

'Rabo-de-bacalhau' building type morphology: data to a transformation grammar-based methodology for housing rehabilitation

Sara Eloy*

Resumo

Este paper foi realizado no âmbito de uma investigação na qual se desenvolveu uma metodologia de reabilitação habitacional que pretende responder aos requisitos funcionais contemporâneos e à necessidade de incorporação de TIC na habitação. A hipótese levantada utiliza as gramáticas descritivas, as gramáticas de forma e a sintaxe espacial como ferramentas que permitem identificar e codificar os princípios e regras de conceção das adaptações necessárias para que habitações existentes possam responder às novas exigências. A metodologia de reabilitação desenvolvida baseia-se numa gramática de transformação para o tipo de edifícios "Rabo-de-bacalhau". Neste artigo faz-se a caracterização (funcional, construtiva, estilística e cultural) do caso de estudo no período em que os edifícios foram construídos e no seu estado atual. O processo de transformação das habitações e a possibilidade de gerar soluções de projeto que satisfaçam os requisitos definidos são discutidos no final do artigo.

Palavras-chave: Edifício de habitação. Gramáticas de forma. Metodologia de reabilitação. Rabo-de-bacalhau.

Abstract

This paper is done in the scope of a research in which a housing rehabilitation methodology is developed to meet contemporary functional and ICT requirements. The methodological hypothesis is to use description grammars, shape grammars, and space syntax as tools for identifying and encoding the principles and rules underlying the adaptation of existing dwellings to meet new requirements. 'Rabo-de-bacalhau' building type was used to develop the transformation grammar-based rehabilitation methodology. This paper focuses on the characterization (functional, constructive, stylistic, and cultural) of the case study buildings at the time of construction and nowadays. The process to transform dwellings and the possibility of generating designed solutions that meet the user's requirements is discussed at the end of the paper.

Keywords: Housing building. Shape-grammar. Rehabilitation methodology. Rabo-de-bacalhau.

*Sara Eloy areas of research are shape grammar systems, space syntax, immersive virtual reality, housing and universal design. Graduated in Architecture (FA.UTL, 1998), PhD in Architecture (IST.UTL, 2012). Assistant Professor at ISCTE-IUL, Lisbon, teaching disciplines of Architectural Computer Aided Design, Computation and Building Technologies.

Introduction

This research began with the premise that a large amount of the housing stock in urban centres requires rehabilitation, either due to constructional anomalies or difficulties in meeting present-day requirements. The problem it aims to address concerns the need to adapt the existing housing stock to contemporary lifestyles and functional and constructional requirements arising out of the use of technologies in housing.

Within the present-day context of construction in Europe and, more specifically, in Lisbon, Portugal, rehabilitation is the future for the housing market. On the one hand, it is known that the number of residents in cities has fallen; in Lisbon by approximately 15% between 1991 and 2001 which has stabilized in the last decade (INE, 2011). This population loss has been accompanied by the gradual deterioration and abandonment of the housing stock in the city and a consequent increase in the amount of va-

cant accommodation which is by far larger than the housing needs in Lisbon.

In terms of population, the traditional family structure which includes one man, one woman and their children does not necessarily reflect the family life of many households. In fact, the traditional nuclear family has become less important and the presence of other groups has increased in society. Elderly people (aged over 65) represent 22% of the Lisbon population, and the most representative families consist of two individuals, followed by 1 individual, being 2.2 the average family dimension (INE, 2011). This data has major consequences for the dynamics of neighbourhoods and their residential buildings, both now and in the future. The need to consider these domestic groups is reflected in the need to understand different ways of living and to incorporate these needs into housing.

Parallel to this increase in new forms of co-residence, the emergence of Information and Communication Technologies (ICTs) and their mass use has changed social relationships amongst individuals and between individuals and the surrounding space, on different levels.

This article is divided into 2 major parts. Firstly a characterization of the case study buildings 'rabo-de-bacalhau' is done considering its social, functional, constructive and aesthetics aspects. This characterization considers both original and current situation and highlight the major conflicts in use. Secondly the methodology of rehabilitation is briefly explained as well as the use of a shape grammar to encode the principles of dwelling transformation.

Rabo-de-bacalhau building type

The housing stock built between the 1950s and 1970s was chosen as the case study for this research on account of what it represents (approximately 36% of Lisbon's buildings were constructed between 1946 and 1970) and the likelihood of its rehabilitation in the near future.

The building type chosen is commonly labelled a 'tenement building' and from amongst these buildings the 'rabo-de-bacalhau' ('cod-tail') type was selected, mainly because the topology is very representative of the period and it has a significant presence in the city.

The typology known in professional jargon as 'rabo-de-bacalhau' first appeared in the 1930s and became common in the 1940s and 50s (NEREU, 2001). By around 1960 new 'rabo-de-bacalhau' buildings had practically ceased to exist and were replaced by buildings with rectangular and square plans (NEREU, 2001).

The need to rehabilitate these dwellings is vital from a functional perspective, but perhaps not as easy to quantify as it is to understand. In fact, the existing housing stock does not meet present lifestyle needs, both functionally and in terms of standards of comfort.

In this chapter, the characterisation of the 'rabo-de-bacalhau' typology is undertaken in accordance with the scheme proposed by Habraken (1988). This characterisation aims to understand the underlying design principles for this building type in order to determine how they can be used today.

The three methods of characterization used are, namely: analysis according to spatial organisation; analysis according to the physical/constructional system; analysis according to stylistic features.

In addition to these three forms of analysis, since dwellings are cultural artefacts: a collective product that portrays a population (HABRAKEN, 1988), it is also necessary to understand the cultural context, social patterns and lifestyles of the period in which they were built.

These systems of analysis are relatively independent of each other and it is through this independence that it is possible to analyse the various aspects of how the dwelling can be adapted to current lifestyles.

Space syntax theories are also used in the analysis of the dwellings in order to understand their spatial structure and the influence of this structure on residents (due to lack of space, the space syntax characterization is only slightly pointed in this paper).

Characterisation of the Original Buildings

The typologies studied are located in the areas of the city which expanded most during the period in question. The sample selected consists of 25 buildings (Figure 1), most of which are situated in the aforementioned areas (76%). The other 24% of the sample includes cases in areas that were more peripheral at the time.

'Rabo-de-bacalhau' buildings are found in various urban contexts. In some cases they were designed for areas that were being developed on the basis of a careful urban plan with properly established street hierarchies, accesses and facilities. In these cases they were built in open blocks that contained plenty of green spaces. This typology can also be found in other recent areas of expansion, in geometrically designed closed blocks.

In these contexts urban development projects were undertaken by the local council or were awarded to private developers and the building work on the sites was also undertaken by private developers.

In other cases, 'rabo-de-bacalhau' buildings appeared in isolation as part of an urban fabric that existed prior to their construction, with less rigid and rationalised planning adapted to the more irregular topology of the area and defined by the outlines of the traditional streets. In general, they are more modest and of a smaller typology than those in more central areas of the city.

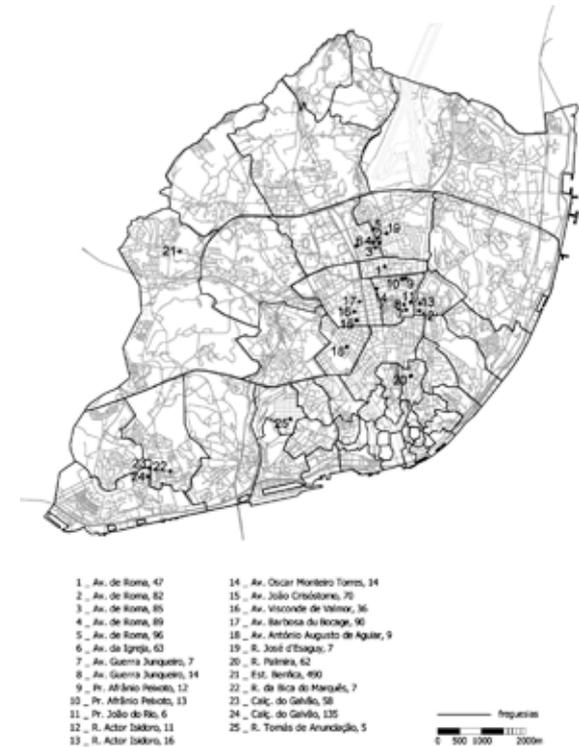


Figure 1. Location of cases analysed.

The methodology used to gather information for the case study was based in three types of data: i) original and alteration building project records; ii) bibliography; iii) a survey to all the dwellings of the sample.

Characterisation of the social and cultural context

The period under study began immediately after the end of the Second World War and corresponds to an easing of the economic and social crisis due to the war.

Throughout this period the Estado Novo regime governed in Portugal. This nationalist regime sought to create a hierarchical and cohesive nation around a strong leadership whose mottos 'God, Fatherland and Family' and 'Everything for the Nation, nothing against the Nation' were key values for the regeneration of the nation.

The society of the time was marked by tradition which, in terms of state propaganda, was associated with the authentic, nationalism, unity and regeneration (CUNHA, 1994, p. 177). Portuguese society was traditional, a concept opposed to the modernity with which the expression Estado Novo was associated, and exaggerated the expressions and dangers of degeneration, the unnatural, dissolution and foreign influences (CUNHA, 1994, p. 177).

The subject of the research underpinning this analysis of types of planning and housing in the 1940s to 1960s is family organisation and its changing structure during the second half of the 20th century, specifically the extent of its influence on the morphology of 'rabo-de-bacalhau' dwellings.

The state only began to build housing for the population in the 1930s. According to Pereira (2006, p. 8) state intervention in this sector can be divided into three areas: the programme of neighbourhoods of prefabricated houses for the neediest section of the population, Casas Económicas (affordable housing) for those 'protected by the state' and quality dwellings for the elites and wealthier classes.

The better quality dwellings for the wealthier classes of the time, which are the subject of this study, aimed to replace the earlier 'gaioleiro' ('birdcage') model – with its functional and social mix within the dwellings – and to reflect, both in morphological and aesthetic terms, the superiority of the Estado Novo (PEREIRA, 2006, p. 8). These dwellings, in the form of multifamily residences, were developed by the private sector but regulated by the public sector.

In the years following the Second World War the consequences of various changes in family life were felt in urban concentrations. The agents of change are associated with a complex set of causes. In a basic analysis, the following may be

highlighted: the economic revival and reduced unemployment; improved living standards and increased consumption of new technology for the home; the new status of working women who no longer stayed at home during the day; the renting or buying of homes by the majority of young couples and the creation of pre-school facilities. Functional characterisation

The functional characterisation was essentially focused on the individual dwellings and the use of spaces planned in the design phase and defined in the building project records. This is relevant to the analysis of the dwelling in terms of the dynamics within its functional sectors – private, social, service and circulation.

The buildings

The configuration of the 'rabo-de-bacalhau' buildings is characterised by a symmetrical plan consisting of a sequence of two or more rectangles, the smallest of which overlooks the open space in the rear.

According to Reis (2000, p. 56), the shape of the rear of the 'rabo-de-bacalhau' is the result of the widening of the (side and interior) yard to the back of the building, meaning that the inner yard was completely merged with the open space in the rear. In various Lisbon blocks it is possible to observe the evolution of the inner yard from its beginnings, when it was enclosed in the centre

of the building or adjacent to the side wall, to its complete opening out onto the open space in the rear (Figure 2).

According to Teotónio Pereira (1995), the need for large areas for more expensive housing required buildings with greater depth which was only possible through the trick of the 'rabo-de-bacalhau' shape. In fact, this solution took advantage of the best perimeter-area relationship for the building and enabled rooms set halfway along the depth of the dwelling to receive natural light and ventilation.

The repetition of 'rabo-de-bacalhau' buildings throughout a street enabled the width of the inner yard to be doubled, increasing the quality and amount of sunlight and ventilation (Figure 3).

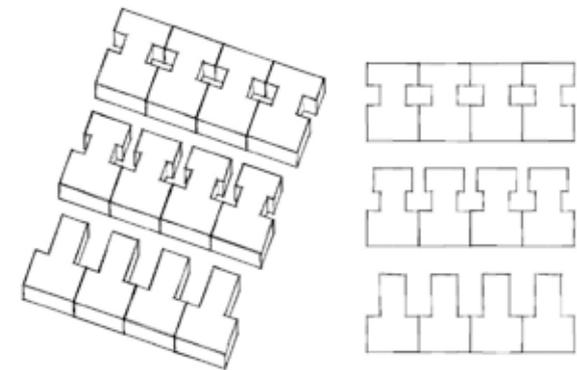


Figure 2. Composition of plan of inner yards and their evolution. Opening up and widening of lateral yard. The lower drawing exemplify the "rabo-de-bacalhau" buildings (adapted from (REIS, 2000, p. 57))



Figure 3. Plot occupied by 'rabo-de-bacalhau' buildings, whose repeating inner yard arrangement over several neighbouring buildings allows their area to be doubled. (source: <http://lxi.cm-lisboa.pt/lxi/>)

All the examples studied have a left/right arrangement with symmetrical plans in most cases. The average number of floors is 6, with the top floor usually designed as a mansard.

The accommodation is arranged centrally on each floor around a vertical access column, with

two dwellings per floor. In some cases there is also a second access column in the form of a stairway in the rear of the building.

The building is accessed from the exterior by the main door and also, in several cases, by a service door. The two different entrances to the building enabled domestic employees to be segregated from the family and their guests, from ground floor level onwards.

The dwellings

Dwellings in 'rabo-de-bacalhau' buildings are characterised by the very marked segregation of the various functional areas, particularly the room between the service and the social or private areas. Figure 4 shows some examples of "rabo-de-bacalhau" dwellings, divided into the four different types explained later, that illustrate the characteristics covered in this chapter.

The dwellings: accesses to dwellings and circulation areas

The dwellings studied often had two entrances, a main entrance linked to the social and private areas and a second or service entrance linked to the service area. Large L-shaped or winding circulation areas, consisting of corridors and anterooms in the connections between the different functional sectors, are characteristic of these dwellings. Most dwellings typically have large cir-

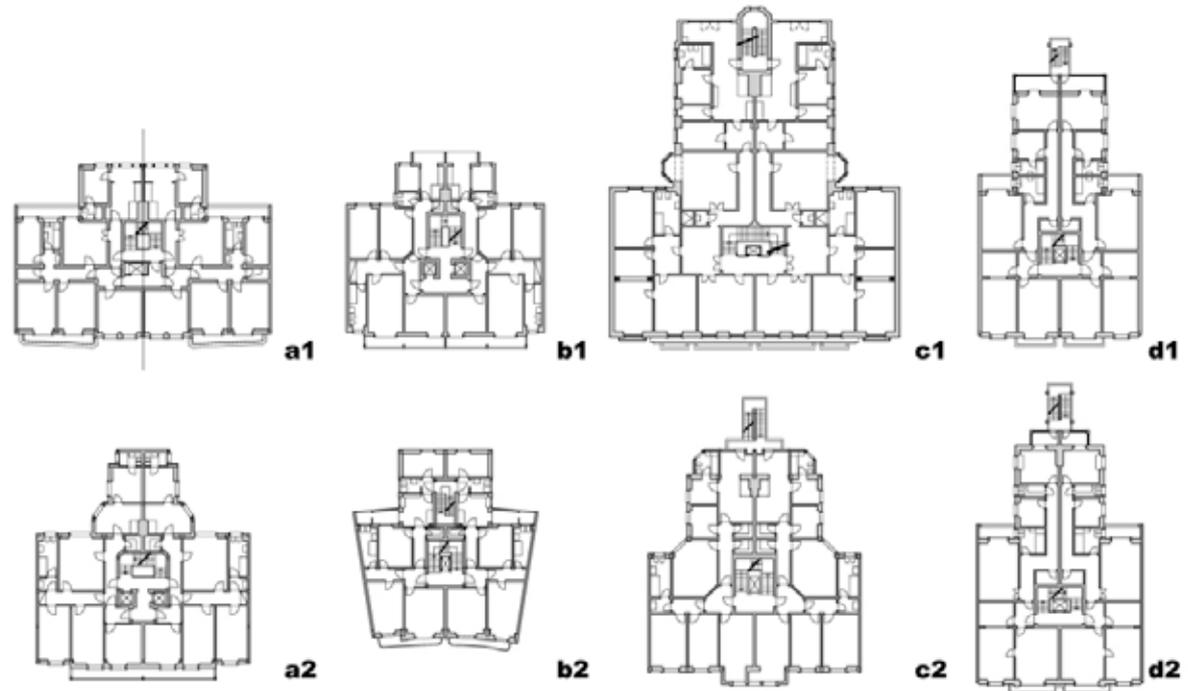


Figure 4. Examples of dwellings within the sample; a1 and a2 (type a), b1 and b2 (type b), c1 and c2 (type c), d1 and d2 (type d).

culation areas totalling approximately 16% of the average floor area.

The dwellings: social areas

Most of the social areas face onto the main facade. The social sector is tripartite with the existence of three areas in the better quality dwellings: a living room for receiving formal visitors; a dining room established as the informal family living area; an office for the head of the household who, even if working outside the home, needed a work

area in order to reinforce his role. This space, if it exists, is autonomous as it usually has a separate entrance. In some cases the space was also used as a guest bedroom.

The family rooms are divided into living rooms, dining rooms or, in the more modest dwellings, a combined living/dining room. Where two spaces exist for this purpose they are either adjacent and face onto the main facade or are separate, with the living room on the main facade and the dining room nearer the service area.

The dwellings: private areas

The private areas (bedrooms, dressing rooms and bathrooms) are usually located in the front wing of the building and are served by a nearby bathroom. The bathrooms are located near the service areas and further away from the private areas only in the older or smaller typologies. The segregation of the private sector (family bedrooms and associated bathrooms) reveals a clear intention to preserve family intimacy, placing greater importance on individuals and their privacy (PEREIRA, 2006, p. 11).

The dwellings: service areas

The totally separate service sector containing the kitchen, maid's bedroom and bathroom, larder and glassed veranda, is located in the less prestigious part of the dwelling – the rear of the dwelling. This distance reinforces the social hierarchies evident in the organisation of domestic space, where clearly social and private areas are set apart so that domestic employees never intruded on residents and visitors.

As a legacy of the 19th and earlier centuries, the presence in middle and upper class households of one or more live-in domestic employees, commonly known as 'maids', made it common for the programme for portuguese middle and upper class urban housing built between the 1940s and 1960s to include a bedroom and separate bathroom for the 'maid'.

Constructional characterisation

Buildings constructed during the period 1940-1960 generally have a mixed structure of reinforced concrete and stone or brick masonry. The so-called 'fully reinforced concrete' structures first appeared in the 1930s-40s but only became common in the 1950s. The period that extends to the mid 1960s features reinforced concrete frames, with double walls in brick masonry and inner dividing walls also in brickwork, generally in stretcher bonds.

The cases in the study include buildings with reinforced concrete in side walls and some of the more essential parts of the building such as pillars and beams and others which use reinforced concrete only in the floor structures. In some cases there are references to beams in interior walls on 'alternate floors' only.

The flooring on each storey consists of reinforced solid concrete slabs or light flooring in the form of prefabricated and pre-stressed reinforced concrete components. In some cases the slabs on the top floor ceiling are also made of reinforced concrete. The ground floors usually consist of concrete grout on 'irrigated and compressed landfill'.

In most cases the foundations are made of reinforced concrete beneath pillars and continuous foundations of hydraulics masonry beneath dividing walls.

The main and rear exterior walls have in most cases a reinforced concrete beam and pillar structure filled with two panels of solid stretcher bond brickwork and airspaces. In some cases the main facade is made of reinforced concrete up to the level of the first floor. The side walls are frequently built from reinforced concrete.

The interior partition walls are built from hollow or solid stretcher bond brick masonry, depending on the floor in question.

The communal (main and secondary) stairways in the buildings are made of reinforced concrete and consist of straight flights separated by landings.

Typification of the study universe

The criteria for analysis used in the previous sections enables the selected dwellings to be classified into categories which have similar features, known as typologies, and eventually for these categories, called types (HABRAKEN, 1988), to be illustrated with concrete examples.

The typification of buildings constitutes a methodological procedure which aims to identify the unchanging characteristics that explain and distinguish types.

A type is based on a set of rules: typological design rules (organisation of the whole and particular type shapes) and technological design rules

(the physical concretisation of the dwelling).

Van Leusen (1994, p. 22) considers type as a class of objects. Types may be divided into sub-types by specifying differences in the essential properties they share with others of their type.

The choice of the universe of 'rabo-de-bacalhau' buildings is, in itself, already a typological choice, in the sense that these buildings are characterised by their very similar functional, constructional, social and aesthetic aspects, amongst other factors, since they emerged during the same period of history. However, throughout the analysis it can be seen that even within an apparently similar sample there are clearly certain characteristics that enable individual cases to be 'catalogued' under different 'headings'.

In the universe analysed in this study, it was possible to typify the 'rabo-de-bacalhau' dwelling in accordance with characteristics common to all the cases in the sample. Within the base type (Figure 5), 4 sub-types of dwellings can be found which can be described as follows.

The base type has characteristics which are common to all sub-types:

- 2 dwellings per floor, on the left and right, which are symmetrical;
- A front wing with a facade overlooking the

- road which contains most of the rooms and is occupied exclusively by the social, private and circulation areas;
- A rear wing in the rear facade where the service areas are concentrated;
- A main access nucleus in the centre of the building which is not connected to either of the facades.

The 4 sub-types encountered were labelled 'Type A', 'Type B', 'Type C' and 'Type D'. The characteristics used to distinguish between these sub-types were: width of front wing; depth of rear wing; functional use of rear wing; location of vertical accesses in building; shape of interior circulation areas in the dwelling. In accordance with the above description, the sub-types were grouped into sets with similar characteristics.

With regard to syntactic properties it can be seen that, in general, there are no great variations between type and sub-types (Figure 6). However, a more detailed analysis by functional area shows that, with regard to depth, the types have marked differences, in particular Type C – which has deeper areas – and Type B – which is not very deep. These results suggest that 'rabo-de-bacalhau' dwelling types A to D have particular characteristics which enable specific rehabilitation strategies to be carried out.

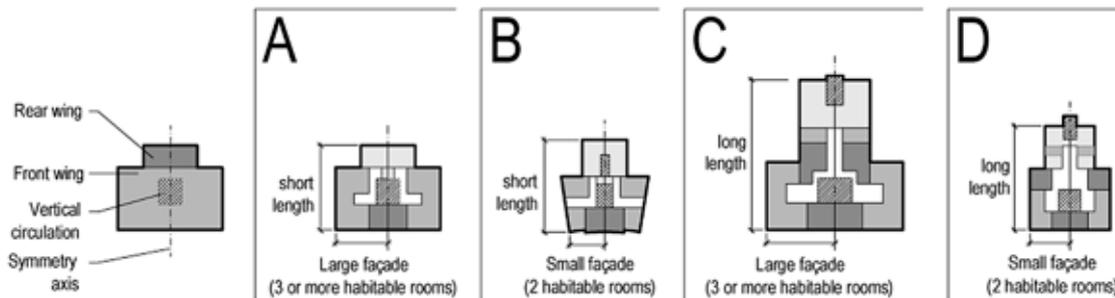


Figure 5. Base type for 'rabo de bacalhau' dwellings and sub-types A, B, C and D.

Figure 6 – Integration (i) and total depth for current node (TDN) of original dwelling according to type (all calculations performed using AGRAPH software).

	<i>Type</i>		<i>Type A</i>		<i>Type B</i>		<i>Type C</i>		<i>Type D</i>	
	i	TDN	i	TDN	i	TDN	i	TDN	i	TDN
Min	1,78	34,00	1,73	35,33	1,87	20,50	1,82	52,50	1,75	29,33
Mean	3,14	48,74	3,11	51,98	3,32	29,86	3,01	72,60	3,12	42,18
Max	5,18	69,60	5,17	76,00	6,00	40,50	4,44	102,50	5,15	60,67
Private area	2,55	53,84	2,64	58,17	2,41	34,50	2,52	79,05	2,59	45,58
Social area	3,10	47,23	3,14	51,00	3,37	28,00	3,32	65,38	2,72	44,17
Service area	2,48	55,40	2,61	55,33	2,56	33,17	2,21	88,70	2,46	48,10
Circulation area	4,36	38,21	4,27	40,22	4,89	23,25	3,83	58,77	4,44	32,47

Diagnosis of Current Situation

There is very little information on the alteration plans submitted to the CML and after the survey was completed it was noted that in many dwellings alterations had been undertaken without the required formal authorisation by the CML.

The analysis of the current conditions of use allow for an understanding of conflicts of use given current housing requirements, as well as the potential this building type affords.

It was common to find that the dwellings had been recently occupied by smaller households than those they had originally been planned for (58% of the households that responded to the survey contained only 1 or 2 residents).

The main alterations involving alterations to rooms correspond to recent occupations and are derived from a desire/need to provide more space. In the majority of cases the number of rooms in the initial typology was reduced, usually by eliminating one or more rooms. The room most frequently altered was the living room (the room nearest the hall), which was extended by being joined to the adjacent bedroom. The creation of one or more new bathrooms, the division of the main bathroom into two or even the relocation of the service bathroom, were also common practices.

There are very few exceptions of concrete data on the construction procedures involved in the demolition and construction of new walls. Demolition of brick masonry which, unfortunately, was common has an effect on the load bearing capacity of the original reinforced concrete constructions, often creating structural deformations in areas where entire walls were demolished.

The main conflicts in spatial organisation in 'rabo-de-bacalhau' dwellings essentially concern the following aspects: the imbalance between habitable and non-habitable areas; the duplication of identical dwellings throughout the building; the existence of inner yards and consequently rooms with less illumination and ventilation; the segregated service areas; the existence of oversized service zones but small kitchens; small living rooms; the existence of interior rooms; few bathrooms; the existence of two nearby accesses to the dwelling; the excessive length of the circulation areas; small habitable areas; the lack of storage space; over-rigid partitioning.

From this analysis of the cases in the study, it may be stated that the residents' strategies generally followed the same path: expansion of the social area, reduction in the number of residents and the addition of a bathroom.

Methodology for Housing rehabilitation based on a transformation grammar

The major aim of the research was to define a rehabilitation methodology for Lisbon's existing housing stock to enable it to respond to new technology requirements and new lifestyles. The goal of the proposed rehabilitation is to upgrade houses by incorporating and updating ICT and domotics infrastructures as well as solving emerging conflicts affecting the use of space prompted by the introduction of new functions associated with these technologies.

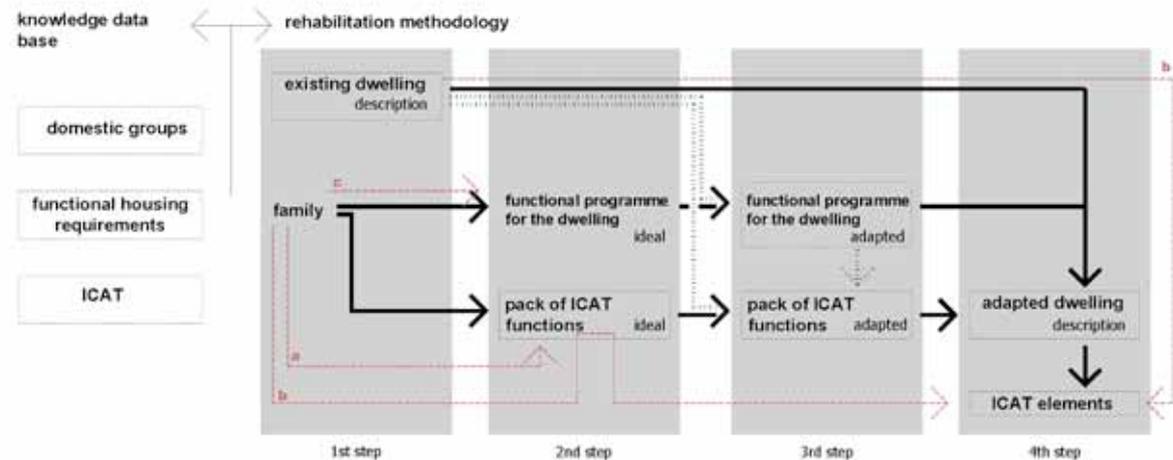
The proposed methodology provides for different rehabilitation solutions according to variable factors.

'Rabo-de-bacalhau' building type was used to develop the rehabilitation methodology to allow us to apply the methodology to concrete buildings so that transformation principles could be inferred

and then tested. Only with a specific morphology would it be possible to test different hypotheses for functional rehabilitation. This means that, although the proposed methodology is generic to all residential buildings, applying all the steps of the methodology, presupposes the rehabilitation of a 'rabo-de-bacalhau' building type.

The hypothesis for the rehabilitation methodology was based on the conceptual schema for the design process proposed by Duarte (2001) for the mass customization of housing. According to this conceptual schema, the design process consists of two sub-processes: a formulation process that takes user and site data and generates a description of an appropriate house, and a design process that takes this description and generates a matching solution within a given design language. Accordingly, it was hypothesized that a rehabilitation methodology should encompass four steps, as shown on Figure 7.

Figure 7. Basic steps in the planned rehabilitation methodology.



Prior to the first step in the methodology a knowledge database was created, which plays a key problem-solving role. It contains the knowledge, which is required in order to perform the proposed rehabilitation. The first step in the rehabilitation methodology consists of gathering the data needed for the rehabilitation process, namely a profile of the household and a description of the existing dwelling. In the second step, the household profile is used to determine the ideal functional programme for the dwelling as well as the ideal pack of ICAT functions. In the third step, the existing dwelling, the ideal functional programme, and the ideal ICAT pack are used to derive a description of a compromise or adapted solution based on the existing dwelling. Since the solution is influenced by the existing morphological structure, it is necessary to transform the description of the ideal solution obtained in the 2nd step into the description of the adapted solution. Finally, the layout of a design solution for the particular family in the particular dwelling is obtained from the description of the adapted dwelling, including the ICAT components needed in the dwelling.

The methodological hypothesis is to use description grammars, shape grammars, and space syntax as tools for identifying and encoding the principles and rules underlying the adaptation of existing houses to meet new requirements.

Shape Grammars, invented by Stiny and Gips (1972), are 'algorithmic systems for creating and understanding designs directly through computations with shapes, rather than indirectly through computations with text or symbols.' (KNIGHT, 2000) A shape grammar is a set of rules that apply step-by-step to shapes to generate a language of designs.

The shape grammar used was called a transformation grammar, as it enables one specific dwelling to be transformed into another by applying transformation rules and rather than generation rules as in a traditional shape grammar.

The use of a shape grammar enables existing houses to be transformed in a very precise and systematic way. This process was used to manage shape transformation within dwellings to create a systematic and methodical process that could encompass all the valid transformation rules for a given dwelling. The transformations respond to functional and technical requirements as well as constructional requirements. This research explores a method which seeks to encode the architect's knowledge in the form of rules. These rules are used to transform dwellings and are assumed to represent the architect's knowledge from a wider perspective enabling a dwelling to be transformed into a new one that matches given requirements, using knowledge that relates family profiles to functional programmes and ICAT packs.

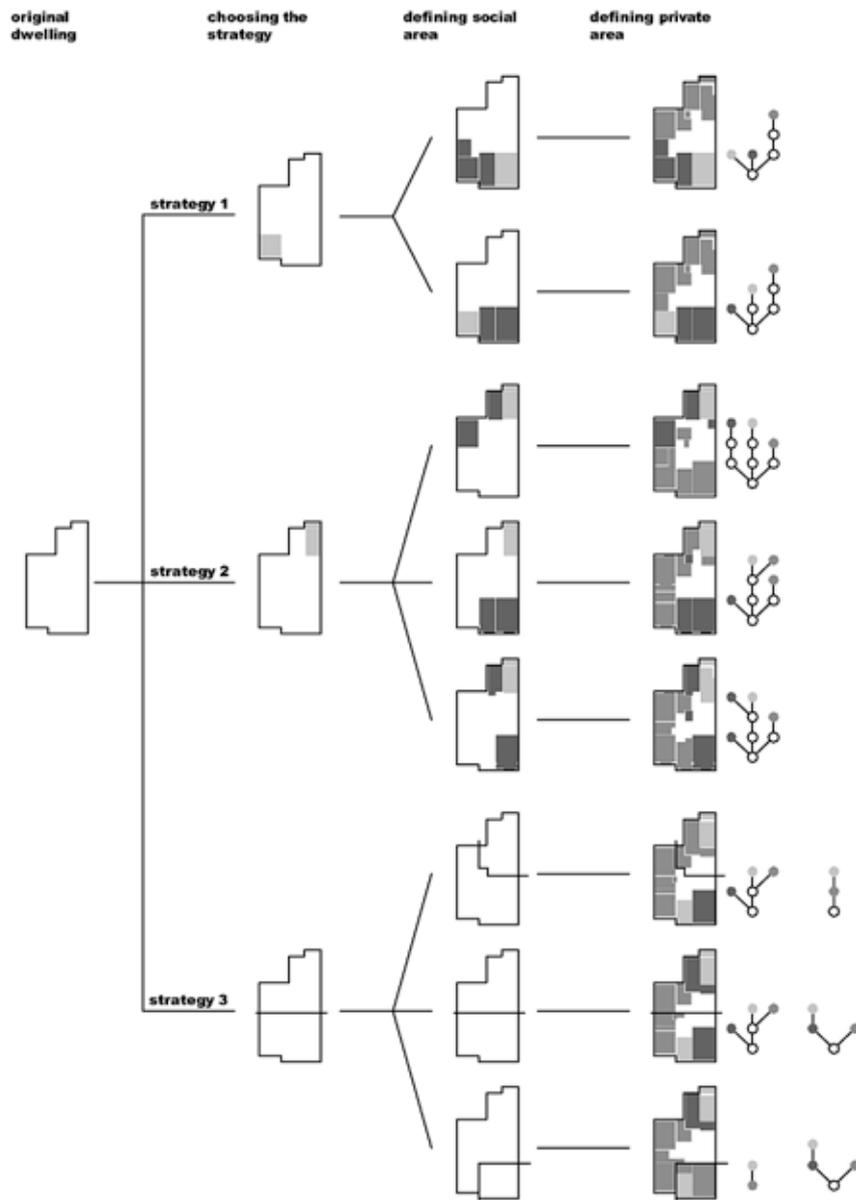


Figure 8. Simplified derivation tree for the different rehabilitation strategies.

The transformation grammar developed proposes three different rehabilitation strategies for the buildings in the case study as shown in Figure 8.

Each of these three rehabilitation strategies has its own advantages and disadvantages in terms of functional and constructional aspects, and they can be combined within the same building to generate a wider market offer. The differences in the resulting transformations lie in the number of dwellings on each floor and the position of the kitchen in each dwelling.

The three strategies are as follows:

1. Maintaining two dwellings on each floor and moving the kitchen from its original position in the rear wing of the building to the front of the building.

The aim is to strengthen the relationship between the social and service areas and to segregate the private area from the rest of the dwelling.

2. Maintaining two dwellings on each floor and the position of the kitchen. The aim is to keep construction transformations to a minimum without compromising the use requirements established in the functional programme. This strategy can be used to rehabilitate just one dwelling in the entire building.

3. Dividing one dwelling into two smaller ones and creating a kitchen in one of the new dwellings.

The aim is to obtain smaller dwellings and a variety of dwelling types within the building.

Because of lack of space the transformation grammar is not described in detail in this paper but it's fully detailed in [name deleted to maintain the integrity of the review process].

Conclusion

This article focuses on a wider research that was carried on to develop a rehabilitation methodology that enables the transformation of dwellings to answer to new ways of life and incorporate ICT. In order to develop an accurate methodology it was used a specific type of building. This paper focuses essentially on the characterization of 'rabo-de-bacalhau' dwellings and allow us to understand the relation between the 40's and 50's society and the dwelling's morphology. In fact Habraken (1998) says that dwellings are cultural artefacts and a collective product that portrays a population. The understanding of both context (cultural, social patterns and lifestyles) of the period in which they were built and those same aspects regarding nowadays it's a key factor to speculate what should be the transformations needed.

The use of a shape grammar informed by social, functional and constructive aspects enables the definition of a process of design which takes into account the needed variables. The proposed methodology seeks to produce rehabilitated designs that are 'legal projects' because they are in the transformation language and 'adequate projects' because they satisfy the a priori set of user requirements. (DUARTE, 2001)

References

CUNHA, L. M. J.. **A nação nas malhas da sua identidade:** o Estado Novo e a construção da identidade nacional. Braga, Universidade do Minho, ICS, 1994 (<https://repositorium.sdum.uminho.pt/bitstream/1822/6440/1/1994%20Provas%20APCC%20Tese.pdf>) accessed June 2010

DUARTE, José Pinto. **Customizing Mass Housing:** A Discursive Grammar for Siza's Malagueira houses. Massachusetts Institute of Technology, Cambridge, E.U.A (PhD Thesis), 2001

HABRAKEN, N. John. Type as a Social Agreement. **Paper presented at the Asian Congress of Architects**, Seoul, 1988.

Instituto Nacional de Estatística (INE) **Censos 2011** (<http://www.ine.pt/>) accessed in Oct 2012, 2011

KNIGHT, Terry W. **Shape Grammars in education and practice:** history and prospects. [online]. Massachusetts: MIT, 14 September 2000. (<http://web.mit.edu/tnight/www/IJDC/>) accessed on 2009-03-21

NEREU, Sílvia. **Evolução das exigências funcionais da habitação:** Um ensaio de aplicação ao Parque das Avenidas Novas. Lisboa: IST (Master thesis), 2001

PEREIRA, Nuno Teotónio and BUARQUE, Irene (1995) **Prédios e Vilas de Lisboa.** (Livros horizonte, Lisboa)

PEREIRA, Sandra Marques. Housing structures and contemporary family patterns: Lisbon private market. **ENHR Proceedings 'Housing in an expanding Europe: theory, policy, participation and implementation'** Workshop 22 – Housing Markets Dynamics, Ljubljana, Slovenia, 2 – 5 July 2006.

REIS, N. M. A. **O Saguão como personagem conceptual estruturador da habitação urbana: o caso de Lisboa – o seu passado recente e o seu futuro: trabalho de síntese.** (FAUTL, Lisboa), 2000.

STINY, George and GIPS, James. Shape Grammars and the Generative Specification of Painting and Sculpture. In C. V. Freiman, ed., **Information Processing 71** (North Holland, Amsterdam, 1972), pp. 1460-1465. ([http:// www.shapegrammar.org/ifip/ifip1.html](http://www.shapegrammar.org/ifip/ifip1.html)) accessed on 2009-04-01

VAN LEUSEN, M. **A System of Types in the Domain of Residential Buildings.** Delft: Delft University of Technology. (PhD thesis) (<http://www.narcis.info/publication/RecordID/oai:tudelft.nl:uuid:f0b1c131>). 1994 accessed on 2010-09-07.

