De-coding Rio de Janeiro’s Favelas

Shape grammar application as a contribution to the debate over the regularisation of favelas. The case of Parque Royal.

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This study constitutes the first step of a broader PhD project, which aims to build a bridge between the architectural and the juridical examination of the typicality of low-income settlements within the city of Rio de Janeiro, the favelas. The purpose is to define a rule-based typological analysis to ease the process of evaluating the typicality of favelas and the possible, desirable form of its regularisation. This objective strives to equip all the actors involved in the debate with an analytical device able to represent the socially acknowledged, yet unofficial, rules that have been moulding favelas so far. By this means, this study tests shape grammar as a methodology for approaching this interdisciplinary issue. A shape grammar for a first case study, Parque Royal favela, located in the Governor Island, is presented. As preliminary results of the research, the paper encompasses the three early stages of construction of the case study: invasion, expansion and consolidation.

Keywords: favelas (slums), urban regularisation, Rio de Janeiro, shape grammar, typology, master plan implementation

INTRODUCTION

Context

According to the last Brazilian census, the population of Rio de Janeiro’s low-income settlements, “favelas”, constitutes the 22% of city dwellers [1], namely 1.5 million. Thus, the territory of Rio’s favelas represents the 10th most populous city in Brazil. These numbers alone explain why one of the main issues of Rio as a city is the issue of favelas (Magalhães 2017). In fact, since 1992, Rio’s master plans established that legal codes, regularising and protecting the typicality of occupation of favelas had to be developed. With this, the master plans deemed that, for the city planning system to be consistent with the democratic, participatory rights, it had to encompass the typicality of favelas among the urban coded types. However, in practice, this did not materialise, as standard-based codification turned out to be unsuitable to describe and regularise favelas (Magalhães 2010).

Problematisation and relevance

The master plan guidelines stated an interdisciplinary problem between the lines, raising the question of what instruments could effectively evaluate
and translate the complex typicality of favelas into an encompassing legal code. This problem concerns many urban disciplines like planning, sociology, jurisprudence, but also architecture. Indeed, to codify the typicality of favelas means to de-code the concreteness of their architectural space, as well. Nevertheless, to the knowledge of the author, there is virtually no literature dealing with this problem in architecture. In this sense, this research aims at filling this critical gap.

**Aim**
This study constitutes the first step of a broader PhD project, which aims to create a linguistic bridge between the will of jurisprudence, to formally include the typicality of favelas in the planning system of the city, and the architectural examination of typicality, namely the typological analysis. This objective strives to equip all the actors involved in the debate about how to regularise favelas (e.g., dwellers, institutions, academics) with a graphic and analytical instrument, for evaluating the current typicality of occupation and its possible and desirable forms of inclusion within Rio’s planning system. By this means, this study aims to test shape grammar as a methodology for visually analysing and de-coding the typicality of favelas. Thus, a shape grammar for a first case study, Parque Royal favela, located in the Governor Island, is presented.

**Hypothesis**
The study is based on the hypothesis that shape grammar formalism can be a consistent methodology to examine and translate the typological analysis of Rio de Janeiro’s favelas into an encompassing discursive code.

**Structure of the paper**
The paper is structured in four parts to present the case study, as follows. First, the state of the art stresses previous shape grammar and procedural modelling applications to unplanned settlements, with a focus on Rio de Janeiro’s case studies. Second, the methodology points out the differences between the morphological approaches described in the state of the art and the methods and matrix of analysis applied in this case study. Third, the grammar description illustrates the outcomes of the shape grammar application through three stages: invasion, expansion and consolidation. Finally, in the conclusions, results are discussed for their ability to respond to the purpose of the study and further developments of the research are indicated.

**STATE OF THE ART**
The literature review shows that there is virtually no architectural research dealing with the legal codification of Rio de Janeiro’s favelas. So far, architectural theory and practice regarding slum-like districts in Brazil have been focusing mainly on analysing morphology and defining computational generative models from it. In 2014, Buehler and Oberhaensli [2] developed a computational model representing Brazilian favelas using CityEngine, to test and show the possibility to use CGA code for 3D generation of informal settlements. The authors pursued their goal by examining the images of favelas in search of their morphological essence [2]. Almost at the same time, shape grammars have been developed for slum-like districts (see Barros et al. 2013), some of which encompassing two case studies among Rio’s favelas (Knight 2014; Dias 2014; Verniz and Duarte 2017). These shape grammars shared the common aim of designing new settlements, or models of intervention for urban renewal, within the same urban local language. For this reason, the objective of these applications was to find a posteriori a generative model out from the examination of the morphology of the selected case studies.

**METHODOLOGY**
Unlike the CGA code and shape grammars cited in the previous section, this study aims to analyse and decode not a morphological model, but the typicality of occupation of favelas. The difference is essential. The works of Rossi (1966), Vidler (1998) and Lee (2012) explain why. Indeed, models strive to define mor-
phology in detail, to reproduce or recombine it. Differently, the examination of what is typical looks for common features, constants, between a series of similar morphologies. Consequently, typology vaguely describes shapes. Indeed, while details solve spatial issues on a case-by-case basis, constants/typicalities bring to light widely acknowledged spatial representations of the collectivity. Thus, types represent the spatial ideas that structure the government of urban spaces, its politics, through the construction of architecture. For this reasons, the typological analysis is chosen to consistently deal with the stated master plan policy and legal problem. Furthermore, despite the differences stressed with the previous examples, shape grammar is selected as the methodology to visually de-code the typological analysis of the presented case study. Indeed, variations on the rule-based interpretation, order, purpose or design theory, allow different kind of analysis to use shape grammar formalism. In fact, shape grammar is chosen because it perfectly matches with the stated legal problem, as it allows to represent shapes and rules visually (Knight 2014) and to merge complementary features of the same typology in an ordered set of rules (Duarte 2001). Finally, the use of CGA code could be, in a future computational implementation of this project, a consistent tool for evaluating and applying its expected outcomes.

The presented study complies with the method defined by Stiny (1980), to build a rule-based shape grammar for the selected favela, following:

- interpretation of the language (both constructive and evocative);
- ordering of the language;
- definition of a design context and purpose;
- selection of a theory able to apply the interpretation of the language to the design context and purpose.

**Interpretation**

This study applies to undesigned settlements an analysis that, as in shape grammar application to authored architectures - e.g., Palladian villas (Stiny and Mitchell 1978), Siza’s Malagueira (Duarte 2001), interprets artefacts through the intent of the author. In this case, there is evidently not a designer, yet there are multiple intents. Indeed, favelas arose as a spontaneous and illegal solution to the Brazilian systematic lack of consistent housing policy (Abreu 1988; 1994). Thus, this study interprets the typicality of favelas as the concrete spatial representation of conflicts and negotiations between the intents of four key actors, following: low-income city dwellers, community leaders, neighbours and municipality. Consequently, the analysis identifies resistance as the primary force that moulded the typical features of the case study. Its action is evident in the historical development of Parque Royal. Its various episodes of forced eviction and re-invasion are the more explicit examples. The presented grammar de-codes the strategy enacted by Parque Royal’s dwellers, to lead with resistance, as ‘to follow the path of least resistance’ (Sennett 2008, p.215). This interpretation allows to define by rules how dwellers act to invade a territory and guarantee its occupation against evictions, within scarcity of technical and economic resources: they choose the most accessible area to invade, path to track, construction system to use and division of land to operate.

**Ordering of the language**

It is fundamental to stress one more essential difference between this study and other applications of shape grammar to architectural artefacts: it examines its object, not as a completed design, but as an essentially unfinished building site. Indeed, every map of favelas could represent just an instant in the timeline of the process of continuous redefinition of their built space. By this means, in the presented grammar rules are partially ordered respecting the first three developing phases of Parque Royal: invasion, expansion and occupation. Every stage adds to the previous its rules. This device allows invasion and expansion rules to recur during the phase of consolidation, as well. At the same time, the grammar allows...
transforming shapes along the three different stages by using colours to represent qualities (e.g., the definition of a land parcel from an existing shack).

**Definition of the design context and purpose**

As a case study, the favela of Parque Royal is chosen because of the extensive field research lead by urban jurist Magalhães (2010) within the community. Indeed, Magalhães’ research provides almost all information about the case study, as follows:

- the description of the historical evolution of Parque Royal in relation with the urban and national context;
- the cartographical surveys of the settlement in 1981, 1982, 1990 and 1994, taken from the municipal archives (see figure 1);
- the analysis of the local unwritten building code through its juridical sources, namely the local private customs (e.g., kinships, friendship, neighbourhood), the city legal systems (e.g., land registry, real estate) and the arbitrary solutions or impositions (e.g. evictions, new invasions lead by the local crime).

In addition to this information, the case study is also based on the examination of open data published by Rio de Janeiro Municipality [4] and GoogleEarth [5]. This study, according to the stated legal problem, aims to analyse and de-code the typology of the case study by merging the broader social, juridical and historical milieu described by Magalhães with the analysis of Parque Royal's material features (topography, infrastructural connection, land parcelling, paths, constructive systems).

**Definition of the design theory**

The study embraces ‘minor science’ and ‘State science’, theorised by Deleuze and Guattari (1980), as design theories able to apply the chosen interpretation and chronological order to the case of Parque Royal, according to the purpose of the grammar (see Jacques 2003). Indeed, these strategies of space occupation allow to de-code and map the different schemes of spatial occupation founded in the cartography of the case study. A ‘nomadic science’ schema occupies the space without counting it before. Lines/traits define the ‘smooth space’ (Deleuze and Guattari 1980) by moving from an existent point to a new one. Parque Royal's development shows this schema explicitly in the stage of invasion (see figure 2). Indeed, small traits additions defined paths by tracking the invasion rhythm. ‘State science’, on the contrary, measures space with a regular grid to occupy it. This strategy is evident when an organised group invade an empty area or collectively redefines the limits or subdivisions of an already invaded area (see figure 3). The construction process of Parque Royal has been continuously mixing and overlapping these two strategies.
Figure 2
Invasion

invasion of an empty urban area alongside a shore

invasion along a bush trail

construction of a leisure area

connection between trails

land parcelling

\[ n(\square) = \text{int} \left[ \frac{K}{S(\square)} \right] \]

eviction / removal

land parcel definition

see figure 3
<table>
<thead>
<tr>
<th>Group</th>
<th>Invasion</th>
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<tbody>
<tr>
<td>R11</td>
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| Building a path alongside a shore by land filling |
| R12   |          |
| R13   |          |

| Land parcelling |
|----|-------------|
| R14 | int \( \frac{f}{s} \) |

| Community controlled land parcelling |
| R15 |            |

| Trail width negotiation |
| R16 |            |

| Parcels subdivision |
| R17 |            |

| Closing a trail |
| R18 |            |

| Invasion on a trail |
| R19 |            |

| Community land parcel registration |
| R20 |            |

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<tr>
<th>Figure 3 Expansion</th>
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<td>R21</td>
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see figure 4
RESULTS

Parque Royal Grammar

A grammar for the ground floor plan of Parque Royal is presented. It de-codes the first three construction stages analysed by Magalhães (2010), namely invasion, expansion and consolidation. The initial shape of the grammar is an empty area subject to flooding, that is accessible from a paved road. It is represented by one dashed-pointed line for the main urban road, one dashed curve for a water canal and a label, an empty triangle, representing the point of access to the area, where the invasion starts (see rule 1). The grammar is composed of an algebra of shapes, augmented with an algebra of labels (Stiny 1980), colours expressing qualities (Knight 1989). The vocabulary of shapes contains the initial shape, a dashed line representing hydrography - both canals and bayside, a dashed-pointed line representing a main road, a continuous line representing a trail within the settlement, a solid black square representing a shack, a solid grey polygon representing a land parcel, an empty grey polygon representing a registered land parcel, an empty black polygon representing a slab and an empty shape. The vocabulary of labels contains an empty triangle representing a point of access, a letter, “L”, representing a leisure area, a solid coloured triangle representing the entrance of a building, an empty circle representing the fenestration side of a building, a X representing a concrete slab and a number, “0”, representing the ground floor of a building. Colours are used to identify qualities as follows: buildings are black (solid black for shacks and empty black line-contours for concrete-brick buildings), and land parcels are grey (solid grey for parcels and empty grey line-contours for parcels registered in the dwellers’ association). Such devices are most useful during the expansion and consolidation stages, as the different micro-areas within the settlement grow at different paces. Notations in the grammar calculate with shapes (Stiny 2006), instead of numbers (see rules 6, 14 and 15), to be consistent with the aim of this typological analysis. Letters in notation refer to the shapes in brackets and are used as follows: “n” for number, “l” for length, “s” for side. Furthermore, the lengths represented in rules 22, 23 and 24, by using “x” and “y”, mean that distances are subject to neighbours negotiation. Thus, they variate on a case-by-case basis. The description of the grammar is structured as follows: the text chronologically presents the most eloquent events for illustrating the stages of construction of the case study, from the first invasion in the ’60s till the consolidation process at the beginning of ’90s. The text relates to rules by references in brackets. The drawings in figure 2, 3 and 4 illustrate rules by subdividing the grammar into three stages, as well. As stated above, in the paragraph regarding the ordering of the language, each stage of the grammar adds its rules to the previous ones. In the drawings, the rules relate to the text with short captions beside the graphic representation. Thus, text, rules and derivations are to be complementary read.

Invasion

The invasion of the area, located in the Governor Island, started in the ’60s (see figure 2). At that time, the area was completely unbuilt, covered by scrub vegetation, with mangroves along the shore of the Guanabara Bay. In 1964, a divorced woman, with her seven sons, built there, first, a shack and, then, a bar alongside a trail close to a canal in the area (see rules 1, 2, and 4). Neighbours and workers of surrounding building sites frequented the area because of its leisure areas, namely a beach on the bayside and a football field close to the entrance of the area (who gave the name to the settlement). The invasion grew at a slow pace, as the first invaders invited new ones to completely occupy the area and, thus, to consolidate the settlement (see rules 3, 5 and 6). Due to the scarcity of technical and economic resources, squatters used construction waste to build shacks or stilthouses in landfilled areas, mainly along canals and bayside. The path traced on the scrub vegetation linked, alongside the canal, the entrance of the settlement to the beach on the bayside. Nowadays, this same path is a paved road, and it is named
Rua da Praia, namely ‘beach road’. The surrounding area, representing the first invasion, is called the ‘upper side’, "a parte de cima", of Parque Royal. Till the ‘80s, police officers and neighbours, living in the surrounding formal apartment buildings, forcibly removed shacks within the settlement (see rule 8). Nevertheless, a higher number of invaders always re-invaded the area at once, during the next nighttime (see rules 2, 3 and 6). In the ‘70s, dwellers initiated a land register of the occupation, to keep track of its growth (see rule 10). Indeed, the dimension of the invasion started growing faster, as the international airport (opened in 1977) and new job opportunities arose in the environs. Then, in 1982, Parque Royal dwellers founded the dwellers’ association, “a associação dos moradores”. This association served firstly to discipline the land parcelling and to politically represent dwellers’ interest. Nowadays, dwellers’ associations still work also for this purposes, thus constituting a self-organised type of local governmental institution.

Expansion

Along the ‘80s evictions slowed down and, having the new legal framework pointed out the willingness to regularise favelas, Parque Royal expanded in the adjacent area, by landfilling another canal (see rules 12 and 13). This area nowadays corresponds to the ‘downside’ of the favela, and its main road is meaningfully called Rua do Rio, ‘river road’. Every new land colonisation, indeed, defines a neighbour micro-area, “microárea de vizinhança” (Alvito 2001, cited in Magalhães 2010, p.268). This concept explains how different neighbourhoods define different micro-communities within the same settlement. The neighbourhood, indeed, constitutes one of the most important relations in the spatial organisation, indeed neighbours negotiate land parcelling (see rules 6 and 14), path width and building alignment (see rules 16 and 17), distances between buildings (see rules 23 and 24) and if paths will be a cul-de-sac or not (see rules 20 and 21). Nevertheless, as the demand for low-income housing solutions grew strong during the ‘80s, the dwellers association handled the land parcelling of the newly occupied area for every family to build its shack. Moreover, the association established to divide the lots facing two paths, for every parcel to be equally accessible (see rules 14 and 15). Further minor nighttime expansions happened during the ‘80s with the cooperation of the association (see rules 2, 3, 5, 6 and 11). In the meantime, dwellers kept subdividing parcels and almost completely occupying lots, to make room for new dwellers (see rules 18 and 19). Thus, at the beginning of the ‘90s, the area of Parque Royal was invaded almost entirely.

Consolidation

At the beginning of the ‘90s, the new public policy of urbanisation helped to consolidate the settlement (see figure 4). Indeed, as evictions stopped, dwellers started to replace shacks with clay brick masonry and concrete structures (see rules 23 and 25). Also in this case, due to the scarcity of economic and technical resources, the construction of a concrete slab became a collective effort, where neighbours, friends and relatives make possible to knead concrete manually and fast pour it in the formwork. The new constructive system allowed dwellers to expand their houses (see rules 26 and 27). Negotiation between neighbours established the distances between buildings and their fenestration sides (see rules 23 and 24).

The two next stages of Parque Royal, urbanisation and regularisation, started in 1992. The purpose of the urban renewal was to implement the necessary infrastructures, pave the roads, make landfill areas safe and stop the invasions along the bayside. The regularisation tried to establish limits to Parque Royal’s expansion by imposing a maximum height for buildings to respect the airway security and to avoid infrastructures to become immediately insufficient. These two last stages, urbanisation and regularisation, will be examined in the next vertical implementation of this study.
Figure 4
Consolidation

dimensioning the ground floor slab and locating the entrance of the building

fenestration

slab-pouring / bater a laje

slab addition

anex / puxadinho

slab subtraction

b = y
CONCLUSIONS

The application of shape grammar to Parque Royal case study validates the initial hypothesis. Indeed, the presented grammar can visually de-code the relations that mould the case study across the stages under analysis. It allows rules to examine and describe Parque Royal’s typicality of occupation by focusing on its regular/typical spatial and social forms. Moreover, despite its flat topography, unusual among Rio’s favelas, the examination of Parque Royal allows decoding the underlying structure of a salient feature of favelas: curves. Indeed this study translates curves as the outcomes of slightly rotating vectors of land invasion along ‘the paths of least resistance’. It will be essential, in the further development of this research, to test if this interpretation suits the hillside favelas. Future steps of this project will be to implement the vertical grammar of the case study across its next stages of development: urbanization and regularization. Next, the outcomes will be tested and, consequently modified to encompass other meaningful case studies among Rio’s favelas. Indeed, to fully validate the results of this study the grammar is expected to be able to describe a representative corpus of favelas, but also to evaluate if other cases belong to the same language and to generate new examples according to it (Stiny and Mitchell 1978).

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