CHAPTER 3

CONTEXTUAL KNOWLEDGE ASSIMILATION

The complementary fields of shape grammar, genetic algorithm and the process of geometric optimisation are being combined for the purpose of generating housing layout plans for fishermen. Rules and relationships that define the settlement pattern and growth are extracted by studying existing organic settlement patterns and from knowledge derived from practice. The layout generative mechanism is driven by these rules and relationships so that the generated solutions reflect the characteristics of the studied settlement patterns. The final output that is required and the scale of complexity that is to be analysed are decided before attempting to extract knowledge from any complex system in order to capture the phenomena of interest and to focus on the right level of description and detail to answer the question in mind. The question here is to capture the complexity at the settlement pattern level and the output is expected to be a base conceptual drawing of a layout which would help the designer to shape his/her final solution on/with it. Therefore the studies done to extract knowledge were mostly based on the settlement level and concentrated on the growth influences, patterns, elements vs. activities and compositions of the settlement. Studies were done on site for several fishing settlements to extract this design knowledge.

The aim of the on site case studies is therefore to understand the concepts and criteria that make up the design knowledge of a complex fishing settlement. The concepts and criteria are based on the activities of the fisher folk and the important building elements, spaces that are integral in their life.
The structure or the underlying pattern in which the settlement is organized, the ordering elements involved and the networks that tie up these also contribute to the design knowledge. The various possible alternatives and the categories that exist amidst various case studies are sorted out based on the structure and ordering elements. Recurring ordering elements amidst the collected data are identified and the spatial relations between them analysed. After identifying the basic rules and relations involved in the making of the settlement, which exist because of personal and social desires congealed through time, the knowledge is abstracted and represented as diagrams.

This chapter gives a detail report of the studies done for the extraction of knowledge from the fishermen’s settlements that have naturally evolved and the assimilation of the knowledge into rules and relationships that lists out the shape grammar. It also lists out certain design decisions taken by the researcher considering practical issues like cost efficiency, land value, sustainability etc.

3.1 SELECTION OF CASE STUDIES

To extract physical knowledge from the fishermen’s settlements, an organized pattern of working was essential and the work plan started with the identification of organically grown fishermen’s settlements that have evolved naturally from their environment, and are formed by simple rules and relationships derived out of necessity and convenience through time. A general study of the coastal areas of TamilNadu both with respect to Tsunami affected zones and otherwise revealed a wealth of fishermen’s settlements, which have evolved with time. The coastal districts of Kanyakumari, Tutucorin, Ramnad in TamilNadu and Trivandrum district in Kerala were identified for the study. (Figure 3.1) by the researcher (Figure 3.1).
The criteria for the choice of the settlements were

- The primary occupation of the settlement dwellers should be fishing
- The settlement should have naturally evolved with time and should have recognizable rules ordering the structure.
- The underlying structure and the relationships tying up the elements should be strong and still active.
- Basic infrastructural facilities like water, electricity, road network should be integrated in the structure of the settlement.

The study area was limited to south TamilNadu and south Kerala. The settlements chosen and studied by the researcher based on the above criteria were Muttam, Colachel, Mandaikadu and Kotilpadu in Kanyakumari district, Vaembar seacoast colony in Tutucorin district, Naripatyr, Rojma...
nagar (Kannirajapuram) and Mookaiyur in Ramanad district and Adimalathura in Trivandrum district. The study area was limited to south TamilNadu and south Kerala.

The work plan included a visual assessment survey of the selected sample settlements. A study of the daily routine of the fishermen with respect to the spaces and the building elements are undertaken and the key design elements of the settlement are identified. Their physical characteristics are studied. The rules governing the growth of the settlement and the relationships between elements are identified. These rules and relationships are abstracted into diagrams, which would form the shape grammar for designing and generating the layout solutions.
3.2. ANALYSIS OF DATA

The variety of solutions was analysed by adjudging the key elements and the features and relationships that exist amidst each one of them. The common key elements are the beach which is the prime ordering element in all the settlements, the community centre, a link pathway between the community centre and the beach which was primarily the main pathway in the settlement, secondary pathways emanating from the main pathway and connecting all the dwelling units and the varied sized dwelling units. Appendix 2 shows a list of photographs of the important elements in the case studies. It was found that the beach is a multipurpose space in all the solutions. It is used as an occupational space (for parking boats, mending nets, auctioning etc.), as a recreational space for the fishermen and the children to relax and play, as a sleeping space during warm nights. The community space is a very prominent space and it could be used for commercial or recreational purpose. The pathways connect the beach open space and the community space and also lead to the plot units. The pathways are rarely linear; they meander along with varying width all through. All plot units are connected to the pathways. The plot units are varied in size and form yet share some basic features such as open yards, multi purpose rooms. The case studies led to a categorization based on the location of the key elements and the relationships that exist between them.

- Position of the sea with respect to the settlement.

- The position of the community center – either on the beach or away from it.
• The boundary conditions – either environmental barriers or sometimes man made boundaries such as a highway.

• The connections or the pathways linking the various elements of the settlement.

It is apparent from the analysis of the chosen settlements that most fishing dwellers considered proximity to the beach as the most important factor in the positioning of the settlement. In Colachel, Kanyakumari district, the seashore has a slight bend and the settlement aligns itself to it. (Figure 3.3). In Muttam, Kanyakumari district, the sea is on two sides of the settlement and the settlement pattern responds to the seashore on both sides (Figure 3.4).

The community centre in most of the cases is a religious structure and is most commonly placed slightly off the seashore. The religious structure formed the first major element of the settlements and it initiated an axial development and became a prime focus in most of the settlement layouts. In Colachel, Kanyakumari district, the church forms the central element for various types of settlements and the fishing community sprawls in its forefront near the sea. (Figure 3.3). The community centre is right on the beach in the Mandaikaadu settlement of Kanyakumari district and the primary connections become parallel to the shoreline. (Figure 3.6). In Naripaiyur, Ramnad district; (Figure 3.7) a mosque forms the community centre of the Muslim dwellers that have settled here earlier than the Christians and occupy the western side of the settlement. The Christians occupy the eastern side with their settlements weaved around a church and a small chapel. With time these two dwellers have mingled well and the strong distinction of spaces has dissolved. Rojma Nagar, Ramnad district (Figure 3.8) is primarily a Christian community and has a chapel right on the beach, which is linked directly to the church by the main pathway. The settlement spreads along this pathway on
either side. A similar situation exists in Vaembar seacoast colony in Thuthukudi district (Figure 3.5), but here a temple and a church is in close proximity and creates an interesting community space.

The primary connections are perpendicular to the seashore in most cases, e.g., Rojma Nagar (Figure 3.8) and Mookaiyur (Figure 3.9) in Ramnad district, Vaembar sea colony in Thuthukudi district (Figure 3.5) and in Kotilpadu in Kanyakumari district (Figure 3.10). Certain solutions were distinguishably linear. This was because of the strong linear force exerted by an important commercial road or a highway (in some cases a canal). In Adimalathura in Thiruvananthapuram district (Figure 3.11) and Mandaikadu in Kanyakumari district the connections run parallel to the seashore because of a strong delineating highway and in the latter because of the community centre, which is placed, near the seashore. In all the settlements the fishing activities like net mending, boat repair, drying, auctioning etc., is done right on the seashore. In Vaembar sea colony the Vaembar River forms a natural barrier to the growth of the settlement on one side. In Kotilpadu and Mandaikadu settlements during the British rule a canal was built along the beach to drain off seawater during high tide. This canal called the Victoria Maharani canal, which runs parallel to the beach, encourages a linear growth. Similarly in Adimalathura there is a highway parallel to the seashore, which has restricted growth and has promoted a linear settlement pattern that is parallel to the beach. In Mookaiyur there is thick vegetation on one side, which forms a boundary.

The smallest of the settlements studied Mookaiyur had a population of 100 dwellers of which almost all of them were fishermen. The settlement in Colachel town, Vaembar sea coast colony and in Adimalathura were among the biggest settlements studied and there were about 500 fisher folk in the studied area (as in the figure). There was a random distribution of the plot sizes noticed in all the settlements. In most of the solutions the plot size did
not adhere to any caste or land value considerations though in history there was a rigid demarcation of land among different caste. This is basically due to the partitioning of property with time and the uneven distribution of economy amidst various castes due to education and job opportunities abroad. This organic development and metamorphosis of the settlement pattern at this point of time in history is considered vital for the complexity of the settlements. The dwelling units are the only private spaces for the fisher folk and there exists a variety in its form, which has responded to the individual needs and activities. Most plot units have a back open space and some have a front open space. The basic dwelling comprises of a multi purpose room, a kitchen and a bathroom along with the yard.

Figure 3.3: A fishing settlement at Colachel, Kanyakumari District, TamilNadu.
Figure 3.4: A fishing settlement at Muttam, Kanyakumari District, TamilNadu. (Source: Study done by II yr B.Arch students of the School of Architecture, Anna University, Chennai for Rural Design studio during February 2002.)
Figure 3.5: A fishing settlement at Vaembar, Thuthukudi District, TamilNadu.  
(Source: Study done by the researcher on August 2005)
Figure 3.6: A fishing settlement at Mandaikadu, Kanyakumari District, TamilNadu.

(Source: Study done by the researcher on June 2005.)
Figure 3.7: A fishing settlement at Naripaiyur, Ramnad District, Tamil Nadu. 
(Source: Study done by the researcher on August 2005.)
Figure 3.8: A fishing settlement at Rojina Nagar, Kannirajapuram, Ramnad District, TamilNadu.

(Source: Study done by the researcher on August 2005.)
Figure 3.9: A fishing settlement at Mookaiyur, Ramnad District, Tamil Nadu.
(Source: Study done by the researcher on August 2005.)

Figure 3.10: A fishing settlement at Kotilpadu, Kanyakumari District, Tamil Nadu.
(Source: Study done by the researcher on June 2005.)
3.2.1 The structure of the fishing settlements.

The data collected from the analysis of organically grown fishermen’s settlements formed a corpus of design knowledge. Appendix 1 gives a list of photographs showing the salient features of the settlements. The structure on which most of the fishing settlements were ordered were analysed. The general structure is listed below

- An open space in the beach area and the community space (which could be a religious building/ institutions/ commercial spaces) serve as the prime nodes of activity.

- The connections between the nodes are not necessarily the shortest – Meandering connections add to the character. *(Figure 3.12)*.
• Almost all the connecting pathways lead to the beach area.

• Interconnecting pathways running in between pathways connecting a pathway and another or a pathway and a node, is common.

• The pathways form the edge or lead to the nodes, but never do they cut across the nodes.

• The width of the interconnecting pathways is definitely smaller than the major pathways.

• The interconnecting pathways are at least 2 house units apart.

• The periphery of the pathways and the nodes are lined with housing units.

• The size of the housing units did not follow any positioning rules, i.e., they were not grouped together depending on sizes or typologies.

• Wall to wall constructions is most common, this has happened over time due to partitioning of property within family.

• Most houses have a front entry and a back entry.

The data collected from various settlements formed the base knowledge, which was then synthesized using the functional, topological and dimensional analysis.
3.2.2 Functional, Dimensional and Topological analysis

In order to obtain the formal compositions of the building elements and the knowledge pertaining to the fishermen’s settlements, the typologies were analysed based on function, dimension and topology. The functional characteristics determine the activity in each zone, dimensional characteristics determine the dimensional limits and the area involved, and topological properties determine the adjacency relations between spaces. (Cagdas 1996)

The settlement sprawl differs based on various conditions such as boundary conditions, rate of urbanization, and vicinity to important towns and so on. A table showing the physical characteristics of all the case studies is given in Appendix 3. The smallest of the settlements was spread in an area of about 5000sq.m with a population of about 100 fisher folk (Mookaiyur, Ramnad District), while the biggest of the settlements studied had an area of about 12500sq.m with a population of about 500 (Fishermen’s settlement in Colachel town, Kanyakumari District).
The community open space occurs in front of the community center and its width and depth is variable and it is often determined by the importance of the community centre in the settlement. In settlements were the community centre is on the seashore, the beach open space and the community open space mingle with each other. The beach open space is the open space in and around the vicinity of the beach, which accommodate the fishing activities. The size and shape of it is determined by the existing physical conditions.

Pathways serve the purpose of connecting various elements. They could be categorized as two, based on their width and the elements that get connected by them, interconnecting pathways and main pathways. Interconnecting pathways are generally smaller in width when compared with the main pathways and they run in between pathways. If the settlement consists of a ‘growth prohibited zone’, that is zones where growth is restricted like dense vegetation, steep slope etc., then there is at least one interconnecting pathway (more often more than one) leading to it. The main pathways mainly connect the beach open space and the community open space. Their width is more than the interconnecting pathways. Both the main pathways and the interconnecting pathways are set at least two dwelling units apart. They do not cut across any open space but they either lead to it or run around it. The secondary pathways have varied width ranging from 2m to 4.5m. Its length varies and it generally connects 4 to 10 dwelling units. The width and length of the main pathways range from 5m to 10m and 6 to 12 dwelling units respectively.

The plot units are of varied sizes and there is no grouping of similar house types. The activity of the household is primarily done in the outdoors with the house as such used only for private activities. The house units are of
varied size and shape, the average area being 40sq.m for the smaller plots and 120sq.m for the bigger ones. Each house is associated with an open space. The front open space in some cases is just a ‘thinnai’\footnote{A thinnai is a pillared open verandah in front of the house meant to entertain guests and for sleeping during warm nights.}. There is invariably a back open space, which involves activities such as drying of fish, net mending, bathing and even cooking in some cases. The size of the back open space ranges from 10sq.m in smaller units to even 50sq.m in the bigger ones. The basic house comprises of a multipurpose room, a kitchen and a bathroom. In economically low households, cooking and bathroom facilities are taken to the yard. The number and size of the multipurpose rooms increases as the economy of the dweller increases.

Other factors like social sustainability, economics had to be considered for the research to be actually applicable in practice. Selection of appropriate house form (individual stand-alone units to multi-storied flats), considering the social characters, livelihood characters, capacity/affordability for operation and maintenance, adjustability to change according to the family needs, and the other factors like environmental considerations and technical feasibility, has to be made for planning a sustainable human settlement. Keeping these factors in mind a research decision of using a cluster settlement containing units of town houses has been consciously made.

A Cluster Settlement is defined as a group of similar or different types of houses numbering over 20 units located in a block of land sharing common utilities and infra structure. A cluster settlement has been proposed keeping in mind the strong communal interactions by way of work / relaxation which prevail in the fishermen commune. Town House is a self-standing multistoried housing unit, with front and rear open space and a possibility of attaching units side-by-side and arranging in clusters or in linear
forms to achieve higher densities, (Fig 3.13). Town House offers the following advantages over Flats, in low-income applications, (Hemantha 2005).

- Management of many common elements including maintaining them is often an expensive and complicated activity, often beyond the capacities of poor irregular income earners. Common problems are colour washing external walls, repairing leaking water lines, roof repairs, wastewater leaking from upper stair slab to down stair house. In the coastal areas proper maintenance will be more important due to high salinity of the environment. Town houses support individual family living without significant dependency on neighbors for management / maintenance of dwelling.

- Town Houses offer more autonomy. Design can address specific user requirements; Number of rooms, floor area requirements, aesthetics to suit individual tastes etc.
Figure 3.13: A Town House - Plans.
(Source: National Housing Development Authority, Sri Lanka.)

- Town Houses stand on an individual land plot, offering garden space, and space for individual on-plot sewage/waste disposal (Cesspit / septic tank, compost bin etc.). Periodical emptying of septic tanks too will be within the self-capacity of the dweller. Individual water and electricity connections to the unit offer simpler self-maintenance possibilities. Therefore town houses are less costly and affordable to poor.
Moreover fishermen should be settled close to the sea. Availability of land is a prime concern and therefore, high-density units such as offered by town houses are more viable.

The analysis of the data thus done, the assimilated knowledge has to be represented so that it could be communicated to the computer. This requires the diagrammatic abstraction of the knowledge and the formulation of rules using shape grammar.

3.3 DIAGRAMMATIC ABSTRACTION

In this research, the distinct and deliberate pattern of hierarchy of spaces wherein a gradual transition from private space at the household level to semiprivate spaces around the house to public spaces at the beach and around the community centers, is identified as the feature that enriches an organic settlement. These features along with the functional, dimensional and topological features that were learnt from the case studies and were decided based on practical knowledge were abstracted into diagrammatic rules and conditions e.g., Fig. 3.14 to Fig. 3.19. Abstraction provides a means of knowledge base reasoning and supports analogical reasoning as well. These conditions are fundamental and elementary and are framed so that they are not prototypical of any particular instance or context. When applied recursively and randomly on a particular context they are expected to generate solutions that would have the characteristics of a naturally grown fishermen’s settlement. These conditions were structured keeping in mind the level of detail of the final expected output, which is a conceptual design drawing. The knowledge acquisition was complete after the reasoning done with the diagrammatic representations.
Figure 3.14: Features regarding the open spaces learnt from the case studies done by the researcher.
MAIN PATHWAYS CONNECT THE IMPORTANT NODES, (BEACH AND COMM’Y CENTRE). THE SECONDARY PATHWAYS RUN IN BETWEEN MAIN PATHWAYS.

THERE IS ATLEAST ONE SECONDARY PATHWAY WHICH LEADS TO THE GROWTH PROHIBITED ZONE.
Figure 3.15: Features regarding the pathways learnt from the case studies done by the researcher.

**THE MAIN PATHWAYS HAVE A MINIMUM WIDTH OF 1 GRID (GRID SIZE SPECIFIED BY USER) AND THE SEC-PATHWAYS HAVE A MINIMUM WIDTH OF \( \frac{1}{2} \) GRID.**

**THERE ARE ATLEAST TWO PLOT UNITS IN BETWEEN TWO PATHWAYS**
Figure 3.16: Dimensional features regarding the pathways learnt from the case studies done by the researcher.

THE BEACH ATTRAJECTS THE PATHWAYS TOWARDS IT.

THE BOUNDARY Restricts the pathways.

THE BOUNDARY Restricts the proliferation of the pathways.

THE BEACH ATTRAJECTS THE PATHWAYS TOWARDS IT.
Figure 3.17: Constraints regarding the pathways learnt from the case studies done by the researcher.

PLOTUNITS EMANATE ALONG THE PERIPHERY OF THE PATHWAYS AND OPENSPACES.

FRONT YARD SPACE IS DEMARCATED ALONG THE EDGE OF THE PLOT FACING THE PATH OR THE OPEN SPACES.
Figure 3.18: Features regarding the plot units learnt from the case studies done by the researcher.

- Dwelling units are demarcated in between the front and back yards. Small plot units do not have a front yard.
- Back yard space is demarcated along the edge of the plot opposite to the entrance.
- Dwelling units have only back yard space.
3.4 SHAPE GRAMMAR RULES FORMULATION

The design knowledge acquired is converted into a shape grammar which acts as a source for the derivation of designs, controls and guides the design process and allows the designer and computer to evaluate the results of designing. The shape grammar captures the spatial relations between different types of spaces (such as the beach, the community space, the pathways, the dwelling units) and defines the boundaries and conditions within which the design generation could take place. The shape grammars extracted from the case studies are shown in Figure 3.20. Rules in the figure though repetitive are vital for the working of the program which relies on directions and orientations of the site.

Rule 1 to Rule 14 specifies the positioning of the beach with respect to the site and the public space around the beach. It specifies the maximum sprawl of the beach open space given the positioning of the beach.

Rule 15 to Rule 18 specify the sprawl of the community open space with respect to the positioning of the community centre. These rules specify that the community centre have to be directly in contact with the community open space.

Rule 19 to Rule 46 specifies the possible direction the main pathway could take given the positioning of the beach open space and the
community open space. They specify the restrictions as well as the relationships that the open spaces exert on the pathway.

Rules 47 to 50 specify the placing of the primary units along each side of the pathway and the possible points where the secondary pathways could shoot off. Rules 51 to 58 indicate the arrangement within a plot unit and it shows the placement of the front and back yards with respect to the path. Rules 59 to 66 show how the yard spaces can proliferate inside the plot unit.
Figure 3.20 Shape grammar of the fishing settlements.

The rules specifying the positioning of the beach and the associated beach open spaces (Rule 1-14), the community open space associated with the community center (Rule 15-24), the positioning of pathways and their directions (Rule 19-46), the positioning of primary units (Rule 47-50) and the arrangement of the plot interior. (Rule 51-66).
and demarcate the dwelling unit thus defining a town house specified in the previous section.

These abstract rules and relationships derived from the case studies describe the grammar that the generated solutions will follow. The context in which the grammar is applied and the decisions of the designer together with the shape grammars and an inherent randomness in the space generation process spell out the character of the layout design that is generated in this research. The assimilation of data thus fully made the next step is to use this data to generate the layout, which is dealt with in the next chapter.