Chapter 4:

CLIMATE AND THE ENVIRONMENT

REFERENCES:

Full credit for this chapter to Prof. Leonard Bachman, University of Houston
Brown, G.Z. Sun, Wind and Light.
Heschong, Lisa. Thermal Delight in Architecture.
Moore, Fuller. Environmental Control Systems.
Olgyay, Victor. Design With Climate.
McHarg, Ian. Design With Nature.
Watson, Don and Kenneth Labs. Climatic Building Design.

RATIONALE:

A. PERFORMANCE CRITERIA: Evolution of building types paralleled structural technology up through high rise. Foremost challenges are now environmental.
   1 comfort and productivity
   2. energy and life cycle economics
   3. indoor air quality and ventilation standards
   4. new building types

B. SUSTAINABILITY ISSUES:
   About 20% of the world's population accounts for some 80% of resources and pollution. As population grows and living standards are elevated to consumerism, the natural environment can neither provide sufficient resources nor absorb the resultant waste and pollution.
   1 nonrenewable resource depletion
   2. growth pressures
   3. maintaining artificial systems

C. ROMANTIC ISSUES:
   Architecture embodies both instrumental and symbolic form. The resolution of these perspectives is a driving dialogue in design activity. Environmental issues inform the instrumental qualities. They also inspire ideas of human significance.
   1. context of climate in macro and micro scales
   2. architecture as "our place in nature'
   3. necessity, variety and delight (Heschong)
   4. experiential context and non-visual interpretation of architecture
   5. magic
   6. architecture in the quantum space time dimension
   7. chaos

a. sophistication of natural ordering systems, morphology
b. interrelatedness, the butterfly effect
c. non-Cartesian cosmologies, the uncertainty principle, the observation effect
d. complexity and spontaneity
e. eastern and western cosmologies and science

D. INFORMING DESIGN:

About 15% of the space, volume, and budget of buildings are give over to ME systems. This increases the envelope area required to enclose and structure needed to carry the building. A compounding ripple of bigness, cost, and maintenance ripples through the entire design to accommodate these systems.

1. smaller is better
2. budget priorities
3. productivity
4. artificial dichotomy
   a. classical thinking
   b. non-assimilative thinking
   c. the sanity of a building

E. FORMAL INSPIRATIONS:

Btu's, footcandles, and decibels are not of great use in conceptual and schematic design stages. Normally the precise analytical activities are reserved for design development decisions because the cumbersome calculations make iterative stages impractical. There exist, however, several formal influences of the experiential context.

1. patterns- natural geometry and morphology of sun and wind
   a. daily cycles
   b. seasonal character
   c. site features
   d. generating parti
   e. achieving elegance
2. icons- cultural links between instrumental and symbolic form
3. indigenous/vernacular basis of regional design, ennoblement of architectural precedent
   a. physical and cultural determinism
   b. climatic correlation
   c. vegetation correlation
   d. animal shelter correlation

THE MULTIVARIATE CONDITION:

PEOPLE	BUILDING	SITE	CLIMATE
interior conditions ♦ temperature ♦ radiant temperatures ♦ air motion ♦ humidity metabolism clothing activity perception acclimatization	modes ♦ mechanical cooling ♦ mechanical temperi ♦ passive cooling ♦ equilibrium ♦ passive heating ♦ mechanical heating loads ♦ envelope conduction convection radiation infiltration solar gain ♦ internal people lights equipment ventilation	topography orientation bodies of water surrounding structures vegetation clustering elongation	elements: ♦ sun ♦ cloudiness ♦ wind ♦ temperature ♦ humidity ♦ precipitation seasons diurnal variation variability **character:** ♦ **temperate** ♦ **hot arid** ♦ **hot humid** ♦ **cold** factors: ♦ latitude ♦ longitude ♦ altitude ♦ continentality ♦ coastal
GIVEN OR RESULT	ARCHITECTURE AS MEDIATION	ARCHITECTURE AS MEDIATION	GIVEN OR RESULT

THE THERMAL CONTROLS MATRIX:

Macroclimate:

The patterns of weather in the region of our building set the context for environmental design. The influences of climate are reflected in the regional styles of buildings all around the world. We can look at indigenous and vernacular architecture in the local area for clues on how to respond to climate. (Olgyay, "Design With Climate")

Building climatology, as an architectural pursuit, is concerned with the behavior of sun, wind and rain. We normally measure these variables in relation to our goal of human comfort. It is important to look at several measures of climate including temperature, humidity, rainfall, days of clear, cloudy, or overcast weather, and at wind direction, speed, and variability.

Microclimate:

The actual experience of climate varies according to several moderating site influences. Vegetation and surrounding building affect shading and wind patterns. Geography and orientation influence solar exposure. Bodies of water and site drainage contribute to humidity in the surroundings.

Arranging the site to maximize the attributes of the macroclimate and minimize its liabilities is an essential design task. This activity also must deal with local impacts such as noise and view.

Envelope:

The building skin can be thought of as a system of filters, barriers and switches which are arranged and operated to interpret the macro and micro climate conditions. By selectively admitting light and cool breezes, or by protecting the interior from harsh sun and cold winds; the envelope becomes the interface between indoors and out.

The building skin is the point of departure for passive solar design. When the envelope responds dynamically to seasonally varying demands and conditions by participating in the events of climate, then we can say that the building is in harmony with its environment and its occupants. (See Reynolds, McGuinness and Stein, MECHANICAL AND ELECTRICAL EQUIPMENT FOR BUILDINGS).

Interior:

Comfort is too often described in static terms of temperature, relative humidity, uniform lighting levels and background noise levels. Reliance on engineering standards has deprived architecture of interaction with buildings in ways that enhance the experiential environment. We can only worship the thermostat (See Heschong, THERMAL DELIGHT IN ARCHITECTURE).

By understanding human comfort experiences, architects can provide engaging and compelling environments which fulfill non-visual qualities of design. This is the Natural Order of architecture.

Hvac Equipment:

Heating, Ventilating and Air Conditioning equipment make dense living possible and add a certain freedom of design from physical determinants. But mechanical equipment is fast becoming a major portion of construction and building operational expenses. With the advent of new economies, ecologies and increasingly technical building demands, the careful and

appropriate use of HVAC technologies is a more and more significant architectural determinate. In the case of high tech design, it is seen as an opportunity to express a true aesthetic of modern buildings.
Mechanical systems use energy sources to make comfort and deliver it to occupied spaces. Some systems have an outdoor component which uses the environment as a heat source or as a heat sink to reject energy to. These mechanical plants and delivery systems require floor space and volume distributed throughout the building. They are responsible for structural loads and can create noise problems. As architects, we must understand the workings and implications of these systems.

THERMAL FUNDAMENTALS:

ISSUES
COMFORT: Activity level, clothing, MRT, acclimation.
METABOLISM: convection, radiation, evaporation, conduction.
QUALITY: Necessity, variety, delight, sacredness (after Heschong).
ENERGY: COP, EER, SEER, Passive, Active Systems.
ECOLOGY: Resource, pollution, sustainable, appropriate technology.
ECONOMY: First cost, operating, maintenance, and replacement costs.
INTEGRATION: Noise, visual element, weight, space and volume.

PASSIVE SYSTEMS
HEAT: Capturing, converting, storing and distributing heat.
COOL: Thermal sinks in environment.
COUPLING: Direct, indirect, and isolated systems; control and efficiency.
ELEMENTS: Aperture, absorber, mass, radiator.

ACTIVE SYSTEMS
HEAT: combustion, resistance, heat pump, steam.
COOL: vapour compression (dx), chillers, absorption systems.
DISTRIBUTION: All air, all water, air & water.
ZONING: Single duct, dual duct, multizone, VAV, 2 pipe, 4 pipe....
CONTROL: Zoning, staging, temperature, humidity, enthalpy, economizers.
ELEMENTS: Compressors, fan/coils, cooling towers, chillers, ducts....

ARCHITECTURAL SIGNIFICANCE
REGIONAL CHARACTER: Vernacular, indigenous, appropriateness.
SUBSTANCE: Experiential context, human factors, ecology, non-arbitrary.
FORMALISM: Solar geometry, compactness, open frame/closed shell, surface-to-volume ratio, clustering, massing, orientation, elongation, fenestration, aerodynamics, earth coupling, surface/interior load dominated, shading, pattern making rule-base.

TERMS AND MEASUREMENTS
HEAT: Enthalpy, entropy, quantity (Btu), intensity (^{o}C or ^{o}F), sensible, latent, long wave, short wave radiation, UV, infrared.
TRANSFER MECHANISMS: Conduction, convection, radiation, evaporation.

ENVELOPE LOADS: Conduction, convection, thermal radiation, solar radiation, surface convection, air spaces.
VENTILATION LOADS: Infiltration, exfiltration, ventilation; sensible and latent components.
INTERIOR LOADS: People, lights and equipment; sensible and latent components.
MATERIAL CHARACTERISTICS: Thermal conductance/resistance (k,C,r,R,u), heat capacitance, thermal lag, specific heat (c), volumetric specific heat (cp), absorption, transmittance, emissivity, solar transmittance, visible transmittance.
MATERIAL DESCRIPTIONS: Insulation, radiant barrier, infiltration barrier, thermal mass, clear, tint, reflective, heat absorbing, heat mirror, and low-e glass.
LOAD PROFILES: uA loss coefficient, Modified Loss Coefficient, Surface/Interior Load Dominated, balance point, tons.
CLIMATE: Types, patterns, correlations, elements (sun, wind & rain), change, measurements (^{o}F, ^{o}C, %RH, degree days, sunshine, precipitation, wind), architectural strategies.
SOLAR GEOMETRY: Sun path, azimuth, altitude, profile, incidence angles; shading masks, shading devices, heliodyne, sun peg, physical modeling.
PSYCHROMETRICS: Dry bulb DB, wet bulb wb, %RH, absolute humidity W, dew point DP, enthalpy h, specific volume ft^3/#.
SITE ANALYSIS: Topography, orientation, slope, bodies of water, vegetation, ground cover, albiedo, surrounding structures, aerodynamics.
ASHRAE: American Society of Heating and Refrigeration Engineers (most M.E.'s belong).
NOAA: National Oceanographic and Atmospheric Administration.
NBS: National Bureau of Standards, Building Science Division.
NERL: National Energy and Renewables Lab (formerly Solar Energy Research Institute).
DOE: Department of Energy.
ASHRAE 90.75: A pending national energy code. Many states/cities already have one.

THERMAL COMFORT:

Jargon:
COMFORT: Physiology, metabolism, met rate, clo value, convection, radiation, evaporation, conduction, Mean Radiant Temperature (MRT), dry bulb, wet bulb, relative humidity, psychrometrics, thermal equilibrium, thermal stress, Surface Load Dominated (SLD), Interior Load Dominated (ILD), Indoor air quality, sick building syndrome.

FORM-GIVERS: Vernacular, indigenous, regional styles, open frame, closed shell, passive techniques, mechanical equipment

Rationale:

The first premise of building is shelter. What then transforms a mere building into a work of architecture? Of course architecture is comprised of many concerns and activities: 'commodity, firmness and delight to use the Vitruvian maxim. The debate over what constitutes 'good architecture' is never ending and won't be quibbled with here. But some qualities are identifiable in the body of work we would largely agree is representative.

Consider the distinction between instrumental (functional) and symbolic (meaning) interpretations of buildings, our environment and for that matter the cosmos. This is largely a

western and modern division. Through medieval times, the inability of most people to improve their standard of living did not promote a confidence in possibilities of functional design improvements. The attributes of function and meaning were thus interwoven. In eastern philosophy, the everyday reality of what we see is often regarded as illusionary. True meaning is vested in the nature of things, not in their work-a-day usage.

Pre-industrial cultures used a different view of the world (cosmology) to define their place in it. Only since the Renaissance has our civilization grappled with the notion of separating form from function. We are not only symbol makers, we are symbol builders too.

So long as we perceived that technology had freed us from the bounds of rational determinism, strict functional demands and resource constraint, architecture has been free to explore. But along the way critics have pondered (as critics will) the other side of the question- 'What is the meaning of an architecture of abstractions? How can buildings ever be viewed as objects separate from their functional intent and physical context?'. Well of course they can't. But technology has given us the palette and power to promote other questions, important questions of culture and art which were not possible before.

"... among architects who work directly with traditional sources, the best are turning away from insubstantial, fictitious uses of history toward and architecture that responds more subtly to regional contexts..... At its best regionalism penetrates to the generating principles and symbolic substructures of the past, then transforms these into forms that are right for the changing social order of the present ... The aim is to unravel the layers, to see how indigenous archetypes have been transformed by invading forms, and to in turn see how foreign imports have been adapted... The moment is right for the assertion of an architectural value system that eschews the aridity of off-hand utilitarianism and the bogus 'remedy' of phony historicism."

Mildred F. Schmertz, from 'Towards an Authentic Regionalism', by William J. R. Curtis, in MIMAR 19, Jan-Mar 1986.

"This acute awareness of tradition is a modern phenomenon that reflects a desire for custom and routine in a world characterized by constant change and innovation. Reverence for the past has become so strong that when traditions do not exist, they are frequently invented."

Witold Rybczyynski, HOME, pg 9.

Before the air conditioner and fluorescent light (not to mention elevators), large, compact and high rise buildings were not viable even if they were structurally possible. Before ventilation and incandescent lighting, all rooms of every building were arranged to have light and air from outside. While the last one hundred years of architecture has been driven by stylistic design, a steady transition from structural innovation to environmental practicality has evolved.

With the advent of the environmental movement and the energy crisis surrounding the 1973 oil embargo. A subtle shift of policy and public awareness began. The first Earth Day celebration was held in 1970 for example (The beginning of the American environmental movement is usually traced to Rachel Carson's book, SILENT SPRING). With global warming, acid rain, dwindling resources, and ozone depletion a new mandate has been made. For architects, this is an opportunity to reunite some aspects of instrumental and symbolic form-making into meaningful placemaking activities.

With the new environmental pursuits of modern science has come many new challenges. Laboratories, clean room manufacturing, and extreme environments' are new building types.

The rising cost of energy has created not only new restrictions and energy codes but also new forms and new meaning.

This 'meaning' is not new really, but a reawakening of architecture as our place in nature. Just as indigenous peoples lived in a precarious but profound harmony with their cosmos, so might we. The examples of vernacular buildings and regional style which are so often venerated and emulated by architects today hold many clues to meaning beyond style and formal resolution.

The one thing that architects do better than any other profession is integrate. The basis of complex solutions to program, budget, code, form, expression, building, craft, technology, science and business make us integrators. If the profession is to answer the split between utilitarian structures and formal expression then we must be knowledgeable of both concerns. If we are to surpass the increasingly burdensome constraints of environment and ecology then we must use the essence of the problem as an inspiration, not a constraint to our creative efforts.

"Pre-industrial man, for all his limited resources, often builds more wisely than we do, and in his architecture he establishes principles of design which we ignore at great cost.....

Western science may be able to measure with great accuracy the environmental forces with which architecture deals. But Western technology too often responds with the mass production of a handful of quite clumsy and wasteful stereotypes."

James Marston Fitch, 'Vernacular Paradigms for Post-Industrial Architecture', from VERNACULAR ARCHITECTURE, by Mete Turan.

Latent And Sensible Heat:

Sensible heat is the heat associated with a temperature change. It is measured in Btu's as a quantity and in degrees F or C as an intensity. The dry bulb temperature of a moist air mixture is read on the horizontal x-axis. The vertical lines that project from the x-axis on the full psychrometric chart are lines of constant sensible heat. In other words, all points on any vertical line have the same sensible heat content. The sensible heat of dry air is 0.01 8 Btu/ cu.ft. ^{o}F or about 0 .22 Btu/# ^{o}F.

Latent heat is the heat associated with a change in phase. For our purposes, we are concerned with the amount of water vapour in the moist air mixture and the amount of energy required to remove the moisture or to change its temperature. Latent heat is measured in Btu and it takes 1061 Btu to change a pound of water into a pound of water vapor. On the psychrometric chart, we look first at the latent heat content as the actual amount of water vapour in the mixture. This 'absolute' humidity, W is measured in #'s of water per # of dry air or in grains of water per pound of dry air. There are 7600 grains in a pound so the latent heat of vapour is 0.14 Btu/grain.

It is interesting to note the relative differences in magnitude of latent and sensible heat. For example, it only requires one Btu to change the temperature (sensible heat) of a pound of water one degree Fahrenheit but about 8000 Btu are required to make a pound of water into a pound of vapour of the same temperature. Also note that there is an assumption of equal pressure in the comparison of any two moist air mixtures. The standard psychrometric chart is made for conditions at sea level and assumes a standard atmospheric pressure of 29.921 in. Hg.

Enthalpy:

The total amount of sensible and latent heat in a moist air mixture is referred to as enthalpy, h. Enthalpy is measured as Btu/#. Any mixture along the same wet bulb line will have

the same enthalpy but different ratios of sensible and latent heat. For that reason, moving from one point to another along the same line of constant enthalpy (i.e. wet bulb line) is referred to as a special case called 'adiabatic'. This process does not add or subtract from the total heat in the mixture, it only changes the ration of sensible and latent. Evaporative cooling is an example of an adiabatic process. By adding moisture to an air mixture we can drive its sensible heat component and its dry-bulb temperature closer to the wet-bulb temperature. Thus evaporative cooling makes the air both cooler and more humid.

Relative Humidity:

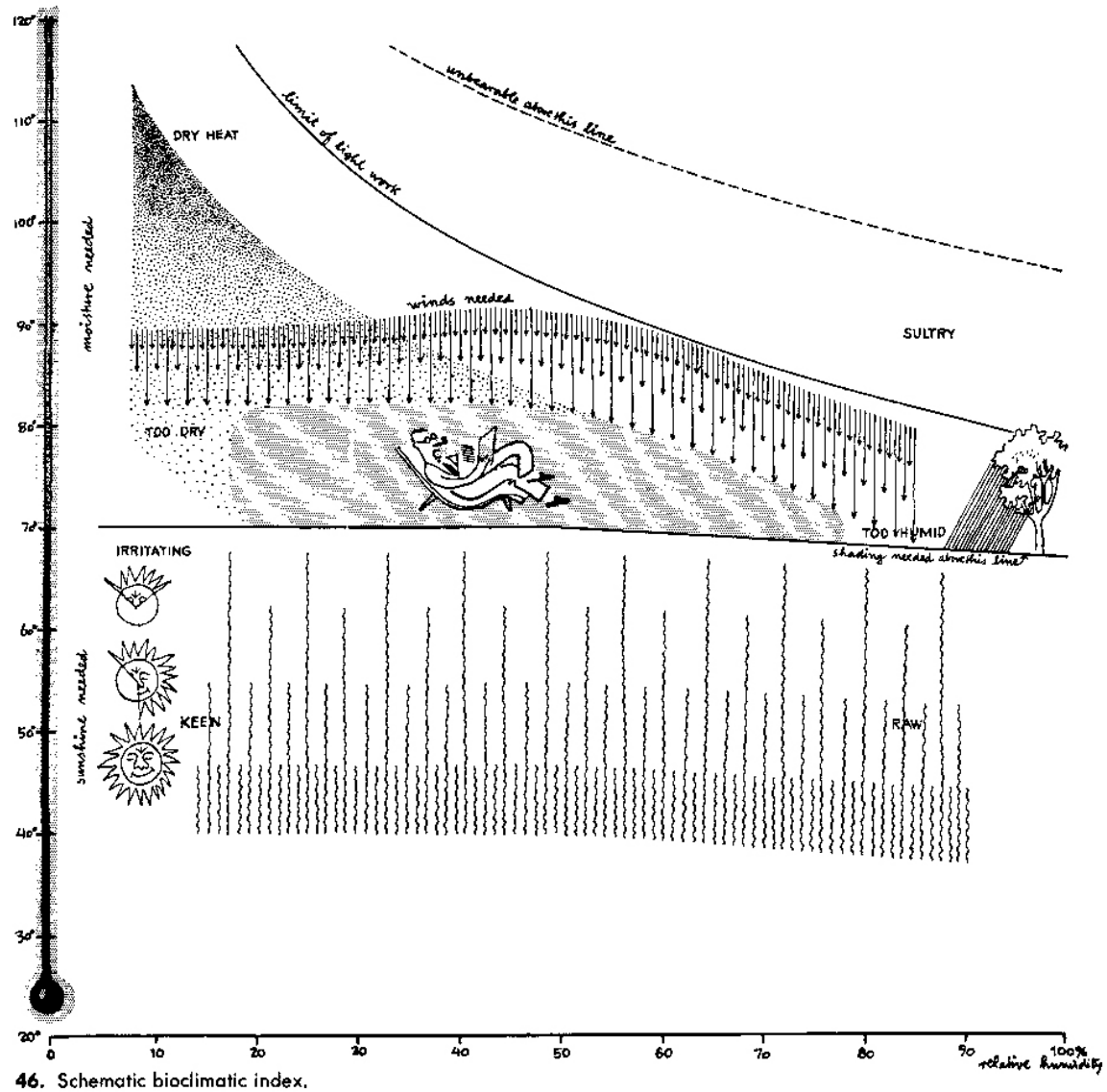
The humidity of a moist air mixture relative to its level of saturation is called the relative humidity. Since warmer air, can hold more moisture, it tends to be less saturated than a cooler mixture with the same amount of absolute moisture content. Similarly, warming up a mixture with a given quantity of water content will decrease its saturation. Cooling a mixture drives it to its dew point. Note that the dew point temperature of a mixture is where condensation will occur and is reached by moving horizontally across the chart to saturation (100%RH). This is different than moving to the wet bulb temperature diagonally (adiabatically). Wet bulb remember is approached by trading sensible heat for latent and indicates the amount of sensible cooling which can be achieved by saturating the air. Dew point is achieved by sensible cooling alone. An air conditioner removes moisture from room air by cooling it below dew point for that mixture before re-introducing it to occupied spaces.

Relative humidity is a measure of human comfort because it is closely linked to our ability to lose heat to the environment by perspiration from our skin and transpiration through our lungs.

Moving Around The Chart:

From any one point on the psychrometric chart, we can identify conditions of sensible and latent heat content. Colder mixtures are to the left and warmer to the right just as dryer mixtures are at the bottom and wetter ones at the top. Hot wet mixtures are thus at the upper right and so on.

It is most important to remember that moving in a horizontal direction indicates a change in sensible heat temperature. Moving in a vertical direction corresponds to a change in latent heat and moisture content. Moving either up or left indicates an increase in relative humidity. Moving diagonally along a wet bulb line indicates an adiabatic process.



46. Schematic bioclimatic index.

Bioclimatic chart interpretation from "Design with Climate" 1963 by Victor Olgyay

Heating And Cooling Processes:

Changing the comfort condition of a space normally means adjusting the sensible and latent heat content of the air. It is important to recognize which processes will have the desired effect on the interior environment. In thermal design we are concerned with equilibrium. All of the thermal loads on a building disrupt thermal balance and push comfort conditions away from acceptable levels. We use notions of psychrometric processes to restore balance.

Reading The Psychrometric Chart:

Once any two factors of a moist air mixture are known (dry bulb, wet bulb, relative humidity, absolute humidity, dew point, and enthalpy) the others can be identified. Use the two known measures to plot a point on the chart and read the other quantities directly. We are often concerned with differences between outdoor air and indoor air conditions. Since we know that

some of the outdoor air will be introduced by leaks (infiltration and exfiltration) and that some will be required for ventilation (up to 20 cubic feet per minute for each occupant) we know that the air must be treated before it is introduced to the occupants. If on the other hand, the air outside is close to the conditions we need inside- we can economize with 100% outdoor air.

PATTERNS

Environmental criteria are sometimes viewed as constraints to design creativity. And it is true that reducing anything to its functional requirements is more engineering than architecture. But it is also true that design is the act of solving a challenge in a meaningful way to the benefit of its owner, occupants and those of us who experience buildings in a myriad of ways. Part of that challenge in architecture is finding a meaningful way to integrate functional requirements and programmatic restraints into the very essence of formal solutions.

So the maxim 'form follows function' is a simplification which can lead to 'reductionism'. Perhaps we should say that form and function dance together. In most cases form would lead but it is still a dance, not a forced march.

For the last fifty years or so, architecture has been driven by formal concerns. In the days of cheap energy, easy financing, and abundant environmental resources; architects turned from the constraints of determinism to pursue the expression of their material culture. In fact, this movement began with Rene Descartes in the 17th century. The Cartesian view of the universe allowed western man to conceptually separate his mental spirit from his physical body. The universe has been essentially seen as a machine since then. Only very recently has mechanistic science concluded that the cosmos is more like eastern mystics describe it than Renaissance man did.

The return to natural ordering principles began in the mid 1960's with Rachel Carson's book *SILENT SPRING*. For architecture, Ian McHarg's *DESIGN WITH NATURE* first appeared in 1968. Victor Olgyay published *DESIGN WITH CLIMATE* in 1963. Earth Day celebrations started in 1970. Coinciding with the changes in society and technology the greening of architecture is finally returning to the forefront (See ARCHITECTURE, July 1991 or ARCHITECTURAL REVIEW, August 1991).

Invention of form involves recognizing geometries that fit the designer's idea of a built solution. As these geometries are adapted they become a rule base, pattern, or formal parti for organizing and resolving the form. Architects often find these geometries inherent in the program, the site boundaries, the view lines, existing axes or other such clues. Natural ordering principles differ only in what is recognized as clues to formal thinking. Patterns of environment yield many astounding and significant geometries of form. In expressing this pattern we can employ several processes: climate geometry, experiential context, iconography of symbol/image, and regional character.

"Form follows nothing- it is integral with all processes. Then form is indivisibly meaningful form, but it can reveal ill fit, misfit, unfit, fit and most fitting. There seems to be no good reason to change these criteria for human adaptations. Is the environment fit for man? Is the adaptation that is accomplished fit for the environment? Is the fit expressed in form?"

Ian McHarg, DESIGN WITH NATURE, pg 173.

Compare these two quotes from Fritjof Capra, THE TAO OF PHYSICS (1975, pg 54):

"The great extension of our experience in recent years has brought to light the simple insufficiency of our simple mechanical conceptions and, as a consequence, has shaken the foundation on which the customary interpretation of observation was based."

Niels Bohr, ATOMIC PHYSICS AND HUMAN KNOWLEDGE, 1958, pg 20.

"All things in fact begin to change their nature and appearance; one's whole experience of the world is radically different.. There is a new vast and deep way of experiencing, seeing, knowing, contacting things."

Sri Aurobindo, ON YOGA II, TOME ONE, 1958, pg.327.

Climate Geometry:

With knowledge of climatic events, we recognize lines of action or vectors that are significant to how a place is ordered and organized. The rhythmic motion of the sun, changing with the hour and the season, suggests notions of shape, orientation, elongation, fenestration, filtering and shading. The different paths of hot, cool and cold winds renders clues to the aerodynamic nature of the building and the site. This climatic geometry is but one of many layers of formal clues to which the building must respond. Just as importantly, it is a geometry that can inspire the invention of form in a way that produces results of human and artistic significance.

Experiential Context:

The non-visual nature of the thermal and acoustic environments sometimes relegates them to neglect. As an opportunity to influence placemaking in the broadest sense the tactile, sensual context should be elevated to par with the visual organization. Unless they are only designed for curb appeal or to be seen from a speeding car we experience places holistically. While much of the information we gather about the world does come through our eyes, even that data is filtered through other sensations- both physiological and psychological. How a room feels, how it sounds, what visual clues it offers about sensual comfort all determine how we finally evaluate it.

Iconography Of Symbol/Image:

Some of the visual clues that connect us to the experiential context come to us in the form of icons. These are objects whose imagery is so significant as to promote its meaning over its image. As a place, the cafe is a symbol/image of sound, smell and taste as well as a vision of tables, chairs and people. In the thermal realm, we often associate water with a sensation of cool and the hearth with warmth. Rugs, blankets, shutters, colors and many other such elements array to form our thermal interpretation of a space. This iconography has been largely negated by over-dependence on mechanical air conditioning. Our icon now is the thermostat.

Regional Character:

The air conditioned mentality bred a bastardization of style. If light weight wood frame construction was used in a hot arid climate, it could still be air conditioned. A Mediterranean villa in New York? No problem. Just as bad, air conditioning allowed for a standardization of style that bred uniformity and subverted style based on character of a region. By understanding the indigenous and vernacular solutions native to any area, we can find clues and inspiration that yield appropriate, elegant and natural solutions.

Significance:

Perhaps it is a question of the real and the artificial or the natural and the contrived. Appropriate solutions are not soul-less reductions to physical determinisms. Natural ordering is in fact an inspirational source of design. It not only offers clues as information, it also creates a significance and a relevance. An elegant solution is both refined and restrained- achieving distinction with grace and meaning through value and human experience.

578 ELEGANCE.-N. elegance, distinction, clarity, purity, grace, felicity, ease; gracefulness, euphony; taste, restraint, propriety, correctness.
Adj. elegant, polished, correct, artistic; chaste, pure; graceful, easy, fluent, unaffected, natural, mellifluous, euphonious; restrained.
felicitous, happy, neat; well expressed.

ROGET'S POCKET THESAURUS