

**1<sup>ère</sup> Conférence régionale Euro-méditerranéenne**  
Architecture Traditionnelle Méditerranéenne  
Present et Futur

Barcelone,  
du 12 au 15 juillet 2007

**1<sup>a</sup> Conferencia regional Euromediterránea**  
Arquitectura Tradicional Mediterránea.  
Presente y Futuro

Barcelona,  
del 12 al 15 de Julio de 2007

**1<sup>st</sup> Euro-Mediterranean Regional Conference**  
Traditional Mediterranean Architecture  
Present and Future

Barcelona,  
12-15 July 2007

## Towards a new Design tool for Urban Islamic Contexts. Zaouiat Lakhdar and the Medina of Marrakech

João de Magalhães Rocha, José Pinto Duarte

---

### João de Magalhães Rocha

Was born in Lisbon, 1969. Teaches architecture at the Universidade de Évora, Portugal. Graduated from FAUTL (1992), earned a M.Sc from Columbia University, New York (1995) and a PhD from MIT (2004). Taught at the Pontificia Universidad Católica de Chile, Santiago (1996) and was a research fellow at Harvard (Fall 2006). Has his own practice in Lisbon.

Departamento de Arquitectura. Universidade de Évora. Largo dos Colegiais. 7000. Évora. Portugal.  
rjoao@uevora.pt

### Teléfono:

++ 351 266 74 0800

### José Pinto Duarte .

Was born in Lisbon, 1964. Teaches architecture at the FAUTL, Portugal. Graduated in 1989 (FAUTL) earned a M.Sc (1998) and a PhD from MIT (2004). Taught at MIT and at the IST, Lisbon. He has his own practice in Lisbon. Faculdade de Arquitectura. Universidade Técnica de Lisboa.

Polo Universitário da Ajuda. Rua Sá Nogueira. Alto da Ajuda .1349-055 Lisboa, Portugal  
jduarte@fault.utl.pt

---

### Research context

The research described in this paper is part of a larger on-going project that aims at incorporating shape grammars (Duarte 2001) with an existing generative design system based on genetic algorithms (Caldas 2001) within a real architectural context - Marrakech Medina as its architectural precedent -(Rocha, 1995). The ultimate goal is to develop a computational tool for generating original urban and housing configurations that could be more sustainable and energy efficient, while respecting certain cultural and architectural qualities. Previous work that constituted an early effort to characterize the urban and architectural patterns of this area, suggested that a stylistically coherent corpus of designs existed and that it had enough variety and value to fit the research objectives.

### 2 Architecture and tradition

The reason for choosing the Marrakech Medina as the case study for this experiment is twofold. First, it draws from the necessity to explore existent architectural values in a new context of investigation. Projects carried out by architects such as Jean François Zevaco with his courtyard houses at Agadir (1963-65) and Serge Santelli's Andalous

residence in Sousse (1975-80) already demonstrate how contemporary architecture can embody traditional spatial and typological features within a new architectural interpretation. The elaborated connections between urban configurations with pure abstract volumes of houses suggest that the systematic use of the patio-house typology allows for the emergence of an urban tissue with such complex characteristics. Second, the population increase that occurred in Marrakech during the last decades, as in most North-African and Middle-Eastern cities, has led to an uncontrolled urban growth that produced urban environments lacking the spatial richness found in historical vernacular districts (FIG01). Thus, this research intends to provide a computational framework that can assist architects in the design of urban environments that all together maintain compositional principles while satisfying new necessities of present-day life.

### 3 Urban heritage

The foundation of the *Zaouiat Lakhdar* quarter, one of the oldest along with those situated north and north-east, *Assouel* and *Hart Soura*, is associated to the construction of the Ben Youssef Mosque in the XII century and to its religious complex. As a city of Islamic origin, Marrakech shares specific social and cultural values which are embedded in its system of social organization, therefore, in its urban and architecture form. While many aspects of Islamic social behavior are related to the Islamic law, *shari'ah*, and certain principles found in urban environments are a tribute to the *shari'ah*, the *Qur'an* and the sunnah (life of the prophet), others stem from traditional building codes related to, inheritance and endowment laws. Which was the inheritance process that shaped the morphological spaces of *Zaouiat Lakhdar*? Can we map out its transformations and relate them to the set of religious and social rules which determine many of the collective patterns that form its urban and architectural configuration? An utmost Islamic social value is that a strong social relationship is underlined by the concept of brotherhood. Strong family ties are expected to last and this partially explains the organization of domestic architectural spaces which are close to each other and contain multifunctional spaces surrounding a courtyard. It also partially explains the unsolved familiar problems which can lead to spatial arrangements such as the closing of a *derb* (*dead-end-street*), the change of its direction, the destruction of a house for its division, or decisions about land division among family members and disputes of inheritance goods. Oleg Grabar in his study on traditional Muslim urban environment says: "it is Islam which gave resilience to the Muslim city and to its bourgeoisie, not because it was necessarily aware of all urban problems but because it had the abstract form in which all of them could be resolved." (Grabar 1976) These laws, which are applied in everyday life, form a dynamic set of rules that actuate in a bottom up manner which influences the development of the city urban tissue.

### Design tool

A detailed analysis of *Zaouiat Lakhdar*, suggests a well-structured urban system with patterns which are topologically similar. It was possible to infer and encode the identified patterns into a reduced number of parametric schemas that constituted the basis for the design grammar. The parametric shape grammar was able to simulate urban growth accordingly to the rules seen and mapped on site. At the outset it was considered necessary to deal with both the urban scale and the scale of the house by developing two independent grammars: an urban



grammar that would account for the urban layout, and a housing grammar that would account for the functional organization of the houses. This paper addresses the first context and proposes a more accurate map of the quarter (FIG 02). Its inner spatial area is structured around 10 *derbs* which form several housing clusters. As the perimeter space of the quarter is only used as commercial area, all housing entrances which form a complex network of private *derbs*, are located within the quarter. Within this network we identify nine major clusters, which hold 142 courtyard houses, organized around specific *derbs*. The longest crosses horizontally from west to east and holds 34 houses, a few of these dating from the early XVI century. This street system which runs from public space until the utmost inner private entrance of the house cell, constitutes 7,8% of the overall plot area of the *Zaouiat Lakhdar* quarter. The functional organization of the houses seemed to be partly responsible for the behavior of the geometry of their perimeter, which also varied on different floors, and with neighboring houses. An initial *Autolisp* implementation of the inferred topological urban features run for 100, 200, 500 and 1000 interactions proving that an automatic generation of a urban space with similar features is possible to achieve. FIG 03 illustrates the complex network of *derbs* and courtyard housing plot areas being generated in real time. Learning from these results a detailed parametric grammar was set where the derivation of designs proceeded through six stages: (1) define neighborhood limits (2) insert *derbs* entrances (3) insert extenders and articulators to *derbs* (4) insert spatial boundaries (5) define spatial constraints. An interpreter was built in *Autolisp* (FIG 04) that facilitated the interface with prototyping technologies. Fig 04 illustrates the interpreter being used in the generation of a new possible urban solution and its model produced by a laser cutter.

In conclusion, the implemented system proved flexible enough to encompass the requirements of such a design experiment. Further work will include the generation of houses and of its urban layouts within a more free architectural framework.

GRABAR, O. (1976). "Cities and citizens: The growth and culture of urban Islam." in B Lewis (ed), *Islam and the Arab World*, Thames and Hudson. 100.

ROCHA, J.(1995). "Marrakech: An evolutionary model." In, *Abstract*, New York, Columbia University Press.

WILBAUX, Q. (2001). *La Medina de Marrakech. Formation des Spaces Urbains d'une Ancienne Capitale du Maroc*, L'Harmattan, Paris.

## Acknowledgements

This research was carried out within the framework of the project POCTI/AUR/42147/2001, with financial support of FCT, Portugal. We thank Gonçalo Ducla-Soares for his role in the survey of the houses and support in the development of the grammar. To Rodrigo Correia, André Valverde, and João Cardoso for their work in the development of the Marrakech urban grammar interpreter. In Marrakech we thank to Abied Driss, Chef du Département des Etudes de le Ministère de l'Interieur. Agence Urbaine de Marrakech; Faissal Cherradi and Abdellatif Marou at the Inspection Régionale des Monuments Historiques et des Sites for providing us valuable graphic and historical information. We also thank to Sara Jacinto and Ana Silva for imaging processing.

## REFERENCES

AKBAR, J. (1988). "Introduction to Crisis in the Built Environment: The Case of the Muslim City". In, *Crisis in the Built Environment: The Case of the Muslim City*. Judith Shaw, ed. Singapore: Concept Media Pte Ltd.

CALDAS, L. (2001). *An Evolution-Based Generative Design System: Using Adaptation to Shape Architectural Form*, PhD Dissertation, Massachusetts Institute of Technology.

CALDAS, L., NORFORD, L., ROCHA, J., (2003). "An Evolutionary Model for Sustainable Design", *Management of Environmental Quality. An International Journal*. [14]. No3, MCB UP Limited. 383-397. ISSN 1477-7835

DUARTE, J. (2001). *Customizing Mass Housing: A Discursive Grammar for Siza & Malagueira houses*, PhD Dissertation, Massachusetts Institute of Technology.

DUARTE, J., ROCHA, J., DUCLA-SOARES, G., CALDAS, L. (2006). "An Urban Grammar for the Medina of Marrakech. Towards a Tool for Urban Design in Islamic Contexts". C.J.S Gero (ed), *Design Computing and Cognition* 06. Springer. 483-502.

DUARTE, J., ROCHA, J.(2006). "A Grammar for the Patio Houses of the Medina of Marrakech - Towards a Tool for Housing Design in Islamic Contexts". In, *Communicating Space(s)* [24<sup>th</sup> eCAADe Conference Proceedings] . ISBN 0-9541183-5-9. 860-866.

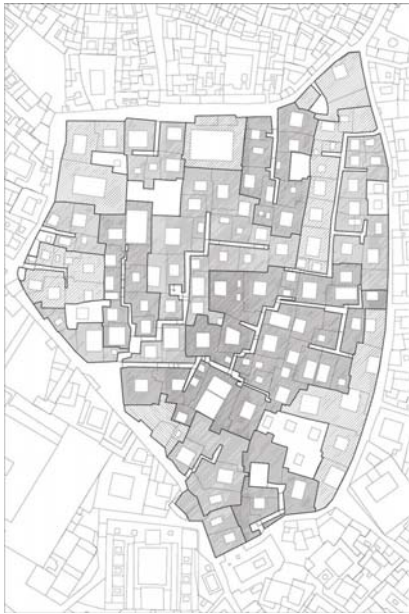


Figure 01. Zaouiat Lakhdar entrance situated in front of Ben Youssef Mosque. New urban dwellings at the southeast of Marrakech Medina. Photo credits: João Rocha



Figure 02. Zaouiat Lakhdar plan with its subdivision in housing clusters and property division accordingly to the existent derbs

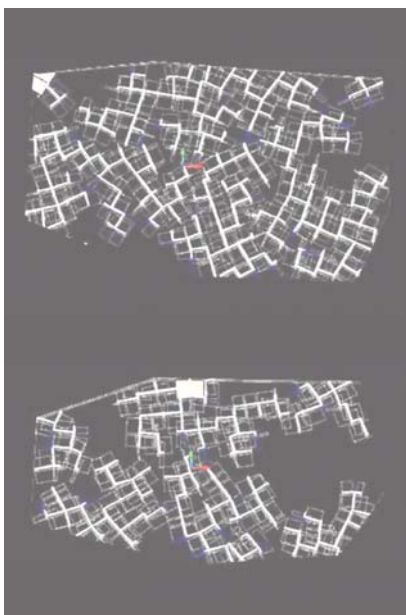


Figure 03. Autolisp implementation with design outputs for 200 and 1000 iteration trials.

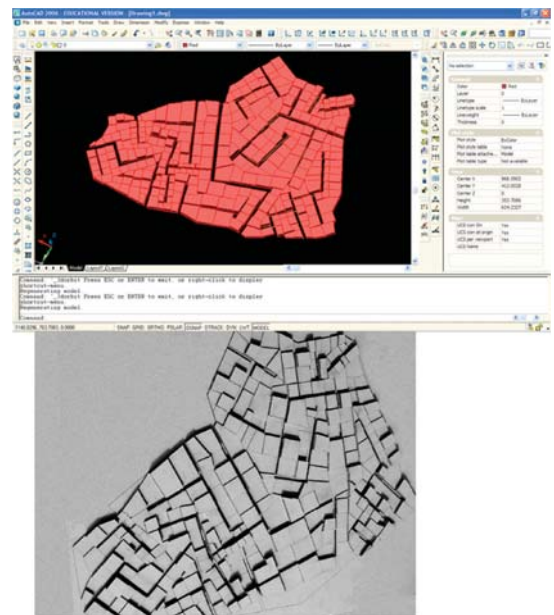


Figure 04. Autolisp Interface Interpreter showing the generated solution and its digitally mockup.