1. Research Objectives:

This project proposes a generative model for a layout of an organic settlement, in particular fishermen’s settlements. It attempts to harness and integrate some of the qualities of organic design process into computer-aided design, capture the complexities of an organic solution and apply it to the housing design decisions. The two complementary fields of Shape Grammar and Generative Evolutionary Design have been converged for this purpose. Shape Grammar is used to extract the style and aspects of organically evolved fisherman’s housing settlement. Generative Evolutionary Design which uses genetic algorithms as a search mechanism is used to explore alternatives and to evaluate the generated design for its functional and usability values and identify the fitter solutions.

2. Evaluation Criterions:

As the design solutions are generated its fitness measure is evaluated simultaneously and calibrated on a scale of 10. A fitness function is some measure of efficiency, utility or goodness that we want to maximize in our solutions. The variables considered for the evaluation of each solution is categorized as follows: The first set of variables are parametric criterions, which calculate the built up area, open space area, area of ambiguous space, density, etc., The criterions are based on the ‘Guidelines for Planning, Design and Implementation of Cluster Housing’ given by the Ministry of Housing and Construction Industry of Sri Lanka, for the Post Tsunami rehabilitation work on 14th January 2005. The second group of variables are for analyzing the quality/ comfort of the dwelling unit based on criterions such as ventilation, lighting etc., National Building Code, (NBC) gives a very detailed
literature for the calculation of ventilation, lighting conditions inside a building. The third group of variables analyzes the whole settlement pattern for its harmony amidst complexity. The principles of Kevin Lynch (1960) have been integrated with the mathematical theories of Nikos A. Salingaros and has been used as a fitness criterion in this research.

3. Preliminary Results

The coding is done with Auto LISP in the Auto CAD environment. Auto LISP is chosen for its cross software compatibility and also because it helps in treating units as separate line/other entities which could be directly utilized or altered for further design process. The model consists of a simple square unit of usable space (shape unit) comprising of four line entities which proliferates along its edges. The edges are chosen randomly and thus it opens up more possibilities. A set of simple rules and restrictions which function continuously, generate a complex shape randomly. These shapes form the boundaries for spaces like community centre, pathways, interconnecting pathways, plot sizes etc. Open spaces are generated along the sides of the beach and around the community centre. A pathway connects the two spaces, and there is a secondary pathway running in between the pathways. The pathways and open spaces are flanged by the random arrangement of the plot units whose area is fixed but the shape varies randomly.

After the open spaces and the pathway configurations are fixed, several iterations could be run to generate the plot units and the dwelling units. Inside each plot unit the dwelling units and the open yard spaces are generated depending on the area specified. The result varies on different runs because the addition rules are randomized. Thus confirming design as a restless movement between accident and rationality. The fitness of each solution is evaluated and the results are tabulated and stored as a text file along with each drawing file. After several iterations an initial population would have been generated. Now reproduction, cross over and mutation occurs to generate a new generation of members.

The search for the optimal solution keeps occurring as the process continues. Human choice and judgment in selecting the various possibilities is also possible. The potential solution space is very huge and the Genetic designing techniques involved, explores the solutions in a non-linear way. Though Nonlinearity results in a combinatorial explosion, the implicit parallelism in the Genetic Design technique allows it to surmount even this enormous number of possibilities, successfully finding optimal or very good results in a short period of time.
4. Conclusion

Genetic design uses the fitness function to choose the ‘best’ solution and makes sure the objectives of the design are satisfied. The fitness function in this project has been derived and modeled on real-life situations/case studies. Many parameters such as space optimization, shape optimization, thermal effectiveness, lighting and ventilation, imageability and legibility, that are problems which could be improved only at the expense of another, are involved in this design process. Intrinsic use of parallelism enables the tool to produce multiple equally good solutions to the same problem, and a human overseer can then select one of these candidates to use. Human intervention in judging and selecting the various possibilities it generates enhances more control. This tool reconciles simple rules learnt from the existing organic settlement patterns and produces alternatives which are not quite the same as the ones in the knowledge base. It makes explicit what was previously implicitly present in its input - an important feature of creativity.

References

Jose C. Damski and John S Gero, A LOGIC BASED FRAMEWORK FOR SHAPE REPRESENTATION, University of Sydney, Australia.
Michalek, J., Choudhary, R. and Papalambros, P.Y., ARCHITECTURAL LAYOUT DESIGN OPTIMIZATION, University of Michigan, USA.
Peter Bentley, ASPECTS OF EVOLUTIONARY DESIGN BY COMPUTERS, Intelligent Systems Group, Department of Computer Science, University College London, Gower St., London WC1E 6BT, UK.
Nikos A. Salingaros, LIFE AND COMPLEXITY IN ARCHITECTURE FROM A THERMODYNAMIC ANALOGY, Physics Essays Publications
Thomas Fischer, Christiane M. Herr, TEACHING GENERATIVE DESIGN, Design Technology Research Centre, School of Design, The HongKong Polytechnic University, Hongkong