THE GRONINGEN EXPERIMENT

Global Co-Operation in the Electronic Evolution of Cities

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Abstract. This paper first describes an experimental evolutionary and generative model for the city of Groningen in northern Holland and goes on to speculate on how such techniques could be broadened and applied to the possible global co-operative evolution of cities.

1. The Groningen Context

Groningen enjoys a reputation for urban design and planning innovation and contributors over the last few years have included Rem Koolhaas, Will Alsop, Zaha Hadid, Bernard Tschumi, Henri Ciriani, John Hejduk, Daniel Libeskind, Paul Virilio, Philippe Starck, Coop Himmelblau, Allessandro Medini, Mecanoo etc. Groningen now have a development plan to the year 2005 and are starting to look beyond at urban strategies for the 21st Century. In this future context, the author in collaboration with colleagues and students from the Architectural Association in London was asked to demonstrate the potential for an intelligent, interactive, evolving, computer model of a sustainable urban environment which would enable the citizens of Groningen to interact and influence the development of their city.

2. Background

This project was the result of a series of workshops called “Opening the Envelope” exploring urban strategies for the 21st Century which were held in 1995 and organised by Chris Möller (who had just won the Ciboga competition in Groningen) and in collaboration with the Groningen Urban
Planning Department. John Frazer was invited to make a presentation on
Intelligent Urban Tools and then ran a workshop which proposed a thought
experiment on the possible nature for a “what if?” planning model for
Groningen. Following a positive response at the workshop a proposal was
made to actually create a small working prototype of such a model to
demonstrate and evaluate its potential. Following a further presentation in
December, agreement was reached to proceed with the demonstration model
in February 1996.

3. Opening the Envelope: Exploring New Urban Strategies

One of the key speakers in the “Opening the Envelope” series was Maarten
Schmitt the Chief City Planner. His talk was crucial to the direction taken by
the project described in this paper (Schmitt 1995).

He said, "A very special atmosphere has been created in Groningen since
the sixties revolutionary atmosphere. The intention has been to create a more
meaningful and coherent society related to such ideals as the American
Pueblo society, especially in reaction to previous failures in post war
European cities.

The quantitative growth of the 60s in Groningen became an
accumulation of private aspirations without any larger ambition and caused a
social reaction. The social reaction collective ambition grew out of this
reaction, focusing on qualitative concerns, and from this developed a larger
idea or framework for cultural, economic and social elements of the city.
This included reducing the role of the car, enabling coherent space for other
activities combined with cleaning public space in order to give it back its
public meaning. Discussion about alternatives for the worn out city elements,
and the introduction of a pluriformity of uses and meanings into the centre
became crucial to a dynamic view of the city and the need for change as a
revitalisation agent. Reducing mobility and encouraging a diversity of
service industries back into the inner city was a crucial achievement of this
social democratic ambition.

Around 1980 the discussion on formal objectivity (creating symbols) in
urban development was raised in professional circles, to develop the cultural
identity of the city as a whole. The main spatial structure formed a fixed
framework for continuously changing uses. These ideas were defined in the
structure plan of 1987. These projects also explored a new type of public
participation based upon the idea of planning by communication of which
participation is an important part. This is initiated by a framework
proposition for urban development which then involves wide public
involvement and comment with the final responsibility held by the city
council to assess and define the outcome.
Other experiments within these ambitions included initiatives such as exploring popular cultural phenomena for example the Video Pavilions project with Bernard Tschumi and Zaha Hadid with its potential for revitalising public space. The City Boundaries project with Daniel Liberskind, John Hejduk and Paul Virilio, explored the city a artifact with clear boundaries defined by a series of new markers layered with the meanings of history and café life which are discussed in Liberskind's Books of Groningen."

4. Opening the Envelope: Intelligent Urban Tool

In a subsequent workshop on Intelligent Urban Tools, John Frazer made a presentation on New Tools (Frazer 1995b):

It was taken for granted that computers are now accepted as useful for drawing, modelling and calculations - tools which do what we already do but faster or better - essentially passive tools.

But new tools implies active tools - tools which offer new ways of thinking, new ways of doing - tools for change - tools that permit the previously impossible, the previously inconceivable. Modelling of non linear dynamic systems - the order of natural systems rather than contrived formalisms.

A brief introduction was give to seven tools:

Tool 1 Interactive input devices
   Intelligent modelling kit to allow non experts access to the design process
Tool 2 Intelligent structures
   Embedded microprocessors for self organising responsive buildings
Tool 3 Concept seeding for automatic design
   The encoding of a generic architectural concept for automatic development.
Tool 4 Rule based systems
   Generalised techniques based on cellular automata and similar techniques
Tool 5 Learning techniques
   The use of genetic algorithms to learn strategies for optimisation
Tool 6 Evolutionary models
   Evolving buildings by evaluation in simulated environmental models
Tool 7 Co-operative interaction
   Evolution of an environment using the Internet
5. Computing without computers: A thought experiment

At the workshop session which followed - Computing without computers: A thought experiment, the workshop group explored conceptually the question:

A new tool for Groningen?

Given unlimited computer power, any input and output devices you can imagine, and a team of programmers who can code any operation that you can conceive of, what sort of new design tool might be useful for the future of Groningen?

In other words, given all the power of unlimited computation without the tedium of actually having to use a computer, what would you do with it?

Would a 'what if?' computer model which demonstrated the evolution of Groningen and allowed future possibilities to be explored, tested and evaluated be useful?

Could a link be made to existing urban morphology models of Groningen and existing geographical information?

What about a system which allowed the citizens of Groningen to experiment with a predictive model?

Why not develop a learning model which improves its ability to plan on the basis of feedback from simulations or from comments by citizens or planners?

Why not develop a self organising and self optimising model which attempts to produce the most energy efficient layouts and plans for a sustainable future?

Perhaps we could build a self organising system which continually rearranged the environment in response to interaction with the inhabitants?

How about combining all the above into a responsive, evolving, learning, optimising, sustainable, interacting, democratic future design tool?

What are the advantages of such techniques and what might be the problems?

The participants in the workshop subsequently produced a report identifying constraints, urban plan desires, internal and external factors, a matrix of objectives against scale/time/payback/range, a graph of rate of change across the city zones and gradation from multiple to singular use, and proposals for input and output. These observations were published in the booklet describing and reporting on the workshop.
6. Proposal for a model

Following the workshop we made a proposal to develop such a demonstration model:

A generative computer model which could mediate in space, scale and time. - In scale between the urban context and the fine grain of the housing typologies. - In space between the existing fabric of Groningen and specific dwelling units. - In time between the life style of the medieval core and the future desires of citizens of the next century.

An Evolutionary Model which explains the transition from the past to the present and projects trajectories for future possibilities. A "what if" model for exploring futures and evaluating them.

This model would require both a generative dimension and the use of genetic algorithms to develop appropriate rules and strategies.

To be convincing about the value of developing such a dynamic computer model we would first need to do a feasibility study and develop a small prototype demonstration model.

For example and more specifically we need to develop a model which simulates the historical development of Groningen in a dynamic and predictive manner. We need to search in the local situation for local rules which will generate self determining emergent properties for the whole. We have to look specifically at the way in which the implications of changing life styles and work patterns can be incorporated into the model. We need a structure for the model which is strategically modular (in the sense that say a tree is) without being geometrically constrained to modularity. We need to embody all the ideas so far for the housing typologies and the site organisation including environmental influences etc etc.

The model would be designed using the techniques which we have developed over the last few years (Frazer 1995a, Frazer, Rastogi and Graham 1995, Frazer and Frazer 1996) but the structure of the model would be new and specifically tailored to the scale and nature of the specific Ciboga project (this makes the project feasible within the timescale).

7. Characteristics of the Model

Citizens influence the development of a virtual model of Groningen which in turn is able to influence the development the actual city.

The model is an abstract personification of what Maarten Schmitt referred to as the "collective ambition"

A virtual model of a city, evolving and experimenting in response to interaction with its inhabitants.
A virtual global city, a connectivity of urban models communicating and exchanging information and experience around the world.

(The global village is the dispersed network of individuals, the global city is the network of concentrated urban nodes)

The Inhabitor models the desires, aspirations, urges, expectations, reactions of the inhabitants to their environment and projected new environments. The Inhabitor can inhabit at any level, a room, house, district, city, region, continent, planet. The Inhabitor can inhabit past environments, present environments and possible future environments. The collective consciousness of the model (the common illusion?) can be inferred from virtual re-inhabitation of past habitats. The Inhabitor does not affect futures by vulgar voting between alternatives but by providing and evaluating feedback tendencies and criteria.

8. The Structure of the Model

The team produced an evolving model which explains the transition from the past to the present and projects possible future trajectories - a 'what if' model for generating, exploring and evaluating alternatives. The model can mediate in scale, space and time:

- in scale between the urban context and the fine grain of the housing typologies
- in space between the existing fabric of Groningen and specific dwelling units
- in time between the lifestyle within the medieval core and the desires of the citizens of the next century.

A particular feature of this prototype is that it combines generative (cellular automata) techniques and learning (genetic algorithm) strategies, to produce a rule-based system which learns on the basis of feedback from the city’s inhabitants.

9. The Operation of the Model

Central to the Groningen model is the idea that the computer program inhabits an environment, enters it, reads it, understands its developmental rules and history, grasps its topography, latitude and climate, models its society and economy - and then starts to solicit suggestions and make proposals for possible features.

The model becomes an inhabitant. It maintains a discourse with other, human inhabitants and tries to understand and interpret their desires,
aspirations, urges, expectations, and reactions to their existing environment and projected future environments. On the basis of this interaction with the actual inhabitants, the virtual Inhabitor patiently modifies its criteria for evolutionary development and selection, endlessly repeating the process of refining and modelling prototypical futures. As it does so, it occasionally produces experimental genetic mutations or amplifies variety.

The Inhabitor can inhabit at any level: cell, room, house, district, city, regions, continent, planet. It can inhabit past environments, present environments and possible re-inhabitation of past and present habitats, and from the interaction of citizens who provide feedback tendencies and selection criteria.

The core of the Inhabitor is the Evolver, an evolving genetic model in which the isospatial datastructure and genepool are controlled by genetic algorithms. The Evolver is a recursively self-similar program which employs the same strategies at each level of interaction. It provides starting configurations or seeds for genetic algorithms, which learn on the basis of feedback from specific sites. The criteria for genetic selection are determined by citizen interaction with the Enabler.

The Enabler has connections to an interactive map (input desire lines, etc.) and an active output model. This is the basis for dialogue between the virtual Inhabitor and the real inhabitants.

The Generators: A hierarchically self-similar datastructure models the environment at the regional, urban, district and site scales (part of a continuum of scales, from global down to cellular). The datastructure is strategically modular without being geometrically constrained to modularity. It can interact with other sites at the same level, or with other levels, either top down or bottom up. Using specific data (GIS), these levels are mapped to specific situations and respond to exogenous influences. In the case of Groningen, the demonstrations are at the level of the local topography, the city form, the Ooesterhamrick district and the Ciboga site. Generative modellers actively generate new possibilities from inputs from the Evolver. In turn, feedback from the specific sites affects the selection processes in the Evolver.

10. How the Model Works (example)

A technical description of the model is outside the scope of this paper but a brief description of the way the solar envelope is developed will give an indication of our working method.

The process starts with our new computer model of the actual geometry, obstructions, boundaries and contours of the site with a specific latitude and orientation. For a point on the site a 3D solar vector template is generated
giving all possible orientations of the sun at hourly intervals for every month during the year. This template will apply to every point on the site. The 3D template is then reverse mapped to the generalised isomesh version of the computer model and is then reverse mapped to the isospacial generative model. We refer to this reverse mapping as pamming (pam being the reverse of map - sorry about that one!). In this pammed isospacial form, we now have an abstraction of rules for solar placement. The generative isospacial modeller now develops aggregated form according to these and other structural and morphological rules employing solar logic fields to determine permissible mole locations. The whole assembly is now mapped back into the generalised isomesh version of the model and from there it is mapped back to actual building geometry on the specific site. The solar performance is now tested in the actual model and the results fed to the genetic algorithm which controls the morphological processes in the isospacial model and so on in a cyclical manner until optimum performance is achieved.

11. The Implementation of the Groningen Prototype

The working prototype was demonstrated in Groningen and then in London in June 1996. It was subsequently exhibited at the Architectural Association in July (Frazer 1996). An interactive map with video input of modelling blocks provided an easy interface to the system. The demonstrations were very favourably received and many valuable comments were recorded. The intention now is to seek further funding for a robust demonstrator system which can be used to test the system with the inhabitants of Groningen. Holland is a cafe oriented society and the intention is to provide interactive systems in some of the many cafes of the city (Frazer 1997).

To paraphrase Stafford Beer "The public is conceived as a system, a model of which is contained in the computer. The public supplies minimal information, which the computer then synthesises in the model. This amplifies variety as required to help the public and attenuates variety to help the manager - thereby meeting the requirement of the law of requisite variety for each of them".

Interaction with the Inhabitor is achieved via the Enabler which has connections to an interactive map (input desire lines etc) and an active output model.

We hope that this experiment goes some way to realise, through the medium of modern digital technology, the preoccupation of Patrick Geddes that the ordinary citizen should have a vision and a comprehension of the possibilities of his own city - the need for and value of "citizen participation" in town planning. The need for a Civic Exhibition and a permanent centre
for Civic Studies in every town - an "Outlook Tower". We are proposing that
the cafes of Groningen should be the Outlook Towers of the future.

12. The Global Context: Talking Cities

Towards the end of the project another possibility developed. One of the
students involved in the project, Cristiano Ceccato, suggested that the
experiment should be extended to networking globally such models of
cities. The intention was that the different models should learn from each
other producing a wealth of experience in different situations. This idea was
also prototyped by networking a series of computers each representing a
different city at different latitudes and with different economies. This made
it possible to demonstrate dramatic difference in the solar envelope at
different latitudes and the effect of different economies on growth patterns.

We referred to this as "talking cities" in deference to the "walking
cities" of Ron Herron whose recent death had deeply shocked us all.

With the move of the author to Hong Kong there is now added
motivation to realise such a global network of cities influencing each other
in their evolution. Potential collaborators are most welcome.

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