

# Knowledge Based Expert System Computer Aided Climate Responsive Integrated Approach to Architectural Design

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**ABSTRACT:** Architectural design is indeed a complex process. Can this process be translated into design decision making process through a knowledge based expert system and achieve ecologically responsive architecture? is the quest of this paper. The computer aided system presented offers a system that supports such architectural design decision making.

**Keywords:** Knowledge, Architecture

## 1.0 CLIMATE RESPONSIVE ARCHITECTURE - THE TOOL AND THE PROCESS

Process of architectural design is a complex exercise, involving interactive relationships between parameters of diverse nature and varying magnitude. Yet, it is the prime generator of architecture as we see and experience.

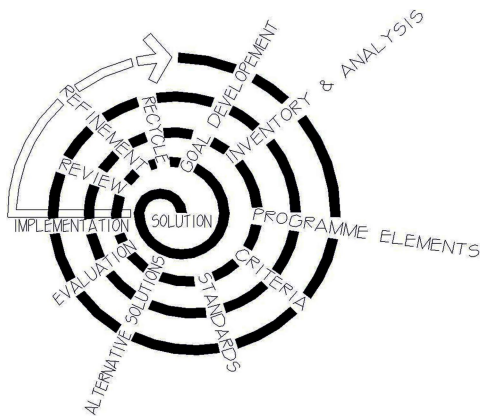


Fig 1.0 Graphical Representation of Process of Design

## 2.0 HISTORICITY:

Various ideas have dominated architectural thought from time to time. Yet, the fundamental issue of energy as an embodiment of Sun, Wind and Light – the ecological context - have not been a basic paradigm of design. Therefore relationship between built-form and ecology should become the driving force behind the process, based on a scientific methodology – leading to climate Responsive Architecture.

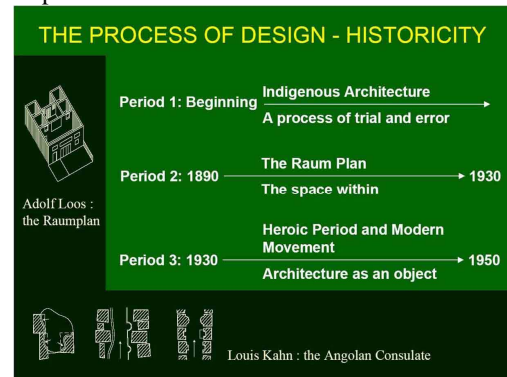


Fig 2.0

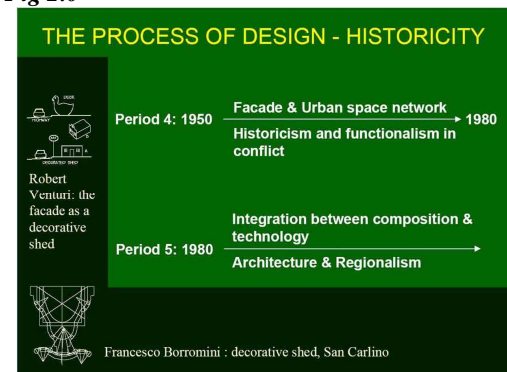


Fig. 3.0

### 3.0 ECOLOGICAL PROCESS OF DESIGN:

The idea of climatically responsive design is to modulate the conditions such that they are always within or are as close as possible to the band of appropriate design.

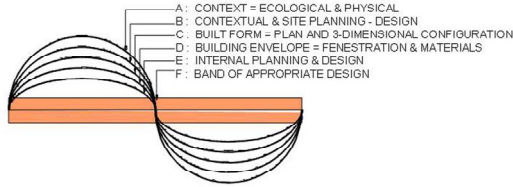


Fig. 4.0 Ecological Process of Design

### 3.1 KNOWLEDGE BASED EXPERT SYSTEM

Architectural design decision making is based on a knowledge based expert system presented below in the form of a 'Design Matrix'. Based on climate analysis the user can make design decisions proceeding in a sequential manner through the design matrix. At every step, design decisions relating to the following can be taken. Site Analysis, Built Form, Street Patterns, Surface Textures, Vegetation, Water bodies, Plan form, Roof Form, Fenestration configuration, Day-light distribution, Building element i.e. roof / wall layering and Building Control details. These decisions are supported by a quantitative and qualitative data base.

Conceptual planning and design decisions taken through the above expert system are stored in a 'Design File' which are then used to arrive at a final design through a graphic package

### 3.0 DESIGN MATRIX AND THE EXPERT SYSTEM

Design and more so architectural design is intrinsically a decision making process. Computer aided knowledge based expert system based on a 'Design matrix' presented below enables design decision making to achieve ecologically responsive architecture.

Climate Responsive Architecture 1.0 An integrated approach to design is a software developed to achieve ecologically responsive architecture.

### 3.0 CLIMATE ANALYSIS

A comprehensive data base of climate for India i.e. its various parameters, is built into the system as reference and for use in various computational sections of the software. Climate is analysed and presented in the form of 'Eco-Charts', 'Comfort Charts', 'Solar Charts', 'Radiation Charts', 'Mahoney Tables'. These are available for a select number of locations – one for each climate zone of India. These charts can be generated through the software based on the climatic parameters data

base. The data base can be expanded by the user, at any point in time, to include any global location.

These 'charts' are not only indicators of climatic parameter variations but are used in the process of development of design strategies and design decisions.

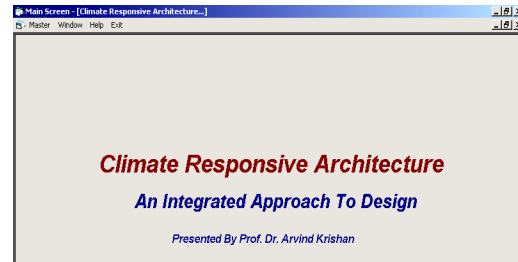
### 3.3 ANALYTICAL SECTION - EXPERT SYSTEM:

Conceptual and final design can be analysed for thermal performance and day-light distribution through following modules. All modules are user-friendly and graphic in presentation and results.

- Thermal Performance parametric analysis
- Ventilation
- Day-light distribution

### 4.0 DESIGN DECISION MAKING MODULES:

#### SCREEN 1:



Master Screen for accessing Various modules

#### Screen II:

Step 1: To access Climate Analysis through Eco-Charts, Comfort Charts, Solar Charts, Radiation Charts, Mahoney Tables.

Step 2: Location Details

Step 3: Generate Design and References

Step 4: Quantitative Analysis

#### Screen III:

Design File indicating selections from Design Matrix.

#### Screen IV:

Step 1: Design Space (Zone) parameters.

Step 2: Quantitative assessment of Conductive Heat Gain, Daylight Factor, Ventilation, Radiation Gain for Glazed Surfaces, Radiation Gain for Opaque Surfaces and Ventilative Heat Gain.

#### Screen V:

Daylight Factor Calculations. Initial (SC), Final (SC), ERC, IRC, Initial (DF), Glazing Factors (GF), Framing Factors (FF), Dirt on Glass (D), Final (DF), Target DF.

#### Screen VI:

Establishing Initial Sky Component From Section

#### Screen VII:

Nomogram for Average Internally Reflected Component.

### 5.0 CONCLUSION

In a user-friendly interactive manner this expert system allows analysis, design decision making to achieve climate responsive architecture which leads to sustainable solutions.



SCREEN - II:

**Main Screen - [Location Master Read Only]**

Master Window Help Exit

Location Details		Charts		Selections From Matrix			
Design File Name :	house	Design Description :	const of house				
Location Code :	L00001	Location Name :	Leh				
Climate Type :	Under Heated	Latitude :	34.09	North	Longitude :	77.34	East
Relative Humidity :	10.00	Precipitation :	200.00	No Of Clear Days :	.00		
Mean Monthly Temp :	.00	Mean Temp Summer Midday :	17.00	Mean Temp Summer Night :	4.00		
Mean Temp Winter Midday :	-7.00	Mean Temp Winter Night :	-14.00	Diurnal Variations :	25.00		
Solar Radiation :	Intense with low percentage of diffuse radiation						
Winds :	Occasionally intense						
Miscellaneous :	Exceptionally harsh cold desert climatic conditions						
Landscape And Veg. :	Mountainous regions with little vegetation						
Sky Conditions :	Fairly clear throughout the year with cloud cover less than 50%						

Comfort Chart	Radiation Chart	Eco Chart	Solar Chart	Mahoney Table
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SA_EW_J	SA_NS_J	SA_NWSE_J	SA_NESW_J	SA_EW_D	SA_NS_D	SA_NWSE_D	SA_NESW_D
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Generate Design Reference Analysis

SCSCREEN - III:

**Main Screen - [Location Master Read Only]**

Master Window Help Exit

Location Details		Charts		Selections From Matrix	
<b>Selections From Matrix For Design Of : house</b>					
Level Number ----->					
1 / 2 : Land Form And Land Form Orientation 3 : Vegetation 4 : Water Bodies 5 : Street Widths And Orientation 6 : Open Spaces And Built Form 7 : Ground Character 8 : Planform 9 : Plan Elements 10 : Orientation 11 : S / V Ratio			12 : Roof Form 13 : Fenestration Pattern 13 : Fenestration Configuration 14 : Fenestration Orientation 15 : Controls 16 : Roof Materials 17 : Wall Materials 18 : External Colors And Textures 19 : Internal Materials 20 : Internal Finishes		

Generate Design Reference Analysis

SCREEN IV:

Main Screen - [Specify Dimensions Of Space...]

Master Window Help Exit

### Dimensions Of :- ROOM1 Design Name :-HOUSE

#### Dimensions Of Section

Scale: 1 mm = 1 twips

**Space Dimensions in mm**

Width Of Space (w1) :

Height Of Space (h1) :

Height Of Window From Floor (h2) :

Height Of Window (h3) :

Window Placement On Side :

#### Dimensions Of Plan

Scale: 1 mm = 1 twips

**Space Dimensions in mm**

Length Of Space (L1) :

Distance Of Window From Corner (L2) :

Width Of Window (w2) :

Section :

Conductive Heat Gain (Qc) :

Daylight Factor (Df) :

Ventilation (W) :

Radiation Gain For Glazed Surfaces (Qsg) :

Radiation Gain For Opaque Surfaces (Qso) :

Ventilative Heat Gain (Qv) :

SCREEN V

Main Screen - [Daylight Factor Calculation...]

Master Window Help Exit

### Daylight Factor Calculation For Window Number : 1

#### Establishing Initial SC From Section

Scale: 1 mm = 1 twips

**Room Dimensions in mm**

Width (w1) :  Height (h1) :

Height (h2) :  Height (h3) :

Window Side :

Obstruction :

Distance (hd) :  Height (vht) :

Overhang :

Height (pht) :  Projection (pd) :

Specify BRS Protractor :

#### Establishing CF From Plan

Scale: 1 mm = 1 twips

**Room Dimensions in mm**

Length (L1) :  Length (L2) :

Length (pl) :  Width (w2) :

Window :

Initial (SC) :	4.46
Final (SC) :	3.528
(ERC) :	0
(IRC) :	0.1875

(CF) :	0
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Initial (DF) :	3.6315
Glazing Factors (GF) :	0.5
Framing Factors (FF) :	0.75
Dirt On Glass (D) :	0.6

Final (DF) :	0.8170875
Target DF :	2.5

