RCP / RELATIONAL CITY PROTOTYPE

ICCS 2015 International Conference on City Sciences Tags: Digital Simulation / Urban Prototype / Dynamic Networks / Programmed infrastructures /Topology / Morphotopology / Metabolism

Multidisciplinary City Design

1-Research Title:
RELATIONAL CITY PROTOTYPE
Urban Planning digital support based on dynamic networks for urban infrastructures, mobility and regulations.

2-Research Questions:
How can be simulated city models that manage the urban complexity and its ever changing data networks, regarding resources, demands and consumption, social needs, and urban regulations? Is it possible to create urban simulations that can be used as experimental frameworks to interweave the different fields of urban expertise within a multidisciplinary method?

3-Methodology:

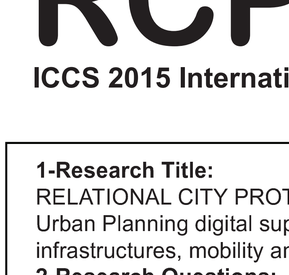
a) Theoretical basis (why?)
Urban infrastructures are the set of networks that allow the exchange of matter, energy and information between the city and the territory that supports it. Moreover, they work as interchange hubs for people and economic interests [5]. One characteristic of these networks is their nodal nature, in which the connection elements become essential. Because of the relationships enabled by these nodes, urban infrastructures generate gradients of connectivity and availability of services that redefine the classic notions of centrality and marginality in the territory [2].

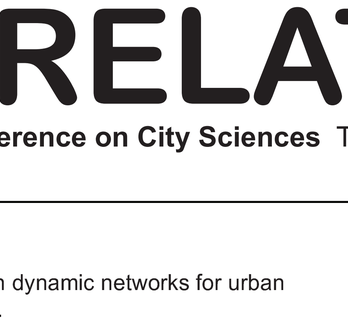
The earth is not flat. The city is not either. Unlike the non-tensorial isotropic models that seek to substructure the urban support, the city is a complex and stereotypical reality, seemingly chaotic and certainly hard to handle. The city is not a flat being, its rules don't allow partial and isolated analysis, and its planning is clearly incoherent with its multidimensional and anisotropic nature. Thus, a new language that integrates and recreates the complexity and dynamism of urban transformation is needed.

b) Proposal (what?). Such new tools for urban planning must conceive networks as dynamic, open, interrelated and flexible entities, able to adapt to the changing nature of the city [4]. Since its inception, urban modeling [1] has proved to be a fruitful tool for the urban research. Our work is framed within this context, by proposing a digital application made by means of a visual programming environment.

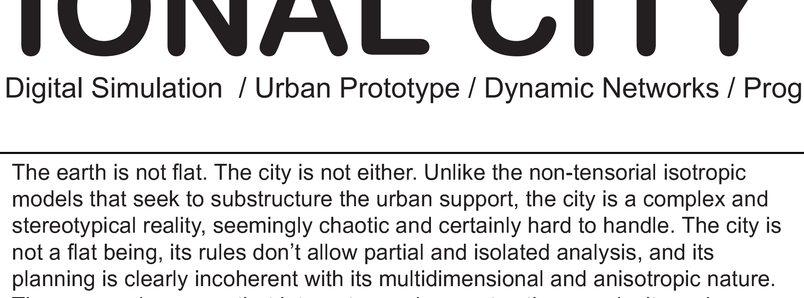
c) Protocols (how?). Three relational urban networks are studied and created by visual programming interface [7]:
N1-Energy Networks (Urban and building Services, Resources consumption and Energy production) and Metabolic Flows. Programmed tool: WORM.
N2-Traffic Networks (Urban Mobility Simulator). Programmed tool: ROADRUNNER.
N3-Urban Rules Networks (Urban Regulations and City Design Relations). Programmed tool: TERMITE.

TERMITE





Relational City - City by the citizens



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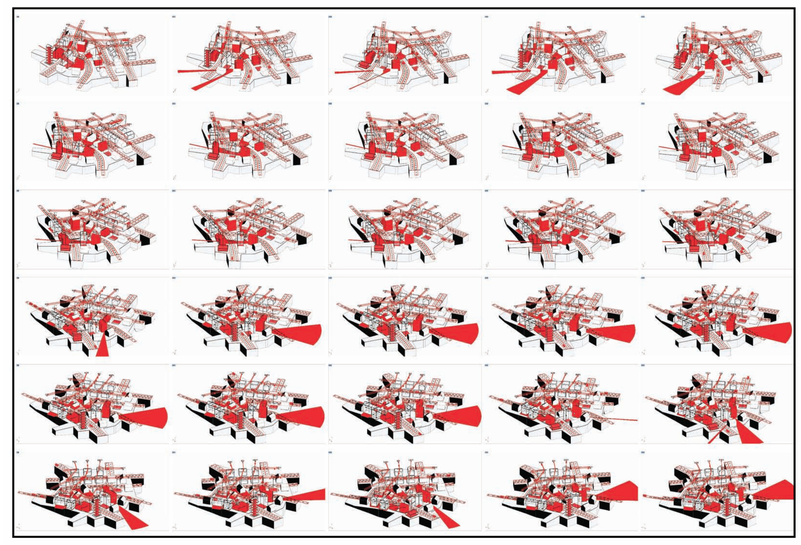
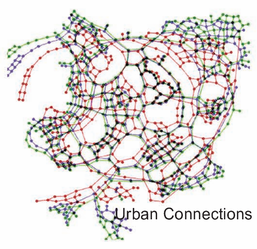
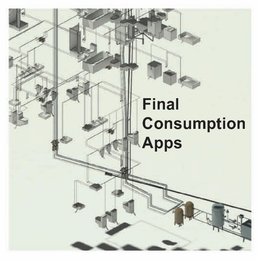

[11] Urban Regulations and City/Citizens Behaviour Urban Systems

WORM



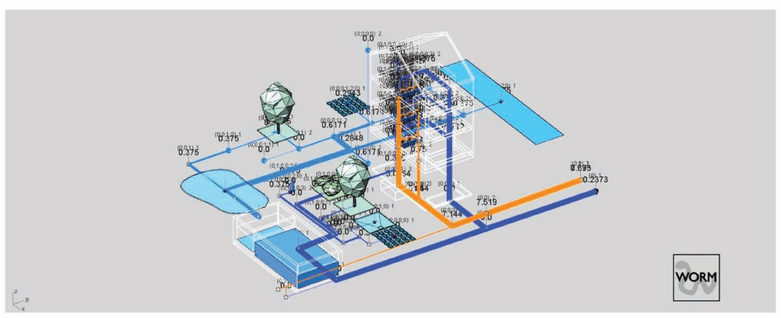
Initial Variables

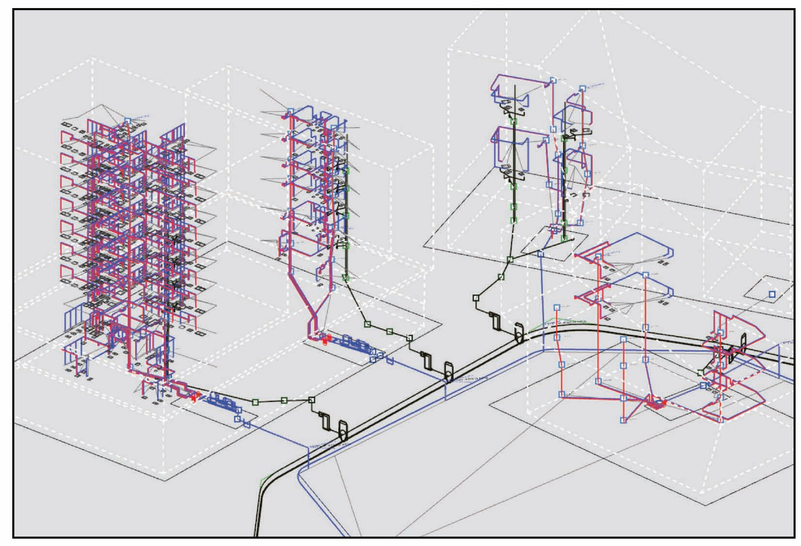


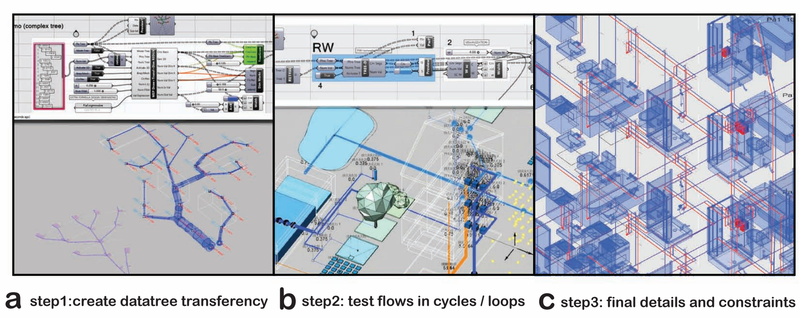
N1-Worm (VIDEO https://vimeo.com/76127290) [9]
WORM (Wizard for Organizing Reticular MEP Nets, WIP) is a digital tool for designing, calculating and dimensioning inter-scalar urban services (from city to dwelling) and make possible to include the real-time dynamic tracing/sketching of the city facilities' networks, into the design project phase, visualizing the interactions and shaping a system that is essential to reach the final formal architectural and urban definition, and to manage "metabolic" processes interactions in urban complexes.
WORM interweaves: Water Facilities (Domestic Hot Water and Cold Water in a WATER WORM tool); Heating (WARM WORM); Sewerage Facilities (EARTH WORM); Ventilation and Air Conditioning (AIR WORM), Electrical (GLOW WORM); Fire Detection and Extinction Systems (FIRE WORM) and Renewable Energies (FLOWER WORM). All of them are based in the same data-transfer programmed holder, and cyclical interrelations.
Energetic urban networks ought to be flexible in order to adapt to the changing needs and technological evolution. Creating a centralized and automatized management of both electrical and heating networks to improve quality and efficiency, and creating coordination through flexible planning in order to fit and integrate the renewable production into demand-supplying cycles, will allow a better supply-demand balance and distribution, having an improved integration of the distributed resources.

This idea includes all buildings uses and areas and a proactive consumer-producer citizen participation to manage efficiently its own consumption. The integration of sensors and devices, open sources protocols development and data/stats obtainment are proven essentially to a proper energy management. Renewable energies integration with electrical vehicles should be taken into account.
Connection between electrical self-consumption, vehicle charge and building control systems are, again, essentially for a proper energy management. This should allow also an upgraded energy storage for daily and seasonal balance between demand and consumption. In some of these cases, micro networks may work perfectly as generation systems and distributed consumption.

The logic behind this tool was conceived through the following steps:
PROGRAMMING STEPS:
a- Programming of datatree transferency components: based in values inheritance by Visual Basic loops. Herarchy of paths, trunk and branches.
b- Testing of the transferency components on local iconic (low detailed) models:cycles of water (supply, sewerage, pluvial) and relations between storage and use, recycle and waste. Programming conversions bewteen nets.
c- Final Dimensions according to the usage, consumption, demand. Programming real time calculation nomograms, diagrams and graphs.



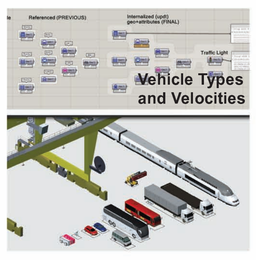

[10] MEP Urban Systems : testing water supply and sewage among three building blocks monitoring while designing



a step1:create datatree transferency b step2: test flows in cycles / loops c step3: final details and constraints

ROADRUNNER

Initial Variables

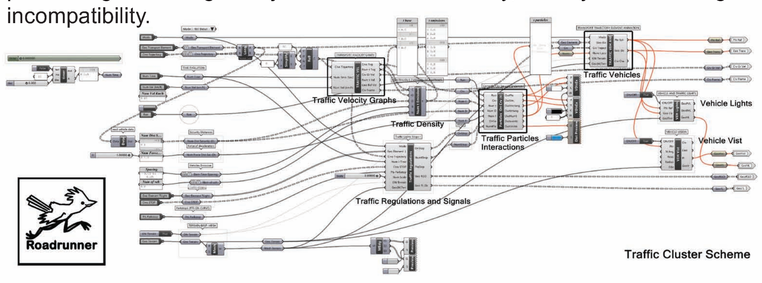


N2- Roadrunner (VIDEO https://vimeo.com/104494902) [10]
ROADRUNNER (Traffic Simulation Tools, WIP) is a digital tool for sketching multi-agent systems on trajectories to simulate vehicle animation and urban traffic behavior. We understand Urban Simulations as dynamic multi-agent (dynamic agent based) frameworks where we can interweave various city flows and functional mobility rhythms.
Remarkable concepts regarding urban mobility are curved space-time and urban sinks. In contrast with a proposed flat and isotropic reality and as such is often conceived or desired, the urban fabric "curves itself" in its space and time and generates a city interpretation based on flows and intensities. These "singularities" deform elastically, concentrate a real mass, tighten and exhale and cyclically disperse that matter on urban board. Their cycles are repeated and reproduce recognizable temporal patterns, that can be hourly, daily, weekly, seasonal, annual, secular, ancient...Managing the accesibility of new urban developments, and the energy that every kind of traffic pattern implies, provides for the urban designer a real time sense of city metabolism. The urban inhabiting must necessarily be linked to these tensions, and severely limits the individual and collective choices. Traditional analysis on urban mobility is opportunistic, circumstantial and always has a market vector character. We seek a more anthropological, evolutional and emotional understanding of city transferences.

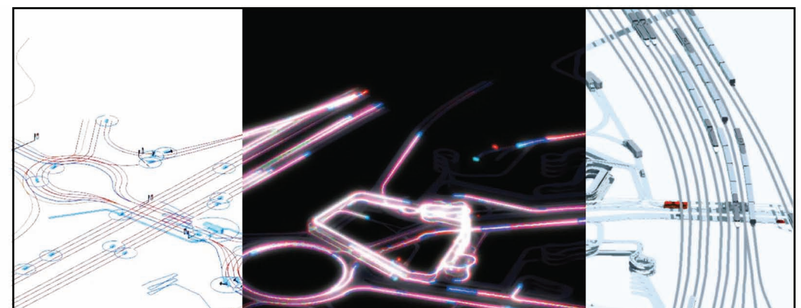
The logic behind this tool was conceived through the following steps:
PROGRAMMING STEPS:
a- Preparing Micro/Macro Simulations. Ideal behicle behaviour depending on vehicle type. Programming Vehicle elements (3D objects, component for custom vehicles)
-Programming Traffic Velocity Graphs, drawn on every trajectory curve (allow custom graphs drawn directly on the vehicle trajectory) or programming velocities according to relation with the other vehicles (step b)

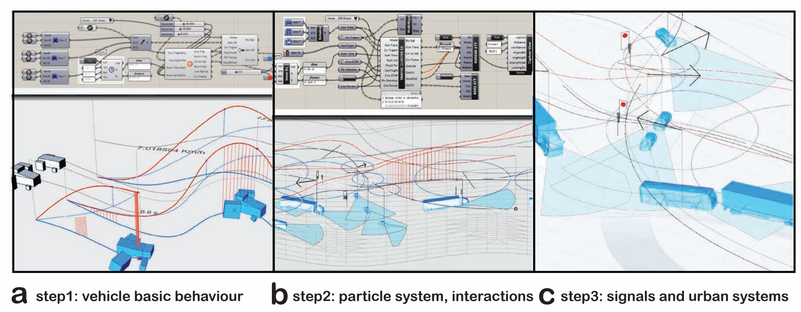
b- Multiple Particle Systems (multiagent system) on trajectory curves to manage traffic regulations and avoid collisions based on security distances: programming of repulsion / attraction vectors according to a certain radius (by vehicle type); according to vehicle position (backwards, parallel, perpendicular, incoming collision...) programming conditions of stop and start engines.
-Traffic Vehicle Animation Modes (to display the vehicles as Dots, Bounding Boxes or complex Meshes keeping the object attributes for final rendering)
-Programming Vehicle Lights and Vehicle Sights, to make visual studies, by means of Isovist algorithms and ray intersection algorithms
-Wheel constraints implemented, or trajectories with free path based curves

c-Traffic Regulation elements (such as Traffic Lights and Stop Signals) and traffic density management. Variable intensities and interactive signal positioning according to trajectories and accesibility, traffic jams and usage incompatibility.



Traffic Cluster Scheme


[10] Traffic Urban Systems Stages of Testing: Particle system behaviour/ night flows and daylight flows interwoven


a step1: vehicle basic behaviour b step2: particle system, interactions c step3: signals and urban systems

4-Conclusions: Outline of expected results
The tool described allows to evaluate and propose (at the same time) metabolic fluxes generated in cities [3]; organize and integrate the technologies that each of the different companies have been developed to manage their own networks [2]; analyze solutions for closing cycles between different networks [6]. Therefore, it can be used to give analytical and diagnose support as well as a purposive and prospective tool.

5-Bibliographical notes
[1] Batty, M. (2009): Urban modelling. En Thrift, N. y Kitchin, R. (eds.) International Encyclopaedia of Human Geography. Elsevier. Oxford, UK.
[2] Graham, S. y Marvin, S. (2001): Splintering Urbanism. Routledge.
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Image[9]: WORM application viewport / Image[10] ROADRUNNER app viewport / Image[11] TERMITE app viewport

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[7] Visual Programming Platform, programming language and base software used for developing the and Digital Tools: Grasshopper3D(Rhinoceros3D) Rutten, David. McNeelTM.
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