

L8



1 Converging Ventilation Corridors

1

CONVERGING VENTILATION CORRIDORS of streets or open space can take advantage of cool air drainage and night thermal currents. [cooling and ventilation]

L8 Urban Fabric

L8



2 Shared Shade

2

SHARED SHADE: Buildings can be arranged to shade each other and adjacent exterior spaces. [cooling]

L8 Urban Fabric

L8



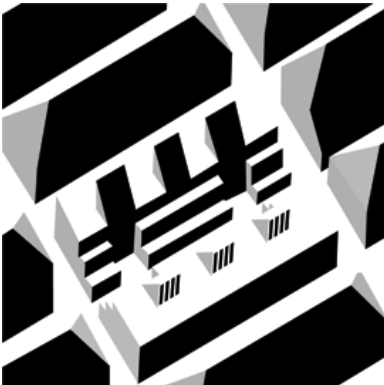
3 Topographic
Microclimates

3

***T O P O G R A P H I C
MICROCLIMATES*** can be used
to locate building groups
[heating and cooling]

L8 Urban Fabric

L8



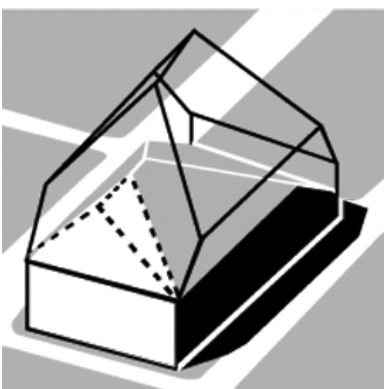
4 Daylight Density

4

Design for ***DAYLIGHT DENSITY***
by configuring streets, blocks
and building massing to support
light to each building.
[daylighting]

L8 Urban Fabric

L8



5 Climatic Envelopes

5

CLIMATIC ENVELOPES organize
urban building mass as the
intersection of volumes for
protecting access to light and
winter sun and/or summer
shade. [heating, cooling and
daylighting]

L8 Urban Fabric

L8



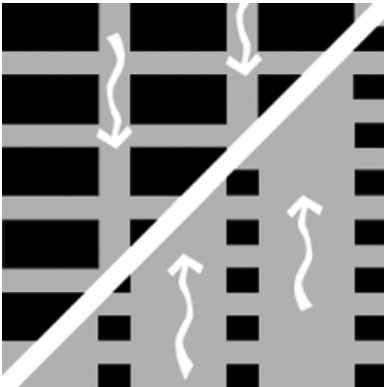
6 Glazed Streets

6

GLAZED STREETS provide light to each building organized to face them. [daylighting]

L8 Urban Fabric

L8



7 Loose or Dense Urban Patterns

7

LOOSE URBAN PATTERNS maximize cooling breezes in hot climates, while **DENSE URBAN PATTERNS** minimize winter winds in heating climates. [heating and cooling]

L8 Urban Fabric

L8



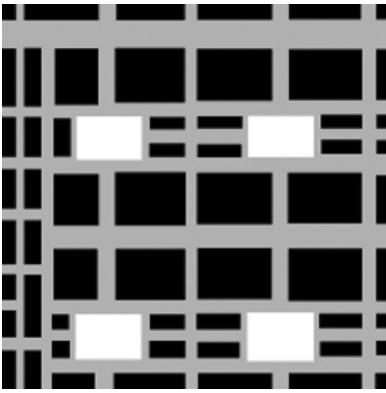
8 Gradual Height Transitions

8

GRADUAL HEIGHT TRANSITIONS of building groups, sloped in the direction of prevailing winds, minimize wind movement in streets. [heating]

L8 Urban Fabric

L8



9 Interwoven Buildings
and Planting

9

**INTERWOVEN BUILDINGS and
PLANTING** can be used to
reduce the ambient air tem-
perature. [cooling]

L8 Urban Fabric

L8



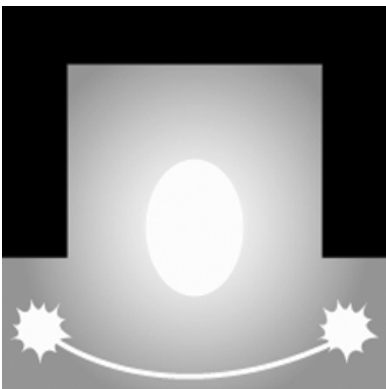
10 Interwoven Buildings
and Water

10

**INTERWOVEN BUILDINGS and
WATER** can be used to reduce
the ambient air temperature.
[cooling]

L8 Urban Fabric

L8



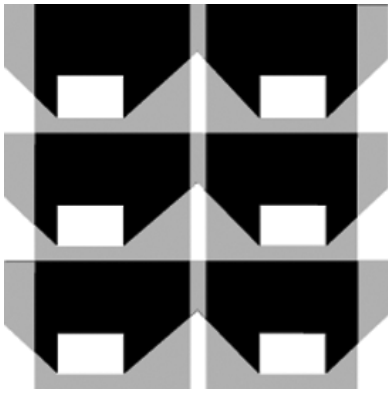
11 Winter Courts

11

WINTER COURTS that are
sunny and wind-protected
can be formed by the location
and arrangement of buildings.
[heating]

L8 Urban Fabric

L8



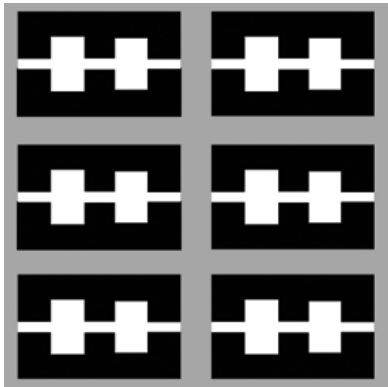
12 Neighborhood
Sunshine

12

NEIGHBORHOOD SUNSHINE can be insured by appropriate configurations of buildings and open space, given a street orientation. [heating]

L8 Urban Fabric

L7



13 Daylight Blocks

13

DAYLIGHT BLOCKS can be enlarged to support taller daylight buildings, more interior daylight or darker skies [daylighting]

L7 Urban Elements

L7



14 Daylight Envelopes

14

DAYLIGHT ENVELOPES can be used to shape and space buildings to assure adequate daylight access to the street and adjacent buildings. [daylighting]

L7 Urban Elements

L7



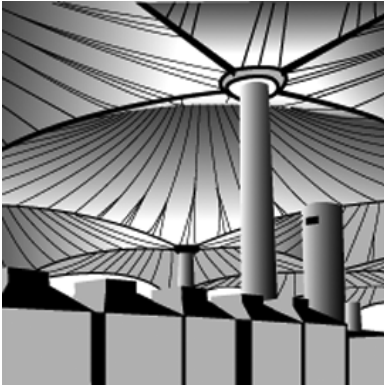
15 Solar Envelopes

15

SOLAR ENVELOPES can be used to insure access to the sun. [heating and power]

L7 Urban Elements

L7



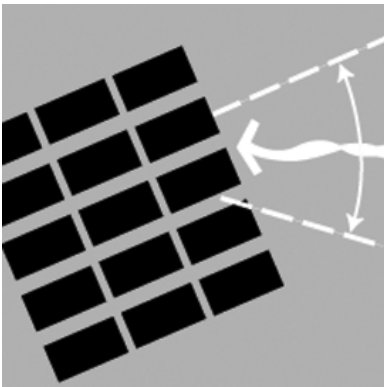
16 Shadow Umbrella

16

SHADOW UMBRELLA organizes building mass and elements to shade open space. [cooling]

L7 Urban Elements

L7



17 Breezy or Calm Streets

17

BREEZY or CALM STREETS oriented to the prevailing wind maximize wind movement in urban environments and increase the access of buildings to cross-ventilation. [cooling]

L7 Urban Elements

L7



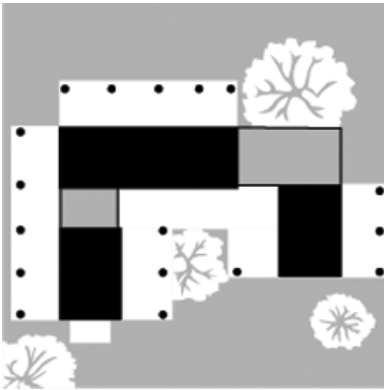
18 Tall Building
Currents

18

TALL BUILDING CURRENTS can be guided by building shape to create favorable street and open space microclimates. [heating and cooling]

L7 Urban Elements

L7



19 Dispersed Buildings

19

DISPERSED BUILDINGS with continuous and wide open spaces preserve each building's access to breezes. [cooling and ventilation]

L7 Urban Elements

L7



20 East-West Elongated
Building Groups

20

EAST-WEST ELONGATED BUILDING GROUPS spaced in the north south direction maximize solar gain while insuring solar access to each building. [heating]

L7 Urban Elements

L7



21 Windbreaks

21

WINDBREAKS can be used to create edges that shelter buildings and open spaces. [heating and cooling]

L7 Urban Elements

L7



22 Green Edges

22

GREEN EDGES of irrigated vegetation can be formed to cool incoming breezes. [cooling]

L7 Urban Elements

L7



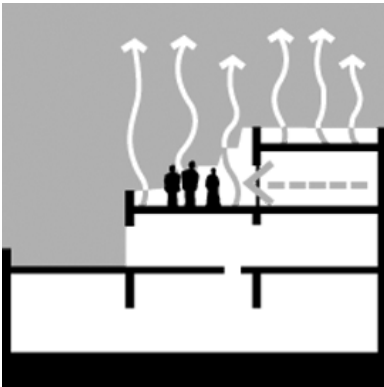
23 Overhead Shades

23

OVERHEAD SHADES can protect outdoor spaces and buildings from the high sun. [cooling]

L7 Urban Elements

L5



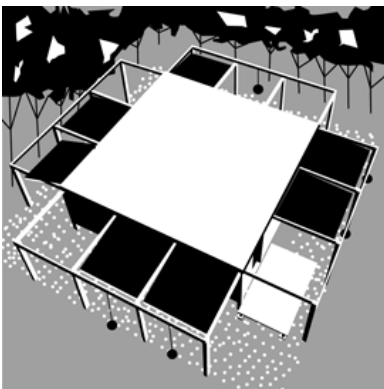
24 Migration

24

MIGRATION: Rooms and courts can be zoned so that activities can take place in cooler areas during warm periods and warmer areas during cool periods of the day or season. [heating and cooling]

L5 Room Organizations

L5



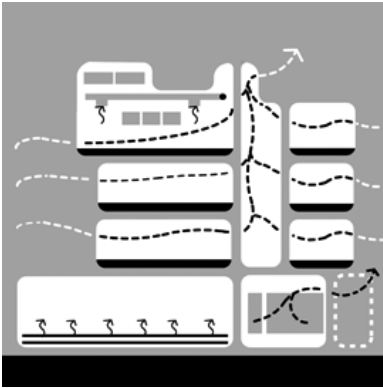
25 Periodic Transformations

25

PERIODIC TRANSFORMATIONS of space help the building adapt in response to changing environmental conditions. [heating, cooling and daylighting]

L5 Room Organizations

L5



26 Cooling Zones

26

Rooms can be grouped into **COOLING ZONES** based on similar cooling requirements, facilitating the use of the same cooling strategies at the same time. [cooling and ventilation]

L5 Room Organizations

L5



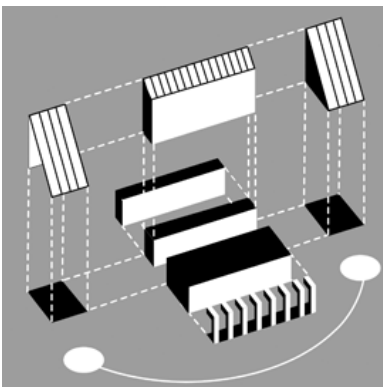
27 Mixed Mode Building

27

A **MIXED MODE BUILDING** is organized to make use of passive, active and hybrid space conditioning systems in different parts of the building and at different times of the day and year. [cooling and ventilation]

L5 Room Organizations

L5



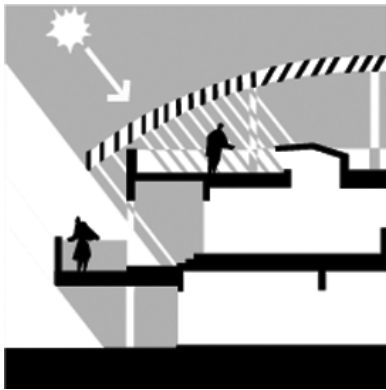
28 Heating Zones

28

Rooms can be organized into **HEATING ZONES** based on their needs for heating and whether or not they can make use of internal heat sources. [heating]

L5 Room Organizations

L5



29 Buffer Zones

29

BUFFER ZONES locate rooms that can tolerate temperature swings between protected rooms and undesired heat or cold, and can temper fresh ventilation air before it enters the occupied space. [heating and cooling]

L5 Room Organizations

L5



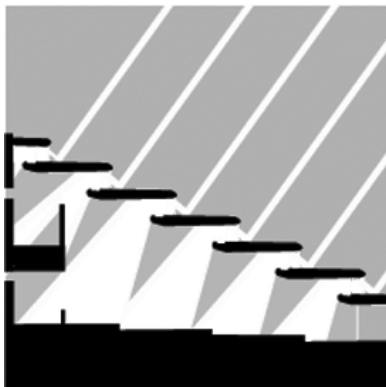
30 Permeable Buildings

30

PERMEABLE BUILDINGS combine open plans and sections for cross-ventilation, stack-ventilation or both. [cooling and ventilation]

L5 Room Organizations

L5



31 Borrowed Daylight

31

BORROWED DAYLIGHT is possible when small rooms are organized adjacent to larger or taller daylighted rooms. [daylighting]

L5 Room Organizations

L5



32 Locating Outdoor Rooms

32

LOCATING OUTDOOR ROOMS in relation to sun and wind can extend the seasons of outdoor comfort. [heating and cooling]

L5 Room Organizations

L5



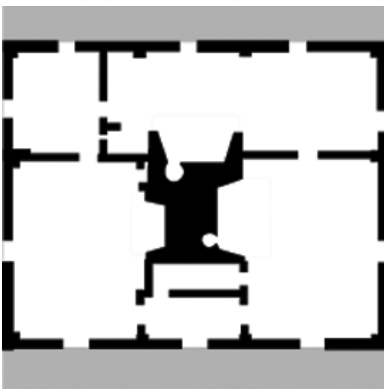
33 Atrium Building

33

An **ATRIUM BUILDING** with a glazed or unglazed light court within can provide light to surrounding interior rooms. [daylighting]

L5 Room Organizations

L5



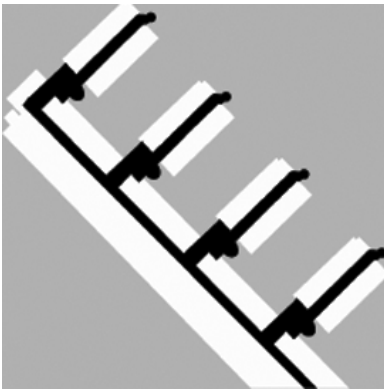
34 Clustered Rooms

34

CLUSTERED ROOMS reduce skin area, thus heat loss and gain. [heating and cooling]

L5 Room Organizations

L5



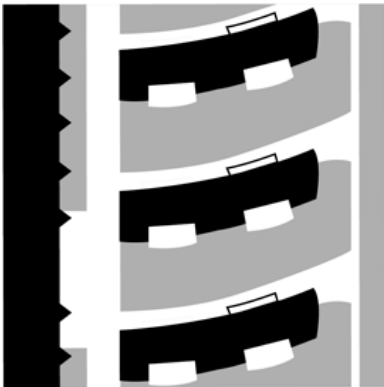
35 Thin Plan

35

THIN PLAN room arrangements will have daylight available for each space. [daylighting]

L5 Room Organizations

L5



36 East-West Plan

36

Long **EAST-WEST PLAN** arrangements increase winter sun-facing skin available to collect solar radiation. [heating and cooling]

L5 Room Organizations

L5



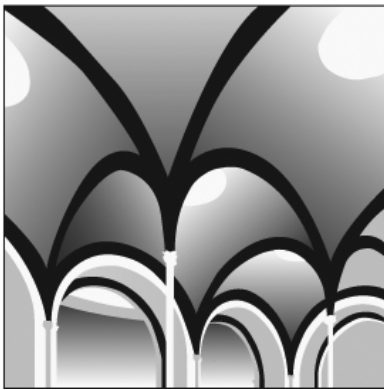
37 Deep Sun

37

DEEP SUN in thick buildings depends on effective pathways organized in plan and section. [heating]

L5 Room Organizations

L5



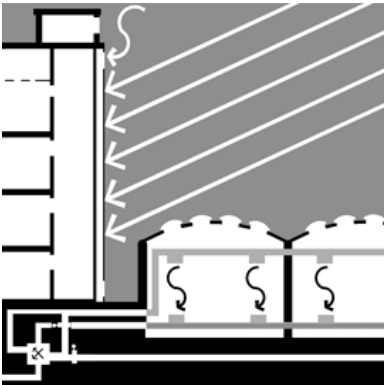
38 Skylight Building

38

A SKYLIGHT BUILDING admits light from above to daylight thick plans and top floors. [daylighting]

L5 Room Organizations

L5



39 Moving Heat to Cold Rooms

39

MOVING HEAT TO COLD ROOMS fits the distribution strategy to the building's room organization and solar system type. [heating]

L5 Room Organizations

L5



40 Stratification Zones

40

STRATIFICATION ZONES organize rooms vertically within buildings to take advantage of temperature stratification. [heating and cooling]

L5 Room Organizations

L5



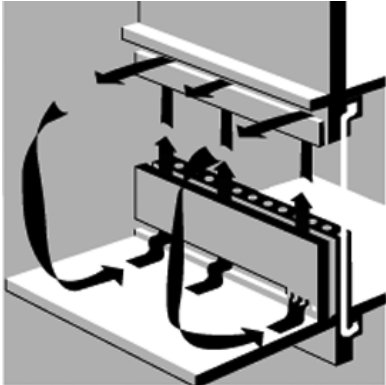
41 Daylight Zones

41

DAYLIGHT ZONES arrange rooms so that activities that need higher lighting levels are near windows while activities that need less light are farther from daylight sources. [daylighting]

L5 Room Organizations

L5



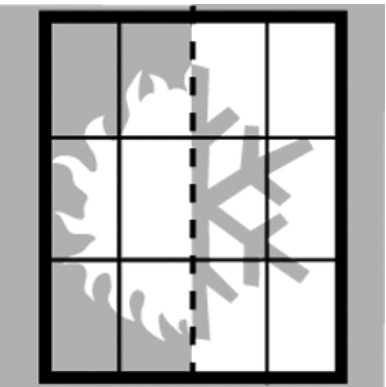
42 Convective Loops

42

CONVECTIVE LOOPS can induce distribution by high and low air paths between rooms that collect heat and adjacent cooler rooms. [heating]

L5 Room Organizations

L1



106 Window and Glass Types

106

GLASS TYPES can be selected to balance concerns for daylighting, winter solar gain and summer shading. [heating, cooling and daylighting]

L1 Materials

L4



43 Rooms Facing the Sun and Wind

43

ROOMS FACING the SUN and WIND increase the effectiveness of solar heating and cross-ventilation. [heating, cooling and ventilation]

L4 The Room

L4



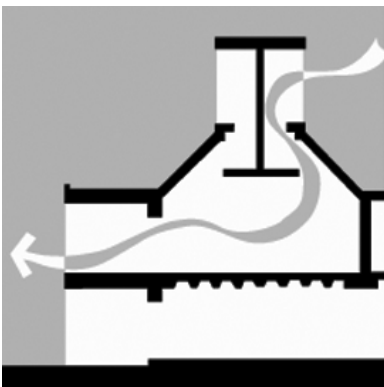
44 Cross-Ventilation Rooms

44

Air flow through **CROSS-VENTILATION ROOMS** is increased by open plans and uninterrupted pathways between windward inlets and leeward outlets. [cooling and ventilation]

L4 The Room

L4



45 Wind Catchers

45

WIND CATCHERS can capture breezes above roof level for buildings whose windows have little access to wind. [cooling and ventilation]

L4 The Room

L4



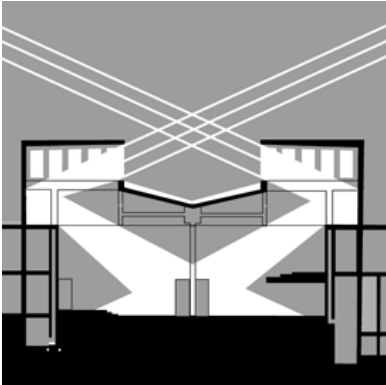
46 Evaporative Cooling Towers

46

EVAPORATIVE COOLING TOWERS can supply cool air to rooms without the use of fans or wind. [cooling and ventilation]

L4 The Room

L4



47 Toplight Room

47

A TOPLIGHT ROOM's proportions and surfaces can be designed to light the room or to also provide light to adjacent rooms. [daylighting]

L4 The Room

L4



48 Direct Gain Rooms

48

DIRECT GAIN ROOMS are open to collect the sun and store heat within a space. [heating]

L4 The Room

L4



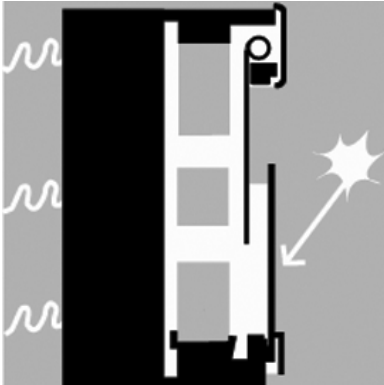
49 Sunspaces

49

SUNSPACES collect the sun's heat, store it centrally, and distribute it to other rooms. [heating]

L4 The Room

L4



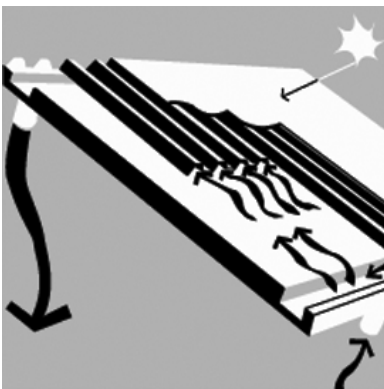
50 Thermal Storage Walls

50

THERMAL STORAGE WALLS collect and store solar heat at the edge of a room. [heating]

L4 The Room

L4



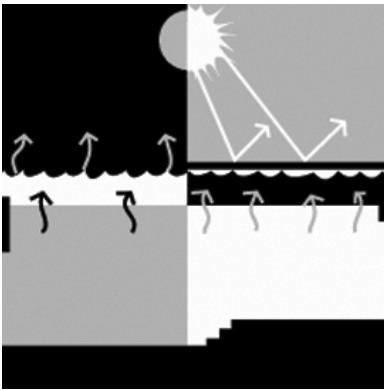
51 Thermal Collector Walls and Roofs

51

THERMAL COLLECTOR WALLS and ROOFS capture solar heat at the edge of a room in a layer of air, which carries the heat to storage in the building's interior structure. [heating]

L4 The Room

L4



52 Roof Ponds

52

ROOF PONDS collect and store heat and cold in the ceiling plane of a room. [heating and cooling]

L4 The Room

L4



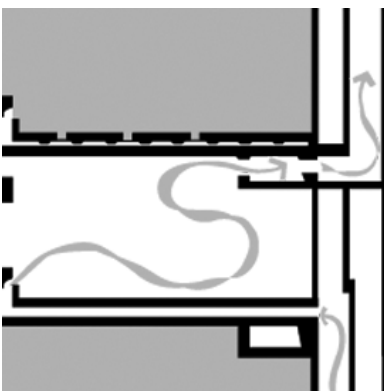
53 Stack Ventilation Rooms

53

Air flow through **STACK VENTILATION ROOMS** is increased by open sections and unrestricted pathways between low inlets and high outlets. [cooling and ventilation]

L4 The Room

L4



54 Night Cooled Mass

54

NIGHT COOLED MASS uses thermal storage to absorb heat from a room during the day and then cool the mass at night with ventilation. [cooling]

L4 The Room

L4



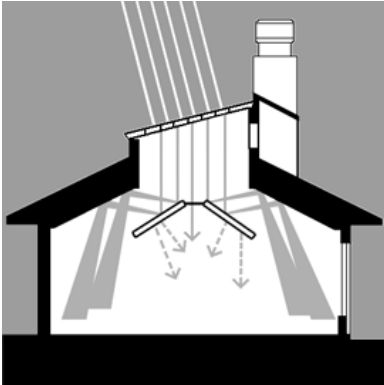
55 Daylight Room Geometry

55

DAYLIGHT ROOM GEOMETRY controls the pattern of daylight distribution within a space. [daylighting]

L4 The Room

L4



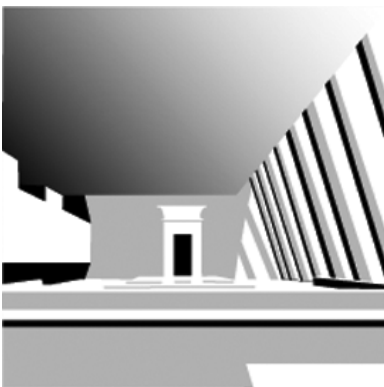
56 Glare-Free Rooms

56

Create **GLARE-FREE ROOMS** by using interior daylight reflection strategies and obscuring the sources of light. [daylighting] [in SWL4]

L4 The Room

L4



57 Sidelight Room Depth

57

SIDELIGHT ROOM DEPTH less than $2\frac{1}{2}$ times the height of the window head maintains a minimum level of illumination and an even distribution of light. [daylighting]

L4 The Room

L4



58 Breezy or Calm
Courtyards

58

BREEZY COURTYARDS are low, wide and permeable, while **CALM COURTYARDS** are closed and tall enough for wind shelter, but wide enough to admit sun. [heating and cooling]

L4 The Room

L4



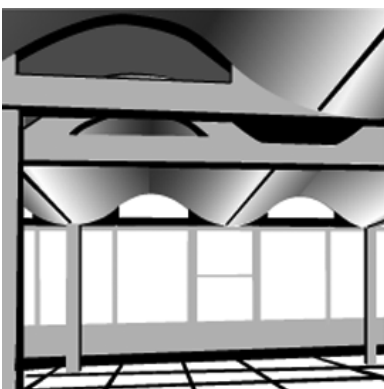
59 Shady Courtyards

59

SHADY COURTYARDS are tall and narrow and can be used as cold air sinks. [cooling]

L4 The Room

L3



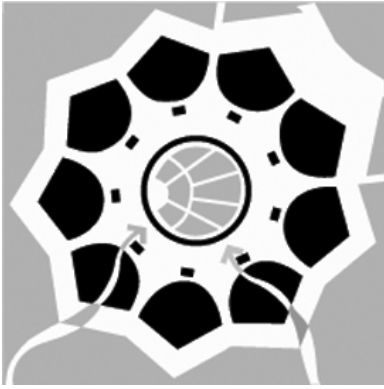
60 Mass
Arrangement

60

MASS ARRANGEMENT can be optimized for solar heating, passive cooling or both. Thermal mass can be located in rooms where sun is collected, in adjacent rooms or outside of rooms, remotely. [heating and cooling]

L3 Building Systems

L3



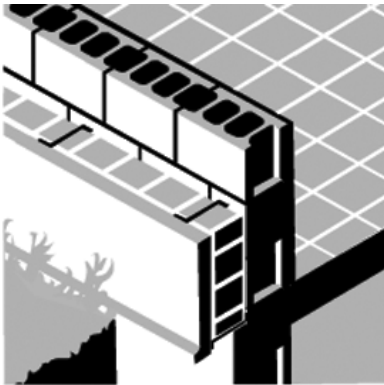
61 Water Edges

61

WATER EDGES can be formed to cool incoming breezes.
[cooling]

L3 Building Systems

L3



62 Insulation Outside

62

INSULATION OUTSIDE the mass of walls allows the mass to store heat from the room and stabilize the interior air temperature.
[heating and cooling]

L3 Building Systems

L3



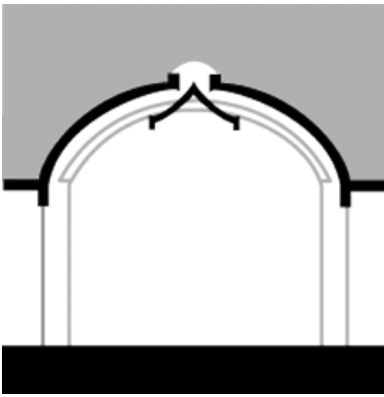
63 Layer of Shades

63

A LAYER OF SHADES overhead can protect the courtyard and building from high sun, while vertical shades can protect from low sun.
[cooling]

L3 Building Systems

L3



64 Reflected Sunlight

64

REFLECTED SUNLIGHT can be used for daylighting in clear sky climates.
[cooling and daylighting]

L3 Building Systems

L3



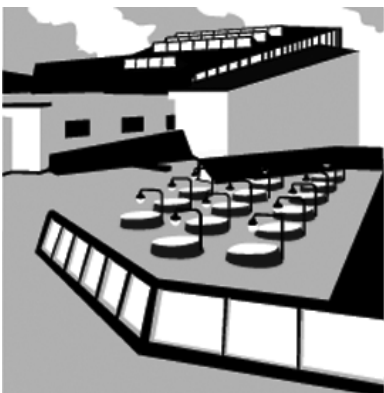
65 Open Roof Structure

65

An ***OPEN ROOF STRUCTURE*** reduces daylight blockage in a toplight room. [daylighting]

L3 Building Systems

L3



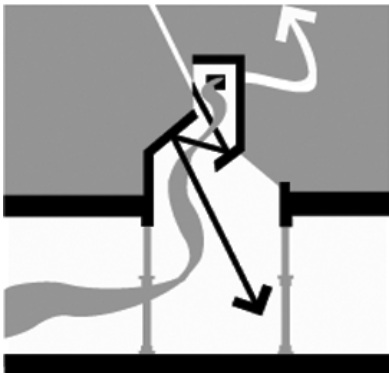
66 Daylight Roof

66

A ***DAYLIGHT ROOF*** is designed to admit and distribute light in desired quantity and patterns to rooms below. [daylighting]

L3 Building Systems

L3



67 Separated or Combined Openings

67

Ventilation, light and solar gain may be accommodated with *SEPARATED OR COMBINED OPENINGS*.
[heating, cooling, ventilation and daylighting]

L3 Building Systems

L3



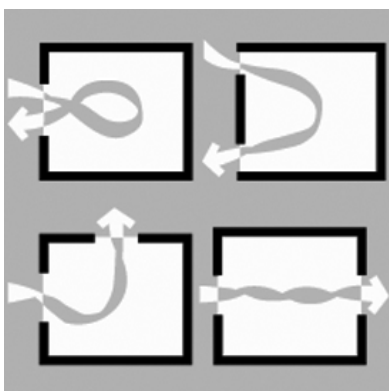
68 Window Placement

68

WINDOW PLACEMENT can be organized to admit and distribute light in desired patterns to rooms. [daylighting]

L3 Building Systems

L3



69 Ventilation Openings Arrangement

69

VENTILATION OPENINGS ARRANGEMENT can be optimized to increase the rate of cross-ventilation in a room and to move air across occupants to increase their rate of cooling. [cooling and ventilation]

L3 Building Systems

L3



70 Well-Placed Windows

70

WELL-PLACED WINDOWS can reduce winter heat loss and summer heat gain.
[heating and cooling]

L3 Building Systems

L3

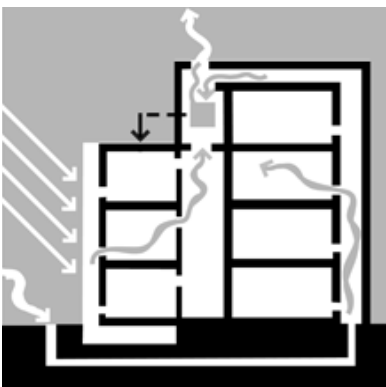
71 Sympathetic HVAC Systems

71

Select **SYMPATHETIC HVAC SYSTEMS** to support the flexibility and sizing needed to maximize the effectiveness of passive strategies [heating, cooling and ventilation] [in SWL4]

L3 Building Systems

L3



72 Mechanical Heat Distribution

72

MECHANICAL DISTRIBUTION systems can be used to connect sources and storage to rooms with thermal needs and to integrate passive heating and cooling strategies with mechanical backup sources.
[heating and cooling]

L3 Building Systems

L3



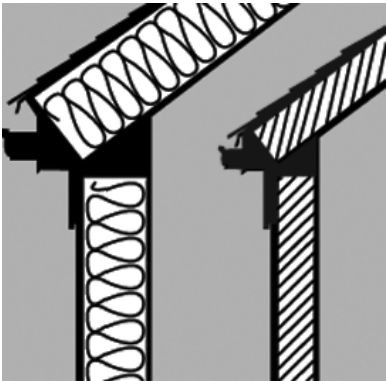
73 Electric Light Zones

73

ELECTRIC LIGHT ZONES can be layered parallel to the window plane so that individual rows can be switched on as needed.
[daylighting]

L3 Building Systems

L2



74 Skin Thickness

74

The building's **SKIN THICKNESS** should be sufficient to accommodate the required insulation.
[heating and cooling]

L2 Elements

L2



75 Thermal Mass

75

THERMAL MASS surfaces should be large enough and thick enough to store adequate heat and cold.
[heating and cooling]

L2 Elements

L2



76 Earth Edges

76

EARTH EDGES can be used to shelter buildings from extremes of heat and cold and to meet a portion of the building's cooling needs. [heating and cooling]

L2 Elements

L2

77 Radiant Surfaces

77

RADIANT SURFACES can change the perception of comfort and deliver passive or active heating and cooling. [Heating and Cooling] [in SWL4]

L2 Elements

L2



78 Photovoltaic Roofs and Walls

78

Orient **PHOTOVOLTAIC WALLS and ROOFS** to collect sun and make them large enough to meet the building's electric load. [power]

L2 Elements

L2



79 Solar Hot Water

79

SOLAR HOT WATER systems require roofs that are large enough as well as sloped and oriented to collect sun. [power]

L2 Elements

L2



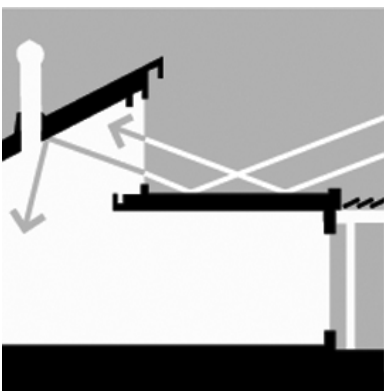
80 Breathing Walls

80

Sunny **BREATHING WALLS** can preheat fresh air for ventilation. [heating and ventilation]

L2 Elements

L2



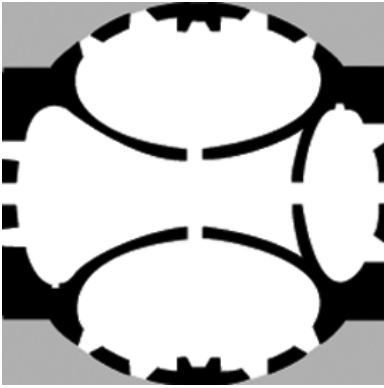
81 Solar Reflectors

81

Roofs and walls can be used as **SOLAR REFLECTORS** to increase the radiation entering sun-collecting glazing. [heating]

L2 Elements

L2



02 Low Contrast

02

LOW CONTRAST between the window frame and adjacent walls will reduce glare. [daylighting]

L2 Elements

L2



03 Skylight Wells

03

SKYLIGHT WELLS can be shaped to distribute daylight to rooms. [daylighting]

L2 Elements

L2



04 Solar Apertures

04

SOLAR APERTURES that collect sun can be enlarged to increase the percentage of the annual heating requirement supplied by solar energy. [heating]

L2 Elements

L2



85 Daylight Apertures

85

DAYLIGHT APERTURES can be enlarged to increase interior illumination levels.
[daylighting]

L2 Elements

L2



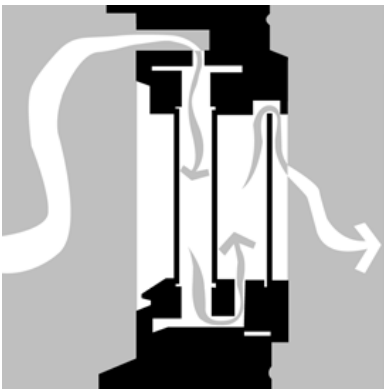
86 Ventilation Apertures

86

VENTILATION APERTURES sizing for cross-ventilation is proportional to the wind velocity, and for stack ventilation, is proportional to vertical distance between high and low openings.
[cooling and ventilation]

L2 Elements

L2



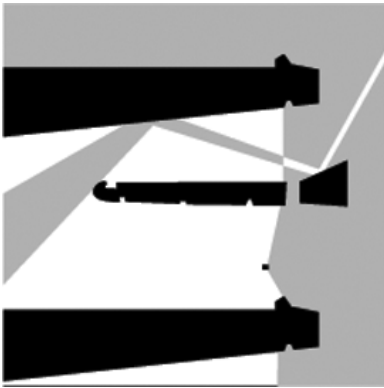
87 Air Flow Windows

87

The area of **AIR FLOW WINDOWS** used to temper fresh air for ventilation supply or reclaim heat from ventilation exhaust can be sized to match the ventilation load.
[heating, cooling and ventilation]

L2 Elements

L2



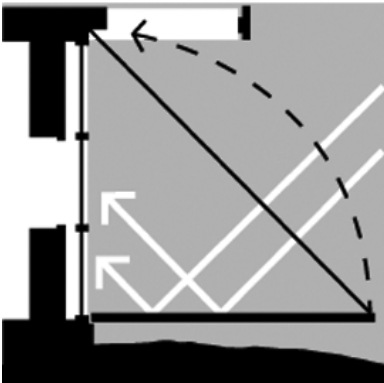
88 Light Shelves

88

LIGHT SHELVES can be used to shade view glazing, evenly distribute light, increase light levels away from windows, and reduce glare. [daylighting and cooling]

L2 Elements

L2



89 Movable Insulation

89

A **MOVABLE INSULATION** layer placed over windows reduces heat loss at night. [heating]

L2 Elements

L2



90 Daylight Enhancing Shades

90

DAYLIGHT ENHANCING SHADES protect windows from solar gain while preserving sky view, reflecting daylight, and reducing glare. [cooling and daylighting]

L2 Elements

L2



91 External Shading

91

An **EXTERNAL SHADING** layer outside the window shades the glazing and reduces solar heat gain. [cooling]

L2 Elements

L2



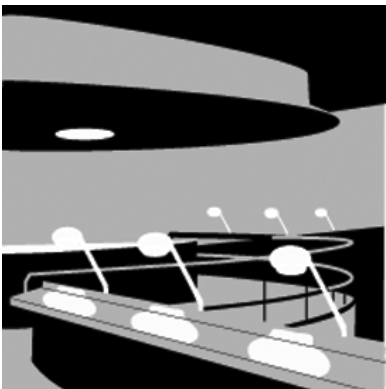
92 Internal and In-Between Shading

92

An **INTERNAL SHADING** layer behind the window or an **IN-BETWEEN SHADING** layer separating two glazing panes reduces solar heat gain. [cooling]

L2 Elements

L2



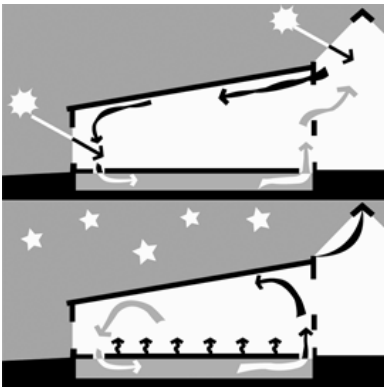
93 Task Lighting

93

Electric **TASK LIGHTING** can be used for localized, high illumination requirements and daylight for ambient lighting. [daylighting and power]

L2 Elements

L2



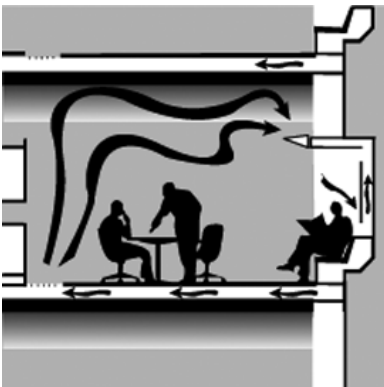
94 Rock Beds

94

ROCK BEDS located remote from the occupied space can be used to increase the amount of heat and cold that can be effectively stored. [heating and cooling]

L2 Elements

L2



95 Mechanical Mass Ventilation

95

MECHANICAL MASS VENTILATION can be used to ensure adequate air movement past the building's thermal storage, thereby improving its cooling or heating potential. [heating and cooling]

L2 Elements

L2



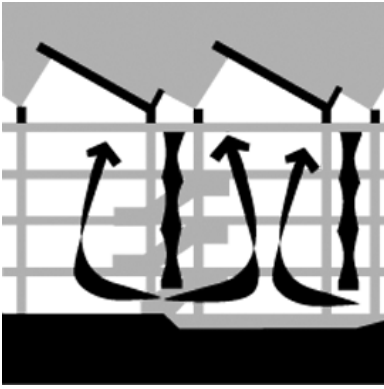
96 Mechanical Space Ventilation

96

MECHANICAL SPACE VENTILATION can be used to cool the building and people during times when natural ventilation forces are weak. [cooling and ventilation]

L2 Elements

L2



97 Ducts and Plenums

97

DUCTS and PLENUMS can be used to move heat to cool parts of the building and cold to hot parts of the building. [heating, cooling and ventilation]

L2 Elements

L2



98 Earth-Air Heat Exchangers

98

EARTH-AIR HEAT EXCHANGERS can temper incoming ventilation air in all seasons and help cool the building in summer. [heating, cooling and ventilation]

L2 Elements

L2



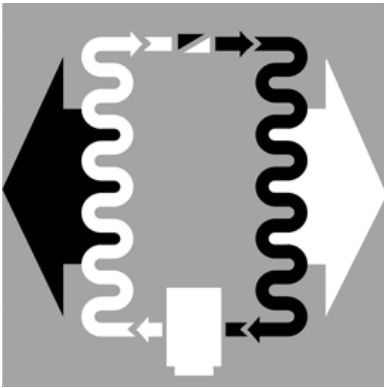
99 Air-Air Heat Exchangers

99

AIR-AIR HEAT EXCHANGERS can be used to reclaim heat or cold from the ventilation air. [heating, cooling and ventilation]

L2 Elements

L2



100 Heat Pumps

100

HEAT PUMPS can be used to move heat or cold from interior rooms to a source or sink outside or in the ground. [heating, cooling, and ventilation] [in SWL4]

L2 Elements

L2



101 Manual or Automated Controls

101

MANUAL OR AUTOMATED CONTROLS for lighting and HVAC can be selected to increase user satisfaction and comfort while maximize the effectiveness of passive strategies [heating, cooling, ventilation, and daylighting]

L2 Elements

L1



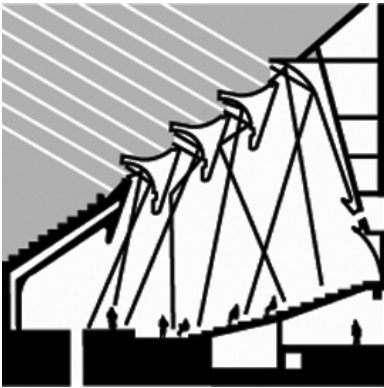
102 Mass Surface Absorptance

102

A high value for **MASS SURFACE ABSORPTANCE** absorbs radiation for thermal storage, while reflective non-massive surfaces redirect radiation to mass. [heating]

L1 Materials

L1



103 Daylight Reflecting Surface

103

DAYLIGHT REFLECTING SURFACES that are light colored increase the lighting level in the space. [daylighting]

L1 Materials

L1



104 Exterior Surface Color

104

EXTERIOR SURFACE COLOR can be dark in cold climates to absorb radiation and light in hot climates to reflect radiation. [heating and cooling]

L1 Materials

L1



105 Double Skin Materials

105

DOUBLE SKIN MATERIALS can be selected to reflect solar heat gain and avoid transmitting heat to the inner layer. [cooling]

L1 Materials