

## GENERATIVE GRAMMAR OF DNA NANOTECHNOLOGY

*Use of DNA pairing as a tool to generate design solutions that are responsive to surroundings and other parameters.*

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**Abstract.** DNA nanotechnology is a subfield of nanotechnology which seeks to use the unique molecular recognition properties of DNA and other nucleic acids to create novel, controllable structures out of DNA. The DNA is thus used as a structural material rather than as a carrier of genetic information. The application of DNA in architecture can produce difference form to self assembly themselves. The objective of the thesis to create a self assembled exhibition space which is arrived by the Hamiltonian path problem. The grammar and set of rules will be derived from the various factors such as the building rules, design program, city byelaws, and other factors

**Keywords.** DNA self assembly, Hamiltonian path problem, DNA Nanotechnology, Dijkstra Shortest path,

### 1. Introduction:

Deoxyribonucleic acid, or as it is mostly known DNA, is a nucleic acid that contains the genetic instructions used in the development and functioning of all known living organisms. A code made up of four chemical bases: adenine (A), guanine (G), cytosine (C), and thymine (T). DNA bases pair up with each other, A with T and C with G, to form units called base pairs. Each base is also attached to a sugar molecule and a phosphate molecule. Together, a base, sugar, and phosphate are called a nucleotide. Nucleotides are arranged in two long strands that form a spiral called a double helix.

DNA Nanotechnology can be applied in architecture to produce designs of user choice. Coupling the block and assembling for a user's choice of

zoning. It is a 'bottom-up' approach to the process of design, where a form is arrived at by parallel and recursive processing of a simple 'initiator' with a set of production rules.

## 2. Scope of work:

The study was carried out with maxscript. Zoning of the spaces is done using the DNA Pairing. Through Maxscript following set of rules like minimum standard for habitable and inhabitable space, no. of room and room dimension, coupling of spaces according to the user needs and height restriction are applied in the design. Blocks like Living room, kitchen, dining, Bedroom with attached Toilet and Balcony are created by user's choice for their required dimension and made sure that it is not less than minimum standard. Then Coupling of the blocks (Figure 1) done with User Interface, like living room coupling with dinning, dining with Kitchen, Similar varies of choice of coupling is done. For unadvisable coupling – instruction is given to the user. Once all the information is given – House is self assembled.



*Figure 1. Coupling and Self Assembling of Blocks*

The current project is experimenting with DNA to Solve the Hamiltonian path problem for creating Exhibition space in three-dimensional space using the 3D graphics software. Now, working on script for getting the shortest path (Figure 2) for the selected space from the Exhibition space, so that the user need not visit all the space, but visit his/her favourite space. Next stage will be making the space and path - dynamic according to the No of people in the space.

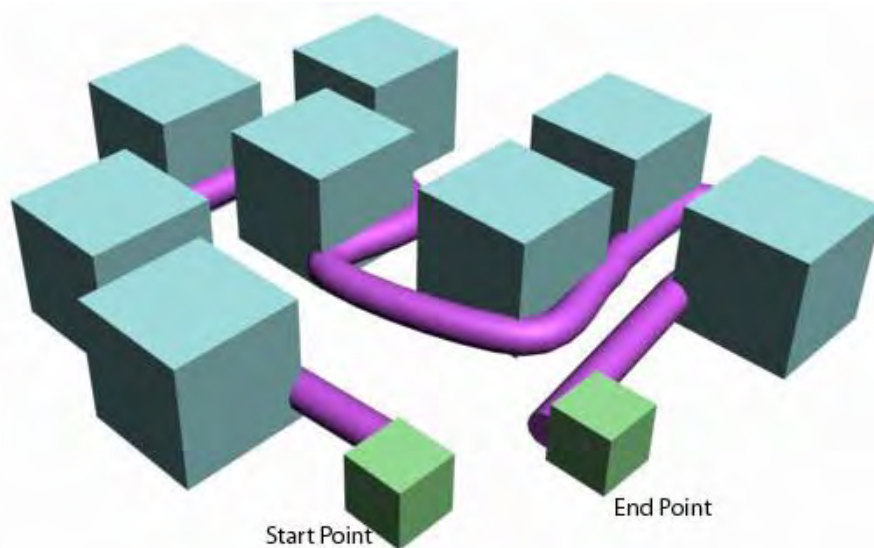


Figure 2. Shortest Path for all the space

The future scope of the study is to explore the possibilities of using DNA Pairing and algorithmic self-assembly as a generative tool in design. The objective of the project is to arrive at design solutions using DNA algorithmic self assembly process which would be responsive to factors building rules, design program, byelaws, and other factors that can affect the design process. The DNA will evolve forms using an initiator and a set of rules derived from the above mentioned factors. Thus DNA Nanotechnology can be a very flexible and open-ended generative tool for design.

## References

- Algorithmic self-assembly: Rothemund, Paul W. K.; Papadakis, Nick & Winfree, Erik (December 2004). "Algorithmic Self-Assembly of DNA Sierpinski Triangles". *PLoS Biology* 2 (12): 2041–2053. doi:10.1371/journal.pbio.0020424, ISSN 1544-9173
- Nanoarchitecture: A New Species of Architecture.** Johansen John M. Princeton Architectural Press New York. (2002).
- 3rd Nanoforum General Report: "**Nanotechnology and its Implications for the Health of the EU Citizen**", first edition published in December 2003.
- 4th Nanoforum General Report: "**Benefits, Risks, Ethical, Legal and Social Aspects of Nanotechnology**", first edition published in June 2004, updated October 2005.
- Nanoforum's website ([www.nanoforum.org](http://www.nanoforum.org))
- Emerging Technology – Housing Prototype.VERTICAL CITY inhabitable slope Pieterjan vermoortel
- Top-down and bottom-up design - Wikipedia, the free encyclopedia.mht
- Richard J. Lipton. DNA solutions of hard computational problems. *Science*, 268:542–544, 1995.

Dijkstra's\_algorithm –Wikipedia, the free encyclopedia,mht

[http://en.wikipedia.org/wiki/Dijkstra's\\_algorithm](http://en.wikipedia.org/wiki/Dijkstra's_algorithm)

<http://www-b2.is.tokushima-u.ac.jp/~ikedasuuri/dijkstra/Dijkstra.shtml>