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EDITED BY
Gerhard Schmitt, Ludger Hovestadt, Luc Van Gool, Frédéric Bosché, Remo Burkhard, Suzanne Coleman, Jan Halatsch, Michael Hansmeyer, Silke Konsorski-Lang, Antje Kunze and Martina Sehmi-Luck

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We hope that the first eCAADe conference in Zurich, the theme of Future Cities, the presentations and the interactions will initiate a new debate on computer aided urban design and planning and thank all participants for coming to Zurich.

Contents

A Generative Design System to Interactively Explore Different Urban Scenarios

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Abstract. *In this paper we present a new parametric approach based on urban regulation, in order to generate digital models of building, directly within a three-dimensional geo-referenced environment. The system allows user, through implementation of specific generative procedures, to manage interactive architectural design processes. The designer is able to explore all possible infinite scenarios and the various possible design alternatives, by changing the parameters values and verifying in real time the results of the changes. This paper presents a short review of the main related works and an experiment.*
Keywords. *Generative design; architectural design; urban design; interactive design.*

Related works

The development of innovative methodologies and software enable designers to manage interactive architectural design processes, in order to generate a single building or whole urban context. The work focuses about the main tools existing at the academic/scientific level. We divide these tools in two categories:

- City modeling; the field of the digital tools that allows designer to generate more buildings.
- Building design; the new digital tools used in order to design one building.

Some generative systems allow the link between architectural shape and various constraints emerging from the context. Very interesting, are the systems which implement generative process, based on constraints derived from urban regulation and architectural practice.

In City modeling, the the main tools allows designers to generate urban context and many buildings. The most important generative systems are:

CityZoom (Figure 1, left) is a Decision Support System for urban planning. The Buildings are generated by applying urban regulations on the plot geometry according to input parameters which determine which of the building characteristics are to be assessed or optimized, such as number of floors, front or size width, slab area, plot occupation and plot ratio (Turkienicz et al., 2008).

CityCAD [1] allows the automatic generation of buildings; the system allows analysis of urban masterplans in the early design stages. It calculates floor areas, densities, costs, car parking requirements and spaces and a wide range of other planning, environmental and financial data (Figure 1, right).

CityEngine (Figure 2, left) enable designers to generate a complete city using a set of statistical (elevation and land maps) and geographical (population density, zone, height maps) input data highly controllable by the user. The tool is based on procedural modeling approach and L-System. It creates urban environments from scratch, based on a hierarchical set of rules that can be extended depending on the users needs. The rules are defined through a CGA shape grammar system enabling the creation of complex parametric models (Parish and Müller, 2001).

Urban Generator (Figure 2, right) is a hybrid system integrating the generator of a large number of design solutions and the browser for searching and structuring the high-dimensional space of the design solutions, according to variable and customisable factors defined by the designer. It allows user to simulate different urban scenarios considering as input, total building volume, front and depth dimensions, floor number and height, number of buildings, minimal distance between buildings, minimal distance from the edge (Caneparo et al., 2007).

High FAR (Figure 3) allows designer to generate high-level residential district planning with a huge superiority, with the focus of layout of high 'Floor Area Ratio' (FAR). The tool is based on the principle of Multi-Agent System (MAS) and simple genetic algorithm (Biao et al., 2008).

City Generator is a tool for urban simulation. The central feature of the tool is a Genetic Evolution (GE) engine, which can quickly generate various urban

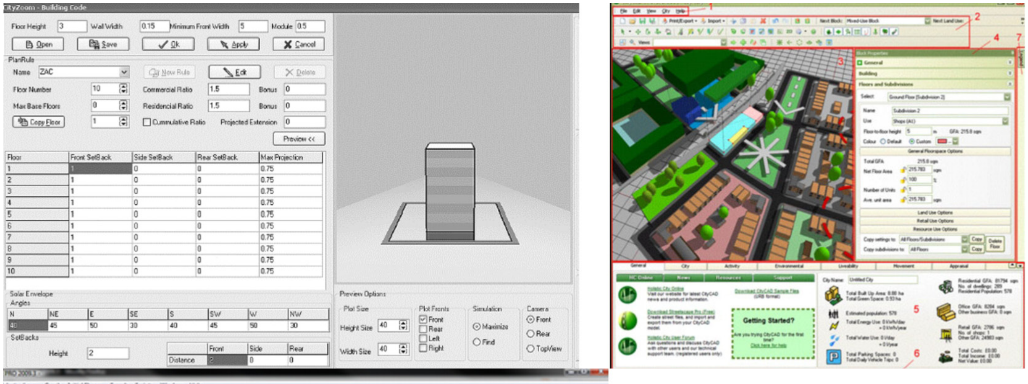

Figure 1
Graphical User Interface. Left: 'CityZoom' (Turkienicz et al., 2008). Right: 'CityCAD'.

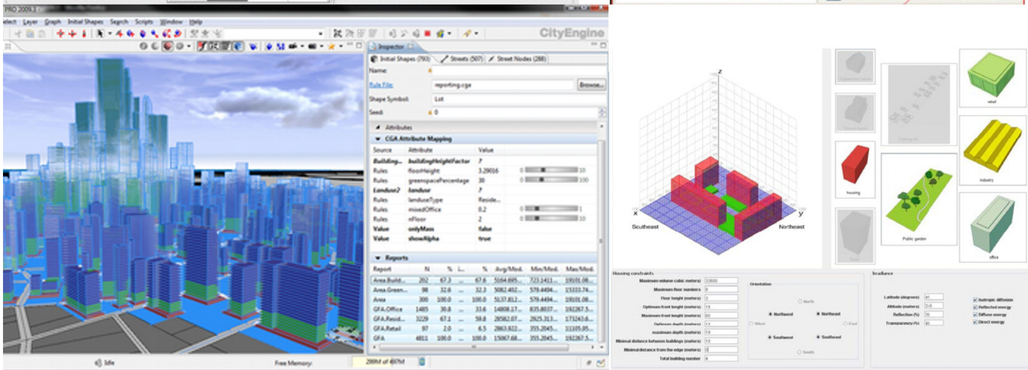

Figure 2
Graphical User Interface. Left: 'CityEngine' (Parish and Müller, 2001). Right: 'Urban Generator' (Caneparo, et al., 2007)

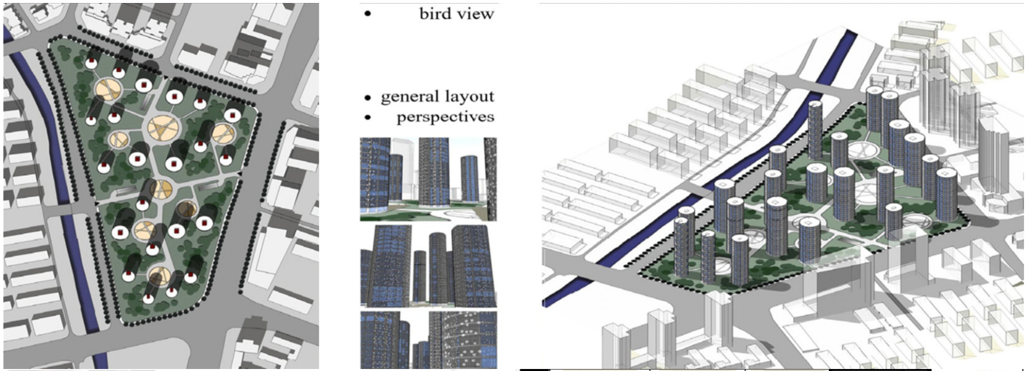

Figure 3
Differents views of scenarios generated with 'High FAR' (Biao, et al., 2008).

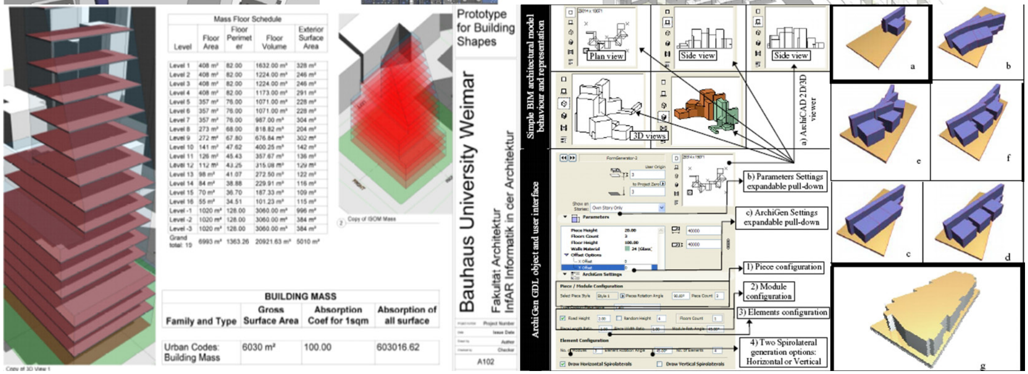

Figure 4
Graphical User Interface. Left: 'Prototype for Urban Code Constraints' (Donath and Lobos, 2008). Right: 'ArchiGen' with some architectural shape generated (Mallasi, 2007).

forms by the combination of L-System controlled procedural model and the GIS map controlled SO (Spatial Occupancy) model (Tang, 2009).

In Building design, the main tool are:

Prototype for Urban Code constraints (Figure 4, left) is a Decision Support Systems that simulate several options for building envelope for a plot according to the parameters required by the city zoning planning, such as 'Buildable coefficient', 'Site coverage coefficient', 'Setback requirements' and 'Sky exposure plane' (Donath and Lobos, 2008).

ArchiGen (Figure 4, right) is a generative application that enables designers to generate architectural shape, within a Building Information Modeling (BIM) environment like ArchiCAD©; it is based on GDL (Geometrical Description Language). The designer is able to explore architectural schape, by changing architectural parameters such as 'floors count' and 'floor height' (Mallasi, 2007).

Parametric Envelope allows designer to create prototypes in Revit; the urban code is turned to computable data and the tool shows the theoretical volume in real time (Melantoni, 2006).

The goal of the work

The goal of the work presented is to generate three-dimensional models of buildings, directly within a 3D geobrowser such as Google Earth®. We have developed a prototype of parametric application that allows designer to generate digital models of buildngs by using the main constraints based on urban regulation. The System developed integrates two different research topics: modeling in geo-referenced environment and constraints modeling. Compared to related works, already existing in building modeling within georefenenced environment, our application is the first generative system based on the use of urban regulation. The application may be used as powerful Decision Support System (DSS), useful at the early stage of city planning as well as for architectural design. During the city planning process, the system allows planners to evaluate the impact of urban regulations and therefore to choose the best set of rules and parameters in order to achieve desired environmental goals.

The System enables designer to interactively operate in the early phase of the architectural design process. It allows designers to optimize specific formal requirements, or generate building models according to most important urban parameters. The designer can explore rapidly many urban scenarios generated and various possible alternatives of the architectural shape. He can change the value of selected parameters and visualize in real time the results of the changes, in their environment.

Interaction Designer-System

A Graphical User Interface (Figure 5, left) allows designer to manage the interactive generative process (Figure 5, right): the designer sets the parameters, loads the input file and runs the application; the System calculates geometrical attributes of the building, generates 3d models and displays them in Google Earth®. The GUI allows to control specific 'Parameters' and 'File' input, more specially:

- Parameters, defined by urban regulation, such as building index, covering ratio, maximum building height, maximum storeys number, setback requirements, minimum storey heigth; other required parameters are maximum storey heigth and texture of facade.
- Files, '.dxf', '.shp' and the 'kml' formats, describe polygons (building plots or building footprint). The designer defines different polygons ('polyline' command), such as convex, concave, regular or irregular one, by using the commercial CAD software or GIS systems. The input file must be georeferenzed, in order to achieve a correct visualization of the building models within the 3D Geobrowser. The system supports georeferenced files, not only in latitude/longitute units, but also in UTM (Universal Transverse Mercator) units. UTM coordinates are more preferred than latitude-longitude, because the system runs very quickly and efficiently.

Parameters and file modifications invoke the automatic regeneration of the 3D model with all architectural elements.

The framework of the System

The architecture of the System developed is based on a Java Enterprise Edition Environment and on the use of XML mark-up language. The System consists of three components:

- Data Processor, implements the generative rules describing the urban regulations, the geometrical and topological relations, and it carries out computational tasks including conversion of coordinates vertices (form latitude and longitude units to meters), determination of geometrical attributes of the building models such as building height, storeys number, storeys height. The outcome consists of a list with the vertices (x, y, z) to triangulate.
- 3D Model Generator, based on 'COLLADA' (COLLAborative Design Activity) and 'kml' (Keyhole Markup Language) technology. It generates two format files representing the building model: 'model.dae' (Figure 6) and 'model.kmz'. The 'model.dae' is exportable into many commercial CAD softwares; the 'model.kmz' consists of a compressed file containing many information about the 3D models, not only geometrical attibutes but also the texture of facades and his location on the Earth surface. A 'Texture Library' contains many images data (jpg, bmp, gif), consisting in textures to apply on the 'model.dae'. The designer can access alwais within the 'Texture Library', in order to update and enrich it.

- Visualizator, enables designer to use the powerful 3D viewer and the other features provided by Google Earth®. It is based on a Java class that launches Google Earth® and places the 'model.kmz' on the Earth surface.

Compatibility with other software

The tool described in the paper is a Decision Support System for the early stages of design. So the compatibility with the architectural design systems was one important issue on which the work has been focused. The compatibility is particularly important in order to enable designer to interactively handle the input file, during the generative process. Referring to input phase, the system is able to interface itself with many kinds of software supporting three widely used file formats, such as:

- CAD systems, supporting '.dxf' format, such as: AutoCAD®, ArchiCAD©, Microstation®, Autodesk Map 3D®.
- GIS systems, supporting '.shp' format, such as: ArcGis®, fGIS®, PostGis®, GrassGis®, gvGIS®, OpenStreetMap®.
- 3D Geobrowsers, supporting' klm', such as Google Earth®, Nasa WorlWind®.

The application combines the modeling ability of CAD systems with the several opportunities offered by geovisualization and 3D Geobrowsers; the interactive display environment enables the designer to make better decisions. The system was designed to display the outcome within Google Earth® and allowing designers to navigate through the three-dimensional scenario which represents the city

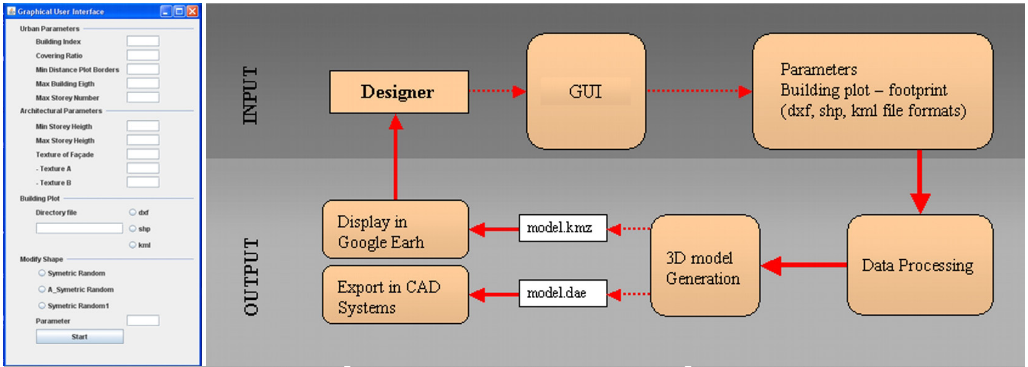

Figure 5
Graphical User Interface of the System (left). The generative process implemented by the System (right).

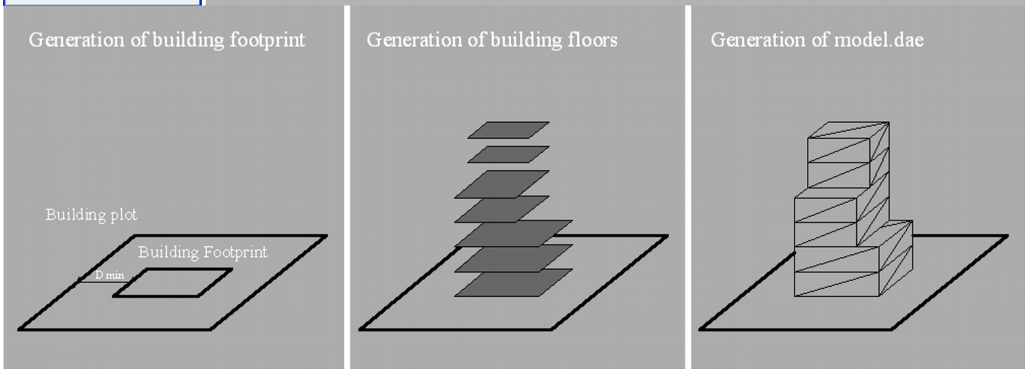

Figure 6
Some phases of 'model.dae' generation: Building plot (left), the system calculates the vertices of the floors according to generative rules (middle), and 3d building shape is generated (right), consisting of triangular mesh.

being modeled, with the blocks, plots, buildings and reconstruction of the 3D terrain. However, the designer is able to export three-dimensional models generated by the system, even within the main commercial software used in the field of architectural design. The '.dae' extension of the digital model, enables the export within CAD (Figure 7), GIS and CFD systems, including AutoCAD®, Revit®, 3D studio max®, Blender®, Maya®, Catia®, MicroStation®, Poser®, Cinema4D®, Softimage XSI®, MeshLab®, CityEngine®, SketchUpPro®, Simlab Composer v2®, Arc2Earth®. The CFD (Computational Fluid Dynamics) systems, integrated with architectural modeling, allow to predict temperatures, air flow direction/velocities and pollution dispersion, within urban space during the early design phase. The designer is able to make architectural changes, i.e. modify building envelope or urban configuration until to get desired results. Two considerable CFD packages are CFX® and Fluent®. New Fluent releases enable designer to use the existing native CAD geometry directly, without translation to '.iges' or other intermediate geometry formats. Both CAD and CFD systems, allow designer to achieve a complete simulation, and to take in account many constraints, not only urban regulations but also climatic features.

Applications

A case study is presented in order to test the potential of the System proposed: the design of residential buildings in a large neighborhood subject to specific urban regulation of an Italian city. Different alternatives to locate the buildings in the neighborhood and their different architectural shapes generate many urban scenarios. The experimentation shows how the system developed enables designer to choose interactively the best solution, valuating critically results and changing directly parameters and constraints optimizing the city planning process and the architectural shape.

We have analysed some examples of residential buildings, designed by different architects and realised in many Europeans cities. Two types of buildings were chosen; the goal of this experiment is to verify the impact on a italian environment, of specific architectures conceived for different contexts. Three scenarios have been generated.

- Scenario 1 (Figure 8), is based on buildings designed by Architect K. Muller-Rehen and built in Berlin (Germany, 1956).
- Scenario 2 (Figure 9), consists of buildings designed by Architects J. Sterling and J. Gowan and built in London (GB, 1958).
- Scenario 3 (Figure 10), takes into account both previous buildings to generate a single urban scene.

The generative process involves AutoCAD® to manage the input files. Three differents set of

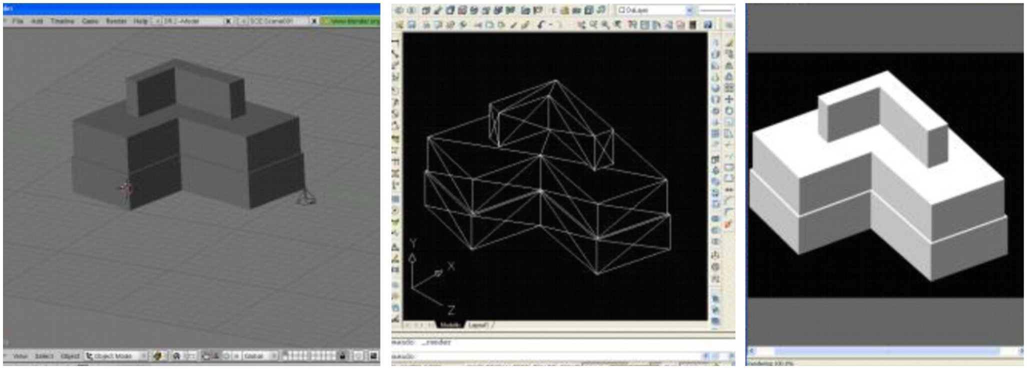

Figure 7
Compatibility with other software: example of 3D 'model.dae' generated with the System and exported in Blender® (left), in AutoCAD® (middle and right).

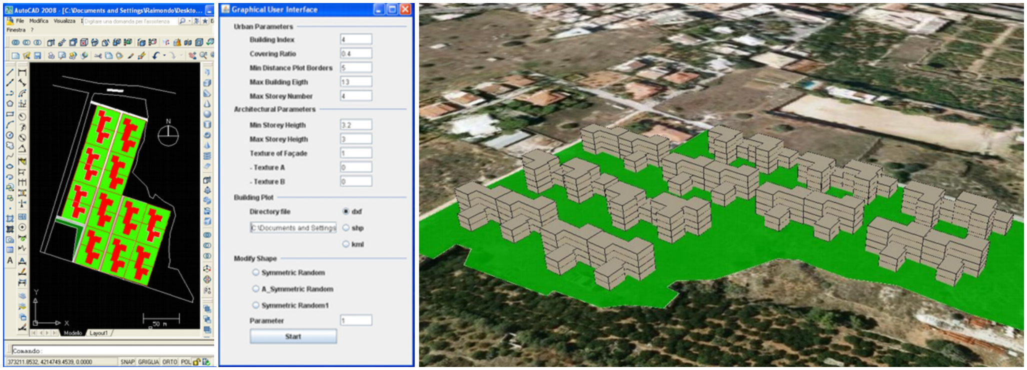

Figure 8
Scenario 2, buildings designed by Architect K. Muller-Rehen. Left: Input file created in AutoCAD®. Middle: GUI of the System with input parameters. Right: 3D building models generated and displayed within Google Earth®.

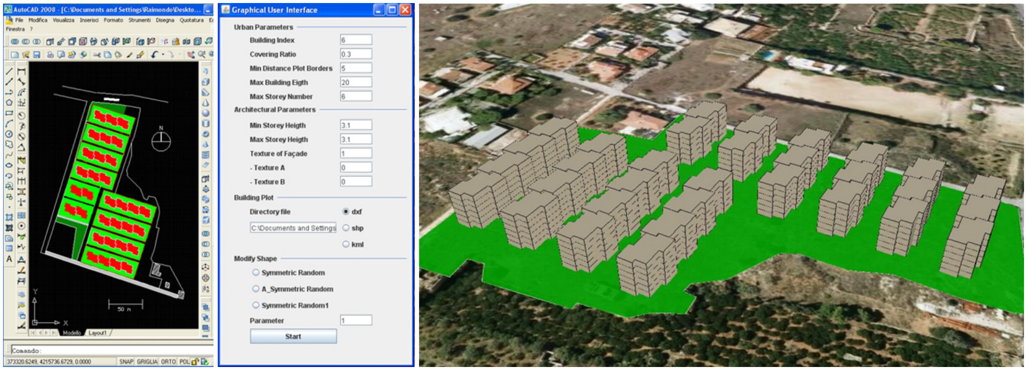

Figure 9
Scenario 2, buildings designed by Architects J. Sterling and J. Gowan. Left: Input file created in AutoCAD ®. Middle: GUI of the system with input parameters. Right: 3D building models generated and displayed within Google Earth®.

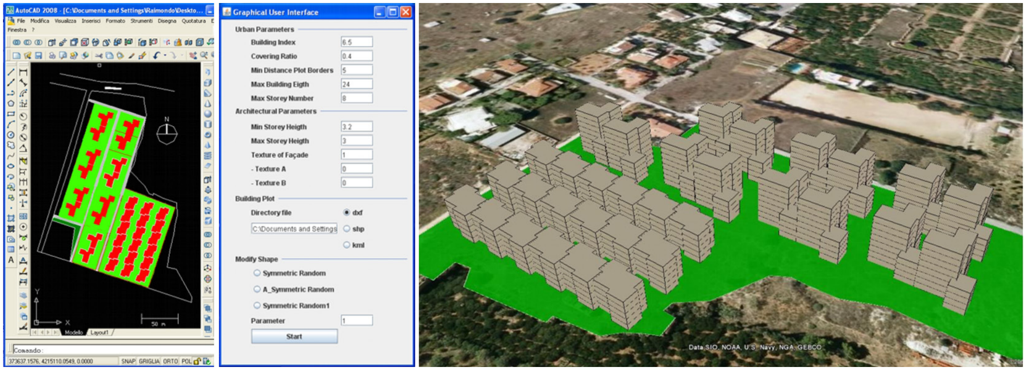

Figure 10
Scenario 3. Left: Input file created in AutoCAD ®. Middle: GUI of the System with input parameters. Right: 3D building models generated and displayed within Google Earth®.

designing parameters, derived from Italian urban regulations, have been chosen, one set for each scenario. The simulation enables designers to explore the multiple scenarios and understand modifications of the urban scene when we change the values of the parameters for the site, plot geometry or type of buildings. Then the designer can analyse both the theoretical volume and final architectural shape by the scenarios generated, and so he can verify the impact on the environment.

The experimentation showed consists only of three simulated scenarios; however it is possible generate more scenarios by changing the building plots, parameters and type of buildings, until the architectural shape and urban configuration satisfy specific formal requirements.

Future developments

We hope to improve the System in order to introduce other kinds of parameters, specially typological and formal, that constraint the shape to urban local conditions or to specific needs. Besides, other environmental elements will be added to better simulate the effects of the context. For instance, physical and climatic factors such as solar radiation.

We will develop better the integration with CNC (Computer Numeric Control) and CFD (Computational Fluid Dynamics) in order to compute the dynamic behaviour and thermal fluxes through the envelope, according to climatic futures.

A better system of generating architectural shape could be developed by dividing the space of a building into functional units, onnected and related between them.

We will include geometric rules for the generation of streets, lots, and land use on a small scale.

Conclusions

The paper describes a new application for generating building models from a set of urban and architectural rules. The results show that using specific information and tools, in the early stages of architectural design or city planning, reduce the time of work, and allows to explore many alternatives in a short period of time.

Many difficulties have arisen when collecting information. The most complex problem is the difficulty in finding the relations between the elements that are often of different nature, defining significant variables that characterize the urban context. Some environmental elements can be easily identified and encoded: geometric components as height, floor number, area of building footprint and other aspects derived from general regulations to name but a few. However, other types of environmental factors, such as social codes, economic factors and psychological aspects, are very often difficult to translate into generative rules. More specifically, the most complex issues dealt with finding and implementing the relations between various types of elements, as well as defining significant parameters that characterise the architectural shape and environmental context. Many of the actions which limit the shape derive from considerations that can not be immediately translated and represented according to pre-defined codes, therefore giving origin to qualitative nature evaluations. These difficulties, aside from the complexity itself bound to concepts that rules a planning process, sometimes also force to a partial behavior in coping with the planning aspects, leaving out some that may be, at times, necessary, in order to research simplifications that the complexity of the system requires.

References

Biao, L., Rong, L., Kai X., Chang, L. and Qin, G. 2008, 'A generative tool base on Multi-Agent System: Algorithm of "HighFAR" and its Computer Programming', *Proceedings of the CAADRIA Conference*, Chiang Mai, Thailand, pp. 335–342.

Caldas, L.G. 2005, 'Three-Dimensional Shape Generation of Low-Energy Architectural Solutions using Pareto Genetic Algorithms', *Proceedings of the eCAADe Con-*

ference, Lisbon, Portugal, pp. 647–654.
Caneparo, L., Collo, M., Montuori, A. and Pensa, S. 2007, 'Urban Generator, Agent-based simulation of urban dynamics', *Proceedings of the CAAD Futures Conference*, Sydney, Australia, pp. 347–360.
De Amicis, R., Conti, G., Simoes, B., Lattuca, R., Tosi, N., Piffer, S. and Pellitteri, G. 2008, 'Geo-visual analytics for urban design in the context of future internet', *International Journal on Interactive Design and Manufacturing*, 3(2), pp. 55–63.
Donath, D. and Lobos, D. 2008, 'Massing Study Support', *Proceedings of the eCAADe Conference*, Antwerpen, Belgium, pp. 101–108.
Larive, M. and Galdrat, V. 2006, 'Wall Grammar for Building Generation', *Proceedings of the international conference on Computer graphics and interactive techniques in Australasia and Southeast Asia*, Malaysia, pp. 429–437.
Mallasi, Z. 2007, 'Applyng generative modeling procedure to explore architectural forms', *Proceedings of the ASCAAD Conference*, Alexandria, Egypt, pp. 335–342.
Marin, P., Bignon, J.C. and Lequay, H. 2008, 'Integral Evolutionary Design, Integrated to Early Stage of Architectural', *Proceedings of the eCAADe Conference*, Lisbon, Portugal, pp. 19–26.
Mellantoni, G. 2006, 'Sólido Capaz: Modelamiento Parametrico de Distanciamientos', *Proceedings of the SIGraDi Conference*, Santiago de Chile, Chile, pp. 127–130.
Muller, P., Wonka, P., Haegler, S., Ulmer, A. and Van Gool, L. 2006, 'Procedural Modeling of Buildings', ACM Transactions on Graphics, vol 25, no 3, pp. 614–623.
Parish, Y. and Muller, P. 2001, 'Procedural modeling of cities', *Proceedings of the conference on Computer graphics and interactive techniques*, New York, pp. 301–308.
Pellitteri, G., Concialdi, S., Lattuca, R., De Amicis, R. and Conti, G. 2008, 'Digital architectures generated using "forces" in urban environment', *Proceedings of the eCAADe Conference*, Antwerpen, Belgium, pp. 951–958.
Pellitteri, G., Lattuca, R., Concialdi, S., Conti, G. and De Amicis, R. 2009, 'Architectural shape generating trough environmental forces', *Proceedings of the CaadFutures Conference*, Montreal, Canada, pp. 875-886.
Tang, M. 2008, 'City Generator: GIS Driven Genetic Evolution in Urban Simulation', *Proceedings of the* ACSA Conference, Houston, Texsas, pp. 366–377.
Turkienicz, B., Bellaver, B. and Grazziotin, P. 2008, 'Cityzoom: A tool for the Assessment of Planning Regulations', International Journal of Architectural Computing, 6, pp. 79-95.
[1] www.holisticcity.co.uk/index.php.