Project Theory

The ugly consequence of the modern era is an industrialized sameness, the loss of a sense of place, culture, and individual personality. This has been particularly true in the third world, and in this country, Indian Reservations. Instead we are driven to be consumers, all be the same cog in the machine of economy, meaning a medium through which material and energy flow in one direction ending in a landfill, or wasted, and money in the other direction, accumulating in the wealthiest.

Where the industrialized paradigm assumes an infinite wealth of natural capital marginalizes human capital while putting a premium on manufactured and financial capital. In fact, in traditional economic reckoning, natural and human capital is ignored.

A sustainable human system will have the following inescapable essential characteristics:

- Simpler living standards
- Small, highly self sufficient local economies utilizing local materials and labor to produce life essential services: food, shelter. (like nature)
- Technologies that minimize resource and environmental impacts. (highly efficient technologies)
- A service economy. Where what is produced and developed is what is best for people and the environment not by what is most profitable for corporations. (technical metabolism.)
- Highly participatory and cooperative systems that optimize specifically to the given conditions.

Good, "Quality" architectural design, and all design in general, for that matter, must first and foremost be "native" or "natural" to its context, or in other words, sustainable. If a building design, or any other designed entity, does not possess a "natural" quality, if it is not sustainable, we ought to consider it of little value – useless and ugly.

Typically we evaluate a design based either on its utility or its beauty, and often both at the same time. As is certainly the case with evaluating architecture. It has been utility and beauty that have helped to define quality design in the modern, industrialized era. However, that the usefulness and beauty of a design is meaningless until the design in question first passes a more rigorous ethical test of sustainability, where nothing is beautiful, if it is not unique to its particular circumstances nothing is useful if it first requires us to surrender our soul.

If we consider design as nothing more than a design making process, through which a single appropriate decision, or set of decision, is derived from a multitude of many possibilities, then we are all, in a sense, designers, if of nothing more than our own lifestyles.

As a consequence of this distinction, the previous evaluation of "quality" design becomes meaningful not only to professional designers, like architects, but to us all. What this essentially means for all of us is this: before we can judge something aesthetically, or functionally, we must judge it ethically.

The goal of this project is to demonstrate a way of accomplishing a sustainable community. This project divides sustainability at 3 levels: community planning, building form design, building material selection. This project demonstrates a sustainable way at all three levels.

At the community planning level, it demonstrates a way to design a community not around the automobile, but around people. This has not only positive environmental consequences, but also positive social and health implications.

At the building form level, it focuses on housing, and a way to design a house that, given an underlying structure, best fits the needs of the user, and the demands of the site. It shows this system of house generation in depth and goes on to detail out an example house.

At the building materials level, a list of materials that meet the before mentioned sustainability requirements is provided as well as a method of assembly that can be accomplished with little or no heave mechanized equipment.

Community Data

The Cannonball Community is located approximately 30 miles south of Mandan, ND. About a mile after crossing the Cannonball River and entering the reservation, Cannonball is located approximately a mile east of the highway. There are over 10,000 residents of the Standing Rock Sioux Reservation. Approximately 1,500 people live in Cannonball, and the surrounding country.

The land surrounding Cannonball is gently rolling hills. The land to the east gradually descends toward the Missouri River. A steep bluff exists to the north along the Cannonball River. To the west, the terrain levels out the flat to the west to a potato growing operation. Rolling hills continue to front the Missouri to the south. Vegetation consists primarily of prairie grasses. The occasional cottonwood tree springs up in lower lying areas. In town, barren earth is most common.

In addition to the occasional trailer house, there are tree typical house designs. The ones on the north end of town are the newest, and all seem to be in equally good condition. They are basic units, rectangular shaped, set back about 100 feet from the street, and spaced about 100 feet on center. The south end of town has the oldest and the largest units. The oldest units are in a state of disrepair, and are set back a great distance while others lie in severe disrepair. On the east end of town nearest the river, are the nicest housing units. Not as new as the ones to the north, or as old as the ones to the south, they now sagging, and break the rectilinear theme. These appear to be in the best kept condition.

Existing non-residential structures include a post office, community center, convenience store, tribal offices, a tavern, a day care center, a school, a day care center, and a gymnasium. The post office is located at the center of town, and appears to be an older wood frame building. The Gymnasium is a metal building recently built that attaches on to the post office. A large parking lot exists next to the gymnasium. The convenience store is located out of town along the highway. The tavern is located toward the north-east edge of town. The school, going up through grade six, is a brick building on the north end of town. The Day Care center is just north of the school, and across the street. Finally, the six churches are sporadically spread out around town.

Community Design

On master planning a community ....

Agricultural valleys – Preserve all agricultural valleys as farmland and protect this land from any development or take up the unique fertility of the soil. Even when valleys are not cultivated now, protect them: keep them for farms parks and wilds.

Pools and streams – Preserve natural pools, streams, and drainage swales. Allow them to form natural barriers in the city.

High places – Build occasional high places as landmarks throughout the city, a place to climb up to, look down and survey the world.

Sacred sites – Weather the sacred sites are large or small, whether they are the center of towns, in neighborhoods, or in the deepest countryside, establish ordinances that will protect them absolutely, so that our roots in the cosmos remains connected and healthy.

Access to water – When natural bodies of water occur near human settlements, treat them with great respect. Always preserve a belt of common land immediately beside the water. Allow dense settlements to come down to the water only at impressive intervals along the edge.

Parallel roads – Avoid interesting major roads. Instead build a system of parallel roads. Keep parallel roads at least 100 yards apart, and no more than 300-400 yards apart.

Identifiable neighborhood – Define neighborhoods no more that 300 yard across, with no more than 400 to 500 inhabitants. Keep major roads outside the neighborhoods.

Neighborhood boundary – Encourage the formation of a boundary around each neighborhood. Limit the number of roads accessing the neighborhood, and place gateways at the places where the access roads cross the neighborhood boundary. Make the boundary zone wide enough to contain meeting places for the common functions shared by several neighborhoods.

Density gradient – Encourage growth and accumulation of density to form clear configurations of peaks and valleys, centered on the community nucleus. Define areas of decreasing density that will allow people to choose a site that will match their personal preference toward either excitement and convenience, or quiet/tranquility and access to nature.

Shopping street – Shopping streets can form the central nucleus to a community, linking the main activity nodes, and places centrally. Put main points of attraction at two ends, to keep constant movement up and down.

Activity nodes – Create nodes of activity throughout the community, spread out about 800 yards apart. At the center of each node, make a small public square and surround it with a combination of community facilities and shops that are mutually supportive. Intensity activity in build one open public green within 5 minutes walk - about 750 feet - of every single dwelling or workplace. Make the greens 150 feet across and at least 60,000 square feet in area.

Promenade – Encourage the formation of a promenade at the heart of the community, linking the main activity nodes, and places centrally. Put main points of attraction at two ends, to keep constant movement up and down.

Looped local roads – Lay out local roads so that they form loops. A loop being any path that is impossible to use as a short-cut, keep the roads narrow - no more than 20 feet wide.

T-junction – To reduce frequency of traffic accidents, avoid 4 way intersections and crossing movements.

Network of paths and cars – Except where traffic densities are very high or low, cut out pedestrian paths and roads for cars at right angles to each other, creating two distinct networks. Make the intersections between the networks at points away from intersection within the network themselves.

Degree of public-ness – People are different and the way they want to place their houses in a neighborhood is one of the most basic kinds of difference. To accommodate different preferences, distribute 3 kinds of homes: those on quiet backwaters, those on busy streets, and those more or less in between. Give each neighborhood about equal numbers of each.

House cluster – Arrange houses to form very round, but identifiable clusters of 6-12 neighbors around some common large and native. Arrange the cluster so that anyone can walk through them without feeling like a trespasser.

Common land – In order to create a physical place for the development of a social scene, give 25 percent of the land in house clusters to common land which touches, or is very near the homes which share it.

Pedestrian street – Arrange buildings so that they form pedestrian streets where people can rub shoulders and interact casually and accidentally. Paths should be straight between goals, and paving should swell around the goals. Goals should be no more than a few hundred feet apart.

South facing outdoors – Always place buildings to the north of the outdoor spaces that go with them.

Site Assessment

User Preferences

Spatial Requirements

What size of family will will this dwelling accomodate?

Single person (detached)
480 sq ft Base (200 public, 150 private, 130 service)

Multiple roommates
250 sq ft base (150 public, 100 service) + 200 sq ft per roommate. (120 private/80 public/30 service)

Married couple without kids
650 sq ft base (250 public, 240 private, 160 service)

Married couple with kids
700 sq ft base + 120 sq ft per child (40 private/40 public/30 service) + 170 per teen (110 private/40 public/20 service)

Single Parent
480 sq ft base + 120 sq ft per child (80 private/40 public) + 180 per teen (100 private/50 public)

Married couple "empty nest" (with tenant)
700 sq ft base + 350 sq ft for tenant

How many guests would you like to be able to accommodate?

Add 50 sq ft per guest (all public)

3

What is the total square footage required of the dwelling?

1100

System's Basic structural form:

In the basic framework of this system....

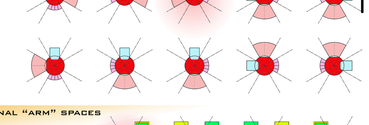
Think of a large quadrants, oriented toward the 4 cardinal directions, and 4 diagonal "arms" positioned between these 4 quadrants, surrounding a circular space between 16 and 18 feet in diameter.

When making selections, keep in mind, the diagrams to the right tend to represent a more enclosed configuration, while the ones on the left represent the most engaging.

Note: The example entry data on this board is the data that went into the design of the example unit

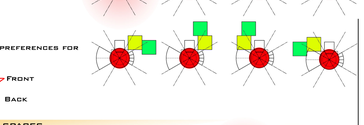
Locating Quadrant spaces

Match you location preferences for the interior quadrants.

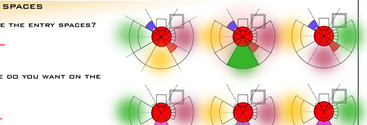


Locating Diagonal "arm" spaces

What layout do your wish to have for the private wings?

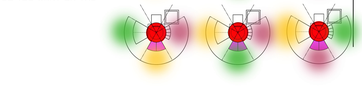


Match you location preferences for the private wings.

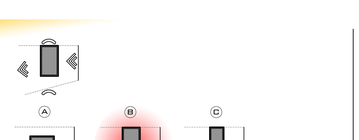


Locating exterior spaces

Where would you like the entry spaces?



Which exterior space do you want on the open quadrant?



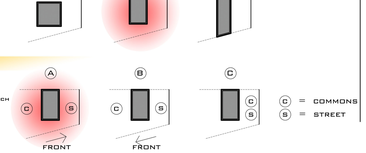
Adjacency:

Match the cardinal direction and its condition:

North – Front
South – Back
East – Open side
West – Closed side

What is the development pattern?

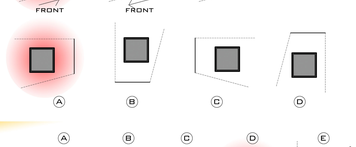
A. Detached - open on both sides
B. Semi-detached - open on one side
C. Townhouse - attached on both sides.



Orientation

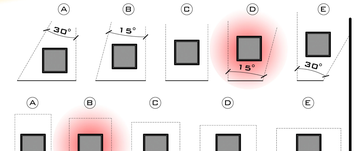
What is considered the "front", according the pattern employed by the particular cluster to which the dwelling belongs?

A. The "front" faces the common green
B. Front faces the street
C. The common green and the street are the same direction



What is the orientation of the front to back gradient?

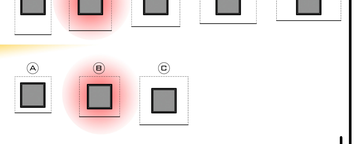
A. Southward
B. Northward
C. Westerly
D. Southerly



Shape

What is the angle created by the side lines?

A. Acute (22.5 - 37.5) opening forward
B. Right (67.5-22.5) opening forward
C. Parallel (less than 5)
D. Obtuse (112.5-67.5)
E. Reflex (37.5 - 22.5) opening backward



What is the ratio of width to depth?

A. significantly deeper
B. Roughly equal
C. Slightly wider
C. Significantly wider

Density

What is the width and depth of the site?

Calculate:
Width X Depth = area

Based on the area of the site, what is the unit density?

A. High (1 500-2000 sq ft)
B. Medium (2000-2500 sq ft)
C. Low (2500-3000 sq ft)

Materials

Material Selection Criteria:

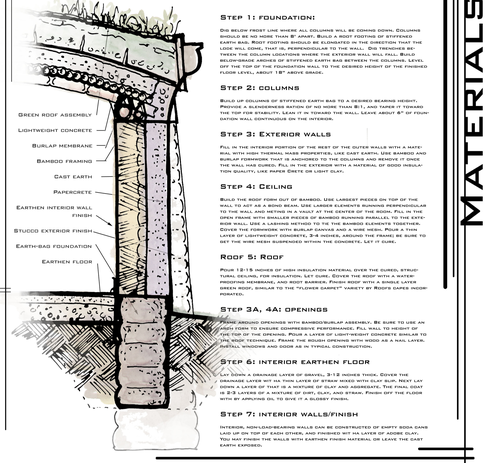
Given the condition of a small, rural community with out alot of capital or aden 15, the building material should be as much as possible harvested from the local region, by local labor. The construction process itself also should use as little mechanized equipment, if any at all. Instead it should be a system that is readily assembled by manpower alone.

The material should allow for on-site adaptation on the fly to specific site conditions unforseen by the designer. Window locations especially should be adjustable to create the best possible framed views.

Materials list:

- Bamboo
- Papercrete
- Lightweight concrete
- Stabilized earth
- Cast earth
- Earthen floors
- Green roof

- Green roof assembly
- Lightweight concrete
- Burlap membrane
- Bamboo framing
- Cast earth
- Papercrete
- Earthen interior wall finish
- Stucco exterior finish
- Earth-bag foundation
- Earthen floor



Material design Consequences:

Because natural, locally harvested materials will tend to be compressive in nature (hight tension strength materials like steel require centeralized infrastructure and high energy input to produce, resources typically not available to rural communities like cannonball,) the form of the building will have to employ the vast, almost exclusive usase of arches, domes and vaults.

Walls will be thick, especially the exterior, in order to achieve the required structural and insulation value.

Step 1: foundation:

Dig below frost line where all column will be coming down. Columns should be no more than 8' apart. Build a post footing of stamped earth ball. Post footing should be elongated in the direction that the load will bear, that is, perpendicular to the wall. Do trenches between the column locations where the exterior wall will fall. Build molded-base arches of stiffened earth ball between the columns. Level off the top of the foundation wall to the desired height of the finished floor level, about 18" above grade.

Step 2: columns

Build up columns of stiffened earth ball to a desired bearing height. Provide a slenderness ratio of no more than 8:1, and taper it toward the top for stability. Lean it in toward the wall. Leave about 8" of foundation wall continuous on the interior.

Step 3: Exterior walls

Fill in the interior portion of the west of the outer walls with a material with high thermal mass properties, like cast earth. Use bamboo and burlap formwork that is anchored to the columns and beams of once the wall has dried. Fill in the exterior with a material of good insulation quality, like papercrete or light clay.

Step 4: Ceiling

Build the roof form out of bamboo. Use largest pieces on top of the wall to act as a bond beam. Use larger elements running perpendicular to the wall to act as a tie beam. Use smaller elements to span the open space with similar pieces of bamboo running parallel to the exterior wall. Use a lashing method to tie the bamboo elements together. Cover the framework with burlap canvas and a wire mesh. Pour a thin layer of lightweight concrete, 3-4 inches, around the frame; be sure to set the wire mesh suspended within the concrete. Let it cure.

Roof 5: Roof

Pour 12-15 inches of high insulation material over the cured, structural ceiling for insulation. Let cure. Cover the roof with a waterproofing membrane, and roof barrier. Finish roof with a sod layer, green roof, similar to the "flower gardens" variety of Roof's open model formats.

Step 3A, 4A: openings

Frame around openings with bamboo/burlap assembly. Be sure to use an arch form to endure compressive performance. Fill wall to height of the top of the opening. Pour a layer of light-weight concrete similar to the ceiling technique. Frame the region (minus with wood as a nail layer. Install windows and door as in typical construction.

Step 5: interior earthen floor

Lay down a drainage layer of gravel, 3-12 inches thick. Cover the drainage layer with a layer of compacted earth with clay as a binder. Next lay down a layer of that is a mixture of clay and aggregate. The final layer is 2-3 layers of a mixture of dirt, clay, and straw. Finish off the floor with by applying oil to give it a glossy finish.

Step 7: interior walls/finish

Interior, non-load-bearing walls can be constructed of empty soda cans laid up on top of each other, and finished wit ha layer of adobe clay. You may finish the walls with earthen finish material or leave the cast earth exposed.

Design Variation

The drawing below are example plans of alternative products of this system

Design Parameters:

The following text explain a brief overview of the design principles and things to keep in mind about each space.

Quadrant spaces:

Kitchen – An open quadrant will allow the home open social terraces and patios at the front and back of the dwelling to come down up to and integrated themselves with the central living space. This is the most engaging of all the quadrant options, if placed toward the front or back.

Kitchen/dining – This will be the most active and social of all the quadrants. Consequently this space allows for the most amount of interaction with themselves with the central living space. This is the most engaging of all the quadrant options, if placed toward the front or back.

Bathing – This is the most closed and private of the four quadrants, with the least amount of glazing and its position should be largely determined by the user's preference for either an engaging or withdrawn dwelling. Unless necessarily demanded otherwise by user-preference for open/closed-ness- try to place this in the north quadrant, or along an adjoining sidewall.

Diagonal "arm" spaces:

Formal entry – This space should be oriented toward the front of the dwelling, and will connect onto the front terrace, and possibly the garden, if may be adjacent to any of the quadrants, and may even combine with either the kitchen/dining space or main living area.

Service entry – This space should be oriented toward the back of the dwelling, and will connect onto either the garden or back patio, or both.

Combined entry – This space is located on the side of the dwelling, combines the feature of both the service entry and the formal entry, and gives access to both the front and back.

Private wing – Place the wings to the north of the site, if at all possible, or along an adjoining side wall. Provide east facing windows for bed alcoves whenever possible. Locate them adjacent to the bathing quadrant.

Exterior spaces:

Garden – This is a semi-private space on the open/closed spectrum (for an exterior space. The garden may be placed directly next to the living room in its own quadrant, or may be placed "behind" or adjacent to the central space) any one of the other quadrant spaces. The garden should be placed as near as possible to the south edge of the site, or, depending on the context of solar access, whichever position on the site that affords it the most sunlight. Place the garden south of any space in which a direct gain heating strategy exists.

Front terrace – This is the most public exterior space, and is characterized by being on the front, most public side of the house. Place this space on a open quadrant, or behind any of the interior quadrants. It is possible to place this on a side quadrant as well with a wide path leading back to it from the street, but doing so will necessitate the garden being placed toward the front.

Back terrace – This is a relatively public exterior space, characterized by its position at the back of the house. Place this space on a open quadrant, or behind any of the interior quadrants. It is possible to place this on a side quadrant as well with a wide path leading back to it from common green, but doing so will necessitate the garden being placed toward back.

Unit Adaptation:

The following drawings demonstrate the process of how a home can be adjusted throughout its lifetime to adjudicate the changing needs of the user.

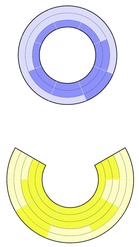
The house when first built as a 2 bedroom, roommate-style dwelling.

The adaptation to a dwelling that will accomodate a married couple. The bath room became a closet, and the second bedroom became a larger bath to accomodate the planned for family.

The adaptation of the dwelling to accomodate 2 children. A second story is added. Also the space was expanded and partitioned as the kids grew into teenagers. After moving out the upstairs could then be transformed into a rentable unit.

Climate

Micro-climate analysis:



What are the microclimate wind conditions, in reference to direction?

1 bar: average wind intensity

2 bars: average wind intensity

3 bars: above average wind intensity

Since wind conditions are less severe to the northwest, restricting placing and providing high insulation to the north becomes less crucial.

What are the microclimate solar conditions in reference to direction?

5 bars: full access
4 bars: slight obstruction
3 bars: moderate obstruction
3 bars: severe obstruction
1 bar: full obstruction

Since solar access is restricted to the direct south, it becomes more important to take advantage of the SSE and SSW orientation for solar gain.

Whatis the severity and direction of the slope?

- Severe
- Moderate
- Slight

With a southward sloping site, it becomes possible to sink the north edge of the building into the earth, providing insulation where it its most crucial, while still allowing solar access to the south where it is most crucial. Making solar gain a more effective strategy, and demanding an elongated east-west axis.

Macro-climate data:

Direction:
Winds blowing from the north and west is prevalent during the winter months, and bears the coldest most severe weather. The wind from the south and east that bears summer weather is prevalent during the summer months.

Design implications:
Be sure to insulate the noth wall especially well and minimize glazing and opening to the north and west because that will bear the brunt of the heat/warming winter wind.

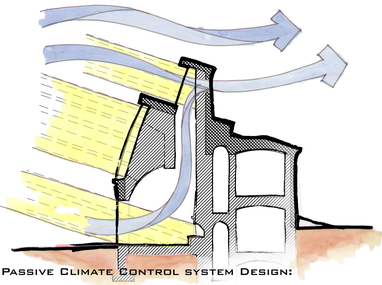
Maximize openings and glazing to the south as that will buffer the least oblique heat load and experience the greatest amount of solar gain.

Direction:
Sun angles are lower during the winter months when heating is required. And steeper during the summer when shading necessary. However, during the fall and spring, while sun angles are the same, the heating and cooling requirements are usually quite different, the spring typically requiring more heating, the fall, more cooling.

The most intense solar gain will occur during midday, when the sun lies directly to the south.

Design implications:
Design the type of shading device that will allow for shading during the winter and early spring and solar access during the summer and fall. This dictates a slope to the shading device of about 13 degrees.

Since solar gain is most effective, orient the thermal mass at a slope of 3:1 degrees



Passive Climate Control system Design:

Intimacy gradient

Lay out the spaces in a building so that they create a sequence which begins with the entrance and the public parts of the building, then leads to the slightly more private areas, and finally to the most private domains.

The flow through rooms

As far as possible, avoid the use of corridors and passages. Instead, use public rooms and common rooms as rooms to move through on the way to other rooms. To do this, place the common rooms to form a chain ... with private rooms opening directly off the public ones.

Tapestry of light and dark

Create alternating areas of light and dark throughout the building. In such a way that people walk naturally toward the light, whenever they are going to important places.

Corner doors

Except in very large rooms, a door only rarely makes sense in the middle of a wall. In most rooms, especially small ones, place doors at the corners and the paths between then along the edge of the room, allowing for the most functional space as possible.

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Sequence of sitting spaces

Put is a sequence of graded sitting spaces throughout the building, varying according to their degree of enclosure.

Common area at the heart

Create a single common area for every special group. Locate it at the center of gravity of all the spaces the group occupies and in such a way that all the paths which go in and out of the building lay tangent to it.

Light on two sides of every room

Locate each room so that it has outdoor space outside it on at least two sides, and then place the windows on the outside walls so that natural light falls into every room from more than one direction.

Ceiling height variety

Let the ceiling height vary according to the intimacy level of the space it encloses. For large public rooms tall ceiling are appropriate, for small intimate spaces, lower ceiling are appropriate.

Couples realm

Make a special part of the home distinct from the common areas and all the children's rooms, where the man and woman of the house can be together in private. Give this place a quick path to the children's rooms, but, at all costs, make it a distinct and separate realm.

Children's realm

Place a small area that will belong entirely to the children in a separate position toward the back of the house. Create a continuous play space starting from this cluster, passing by, but not through, common areas of the substantions the children need, and ending in an outdoor room, connected to the street. Place the children's beds in alcoves or small alcove-like rooms, around a common play space. Make each alcove large enough to contain some floor area where each child has his own things. Give the alcove curtains looking into a common space.

Bathing room

Concentrate the bathing room, toilets, showers, and basins of the house in a single tiled area. Locate this bathing room beside the couple's bedroom between the private secluded parts of the house and the common areas; if possible, give access to the outdoors. Put in a large bath, an efficiency shower and basins, for the actual business of cleaning, and two or three racks of huge towels.

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Entrance Transition

Make a transition space between the street and the front door. Define the path which connects street and entrance through this transition space.

Entrance room

At the main entrance to a building, make a light-filled room which marks the threshold and straddles the boundary between indoors and outdoors, covering some space outdoors, and some space indoors. The inside part may be like an old-fashioned porch; like a hall or sitting room.

Half-hidden garden

Do not place the garden fully to the front nor fully to the back. Instead place it in some kind of half-way position, side by side with the house, in a position that is half hidden from the street, half exposed.

Wings of light

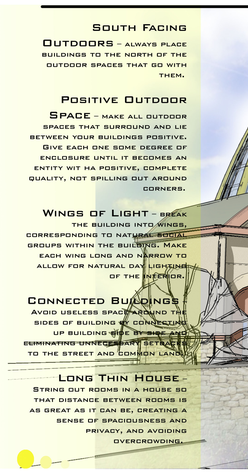
Break the building into wings, corresponding to natural social groups within the building. Make each wing long and narrow to allow for natural day lighting of the interior.

Connected buildings

Avoid useless space around the sides of buildings by connecting up building sites by side and eliminating unnecessary setbacks to the street and common land.

Long thin house

String out rooms in a house so that distance between rooms is as great as it can be, creating a sense of spaciousness and privacy, and avoiding overcrowding.



Teenager Cottage

To mark a child's coming of age, create a place in the home into a kind of cottage that expresses, in physical way, the beginning of independence. Place the cottage attached to the home, but make it a distinctly visible bulge, with its own private entrance, perhaps its own roof.

Home workshop

Make a place in the home where special work can be done; not just a job, but a hobby. Give the workshops a few hundred square feet, and locate it so it can be seen from the street.

Rooms to rent

Make at least some part of the building rentable, when the spatial needs of the occupant diminish (for instance, the kids grew up and move out); give it a private entrance over and above its regular connection to the rest of the house. Make sure that the regular entrance can be easily closed off without destroying circulation in the house.

Private space