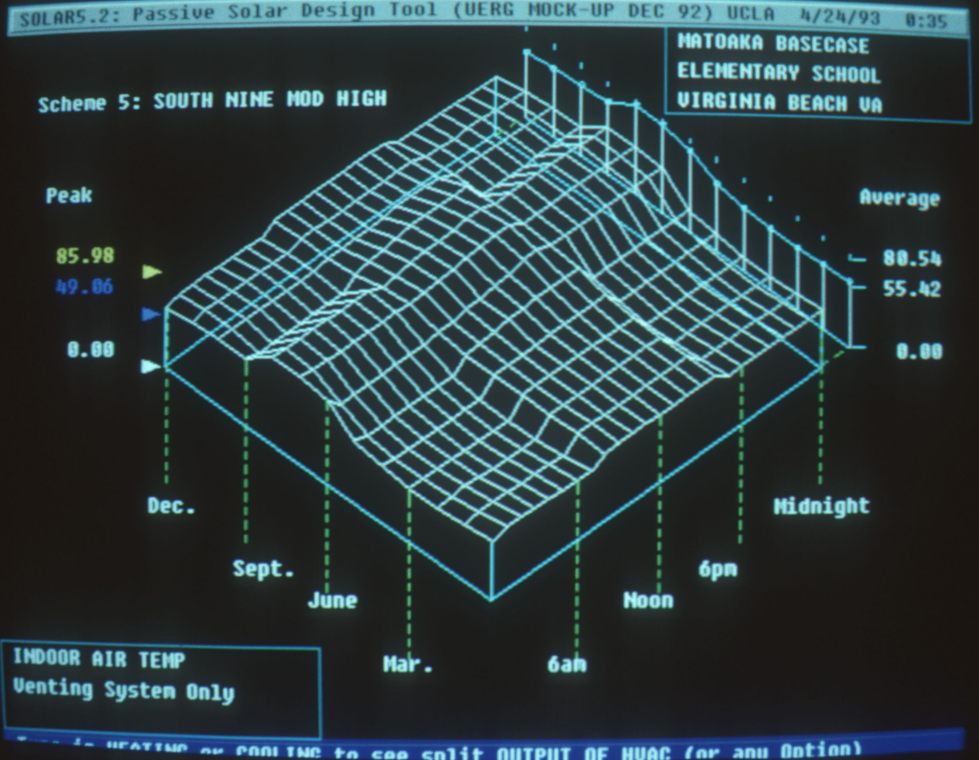
PERFORMANCE SUMMARY
Scheme 4: SOUTH CLASS NINE MONTH

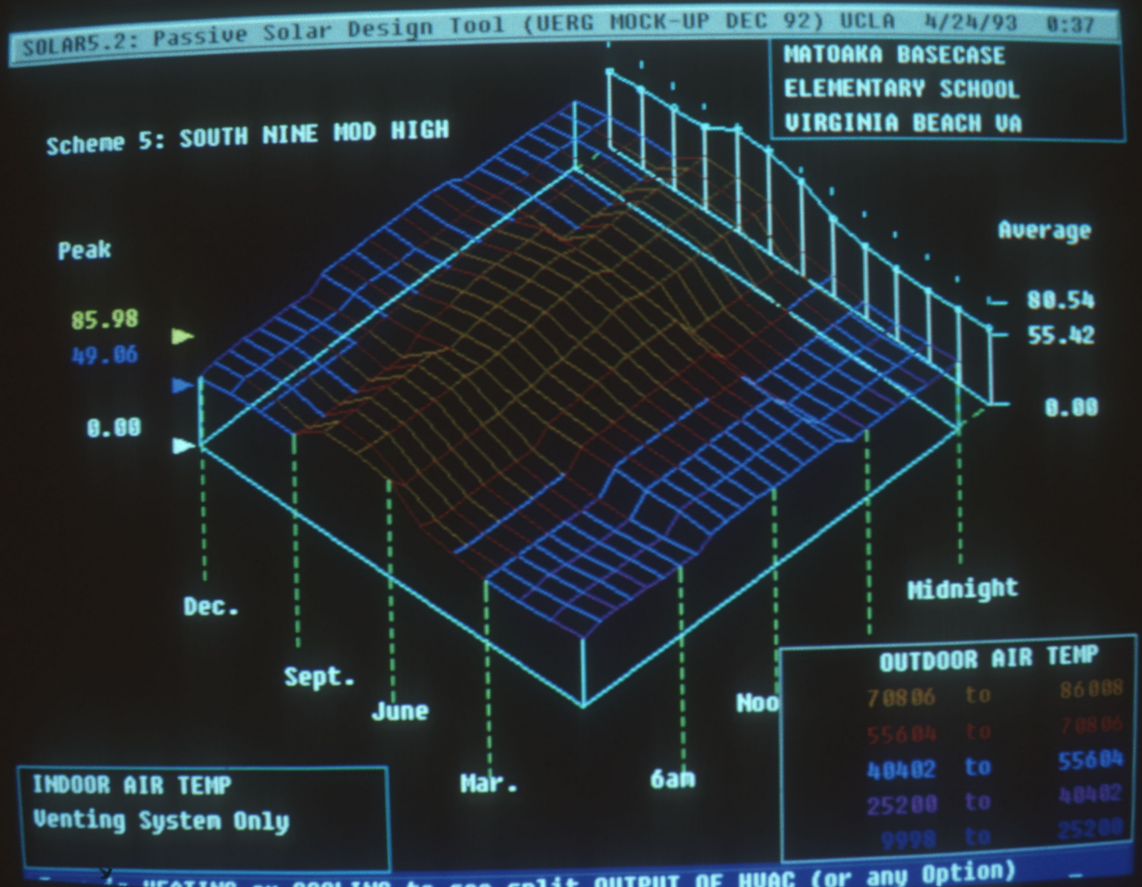
Project Title: MATOAKA BASECASE
Building Type: ELEMENTARY SCHOOL
Climate Data : VIRGINIA BEACH VA

| | | SCHEME 4 |
|---|---|---|
| | | ********* |
| SF | Total Floor Area | 14856.000 |
| SF | Total Glazing Area | 5520.000 |
| SF | Total South Glazing Area | 73140.000 |
| SF | Total Roof + Skylight Area | 34664.000 |
| SF | Total Wall + Window Area | .050 |
| BTUH/SF/DEG.F | AVG. Roof U-value | .287 |
| BTUH/SF/DEG.F | AVG. Wall U-value | .223 |
| BTUH/SF/DEG.F | Heat Loss Factor | -6.901 |
| BTUH/SF | Normalized Heat Loss | -1009.415 |
| KBTUH | Design Heat Loss (K=1000) | -310.955 |
| KBTUH | Peak Hour Total Heat Loss | 1321.297 |
| KBTUH | Peak Hour Total Heat Gain | 10.156 |
| PERCENT | Window Area/Floor Area | 3.774 |
| PERCENT | South Glazing/Floor Area | 6.382 |
| PERCENT | Non-South Glazing/Floor | 47.307 |
| DEG.F | Balance Point TEMP. No-Sun | 40.013 |
| DEG.F | Balance Point TEMP. In-Sun | |



HEATING or COOLING to see split OUTPUT OF HVAC (or any Option)


SOLAR5.2: Passive Solar Design Tool (UERG MOCK-UP DEC 92) UCLA 4/24/93 0:35
MATOAKA BASECASE
ELEMENTARY SCHOOL
VIRGINIA BEACH VA
Scheme 5: SOUTH NINE MOD HIGH
Peak
85.98
49.06
0.00
Average
80.54
55.42
0.00
Dec.
Sept.
June
Mar.
6am
Noon
6pm
Midnight
INDOOR AIR TEMP
Venting System Only


SOLAR5.2: Passive Solar Design Tool (UERG MOCK-UP DEC 92) UCLA 4/24/93 0:37
MATOAKA BASECASE
ELEMENTARY SCHOOL
VIRGINIA BEACH VA
Scheme 5: SOUTH NINE MOD HIGH
Peak
85.98
49.06
0.00
Average
80.54
55.42
0.00
Dec.
Sept.
June
Mar.
6ah
Noo
Midnight
OUTDOOR AIR TEMP
70806 to 86008
55604 to 70806
40402 to 55604
25200 to 40402
9998 to 25200
INDOOR AIR TEMP
Venting System Only
HEATING or COOLING to see split OUTPUT OF HVAC (or any Option)

SOLAR5.2: Passive Solar Design Tool (UERG MOCK-UP DEC 92) UCLA 4/24/93 0:39

BAR CHART: PEAKS

Project Title: MATOAKA BASECASE
Building Type: ELEMENTARY SCHOOL
Climate Data : VIRGINIA BEACH VA

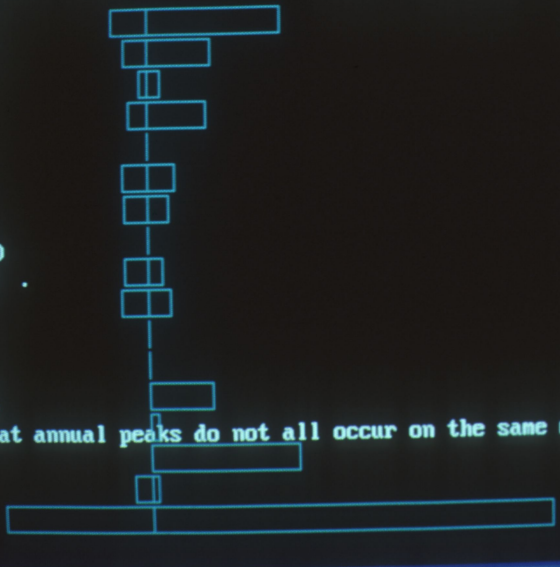
Scheme 5: SOUTH NINE MOD HIGH

Component Annual Peaks

Units = BTU/HOUR

| | Peak Loss | Peak Gain |
|---|---|---|
| SOUTH WINDOW | -2885.1 | 10802.8 |
| WEST WINDOW | -1801.9 | 5131.1 |
| NORTH WINDOW | -616.2 | 1032.9 |
| EAST WINDOW | -1481.2 | 4828.6 |
| SKYLIGHT | .0 | .0 |
| SOUTH WALL | -2006.7 | 2209.5 |
| WEST WALL | -1796.4 | 1766.0 |
| NORTH WALL | .0 | .0 |
| EAST WALL | -1845.6 | 1204.4 |
| ROOF | -2160.9 | 1880.9 |
| FLOOR (RAISED) | .0 | .0 |
| SLAB ON GRADE | .0 | .0 |
| LIGHTING | .0 | 5184.6 |
| EQUIPMENT | .0 | 740.7 |
| OCCUPANTS | .0 | 12000.0 |
| INFILTRATION | -1287.7 | 563.4 |
| ** TOTAL ** | -12247.8 | 32525.7 |

Note that annual peaks do not all occur on the same month and hour



Do you want to see a Bar Chart for a specific month and hour (Y N options)

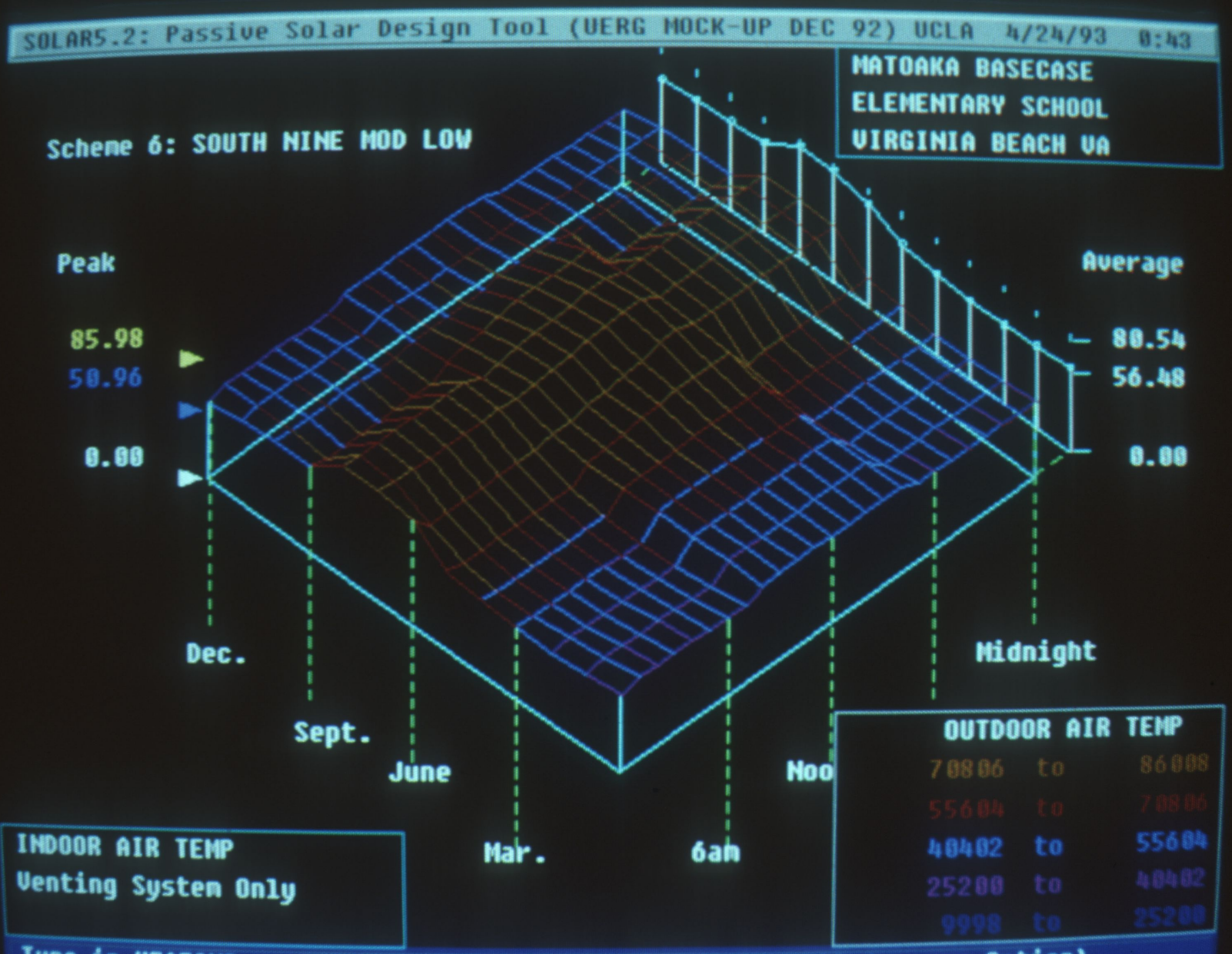
SOLAR5.2: Passive Solar Design Tool (UERG MOCK-UP DEC 92) UCLA 4/24/93 0:40

PERFORMANCE SUMMARY
Scheme 5: SOUTH NINE MOD HIGH

Project Title: MATOAKA BASECASE
Building Type: ELEMENTARY SCHOOL
Climate Data : VIRGINIA BEACH VA

| | | SCHEME 5 |
|---|---|---|
| SF | Total Floor Area | ********** |
| SF | Total Glazing Area | 14856.000 |
| SF | Total South Glazing Area | 5520.000 |
| SF | Total Roof + Skylight Area | 73140.000 |
| SF | Total Wall + Window Area | 34664.000 |
| BTUH/SF/DEG.F | AVG. Roof U-value | .050 |
| BTUH/SF/DEG.F | AVG. Wall U-value | .523 |
| BTUH/SF/DEG.F | Heat Loss Factor | .278 |
| BTUH/SF | Normalized Heat Loss | -8.632 |
| KBTUH | Design Heat Loss (K=1000) | -1262.709 |
| KBTUH | Peak Hour Total Heat Loss | -500.168 |
| KBTUH | Peak Hour Total Heat Gain | 1416.122 |
| PERCENT | Window Area/Floor Area | 10.156 |
| PERCENT | South Glazing/Floor Area | 3.774 |
| PERCENT | Non-South Glazing/Floor | 6.382 |
| DEG.F | Balance Point TEMP. No-Sun | 54.158 |
| DEG.F | Balance Point TEMP. In-Sun | 41.408 |

Type in HEATING or COOLING to see split OUTPUT OF WHAT (or any Option)


SOLAR5.2: Passive Solar Design Tool (UERG MOCK-UP DEC 92) UCLA 4/24/93 0:43
MATOAKA BASECASE
ELEMENTARY SCHOOL
VIRGINIA BEACH VA
Scheme 6: SOUTH NINE MOD LOW
Peak
85.98
50.96
0.00
Average
80.54
56.48
0.00
Dec.
Sept.
June
Mar.
6am
Midnight
OUTDOOR AIR TEMP
70806 to 86008
55604 to 70806
40402 to 55604
25200 to 40402
9998 to 25200
INDOOR AIR TEMP
Venting System Only
Type in HEATING or COOLING to see split OUTPUT OF HVAC (or any Option)

SOLAR5.2: Passive Solar Design Tool (UERG MOCK-UP DEC 92) UCLA 4/24/93 0:45

PERFORMANCE SUMMARY
Scheme 6: SOUTH NINE MOD LOW

Project Title: MATOAKA BASECASE
Building Type: ELEMENTARY SCHOOL
Climate Data : VIRGINIA BEACH VA

| | | SCHEME 6 |
|---|---|---|
| SF | Total Floor Area | ********* |
| SF | Total Glazing Area | 14856.000 |
| SF | Total South Glazing Area | 5520.000 |
| SF | Total Roof + Skylight Area | 73140.000 |
| SF | Total Wall + Window Area | 34664.000 |
| BTUH/SF/DEG.F | AVG. Roof U-value | .050 |
| BTUH/SF/DEG.F | AVG. Wall U-value | .523 |
| BTUH/SF/DEG.F | Heat Loss Factor | .278 |
| BTUH/SF | Normalized Heat Loss | -8.632 |
| KBTUH | Design Heat Loss (K=1000) | -1262.709 |
| KBTUH | Peak Hour Total Heat Loss | -463.081 |
| KBTUH | Peak Hour Total Heat Gain | 1440.035 |
| PERCENT | Window Area/Floor Area | 10.156 |
| PERCENT | South Glazing/Floor Area | 3.774 |
| PERCENT | Non-South Glazing/Floor | 6.382 |
| DEG.F | Balance Point TEMP. No-Sun | 54.158 |
| DEG.F | Balance Point TEMP. In-Sun | 41.615 |

Type in HEATING or COOLING to see split OUTPUT OF HVAC (or any Option)

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