

OUTLINE OF PROCESS FOR LAYOUT AND CONSTRUCTION
OF SELF-HELP HOUSING PROJECT IN SANTA ROSA, COLOMBIA

Center for Environmental Structure

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SECTIONS OF PROCESS

The process consists of the following sections:

- SECTION 1. Organization of project and responsibilities of participants.
- SECTION 2. Selection of families.
- SECTION 3. Overall process.
- SECTION 4. Description of neighborhood structure.
- SECTION 5. Description of house patterns.
- SECTION 6. Process for checking the validity of patterns.
- SECTION 7. Layout process of the whole neighborhood on the site.
- SECTION 8. Site excavation of street and view terraces.
- SECTION 9. Selection by the families of area in the neighborhood where house lot will be located.
- SECTION 10. Layout process of site micro-structure. (Streets and lots).
- SECTION 11. Survey of site, transfer of titles, payment for land.
- SECTION 12. Layout process for individual house.
- SECTION 13. Building permits.
- SECTION 14. Organization of labor and use of subcontractors.
- SECTION 15. Construction management.
- SECTION 16. Construction system and cost breakdown of house.
- SECTION 17. Cost control and fund allocation.
- SECTION 18. Construction process for the house.
- SECTION 19. Final staking and excavation of trenches for foundations, by the families.
- SECTION 20. Construction of infrastructure.
- SECTION 21. Construction process of streets and view terraces.
- SECTION 22. Finishing of houses and garden walls.

SECTION 1.

ORGANIZATION OF PROJECT AND RESPONSIBILITIES OF PARTICIPANTS

The aim of the project is to implement a LAYOUT AND CONSTRUCTION PROCESS FOR LOW-COST HOUSES, developed by CES, in which the individual families are involved in the design of their house and neighborhood.

The participants in the project are:

RIAC, the research corporation of the Royal Institute of Architects in Canada, who has invited CES to implement the process in Colombia.

CONSTRUYAMOS, the federation of self-help housing association in Bogota, Colombia. Construyamos is responsible for the construction management of the project.

X_____, a non-profit development agency, in Colombia, to act as the financing and legal organizational body of the project.

CES, the Center for Environmental Structure, a non-profit corporation of architects and contractors, in Berkeley, California. CES is responsible for the design of the neighborhood, the houses, and for the overall implementation of the process.

30 FAMILIES, who will lay out their houses on the site, and contribute 50% of the labor for their construction, under the direction of CES.

A JOINT VENTURE will be formed among CONSTRUYAMOS, (X) and CES. It will be a non-profit development corporation, whose aim is to implement the process in project "Horizontes" in Santa Rosa, and then to continue this in other low-cost housing projects in Colombia.

A basic clause of the Joint venture agreement is that each project generates 15% surplus. The 15% is seed money to be used ONLY for the purchase of land and infrastructure for the development of the next housing project, according to CES's layout process.

SECTION 2

SELECTION OF FAMILIES.

(X) --the development agency-- is responsible for selecting the families who will participate in the project. These families will be selected at least two months before the beginning of the layout process. A formal agreement between each family and the joint venture has to be signed.

The criteria according to which families will be selected are:

- The family understands the need for the layout process, and is willing to cooperate until completion of construction.
- The family lives and works in the area.
- The family is able to contribute 50% of the labor for construction.
- The family is eligible for a bank loan
- The family can provide the initial down payment -- 10-20% of cost of construction.

Another criterion is that there will be a range of income levels in the neighborhood, which can allow for informal forms of cross-subsidies between the families.

SECTION 3

OVERALL PROCESS

The overall project is structured around an on-site layout process.

The neighborhood as a whole, the streets and all individual houses are laid out on the site on the basis of a set of rules, which describe the sequence of steps to be followed by all participants and the families.

The layout process consists of three parts:

- a) Layout on the site of the neighborhood as a whole.
- b) Layout on the site of house lots and small streets.
- c) Layout on the site of individual houses.

SECTION 4

DESCRIPTION OF NEIGHBORHOOD STRUCTURE

The basic overall structure of the neighborhood is described in terms of the following entities and assumptions.

1. There is a main street through the neighborhood, parallel to the contours of the site. The main street is the focal point of the 30 houses. About 50% of the houses will be directly on the main street. The main street varies in width. At some points it gets as narrow as 4-5 meters. There is a part of the street which will be about 12-15 meters wide; this is the focus of the street, a kind of square along it, where a shop and a cafe will be located.
2. Along the main street or in other parts of the site, where the view is the best, there will be view terraces.
3. The houses are two-storey row houses, between 70-100 sq. mt. Each house lot is 150 sq.mt.
4. The main volume of the house is long and thin. It is about 8 to 12 mt. long and 3.5 to 5 mt. deep.
5. The long direction of the house volume is parallel to the contours and the main street. This location will allow breeze and sun into all rooms of the house.

SECTION 5

DESCRIPTION OF HOUSE PATTERNS

All houses of the neighborhood are similar in terms of their overall structure. They will be laid out according to the same patterns. However, each one will be adapted to the particular needs of the family and to the specific requirements of its site. At the end of the process, each house will have its own plan and its own identity.

The following are some basic patterns, to be incorporated into all houses:

1. Each house has a major volume --60% of the total-- long and thin, placed next to the street. Street and main house volume are parallel.
2. There are one or two minor volumes in each house depending on the slope. The minor volumes are placed perpendicular to the major one.
3. There is a part of the garden, level and paved, enclosed by the major and minor volumes, always facing away from the street, and having some connection to the view.
4. The center of the house is the VERANDA.
 - It is about 3 mt. deep and 5 to 6 mt. long.
 - It is an outdoor room enclosed on two or three sides.
 - It is always above ground; it could be raised just one mt. above ground, or it could be up in the air, on the second floor.
 - It is covered with a roof and has columns and railing, along its open side(s).
 - The veranda is always oriented towards the garden; and it is connected with it by a staircase.
 - The veranda is located in the part of the house where the view is best.
5. The main room of the house is the comedor. It is a private room, connected with the veranda, and wide open to it.

SECTION 6

PROCESS FOR CHECKING THE VALIDITY OF PATTERNS

Since CES has developed the patterns for the neighborhood and the house on the basis of second hand information there is a need that the validity of the basic patterns and assumptions be checked.

An extensive verbal description of each pattern and assumption, coupled with a sketch, will be prepared by CES. A representative of RIAC or Construyamos will be responsible for checking the validity of these assumptions, with families living in the area of Santa Rosa. It is preferable if the families which will give insight into these assumptions are not the same families who will participate in the project.

The process for checking their validity is the following: The representative of RIAC or Construyamos will meet with individual families, SEPARATELY, to discuss the assumptions. It is extremely important that he meets one family at a time since the point of the discussion is to get a real insight regarding the extent to which these patterns and assumptions will really work in the context of Santa Rosa.

SECTION 7

LAYOUT PROCESS OF THE WHOLE NEIGHBORHOOD ON THE SITE

The layout of the whole neighborhood takes place on the site, entirely without preconceptions.

The layout process includes the siting and size of street and main square, locating the entrance to the neighborhood, view terraces, entrances to smaller streets off the main street, and the siting and size of smaller streets.

There is a scale model on which decisions from the site are recorded. This allows for a back and forth relationship between an overview of the design of the entire project (model) and reality (site).

The layout process takes one week.

Participants on the site:

Seth (CES)

Construction Manager (Construyamos; to be referred to as CM)

X (Development Agency)

2 representatives from families.

SECTION 8

SITE EXCAVATION OF STREETS AND VIEW TERRACES

Major site structures determined in the site layout process are now established physically on the site by adding and removing earth to shape the main street and view terraces.

The layout will generally follow contours, so the bulk of the excavation will be cut and fill.

The initial earth moving will be done with heavy machinery and therefore, it will be sub-contracted.

~~Any hand work needed will be supplied by families.~~

SECTION 9

SELECTION BY THE FAMILIES OF THE NEIGHBORHOOD AREA
WHERE THEIR HOUSE LOT WILL BE LOCATED

With the excavation done, the site stands divided into areas determined by the streets, main square, and view terraces.

Seth and X will study how the areas relate to one another and will then designate 4-6 separate lot zones.

Families will go to the site to select their first and second choice for their house location. A statement of these choices will be given to X and may include specific reasons why a certain area was chosen.

Groups of families who want to be immediate neighbors will select their choices together.

Seth and X will determine lot assignments based on family choices.

SECTION 10

LAYOUT PROCESS OF SITE MICRO-STRUCTURE
(Streets and lots)

This involves the detailed layout of streets and house lots in the designated lot areas.

Areas are laid out one per day in a predetermined sequence based on the neighborhood structuring importance of each area.

1. Main square.
2. View terraces
3. Junctions along main street.
4. Openings along paths.
5. Smaller paths.

The layout is completed in 6-10 days.

Each day 3-6 families go as a group to the site to lay out their chosen area.

Together they lay out the house lots, the position of house volume and garden, and define in detail the shape of involved streets.

Seth and X guide this process.

Decisions are recorded and checked on the site model.

Adjustments will be made by Seth, after he has an overview of the whole. Changes will be explained to the families.

SECTION 11

SURVEY OF SITE LAYOUT, TRANSFER OF TITLES
AND PAYMENTS FOR LAND

The lot layouts by each group of families is surveyed and recorded the day after they are staked out.

The process for legal ownership (transfer of title) now takes place, with the families paying for the land and receiving title to it.

SECTION 12

LAYOUT PROCESS FOR THE INDIVIDUAL HOUSE

When the families have decided how many square meters their houses will be, the layout process can begin. To initiate the process, a description of the layout steps for the house is given to each family and is discussed. A schedule is set, so that two families go to the site each day to lay out their houses. The families follow the process described in their printed guides exactly, and will have the assistance and guidance of Seth and X. The layout process takes one day, plus an additional half day for minor adjustments. With two houses laid out per day, the process for laying out 30 houses will be completed in 15-20 days.

To provide families, Seth, and X with an overview of the relationships between established and current design decisions, at all points during the process of layout, a site model at 1:100 will be present on site whenever layout work is occurring. Each family is responsible for understanding and taking into consideration the layout of bordering houses as staked out on the site and recorded on the model. The families and Seth update the model at the end of each day, with the addition of 1-2 houses.

Houses along the main street are laid out first, then those above and below.

Seth and X are responsible for the smooth operation of the house layout process.

There are three steps which Seth follows in approving each family's layout:

Mid-morning	Mid-day	Evening
Check sq mt of volumes.	Check relationship of veranda, comedor, and garden.	Final approval
Check location, size, and shape of volumes, and check that corners are square where desired.		

The sequence of the layout for each individual house is:

1st day: Layout on site.

2nd day: Adjustments.

3rd day: A plan and a volumetric sketch are drawn.

SECTION 13

BUILDING PERMITS

There are no permits for individual houses.

There is a permit for a prototype house, the basic construction system, and a prototype layout of the overall plan.

Permits are acquired prior to their associated operation.

SECTION 14

ORGANIZATION OF LABOR AND USE OF SUBCONTRACTORS

The labor for the completion of each individual house is partly family labor and partly paid labor.

Each family is responsible for building its OWN house. It will contribute 50% of total labor, which is about 80-100 man days.

The construction of all thirty houses proceeds in parallel. That means that the foundations of all houses have to be completed at the same time, the walls of all houses at the same time.. and so on. Each operation is allotted a specific amount of time within which it has to be completed, and the family is personally responsible for that.

The labor contributed by the families is structured in the following way: each family contributes two days per week, plus 15-20 days of continuous solid work on the site (most probably structured in two parts) for the completion of the basic shell of the house.

A detailed SCHEDULE OF FAMILY LABOR will be given to each family, listing the sequence of operations, the amount of time they will have to contribute for its completion, and the date it will have to be completed.

50% of the labor is subcontracted. Subcontracted labor is for specific operations, the same for all houses. e.g. concrete second floor slabs. The subcontractor completes the specific operation he is hired for at the same time for all houses.

Subs are organized by the construction manager, not by individual families.

Before construction starts, a LIST OF OPERATIONS will be prepared specifying which operations will be completed by family labor, and which ones by subcontractors.

The criteria for specifying family's and contractors' operations are: complexity and cost of operation, and character of design decisions to be made during the operation.

Families are organized in groups of 3 to 4. There is a leader in each group. He is responsible for organizing them, for keeping a DETAILED RECORD OF REQUIRED FAMILY LABOR for each house of its group --structured in terms of operations-- and for making sure that this is kept.

Families will help each other. However, exchange of family labor will take place only among families of the same group, and it will be planned ahead of time for specific operations that need a lot of hands. e.g. pouring of foundation slab.

SECTION 15

CONSTRUCTION MANAGEMENT

Construction management is organized as follows:

The head of all construction is the construction manager. He is a member of Construyamos, and has the following tasks: schedule of construction operations, arrangements with sub-contractors, ordering of building materials, inspection of work, arrangement for technical assistance, responsibility for completing construction operations within budget.

There is a close collaboration in managing the project among the following three people: the construction manager, (X) from the development agency, and Seth from CES. They have to be a strong team.

- (X) is responsible for controlling the cost of each individual house. He keeps a separate record for each individual house, in terms of materials and labor. He is also responsible for distributing material to groups of families.
- Seth, from CES is responsible for making sure that the process is completely followed by all participants, during layout and construction.

The leader of each group of families is instrumental to the management of the project. He operates on the level of a group of families. He smooths conflicts between families of his group, he is responsible for the information regarding the actual amount of materials needed for each operation, for the houses of his group, and for getting the materials from the builder's yard and distributing them to the families before each operation.

The leaders of family groups have a close working relationship with X from the development agency, and they are responsible to him.

Families play some role in the management of their project, since they are responsible for securing the building materials they receive before each operation, and since they are responsible for completing each operation in time.

Important working relationships:

Seth has individual working relationships with construction manager, each individual family and X.

X has important working relationships with the leader of each group of families.

SECTION 16

CONSTRUCTION SYSTEM AND COST BREAKDOWN OF HOUSE

The construction system is basically the same as the one used by Construyamos in their projects, with minor alterations and adjustments.

The foundation, because of the slope, is a stepped trench following the perimeter of the house and under major interior walls.

Walls are made out of solid brick with concrete posts and perimeter beams.

Concrete slabs.

Bamboo roof with tiles.

Bamboo in the veranda.

The cost of the house is broken down into the following major items:

- A) Cost of land
- B) Cost of site excavation and infrastructure
- C) Cost of foundations
- D) Cost of basic house
- E) Cost of administration
- F) Cost of house finishes and garden walls
- G) Cost of street pavement, stone paths, view terraces
- H) 10-15% profit

(A)+(B)+(C) will be covered by the down payment

(D)+(E)+(F)+(G)+(H) will be covered by the bank loan

(E)+(F) = 9% of (D)

(B)+(C)+(D)+(E) = Construyamos house cost

A detailed breakdown of costs will be provided in separate sheets for items (B),(C),(D),(E),(F),(G).

SECTION 17

COST CONTROL AND FUND ALLOCATION

It is vital to the success of the project that the flow of money for materials and labor is organized such that expenditure cannot go beyond estimated levels. To accomplish this, the construction of the project as a whole and of individual houses, will be monitored constantly, by breaking down the construction into manageable units and evaluating them in terms of material and labor.

Each house will be built in a sequence of 27 operations. Taken individually, an operation's cost can be determined as follows:

1. Materials used in each operation are assigned a basic quantity value in terms of square meters, linear meters, by piece, etc.
2. A per unit cost is found for the unit of material in each operation.
3. A maximum number of units per square meter of house needed, is determined for each material, by evaluating the quantity of material used in a prototypical house. This quantity for each material is the basis for the control of cost and allocation of materials.
4. A price per square meter of house for each operation is found by multiplying the unit price for material by the maximum units allowed.
5. A percentage cost for each operation is given, relative to the total cost of each house.
6. The cost of each house is then determined by multiplying the total square meter price by the number of square meters desired.

After each house is laid out, X and Seth determine the quantity of materials needed in each operation based on the preceding procedure. This provides a definite and detailed cost and material list for all the houses, collectively and individually, and allows for accurate ordering of materials in bulk quantity.

Construction of all the houses will be done in parallel with all the families working on the same operation at any given time. At the onset of an operation, each family will be allocated the exact quantity of materials needed for that specific operation for their particular house. If this quantity is more than that allowed for by the prototype house, then the family is charged extra for the additional material needed.

Responsibilities:

- a. X is responsible for keeping the books relating to cost control and fund allocation.
- b. CM and Seth determine the quantity of material needed for each operation based on a prototype house, and set appropriate unit costs.
- c. CM determines the cost per unit and operation.
- d. Seth and X determine the quantity of materials needed for each operation in each house based on the family's layout.
- e. X informs CM of the collective quantity of materials the families need, prior to the operation they are needed for.
- f. X gives surcharges to families using more materials than the maximum allowed in any given operation.
- g. CM orders materials and X delivers them to the individual family groups in the exact quantities needed.
- h. X alerts Seth to families having difficulty staying within the material limits.
- i. CM and Seth determine ways in which families with difficulties can reduce cost in future operations, so that they can get back on track and avoid financial burden.
- j. The individual families are responsible for staying within their means and the general material guidelines specified by CM and Seth. Families are also responsible for their materials after they have received them.

SECTION 18

CONSTRUCTION PROCESS FOR THE HOUSE

One of the beauties of this process is that many design decisions are made during the construction process. The definition of operations and their sequencing are specifically designed to allow and require families to make vital choices in the appearance and function of their houses, while they are building them. Most decisions about the design of a part of a building are best made just prior to the construction of that part. The height of a ceiling is best determined when one is able to stand on its accompanying floor, not by making a drawing in some distant office. The same is true of windows. It is impossible to determine the best position for a window, without first being able to experience the room it will light and the views it might provide. Examples like these exist throughout the design of any building. The construction process then, functions as a complete integration of construction and design, one not separable from the other without disrupting the development of the whole. It is a process that goes step by step, one operation leading naturally to the next; the house growing and developing both physically and emotionally as it is shaped by the family.

Operations:

1. Step foundation, brick or block to ground floor level.
2. Perimeter bond beam, grade beams for interior walls, and slab. Rough-in under slab plumbing (sewer and water).
3. Chalk in the ground floor layout (rooms, stairs, doors).
4. Mock-up ceiling heights.
5. First floor columns.
6. Perimeter and interior beams and second floor slab.
7. Stair.
8. Chalk in second floor layout.
9. Mock-up second floor ceiling heights.
10. Second floor columns and beams.
11. Terrace.
12. Roof structure.
13. Roof tiles.
14. Interior walls.
15. Mock-up windows and doors.
16. Brick infill to window sills.
17. Sills.
18. Brick to lintels of windows and doors.
19. Lintels.
20. Complete brick infill.
21. Stretch exterior across gable ends.

- 22. Mock-up windows and doors.
 - 23. Make windows and doors.
 - 24. Install windows and doors.
 - 25. Second floor ceiling.
 - 26. Plumbing fixtures (toilet, sinks, shower, lavadero).
 - 27. Electrical fixtures (lights, switches, outlets, etc.)
- Note: Rough-in operation depends on technique used.

Each building operation will be described in terms of the steps it includes to be completed. The following is just an example of three operations: step foundation, perimeter bond beam, terrace.

Steps in each operation:

- 1. Step Foundation
 - a. Trim trench work.
 - b. Formwork.
 - c. Steel.
 - d. Concrete
 - e. Brick or block to ground floor level.
- 2. Perimeter bond beam, grade beams for interior walls, slab, rough-in plumbing under slab.
 - a. Form perimeter for bond beam, and slab.
 - b. Fill foundation cavity with earth to support slab.
 - c. Check interior layout of ground floor and form grade beams for interior walls.
 - d. Lay steel and stub up for columns.
 - e. Rough-in under slab plumbing for sewer and water; hook up to main.
 - f. Pour concrete.
- 3. Terrace
 - a. Mock-up terrace.
 - b. Footings.
 - c. Erect cuadro frame.
 - d. Terrace floor.
 - e. Stair to garden.
 - f. Balustrade.

SECTION 19

FINAL STAKING AND EXCAVATION OF TRENCH FOUNDATION
BY THE FAMILIES

Excavation for foundations begins the day after each family lays out their house.

Because just two homes are laid out per day, there is much lag time from the time some families lay out their houses until others begin. This allows for an exchange of labor on excavation, between families who are scheduled some days apart. If the first two families are helped by the two middle families, the second two by the two families after the middle two, and so on, then, when the middle families are ready to excavate, the process reverses and continues until all foundation excavations are completed.

X is responsible for the smooth operation of labor exchange for excavation.

SECTION 20

CONSTRUCTION OF INFRASTRUCTURE

This construction involves the placing of water lines and sewer pipes under the major and minor streets and stubbing up for individual unit access.

The construction of infrastructure is subcontracted.

Work begins as soon as lots are defined and surveying is completed.

House layout and infrastructure proceed in parallel.

SECTION 21

CONSTRUCTION PROCESS FOR STREETS AND VIEW TERRACES

Operations:

1. Finish grade main street.
2. Locate street furniture (fountain, raised cafe terrace).
3. Mock-up street paver patterns.
4. Form guadua grid for pavers.
5. Pour concrete.
6. Grade minor paths.
7. Mock-up stair layout and paver patterns.
8. Form steps and pavers.
9. Set stones and pour concrete.
10. Mock-up view terraces in detail.
11. Retaining walls.
12. Grade view terraces.
13. Locate furniture (benches, balustrade, sitting walls).
14. Mock-up paver patterns.
15. Form pavers and any steps.
16. Set stones and pour pavers.
17. Mock-up furniture for main street, paths, and view terraces.
18. Make furniture.
19. Remove all forms and seed between pavers.

Operation Steps:

4. Form guadua grid for pavers.
 - a. Cut 3" diameter guadua to paver dimensions.
 - b. Cut 45 degree ends on guadua.
 - c. Lay out grid, securing guadua with wire 'U' stakes.
 - d. Pour concrete.
 - e. Remove guadua.
 - f. Seed.

SECTION 22

FINISHING OF HOUSE AND GARDEN WALLS

Operations:

1. Mock-up garden/path walls (height, thickness, materials, degree of transparency).
2. Trench for wall footing.
3. Pour concrete footing.
4. Finalize mock-up of walls.
5. Build walls.
6. Plaster house exterior.
7. Plaster house interior (walls and ceiling).
8. Finish floor.
9. Paint windows and doors.
10. Paint exterior.