DSPACE

https://dspace.org/

Passive solar systems for domestic architecture in Southern Africa

Almeida, Dulce Moreno Marques de

2015-02-20
http://hdl.handle.net/10539/17038

Downloaded from a DSpace repository. https://dspace.org/


REFVSIO·OCEANI·AB·OCCIDENTE·IN·SEPTENTRIONEM·
REFVSIO·OCEANI·AB·ORIENTE·IN·SEPTENTRIONEM·
REFVSIO·OCEANI·AB·ORIENTE·IN·AVSTRVM·
REFVSIO·OCEANI·AB·OCCIDENTE·IN·AVSTRVM·
FRIGIDA
EVROPA
rhiphei mõtes
ASIA
hierusa
babil
INDIA
ATLAS
APHRICA
PERVSTA
aethiopia
mare rubr
ALVEVS·OCEANI
PERVSTA·
TẼPERATA·ANTIPODVM.
NOBIS. INCOGNITA.
FRIGIDA.

The idea that building settlements and cities are forms of shelter, creates a central concept even in the earliest classical writings on Architecture, Building and Medicine.

Vitruvius, drawing on earlier work, discusses the concept together with its necessary counterpart - the elements from which shelter is required - the Climate.

In the III century A.D., Vitruvius presented his ideas on the layout of towns and of individual buildings according to various climatic influences. He has since been described as the forefather of modern town planning. He stated:

"...he (the Architect) must know the art of medicine in its relation to the regions of the earth (which the Greeks call climata) and to the characters of the atmosphere, of localities (wholesome or pestilential), of water supply. For apart from these considerations, no dwelling can be regarded as healthy".

and he noted:

"1. First the choice of the most healthy site. Now this will be high and free from clouds and hoar frost, with an aspect neither hot nor cold but temperate. Besides, in this way a marshy neighborhood shall be avoided. For when the morning breezes come with the rising sun to a town, and clouds rising from these shall be conjoined, and, with their blast, shall sprinkle on the bodies of the inhabitants the poisoned breaths of marsh animals, they will make the site pestilential. Also, if the walls are along the coast and shall look to the south or west they will not be wholesome, because through the summer the southern sky is warmed by the rising sun and burns at midday. Also, that which looks to the western sun is warm at sunrise, hot at noon, burns in the evening."

"2. Therefore by the changes of heat and cold, bodies which are in these places will be infected. We may even perceive this from those bodies which are not animal. For in wine stores no one takes light from the south or west, but from the north, because that quarter at no time admits changes, but is continually fixed and unchangeable. So also those granaries which look towards the sun's course quickly change their goodness; and fish and fruit which are not placed in that quarter which is turned away from the sun's course do not keep long."

"3. For always, when heat cooks the strength out of the atmosphere and with warm vapours removes by suction the natural virtues, it dissolves and renders

them weak, as they become softened by warmth. Moreover, we see the same thing in iron, which is hard by nature and yet when it is heated through in furnaces, by the vapour of fire becomes so soft that it is easily fashioned into every kind of shape; and when, being soft and red-hot it is chilled and steeped in cold water, it hardens again and is restored to its previous character."[1/2]

"4. We may also consider that this is so from the fact that in summer, not only in pestilential, but in salubrious districts, all bodies become weak by the heat: and also, through the winter, even the regions which are most pestilential, are rendered salubrious because they are rendered solid by freezing. Not less also the bodies which are transferred from cold to warm regions cannot endure but are dissolved; while those which are transferred from warm places under the northern regions not only do not suffer in health by the change of place but even are strengthened."

"5. Wherefore in laying out walls we must beware of those regions which by their heat can diffuse vapours over human bodies. For according as from the elements (which the Greeks call stoccheia) all bodies are composed, that is from heat and moisture and earth and air, just so by these mixtures, owing to natural temperament, the qualities of all animals are figured in the world according to their kind."

"6. Therefore in whatsoever bodies, one of their principles, heat, is predominant, it then kills them and by its fervency, dissolves the rest. Now a hot sky from certain quarters produces these defects; since it settles into the open veins more than the body permits by its natural temperament or admixture. Again, if moisture had filled the bodies and altered their dimensions, the other elements, as though decomposed by liquid, are diluted and the virtues dependent on this proportion are dissolved. So also from the chilling of moisture of winds and breezes, vices are infused into bodies. Not less the natural proportion of air and also of the earthy element by increase or diminution weakens the other elements; the earth by repletion of food, the aerial, by the heavy climate."

"7. But if anyone wishes carefully to apprehend these things by perception, let him regard and attend to the natures of birds and fishes and land animals, and we will so consider differences of temperament or admixture. For the race of birds has one temperament, fishes another, far otherwise the nature of land animals. Birds have less of the earthy, air. Therefore, being compounded of the

lighter principles, they rise more easily against the onrush of the air. But fishes with their water nature (because they are tempered by heat and are compounded of much air and earth, but have remarkably little moisture), the less they have of the principles of moisture in their frame, the more easily they persist in moisture; and so when they are brought to land they lose their life along with the water. Terrestrial animals, also because they have a moderate degree of the elements of air and heat, and have less of the earthy and more moisture, cannot keep alive long in water."

"8. Therefore if these matters are accepted as we have set forth, and if we apprehend by perception that the bodies of animals are compounded of elements, and if we judge that they suffer and are dissolved by excess or defect of them, we do not doubt that we must diligently seek to choose the most temperate regions of climate, since we have to seek healthiness in layout out the walls of cities."[1]

The foregoing treatise is distinctive because it exemplifies the fact that the climate of a site influences not only the layout of the buildings but the health of the inhabitants.

The genius of Vitruvius is again expressed in other passages: "When the walls are set round the city ... these will be rightly laid out if the winds are carefully shut out from the alleys. For if the winds are cold they are unpleasant; if hot, they infect; if moist they are injurious. And: "For when the quarters of the city are planned to meet the winds full, the rush of air and the frequent breezes from the open space of the sky will move with mightier power, confined as they are in the jaws of the alleys. Wherefore the directions of the streets are to avoid the quarters of the winds so that when the winds come up against the corners of the blocks of buildings they may be broken, driven back and dissipated." Vitruvius also furnishes two plans to illustrate the principles he proposes. One is "so mapped out that it may appear whence the certain breezes of the winds arise; the second, how by layings out of quarters and streets turned away from their violence, dangerous currents may be avoided." In Book V, Vitruvious comments: "the shipyards are to be built with a northern aspect, as a rule. For southern aspects because of their warmth generate dry rot, wood worms and ship worms with other noxious creatures, and feed and maintain them."[1/2]

But the full scope of Vitruvius' thinking is probably expressed in the following

quotations: "For in one part of the earth is oppressed by the sun in its course; in another part, the earth is far removed from it; in another, it is affected by it at a moderate distance. Therefore, since, in the sun's course through the inclination of the zodiac, the relation of the heavens to the earth is arranged by nature with varying effects, it appears that in like manner the arrangement of buildings should be guided by the kind of locality and the changes of climate. Towards the north, buildings, I think, should be vaulted, thoroughly shut in rather than exposed, and with an aspect to the warmer quarter. On the other hand, where the sun is violent in southern regions because they are oppressed by the heat, buildings should be open to the air with a northern, or north-eastern aspect." Thus we may remedy by art the harm that comes by chance. In other regions also, buildings are to be similarly adjusted to suit the relation of climate to latitude. In relation to the orientation of the various rooms depending on their proper aspects he said that "The baths and winter diningrooms should look towards the winter setting sun, because there is need of the evening light. Besides, when the setting sun faces us with its splendour, it reflects the heat and renders this aspect warmer in the evening. Private rooms and libraries should look to the east, for their purpose demands the morning light. Further, the books in libraries will not decay. For in apartments which look to the south and west, books are damaged by the bookworm and by damp, which are caused by the moist winds on their approach, and they make the papyrus rolls mouldy by diffusing moist air. The spring and autumn diningrooms should look to the east. For exposed as they are to the light, the full power of the sun moving to the west renders them temperate at the time when the need to use them is customary. The summer diningrooms should have a northern aspect. For while the other aspects, at the solstice, are rendered oppressive by the heat, the northern aspect, because it is turned away from the sun's course, is always cool, and is healthy and pleasant in use. Not less should the picture galleries, the weaving rooms of the embroiderers, the studios of painters, have a north aspect, so that, in the steady light, the colours in their work may remain of unimpaired quality."[1/2]

There are yet other references to climate in Vitruvius' thesis on architecture, as in Book VI, chapter vi, where there are details on how to orient various units in the farmyard and the farmhouse. We have seen, however, from what has already been quoted, Vitruvius possibly may so have

the distinction of being the first "architectural climatologist."[2]

References

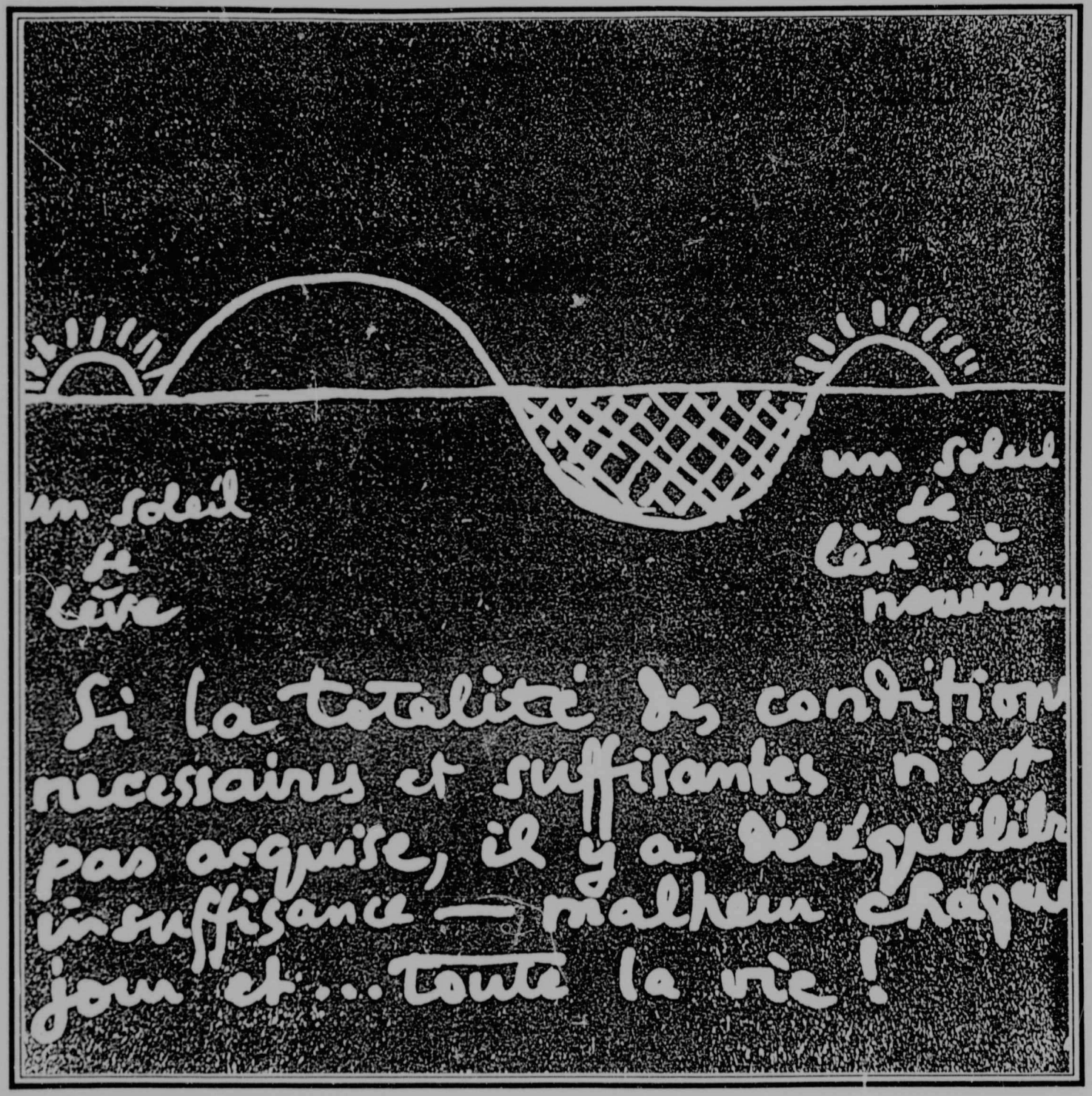
1. Vitruvius
   The Ten Books on Architecture
   Translated by Morris Hicky Morgan, PH.D., LL.D.
   Dover Publications N.Y. 1960

2. Climate and Architecture
   Progressive Architecture Book
   by Jeffrey Ellis Aronin
   Reinhold Publishing Corporation N.Y. U.S.A. 1953

From

Vitruvius

To date


un soleil se lève
un soleil se lève à nouveau
Si la totalité des conditions nécessaires et suffisantes n'est pas acquise, il y a déséquilibre — insuffisance — malheur chaque jour et... toute la vie !

Vitruvius may have been read and the practical aspects of his work used during the Middle Ages.

But it is in the 15th century that the series of great theories, many of them commentaries on, or critiques of, Vitruvius starts with the publication of Aberti"s "Ten Books on Architecture" in 1485.

His picture of the beginning of architecture is simpler and more general than Vitruvius'. But his work, like Vitruvius', devotes substantial parts to the selection of the site, microclimate, suitable materials for keeping space warm or cold and protection against sun and wind.

He gives one of the earliest descriptions of advection and post hollows.

Alberti's example was followed by others. Palladio refers to Vitruvius' description of the original hut and elaborates on the change from flat to pitched roofs.

He too advises against valley sites, on account of humidity, wind and the reflection of the sun's rays creating excessive heat.[1/2]

He wrote:

"It is not advisable for any one to build in valleys which are enclosed by mountains;... when you are determined to build upon an eminence, choose such a situation as faces the temperate region of the air, and is neither always overshadowed by higher hills, nor scorched up, as it were, with two suns, by the reflection of the real one from some adjacent rock: For in either of these cases, it becomes an incommodious habitation.[2]

However, the Renaissance architects (17th and 18th century) did not realize to the full the implications of their climatic differentiation theories any more than the Roman architects had before them.

This is not to say the buildings were environmentally or climatically unsound far from it.

Generally of massive construction, with limited window areas, they achieved a technology which had the universal merit of thermal mass, limited heat loss and gain through windows and reasonable thermal resistance of walls and roofs.

This served well in both warm and cold climates, against diurnal swings - and at a time when internal thermal standards and expectations were, by all acount, fairly low.[3]

Nevertheless, it is surprising to find

that a Palladian villa in Lombardy and in London uses the same plan form, window pattern and volumetric relationships.

This lack of differentiation, is in striking contrast to the variety found in vernacular building even within a limited area such as Provence, Tuscany or the Black Sea coast.

Rykwert shows that the preocupation, obsession perhaps, with the primitive hut comes through the 19th and the first half of the 20th centuries.[3/4]

Loos, the futurist Sant'Elia, Mendelsohn, Neutra, Frank Lloyd Wright, Corbusier and Gropius each in his way returned to the purity and harmony of this natural source.

But, the descriptions are now more in terms of landscape, unselfconscious forms and honest use of materials than of climatic factors.

It must be emphasized that climatic principles, (as they were understood), deeply influenced the thought and work of these architects.

To refer merely to the last three in the list: Wright used solar geometry in a number of houses; notable is the Sturges house, Los Angeles, where the varying projection of the eaves on each elevation was related to solar angles Fig.24.[3]

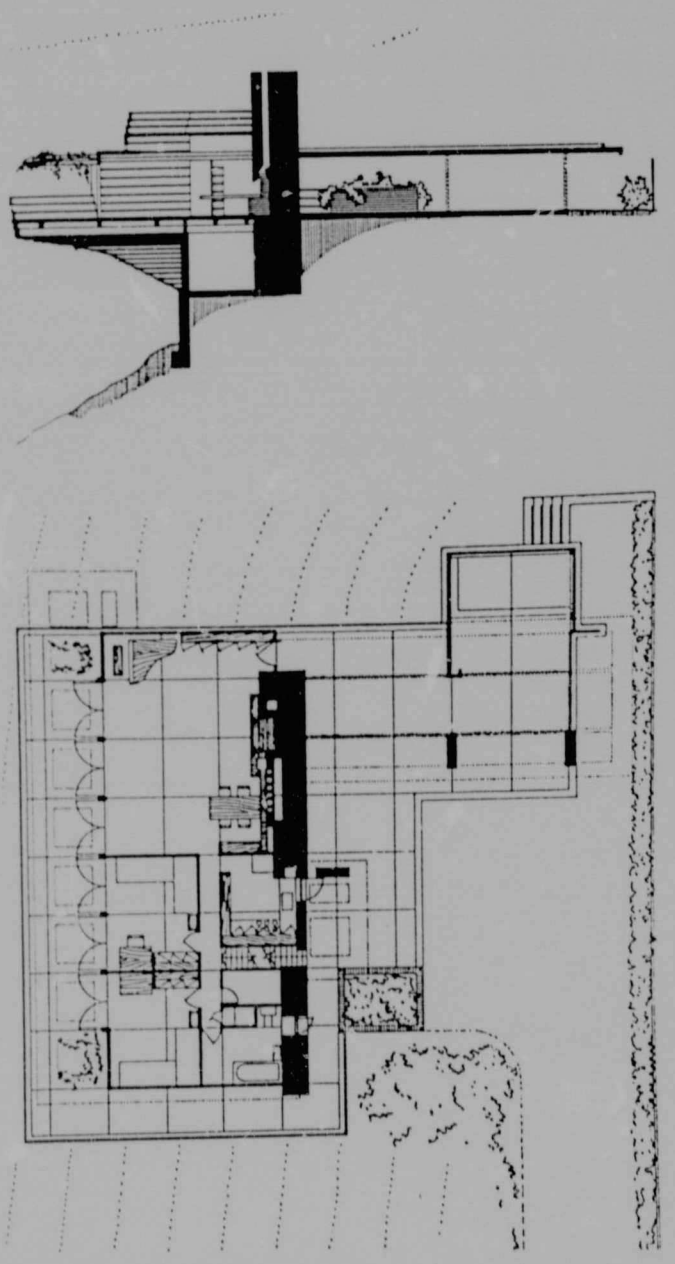


Fig.24.

Gropius put climate as foremost in basic design conception:"... true regional character cannot be found through sentimental or imitative approach by incorporating either old emblems or the newest local fashions, which disappear as they appear.

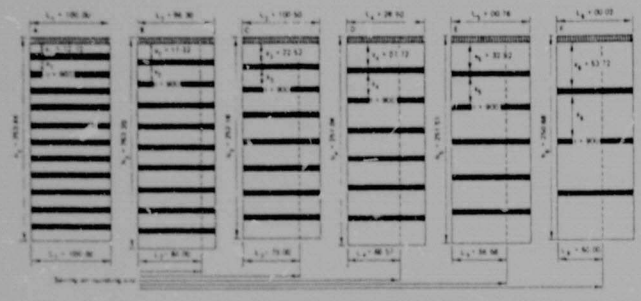


Fig.25 a) If the site area and the illumination angle remain the same, the number of rooms increases with the number of storeys

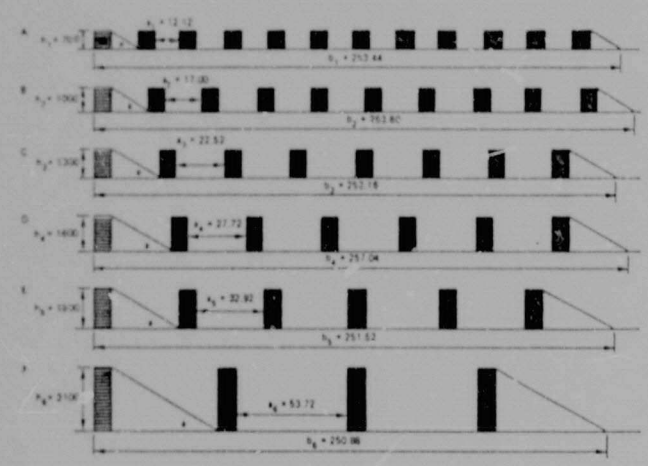


Fig.25 b) If the illumination angle and the number of rooms remain the same,the site area diminishes as the number of storeys increases

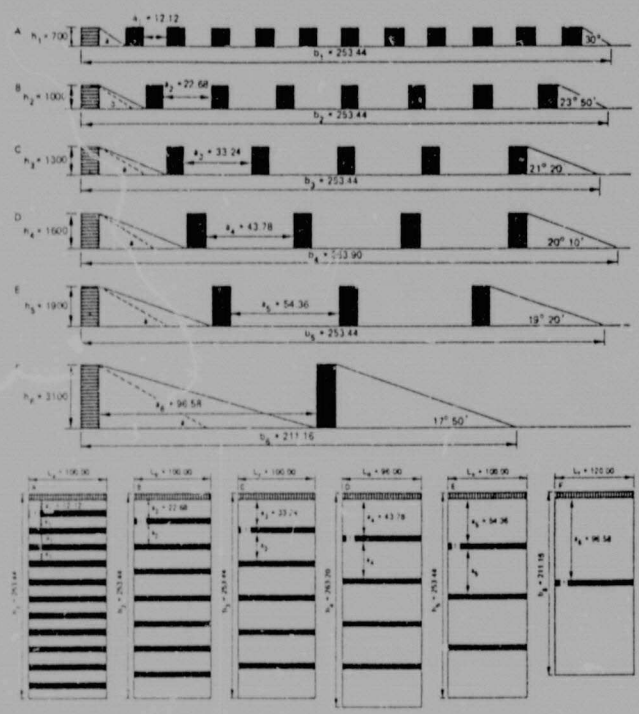


Fig.25 c) If the site area and the number of rooms remains the same, the illumination angle diminishes and the sun exposure improves with the number of storeys

But if you take ... the basic difference imposed on architectural design by the climatic conditions ... diversity of expression can result ... if the architect will use the utterly contrasting indoor-outdoor relations ... as focus for design conception."[3/5]

Much of his housing and planning design was based on angles suitable for sun penetration Fig.25 a) b) c).

Corbusier, from the 1920's onwards, was deeply concerned in his design research and writing with the use of the sun and wind as formative influences in city planning.

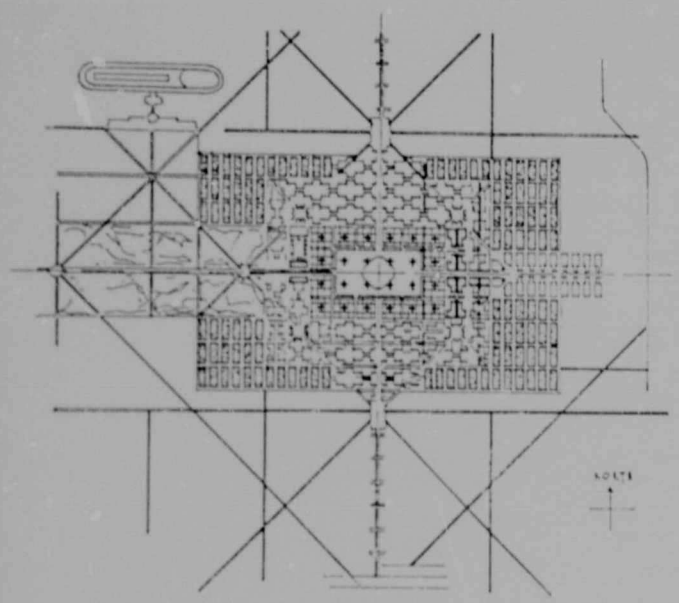


Fig.26

But at this time the idea of climatic influence on building design was still unformed. In 1922 his cruciform tower block of "une ville contemporaire" shows no attempt at elevational differentiation or solar control Fig.26. In 1929 he describes the future office block:

'A sheet of glass and three partition walls make an ideal office: this type of construction holds good when a thousand have to be provided.

So from top to bottom the facades of the new city's office buildings form unbroken expanses of glass... These translucent prisms that seem to float in the air without anchorage to the ground flashing in summer sunshine, softly gleaming under grey Winter skies, magically glittering at nightfall - one huge block.' 3/6

Although he was vaguely becoming aware that this really could not work, the abstract picture became concrete in the hands of hundreds of hack designers from the late 1940's on.

So in all cities of the world there are now acres of just such climatically uncontrollable catastrophes - curtain wall facades.

Corbusier himself saw that in summer "... l'entrée catastrophique du soleil" needed to be combatted. In 1928 he is already experimenting with sun shading in the house at Carthage, Fig.27.

By 1933 his Algiers housing has more complete shading strategy Fig.28 a) b). And by 1936 he suggests the "brise-soleil" to Oscar Niemeyer and his associates for the National Education and Public Health Building in Rio de Janeiro.

This, like so much of his work, became a fashion which for a quarter of a century

was plastered on buildings in a variety of climates, irrespective of orientation, latitude or shading principles.



Fig.27

Corbusier's own solar studies always remained simple often consisting of no more than a few sketches or the note of solar altitude in mid- winter or mid--summer on a particular orientation at noon or the notion of the "axe héliothermique" explored in his plans for Nemours.

He had the CIAM Athens Congress of 1933 adopt his principle that "the material of town planning are: the sun, the space, the vegetation, steel on concrete in that precise order and hierarchy."[3]

One of the most extraordinary aspects of early 20th century architectural thought and practice is the unawareness of the effects of scale and size.

Some experiences of tall buildings had already been obtained in the late 19th century in North American cities, but they were generally in main streets and of limited height.

The new towers and slabs were designed as simple proportional enlargements of traditional smaller structures.

In terms of solar geometry this worked but only within the limits that shading angles remained unaltered.

Vast areas of open ground between the blocks were more or less permanently deprived of sunlight, and substantial parts of skylight, too, with consequent loss of energy for photosynthesis in grass and plants.



Fig.28 a)

Moreover, the white concrete building

surfaces - later to be replaced by mirrors of curtain walling - reflected solar energy so that even north-facing facades and windows in the northern hemisphere were now receiving substantial solar heat gains.

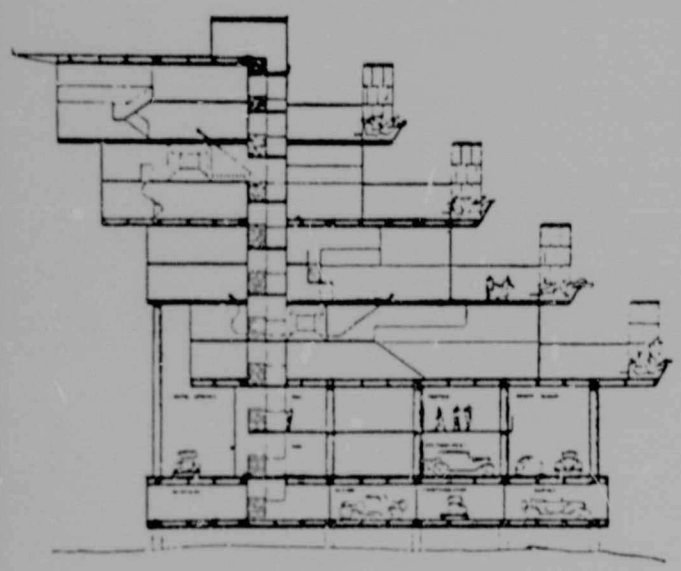


Fig.28 b)

Even Alberti, who had conceived no buildings of this scale was nevertheless aware of this "double sun" effect, from south-facing valley slopes.[3]

The tall buildings also experienced a new wind climate; higher velocities, turbulence and rain flowing up a building facade under the pressure of wind. In turn they altered the climate around their base.

The remarkable aspect of the 18th and 19th Century Beaux Arts writings , and of the theories and practices of the "modern masters" is the over-simplified view of climate.

The most obviously and easily handled was solar geometry - it involved graphics, shadows would be projected and drawn on plan, section and elevation, or better still, on racy perspective sketches and spatial rules deduced from sun paths.

But it was mainly pictorially handled and there was little of any greater analytic depth.

This was all the more remarkable as the growth of scientific climatology and meteorological instrumentation from the mid-18th Century made available theoretical and empirical data of immensely greater power than the Renaissance writers could draw upon.

Soon new orientations in Architecture Theory and History arose, not only from architects but also from historical studies and discoveries of archaeology and anthropology and finally they became reinforced by economic, political and popular forces.[3]

These reached a climatic expression

after the conflict of 1973, with the consequent reappraisal throughout the world, of the availability and uses of the globe's fossil fuel reserves.

It may turn out that this war and its particular consequences will be seen by future historians of our environment as having created changes as significant as those brought by the industrial revolution and the urbanization of rural populations.[3]

Two Americans who have conducted many investigations concerning the relation of climate to architecture are twin brothers Victor and Aladan Olgyay.

Their mode of approach to a particular problem is suggested by their sketch Fig.29. "A" shows the usual observation of radiant heat impact - on main directions only - "B" proposes that more elaborate charts are necessary; "C" depicts the winter and summer sun positions with respect to the overheated period. "E" The "Helio axis" and the "Thermo axis" wich complicate orientation problems. 1/7

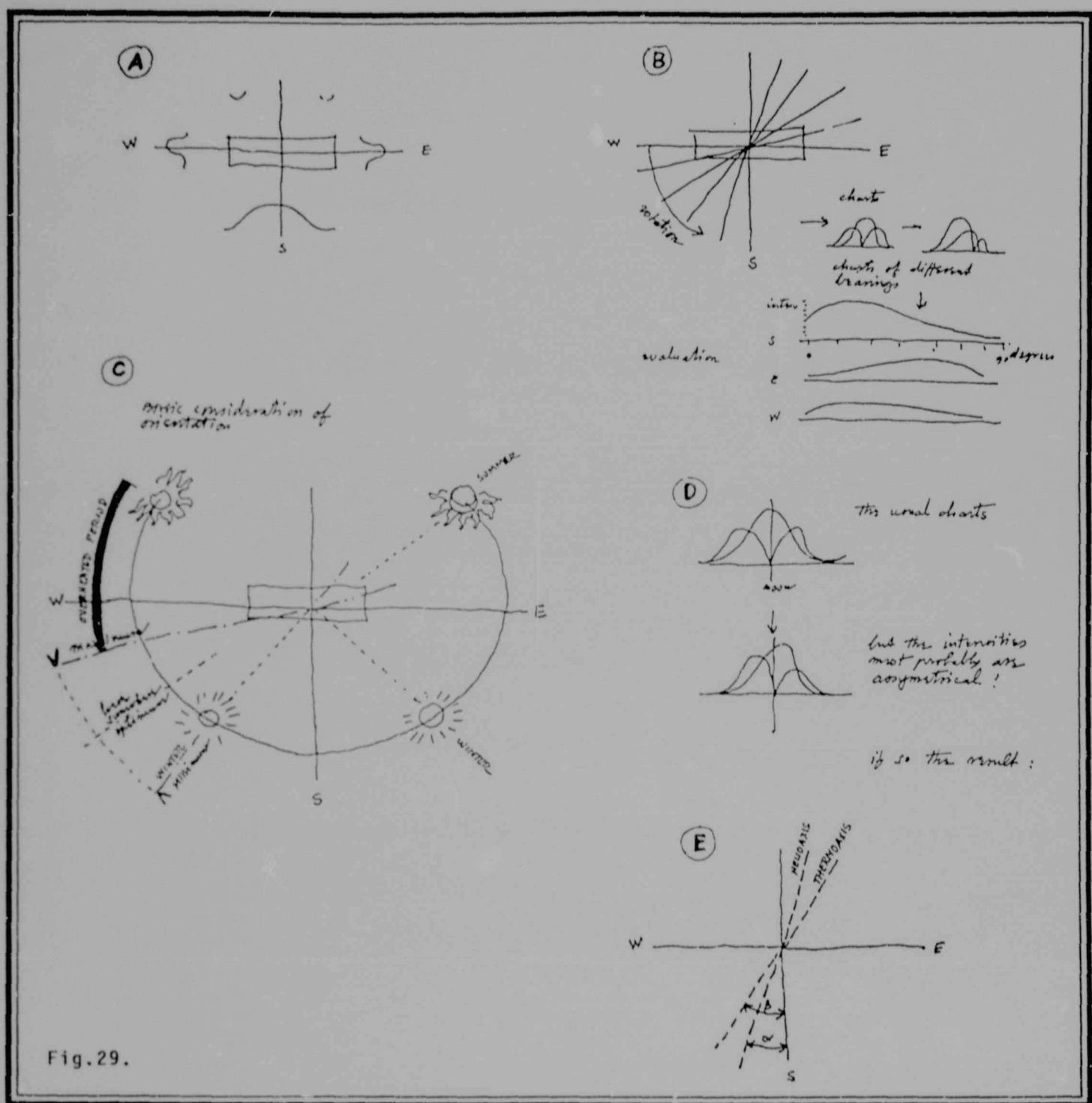

A
W
E
S
B
W
E
S
rotation
charts
charts of different bearings
evaluation
inter
S
E
W
degrees
C
Basic consideration of orientation
SUMMER
W
E
S
WINTER
D
the usual charts
but the intensities most probably are asymmetrical !
if so the result :
E
NEUDAXIS
THERMOAXIS
W
E
S

Fig.29.

References

1. Climate and Architecture
   Progressive Architecture Book
   by Jeffrey Ellis Aronis

2. The Four Books of Architecture
   by Andrea Palladium
   Translated by I. Ware
   Dover Publications Inc. N.Y. 1965

3. Building Climate and Energy
   by T.A.Markus and E.N.Morris 1980

4. On Adam's House in Paradise
   The Idea of Primitive Hut in
   Architectural History
   by J. Rykwert
   Museum of Modern Art, N.Y. 1972

5. A.I.A. Journal Feb. 1977

6. Oeuvre Complète de 1910-1929 and
   Oeuvre Complète de 1938-1946
   by Le Corbusier
   Boesiger and Stonorov, Zürich 1964

7. Design with Climate
   by V.Olgyay
   Princeton University Press 1973

A Matter of interest

"SunDials"



That sunlight follows cycles must have been known since the dawn of mankind.

Much of man's basic work is governed by the periodic rise and fall of the sun, by the sequence of day and night, and by the cycle of the seasons.

One day men noticed that during the day time there was a shadow created by the trees ... and what was more ... this shadow would move and change during the day.

From there on, they started correlating their activities according to the shadow configuration and position.

However, it was only at Babylon, about 6000 years ago that the space covered by the shadow during the day, was divided into equal parts, and the first sundial created.

Sundials left by our ancestors are innumerable.

There are a great variety and they can be related to Mathematics, History, Art; their study would take dozens of chapters of description.

The apparent daily and regular movement of the sun around the Earth (as our senses furnish,) was noticed in all eras and used to measure time, Fig.30.



Fig.30

One important remark must be made from

Author De Almeida D M M
Name of thesis Passive solar systems for domestic architecture in Southern Africa 1988

PUBLISHER:
University of the Witwatersrand, Johannesburg
©2013

LEGAL NOTICES:

Copyright Notice: All materials on the University of the Witwatersrand, Johannesburg Library website are protected by South African copyright law and may not be distributed, transmitted, displayed, or otherwise published in any format, without the prior written permission of the copyright owner.

Disclaimer and Terms of Use: Provided that you maintain all copyright and other notices contained therein, you may download material (one machine readable copy and one print copy per page) for your personal and/or educational non-commercial use only.

The University of the Witwatersrand, Johannesburg, is not responsible for any errors or omissions and excludes any and all liability for any errors in or omissions from the information on the Library website.