PAPER REF # 8215
Proceedings: Eighth International Space Syntax Symposium
Edited by M. Greene, J. Reyes and A. Castro. Santiago de Chile: PUC, 2012.

CAN GENOTYPE PATTERNS CHANGE OVER TIME?

AUTHOR: **Viviane CUNHA**
Viviane Cunha Associados Arquitetura e Sustentablidade, Brazil
e-mail: viviane@vivianecunha.com.br

KEYWORDS: *Spatial Transformations, Descriptive Tabulation, Genotype, Phenotype, Mutating Genotype*

THEME: Building Morphology and Usage

Abstract

This question arises from a PhD research project that studied the spatial organization of middle class apartments in Rio de Janeiro, Brazil, from the1930s until the end of the 20th century, to investigate if and how different apartment plans could express numerous social changes occurring during that period of time in this context. Two instruments were generated in this work, related to the investigation of historical samples from Space Syntax perspective, named as: descriptive tabulation and mutating genotype. Descriptive tabulation starts by combining the results of classic space syntax methods to describe and analyze patterns of permeability, integration and others methods – as the simplification of justified graphs by sectors (found in Paula, 1992 and Amorim, 1999) and new procedures as found in Conran Dalton and Kirsan (2005) about isomorphism of graphs. The novelty of this technique is the logic of ordering the diverse results in just one table, to be visually grasped by Cartesian representations in which spatial properties manifestations arecorrelated to the chronological development. It is done by identifying and isolating diverse spatial properties from the plans and disposing of them in a particular order as distinct columns in the same table. In this way, spatial variables can be clearly isolated and correlated to others results, revealing repeated patterns between the cases of the sample and the possibility of their variations along the time. If genotypical characteristics, when observed in a long period of time and using a detailed description of different spatial variables - as done by the logic of methods combination as descriptive tabulation - present alterations in some of their aspects also in a consistent number of cases in the sample, could it not be said that genotypical spatial patterns can mutate along the time, as it can happen in biological patternsfound in nature? If the answer is affirmative, to the definition of genotype, from Space Syntax theory, of stable pattern of spatial structure that underlies the phenotypical formal expressions, it could to be added the possibility of genotype transformations across time, while main characteristics are kept the same, as the reorganization of aspects of spatial relations due to possibilities of variations in social manifestations – which could be defined as mutating genotype.

1. SPACE SYNTAX AND GENOTYPE

Space syntax theory (Hillier and Hanson, 1984) proposes principles relating to the social dimension of space. This spatial theory argues that the distributional structure of architectural space, by the logic of their configurations, interacts with the ordering of society in which it is constructed, as one of their social systems. Architectural environments, thus, not just generate built forms but also organize patterns of interaction among people by the way their spaces are distributed.

Techniques were generated by Space syntax to identify and describe characteristics of spaces that occur in relevant repetitions within the different systems of a specific society, interpreting from them a correlation to social factors. These patterns that structure spatial configurations, when found in a consistent way in a sample of architectural cases, are classified by Space Syntax as 'genotypes', while the occurence of these abstract patterns in different geometric forms are referred to as 'phenotypes'. While phenotype manifestations are expected to develop in an infinite variety, genotype patterns maintain the same descriptions, to delineate the abstract expression of society in space. Hillier and Hanson argued that "different types of social formationÉrequire a characteristic spatial order, just as different types of spatial order require a particular social formation to sustain them" (1984, 27).

This work brings the idea that some aspects of genotypes can change over time, while the stability of genotype characteristics are kept, the social codes they are expressing may also have altered along the decades, although the same society continues to be recognized therein. The possibility of finding these aspects seems to depend on an investigation into historical sample that can show how these changes emerge

2. INTRODUCTION TO THE RESEARCH

This paper is based on PhD research from the same author (Cunha, 2007) which was focused on the social significance of spatial elements of architecture (originally proposed by Hillier and Hanson's theory of space). The aim is to verify if and how a sample of 95 apartments randomly collected, from 193 0s to 1990s, could express (see cases of each decade in figure 1) lifestyle through patterns of continuity and changes of spatial configurations.

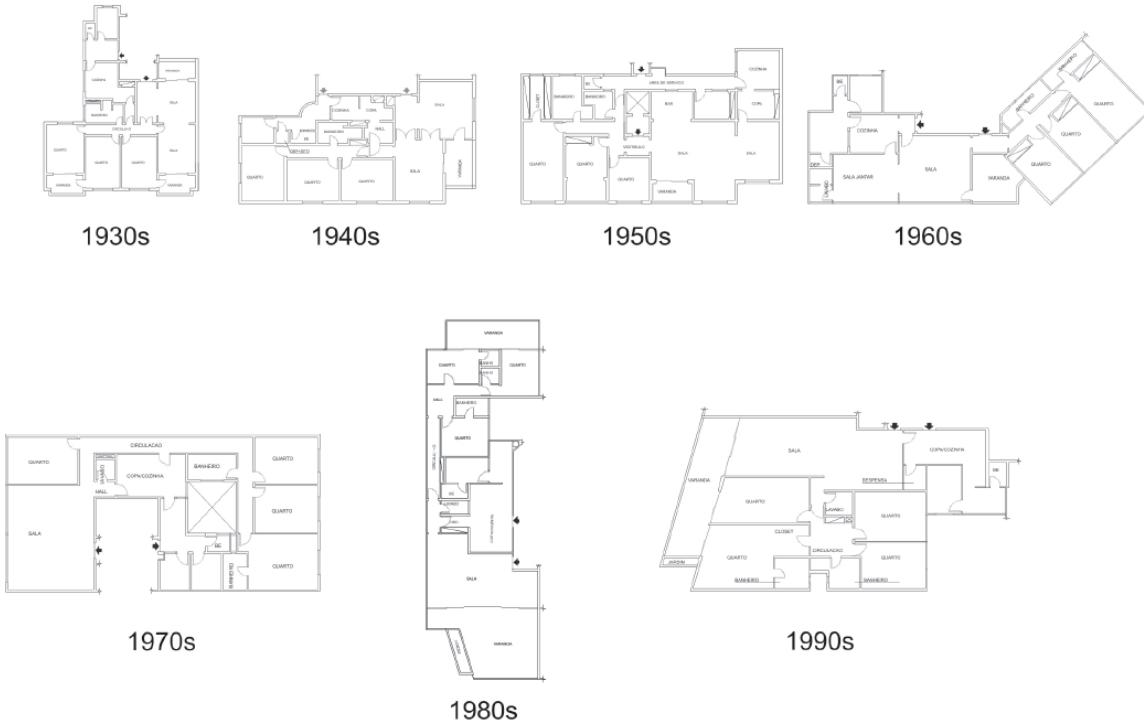


Figure 1 – examples of sample's apartment plans of each decade.

1930s - Living rooms are divided by wall demarcations for defined activity areas (which tend to disappear) and bedrooms located close to the social zone, with one bedroom directly linked to it. 1940s – Increasingly elaborate social spaces and no cases of en-suite bathrooms and lavatories up to this point, even in larger apartments. 1950s – More spatial elaboration of the social area than in the 1940s and Bedrooms start to gain distance from social zone, with some cases of en-suite bathrooms and lavatories. 1960s – Bedrooms, positioned as far as possible from other house rooms, and lavatories become very frequent. Kitchen and social entrance access living room directly. 1970s - Corridors made longer to separate intimate areas, and en-suite bedrooms in almost all cases. 1980s- En-suite bedrooms are not only present in all cases but sometimes for all bedrooms in some apartments. Main bedrooms are formally elaborated and en-suite bedroom for maid. 1990s- Main bedroom also connects to the social veranda in some cases, to the intimate area corridor.

The investigation started with the quantification of the integration relations found in these different systems, using Space Syntax software, for the spaces of the apartments. Integration, as defined by Hanson (1998, 32) is "one of the fundamental ways in which houses convey culture through their configurations".

21 different sequences of integration were found for the 6 main labeled rooms, mathematically 720 distinct possibilities could be generated by this combination of 6 rooms. From these 21 sequences, 3 sequences represented more than half of the sampled residences, as strong tendencies of domestic organizations (see table 1).

Type/decade	30	40	50	60	70	80	90	Total
T1- T<K<L<E<B<M	0	40.9	50.10,15,18,19	60.3,5,11,19	70.5,15	80.1,2,4,5,12,16,20	90.8,9,13,14	22
T2- L<T<K<E<B<M	30,11	0	50.4,16,20	60.2,13	70.1,8(D),14,16,19	80.3(D),7,8	90.2,4,5,7	18
T3- T<L<K<E<B<M	30.8,16	40.12,17	50,7	60.17,18	70.6,12(D),18	80,13	90.10(D)	12
T4- L<T<E<K<B<M	30.18(D)	40,1	50,11	60,12	70.13(D)	80,14	90,17	7
T5- L<T<K<B<E<M	30,14	0	0	60.15,20	70,2	80.15,19	0	6
T6- T<K<L<B<E<M	0	40.2(D)	50.13,17	60,9	70.3(D),	0	90,15	6
T7- T<L<E<K<B<M	30.1,2	40,8	50,6	0	0	0	90,12	5
T8- T<L<K<B<E<M	30,9	0	0	60,7	70,17	0	0	3
T9- L<E<T<K<B<M	30,19	0	0	60,16	0	0	0	2
T10- T<E<L<B<K<M	0	0	50,1	0	70,2	0	0	2
T11- T<L<E<B<K<M	30,12							1
T12- T<L<B<E<K<M	30,7							1
T13- T<E<K<L<B<M	30,1							1
T14- T<E<Kl<B<L<M	30,17							1
T15- T<K<E<B<L<M		40,5						1
T16- T<K<B<E<L		40,3						1
T17- L<K<T<E<B<M		40,13						1
T18- T<L<B<K<E<M			50,9					1
T19- T<L<E<M<K<B			50,8					1
T20- T<K<L<E<M<B				60,4				1
T21- L<T<B<K<E<M					70,9			1

Table 1 – integration sequences for main spaces: T= transition space/ K= kitchen/ L= living space/ E= exterior/ B= main bedroom/ M= maid's bedroom

The study aimed to verify if permeability patterns could also structure the composition of the apartment plans, as well as integration patterns, and in addition, if their repetitions could be correlated. If repetitions occurred, the genotype characteristics resulting from the relation of these different spatial properties could, possibly, be expressing elaborated social connections, bringing more information to the complexity of domestic systems. Justified graphs from the exterior were constructed for each apartment and these graphs were then summarized by concentrating groups of spaces with related activities as a single node. This simplification of the justified graphs was previously done by the author (Cunha, 1992) and by Amorim (1999), and seeks to make visible the regularities in the way areas or sectors of specific activities relate to each other (see figure 2). The trends between activity areas in an architectural system from these summarized justified graphs can delineate an order of interaction among categories of users of these spaces, which could be covered by numerous intercommunications between spaces in full justified graphs.

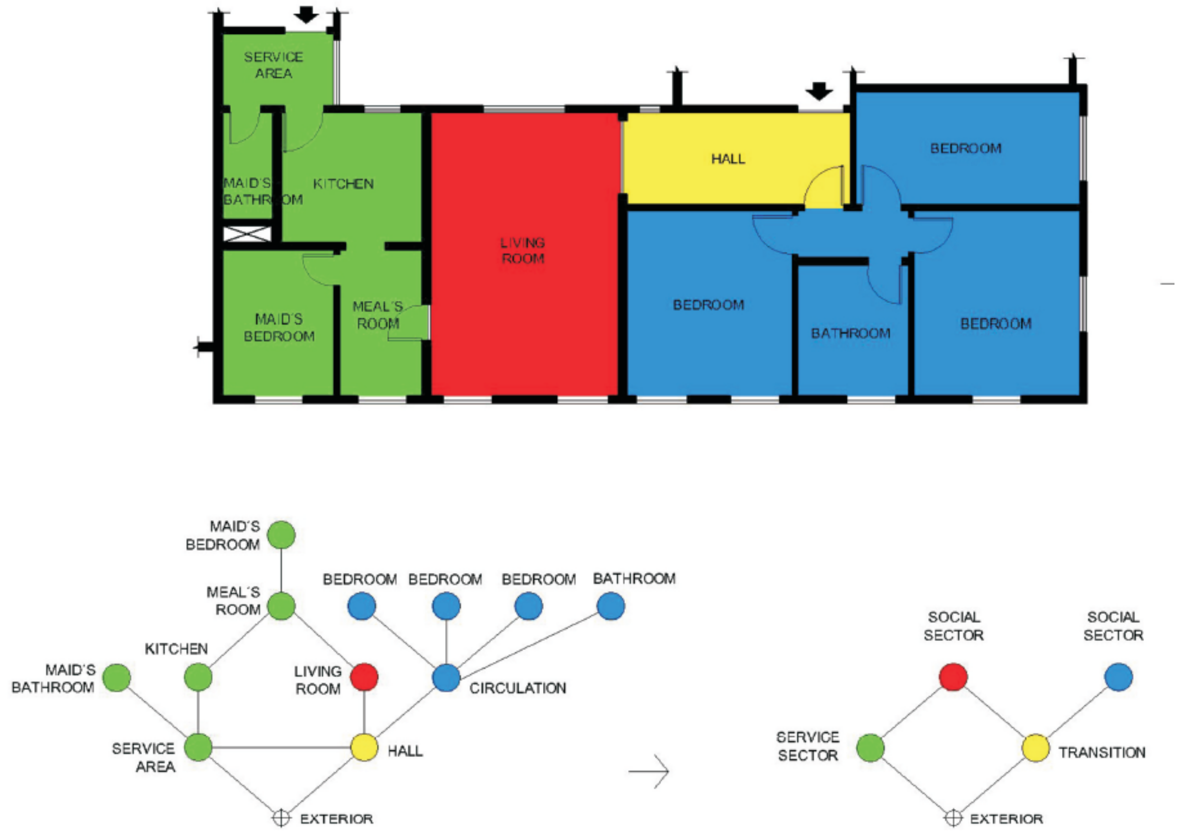
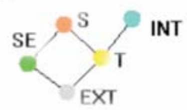
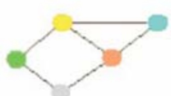


Figure 2 – Example of apartment plan from the sample, with different sectors of activities in different colours, and respectives justified graph and summarized justified graph from exterior

The purpose of using the justified graphs summarization in this work is to identify patterns of access connections between different groups of activities in the plans, which are socially related to codes of interaction among categories of people who use these domestic spaces.

As seen in table 2, the simplification of justified graphs from the 95 plans led to15 types of permeability graphs. From these graphs, six types of graphs appeared to represent a consistent number of apartments, as they are repeated in 6 to 35 cases, while the other 9 are in 1 to 4 cases.

TYPES/ GRAPHS	PLANS	TOTAL
A 	30,1 60,2	2
B 	30,2 40,3 50.6, 50.8	4
D 	30,8 40.1, 2, 6, 9 50.13, 18, 19, 20 60.3, 4, 5, 9, 11, 19 70.3, 5, 6, 12, 15, 17, 18 80.2, 3, 4, 5, 13, 15, 16, 20 90, 9, 10, 13,19,20	35
E 	30,18 60,16	2
F 	30,19 50.9, 17 80.1, 12 90.14, 15	8
G 	30,14 40.15, 20 50.4, 11, 16 60.12, 13, 15 70.1, 2, 8, 13, 14, 16, 19 80.8, 19 90.1, 6	20
H 	30.7, 9, 10 50,7 70,9 90.4	6
I 	40.5, 12, 17 50.1, 10 60,7 70,2	7

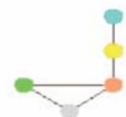
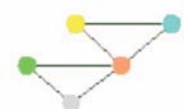
TYPES/ GRAPHS	PLANS	TOTAL
L 	60,18	1
M 	30,11 60.17, 20 80.7, 14 90.2, 5, 7	8
N 	30,16	1
O 	30,12	1
P 	90,17	1
Q 	30,17	1
R 	40,8	1
LEGEND	● EXTERIOR ● SOCIAL AREA ● SERVICE ● INTIMATE ● TRANSITION	

Table 2 – Summarized justified graphs for all plans of the sample

Types D and G are the most frequent by far: D is in 35 plans and G in 20. As can be seen in table 3, these types are found throughout the sample period. D and G access types are found in 55 apartments, which is more of half of the whole sample.

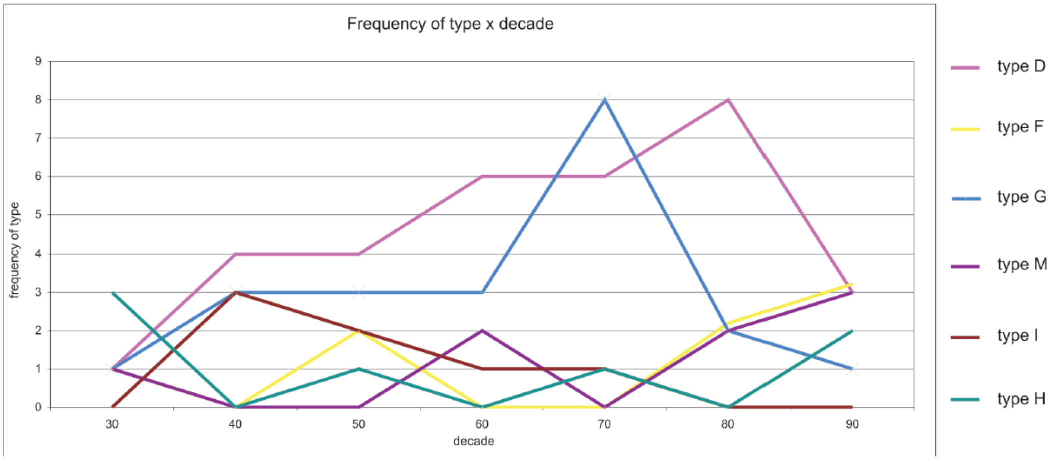


Table 3 – Frequency of the predominant summarized justified graph along the sample period of the research.

The persistence of these permeability tendencies led the research to look for the possibility of a correlation of these repetitions to the repetitions found in integration types.

The first procedure of this comparison was that each apartment plan number was substituted by the type of summarized justified graph which represents it, in the table of the main integration sequence (taken from table 1), which generated table 4.

Type/Decade	30	1940	50	60	70	80	90	TOTAL
T1- T<K<L<E<B<M		**D,D**	**I,D,D,D**	**D,D,D,D**	**D,D**	**F,D,D,D,F,D,D**	**F,D,D,F**	22
T2- L<T<K<E<B<M	**M**		**G,G,M**	**A,G**	**G,G,G,G,G**	**D,M,G**	**M,H,M,M**	18
T3- T<L<K<E<B<M	**D,N**	**I,I**	**H**	**M,L**	**D,D,D**	**D**	**D**	12

Table 4– List of the main types of integration and the plans where they occur being presented by the type of summarized justified graph, which represents them.

The analysis of table 4 showed that almost all apartments that followed on of the main integration types also had one of the main summarized access graphs. The most recurrent integration sequence Đ T1 Đ happens in residences in which the distribution of spaces accesses' is as the justified graph D. In the same way, the second most common integration sequence Đ T2 - is mostly correlated to G, the permeability simplified graph that follows D in number.

At this point the study went deeper with the intention to identify more clearly the relation that can be established between these spatial properties, seeking to understand how they can contribute to the construction of social interactions in the domestic realm of these apartments.

The closer observation of the six predominant access types delineates that they have just few differences among each other. Could they be variations of one or a few types instead of being distinct types? Another analytical procedure was introduced to the study to verify if it is not that small variations in a sample obscure or impede the correct identification of genotype consistencies. This procedure is referred to as “small graph combination”, and was proposed by Conran Dalton and Kirsan (2005) as a comparison between graphs to see how many normative operations are necessary to transform one into another. A low level of similarity between them, as defined by the authors, means few actions required to make the transformation, which determines a ‘genotype signature’ between them.

This technique was applied to the 6 summarized justified graphs, looking for pairs of graphs in which the number of actions required to normalize the differences between them would be up to three; the process that would define their genotype signatures. Through this process types D, F, G, II, I and M split into two groups of high similitude level, D and F in one signature group and G, II, I and M in the other. The genotype signatures for permeability were named after D and G respectively (figure 3).

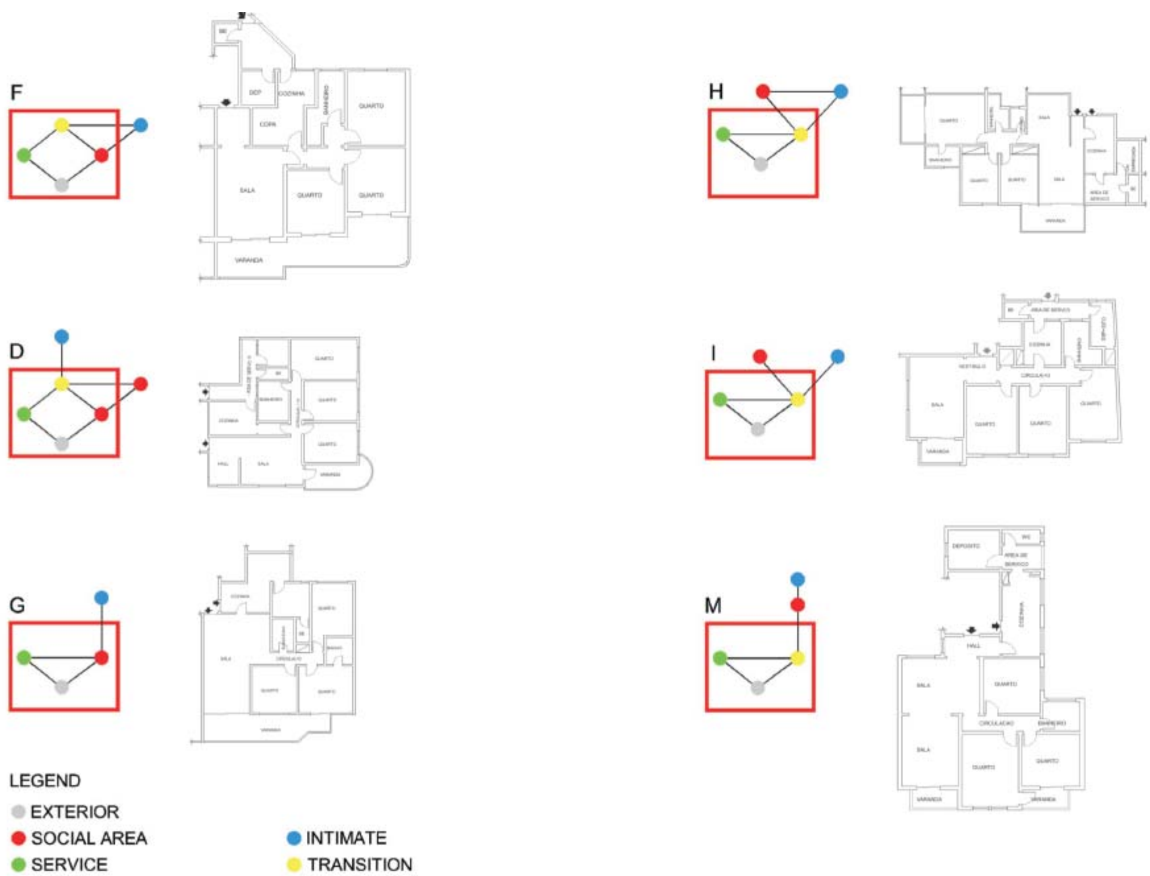


Figure 3 - Main summarized justified graphs and examples of plans of each type

3. MUTATING GENOTYPES

According to table 4, it appeared that the integration type T1 relates to genotype signature D, T2 to G and T3 to both D and G signatures.

The correlation between the permeability genotype signatures and their access characteristics was considered both for before and after normalization and the main types of integration, describes two different orders that classify most of the apartments of the sample, as genotypes. These genotypes were also named after D and G: as they are constructed respectively by access aspects of genotype signature D - with both integration types T1 and T3 - and access characteristics from signature G - with aspects from integration types T2 and T3.

While the genotypes maintain main characteristics found in all cases, they can show variations in some characteristics between the groups of specific periods of time, as can be observed in table 5.

Genotypical Signature D	Genotypical Signature G
Service sector accessed since the exterior	service sector accessed since the exterior
Service sector always connected to transition space	service sector connected to social or transition space
Service sector always connected to transition	service sector connected to transition or social space
Social sector always connected to exterior	social sector near or away accessed from the exterior
Social sector connects to intimate through ring	social sector connected to intimate through ring or not
Intimate always connected to transition, same also social	intimate always connected to social, some cases also transition
Transition as distributor but away from the exterior	transition, if exists, as distributor with the exterior
Transition always existing	transition doesn't always exist

Characteristics of integration types T1, T2 and T3

T1	T2	T3
Centered on the movement	centered on the occupation	centered on the movement
Transition – more integrated space	living room – more integrated space	transition – more integrated space
Kitchen more integrated to living room	living room more integrated than kitchen	living room more integrated than kitchen
Exterior in medium position	exterior in medium position	exterior in medium position
Main bedroom well isolated	main bedroom well isolated	main bedroom well isolated
Maid's bedroom – most segregated space	maid's bedroom – most segregated space	maid's bedroom – most segregated space

Characteristics of genotypes D and G, found by the correlation between aspects of genotype signatures D and G and integration types T1, T2 and T3

GENOTYPE D	GENOTYPE G
always transition spaces and as the most integrated space	transition spaces not in all cases
transition as distributor spaces, far from exterior	transition as distributor spaces, close to exterior
kitchen more integrated than living room	living room more integrated than kitchen
living room as most integrated than kitchen in cases of 1930s, 70s to 90s	living room as most integrated space
social area always directly connected to exetrior	social area directly linked to exterior mainly in the 1960s and 1970s
transition space always connected to intimate area	transition space connected to intimate area in 1950s/ 1990s (through rings)
social space directly connected to intimate area in 1980s/ 1990s (through rings)	social space always connected to intimate area
intimate area as very segregated	intimate area more segregated in 1930s, 50s, 60s, 80s and 90s
exterior far from transition space as distributor	exterior connected to transition space as distributor, when this transition space exists
maid's bedroom as the most segregated space	maid's bedroom as the most segregated space

Characteristics that suffered changes along the study time period

Table 5 – Characteristics of genotypical signatures D and G, integration types T1, T2, T3 and genotypes D and G

In this way, genotype D delineates houses where relations between people is suggested to happen mostly as they cross each other in the corridors rather than in the rooms, due to the relatively higher integration values of transition spaces and the constancy of their existence in apartments of the sample. This spatial characteristic implies not just a different dynamic of experience – in corridors people are mainly walking while in activity spaces they tend to be stationary – but also temporal distinctions: meetings in transition areas tend to not last long when compared to meetings in rooms. Interactions among people in apartments with genotype D, on the other hand, tend to be disconnected to exterior, as access to outside space is distant from integrated corridors and the system has a medium level of integration. The movement of people in the kitchen is suggested to be the second most integrated and the living areas tend to have less frequent use.

Due to mutations of genotype D in cases with integration type T3, the 1930s living room appears to be more integrated than kitchen; in the 1970s and 1990s apartments both this and an inverse integration pattern occur. Service cells are always directly linked to the exterior, in all cases of the both genotypes, but in genotype D people that usually circulate this area, mainly maids, can enter from the street directly to the room that most commonly aggregates people's connections – the kitchen. The social zone is also directly linked to the outside, facilitating peoples entry into the house – mainly inhabitants and visitors. Although, as social rooms are more integrated, it seems to suggest that this route is not so frequently used. Access to bedrooms is not through social spaces, but through corridors distant from the exterior, indicating that the intimate areas are kept far from the the rest of the house. This is intensified by the high segregation level of the main bedrooms, suggesting less movement in these private rooms. Maid bedrooms are even more isolated. The second mutation found for this genotype D is that in the 1980s and 1990s the bedroom areas gain an optional direct link with the social zone due to the F pattern of permeability, this introduces the possibility of people and activities from the bedrooms to interact with the social zone movement, and with visitors that can access there. This tendency happens also in the 1990s for T3 characteristics.

In the apartments of genotype G the use of living areas is more common than in any other space of the house. In the 1930s and 1940s this social zone was rather substituted by corridors that distribute the access to different areas of the house. This organization also functions as intermediary filter among spaces and people inside and outside the apartments, due to M and I summarized access types in T2 and T3, this places the corridors as intermediaries in this connection. These circulation spaces are not present in all cases, as seen in genotype D. When they exist they tend to be very integrated, the conjunction between integration type T3 and access types M, II and I from 1930s to 1 960s, makes the movement of people in the living spaces less probable. In the 1950s this transition filter existed for access types II and M, but after this decade the social entrance directly linked the exterior to social spaces. However, from the 1960s and on this genotype stopped being influenced by T3 and its high integration pattern for corridors, this divided the main movement of the house between corridors and living rooms as seen in the cases of genotype G with T3. Kitchens do not have the tendency for so much people integration in genotype G as they do in genotype D (where it happens due to both T1 and T3) and the service places and their principal users – servants – reach other areas closer to the outside, without entering into the system. These aspects, when brought together seem to indicate an intention to restrict the interaction of service areas with social spaces, commonly used for interactions between maids and inhabitants, concentrating servants more in their service zones and inhabitants in the others areas. The exterior, as in cases of genotype D, is kept far away from what happens in the apartments and activities inside the houses are much less connected to the movement outside. Intimate spaces tend to go toward isolation and few encounters happen there, as shown by their consistent low integration values. In the 1930s it was necessary to pass through social areas to reach intimate spaces, but by the 1940s, because influence of access type I this was no longer the case. After this decade, the path to bedrooms was, once again, through social spaces, due to access types G and M, with optional routes through corridors in the 1950s and 1990s, due to access characteristic II. The maid's bedroom, on the other hand, continues to be, as in genotype D, the most isolated key room in the apartments.

In this way, the mutation of genotypes D and G indicates fundamentally diverse patterns mainly for social and service spaces, it was in these areas that mutations occurred to the effect of increasing their similarity, similar patterns where observed for external areas and the bedrooms of the house.

Movement, not occupation, patterns are dominant in genotype D, with higher integration in the corridors. In genotype G, on the other hand, occupation is favored, as rooms are more integrated than circulations. Throughout the study, corridors are more commonly found in G and they are responsible for much of the people distribution for each activity area, normally a function of the social zone. In genotype D, on the other hand,this function has become less common in corridors over the last two decades. In both genotypes social sp aces tend to connect to intimate areas directly by the end of XX century, and both genotype G and D, in the last two decades, place the service zone apart. In genotype D, exterior is still accessed directly by social spaces, from the social entrance, while in genotype G this happens in the 1 960s and 1970s only and in other decades this link is made through transition spaces. In this way, the abstract inhabitation models found in the research - D and G - indicate different directions concerning social areas, that suffer some transformations in specific decades, while maintaining similar patterns of graded segregation of outside spaces, main and maid's bedrooms in relation to the rest of the house.

These are some aspects of the sample's domestic realms, which could be delineated by persistent general characteristics of both integration genotypes and permeability summarized justified graphs. Results grasped by the study of summarized justified graphs express main access relations between spaces and users catego ries.

On the other hand, the analysis of full justified graphs can bring to light important specific spatial aspects of how spaces tend to be distributed in the sample throughout the study period. In this way, seeking to investigate the tendency for mutation for the two genotypes, the next stage of this research is to identify, describe and correlate several specific configuration and compositional aspects of apartments from both the whole sample and the individually for genotypes D and G, searching for similarities and distinctions that can be summed to make distinct general abstract patterns for both genotype models.

In order to correlate the results from each configuration aspect to be studied for this historical sample – rings, sequences, bushes, depths, space-types and convexities – these results were organized using a technique also developed in this research, called descriptive tabulation.

4. DESCRIPTIVE TABULATION TECHNIQUE

Descriptive tabulation is a manner of ordering a range information from spatial results, through the application of Space Syntax methods in a single table, in a chronological sequence, in a way that allows the generation of several Cartesian graphs relating some of these factors in a way that facilitates the presentation and understanding of different relations over time. For example, the justification of plans' access graphs reveals the possibility of system permeabilities, classified by Space Syntax as rings, bushes and sequences. Following the logic of descriptive tabulation, all possible information that can be extracted from graphs is listed in a single table as:

Plan year
Plan decade
Total number of rings
Total number of external rings
Sectors involved in external rings
Maximum depth of external rings
Minimum depth of external rings
Total number of internal rings
Sectors involved in internal rings
Maximum depth of internal rings
Minimum depth of internal rings
Number of sequences
Maximum depth of sequences
Minimum depth of sequences
Sectors involved in sequences
Number of bushes
Maximum depth of bushes
Minimum depth of bushes
Sectors involved in bushes

DECADES	YEAR ok	PLAN ok	PLANT	EXT RING	SEC IN EXT TO RING	E-RING TO DEPTH	INT RING	SEC I TO RING	I-RING FROM DEPTH	I-RING TO DEPTH	TOTAL RING	TREE	TREE FROM DEPTH	TREE TO DEPTH	SEC IN TREE	BUSH	SEC IN BUSH	BUSH FROM DEPTH	BUSH TO DEPTH
30	30	30.18	30.18	1	S/SE/T	3	0	0	0	0	1	0	0	0	0	1	I	3	3
	34	30.12	30.12	2	S/SE/T, S/T	2	0	0	0	0	2	0	0	0	0	0	0	0	0
	35	30.16	30.16	1	S/SE	1	2	S/T, T/I	1	2	3	1	1	1	SE	0	0	0	0
	35	30.19	30.19	3	S/SE/T, S/SE/T/I	3	6	S/I, S/T/I, T/I	2	3	9	0	0	0	0	0	0	0	0
	36	30.11	30.11	1	SE/T	1	1	I	3	3	2	1	1	1	SE	1	I	3	3
	37	30.10	30.10	1	SE/T	2	1	S/T/I	1	3	2	0	0	0	0	0	0	0	0
	37	30.14	30.14	1	SE/S	2	3	S/I	2	5	4	0	0	0	0	0	0	0	0
	37	30.2	30.2	3	S/SE/T	3	3	S/SE/T	1	1	6	0	0	0	0	1	I	3	3
	37	30.7	30.7	1	SE/T	3	3	S/T/I	1	4	4	0	0	0	0	0	0	0	0
	38	30.1	30.1	1	S/SE/T	3	0	0	0	0	0	0	0	0	0	0	0	0	0
	38	30.8	30.8	1	S/SE/T	3	0	0	0	0	1	1	2	4	S	0	0	0	0
	39	30.17	30.17	7	S/SE/T/I	2	1	T	2	2	8	0	0	0	0	0	0	0	0
40	44	40.20	40.20	1	S/SE	3	6	S/I	2	4	7	0	0	0	0	0	0	0	0
	45	40.15	40.15	1	S/SE	3	0	0	0	0	1	0	0	0	0	1	I	3	4
	45	40.17	40.17	2	S/SE/T	3	1	S/T	2	4	3	0	0	0	0	0	0	0	0
	45	40.2	40.2	2	S/SE/T	3	2	S, T/I	1	4	4	0	0	0	0	0	0	0	0
	45	40.5	40.5	1	SE/T	2	0	0	0	0	1	0	0	0	0	0	0	0	0
	47	40.12	40.12	2	S/SE/T	3	1	S/T	1	3	3	0	0	0	0	0	0	0	0
	48	40.1	40.1	3	S/SE/T	4	3	S	1	3	3	0	0	0	0	1	I	4	5
	48	40.8	40.8	1	S/T	1	0	0	0	0	1	1	1	2	S	0	SE, I	2	4
	49	40.13	40.13	1	S/SE	2	0	0	0	0	1	0	0	0	0	1	I	3	4
	49	40.3	40.3	2	S/SE/T	2	0	0	0	0	0	0	0	0	0	0	0	0	0
	49	40.9	40.9	1	S/SE/T	3	0	0	0	0	0	0	0	0	0	0	0	0	0
50	50	50.4	50.4	1	S/SE	3	0	0	0	0	1	0	0	0	0	1	I	3	4
	51	50.17	50.17	2	S/SE/T/I	4	1	S/T/I	1	4	3	0	0	0	0	0	0	0	0
	51	50.7	50.7	1	SE/T	1	10	S/T/I	1	4	11	0	0	0	0	0	0	0	0
	52	50.11	50.11	1	S/SE	4	1	S/T	2	3	2	0	0	0	0	0	0	0	0
	53	50.1	50.1	1	SE/T	2	2	S/T/I	1	4	3	0	0	0	0	0	0	0	0
	53	50.6	50.6	2	S/SE/T	3	0	0	0	0	2	0	0	0	0	0	0	0	0
	53	50.9	50.9	3	S/SE/T/I	5	2	S/T/I	2	5	5	0	0	0	0	0	0	0	0
	55	50.15	50.15	1	S/SE/I	3	0	0	0	0	1	0	0	0	0	0	0	0	0
	55	50.16	50.16	1	S/SE	3	0	0	0	0	1	0	0	0	0	1	I	4	5
	56	50.10	50.10	2	S/SE/T	3	3	S/T	2	3	4	0	0	0	0	1	0	3	4
	56	50.18	50.18	2	S/SE/T	3	3	0	2	0	5	0	0	0	0	0	0	0	0
	57	50.20	50.20	2	S/SE/T	4	1	S/T	2	4	3	0	0	0	0	1	0	4	5
	57	50.8	50.8	7	S/SE/T	4	6	S/SE/T	1	4	13	0	0	0	0	0	0	0	0
	58	50.19	50.19	1	S/SE/T	4	0	0	0	0	1	0	0	0	0	1	0	3	4
60	60	60.16	60.16	1	S/SE/T	3	0	0	0	0	1	0	0	0	0	1	I	2	4
	60	60.7	60.7	3	S/SE/T	3	3	S/T	1	4	6	0	0	0	0	1	0	3	5
	62	60.2	60.2	2	S/SE/T	3	1	S/SE	2	3	3	0	0	0	0	1	0	2	5
	62	60.9	60.9	1	S/SE/T	2	0	0	0	0	1	1	1	4	SE	1	0	2	5
	63	60.12	60.12	2	S/SE/I	3	1	S/I	2	4	3	0	0	0	0	0	0	0	0
	63	60.15	60.15	3	S/SE	3	0	0	0	0	1	0	0	0	0	1	I	4	5
	63	60.4	60.4	1	S/SE/T	3	0	0	0	0	1	0	0	0	0	0	0	0	0
	64	60.13	60.13	1	S/SE	3	0	0	0	0	1	0	0	0	0	0	0	0	0
	64	60.19	60.19	1	S/SE/T	3	0	0	0	0	1	0	0	0	0	0	0	0	0
	65	60.5	60.5	1	S/SE/T	3	0	0	0	0	1	0	0	0	0	0	0	0	0
	68	60.11	60.11	1	S/SE/T	2	0	0	0	0	1	1	1	6	SE	0	0	0	0
	68	60.17	60.17	1	SE/T	2	0	0	0	0	1	0	0	0	0	1	I	3	5
	68	60.20	60.20	1	SE/T	1	2	S/I	2	4	3	1	1	4	SE	0	0	0	0
	69	60.18	60.18	2	S/SE/T	3	1	S/SE/T	1	3	3	0	0	0	0	0	0	0	0
	69	60.3	60.3	1	S/SE/T	3	0	0	0	0	1	0	0	0	0	1	I	3	5
70	70	70.17	70.17	1	S/SE	1	0	0	0	0	1	0	0	0	0	1	I	2	4
	70	70.19	70.19	1	S/SE	2	0	0	0	0	1	1	1	4	SE	1	I	3	6
	70	70.20	70.20	1	SE/T	3	0	0	0	0	1	0	0	0	0	1	I	2	3
	71	70.14	70.14	1	S/SE	2	0	0	0	0	1	0	0	0	0	1	I	3	5
	73	70.6	70.6	1	S/SE/T	4	0	0	0	0	1	0	0	0	0	1	I	4	5
	74	70.1	70.1	1	S/SE	3	0	0	0	0	1	0	0	0	0	0	0	0	0
	74	70.2	70.2	1	S/SE	2	0	0	0	0	1	1	1	5	SE	1	I	4	6
	76	70.15	70.15	2	S/SE/T	3	0	0	0	0	2	0	0	0	0	1	I	4	7
	76	70.16	70.16	1	S/SE	1	0	0	0	0	1	0	0	0	0	1	I	2	4
	76	70.3	70.3	1	S/SE/T	2	0	0	0	0	1	1	1	4	SE	1	I	2	4
	77	70.12	70.12	4	S/SE/T	3	2	S/T	1	3	6	0	0	0	0	1	I	3	5
	77	70.18	70.18	1	S/SE	1	0	0	0	0	1	1	1	3	SE	1	I	2	5
	77	70.5	70.5	1	S/SE/T	2	0	0	0	0	1	0	0	0	0	1	I	3	6
	77	70.8	70.8	1	S/SE	1	0	0	0	0	1	1	1	6	S	1	I	2	4
	78	70.13	70.13	1	S/SE	1	0	0	0	0	0	0	0	0	0	1	I	2	4

TABLE 6 - Table listing permeability aspects: rings, sequences and bushes

A table generated this way makes it possible to construct several combinations of aspect results in Cartesian graphs, as minimum and maximum depth of internal rings, the number of sequences and sectors involved in bushes, as shown in figure 4. These graphs delineate correlations in a clear way, that allows verification of the tendency for mutation of genotype aspects, as graphs were constructed for both sample and the two genotypes in this work. So it is simple to confirm whether internal rings occur more by the end of the 20th century than before, for both the whole sample and the separate genotypes, using both data of the frequency with which they occured and data of which cases and genotypes that are deeper or shallower. It is also clear, from the graphs in figure 3, that sequences are concentrated in the 1980s and 1990s and that they occur more in genotype G than in D. Yet, it is also possible to understand that bush formations in the sample are almost exclusively related to intimate cells and that they are more frequent in genotype G than in D.

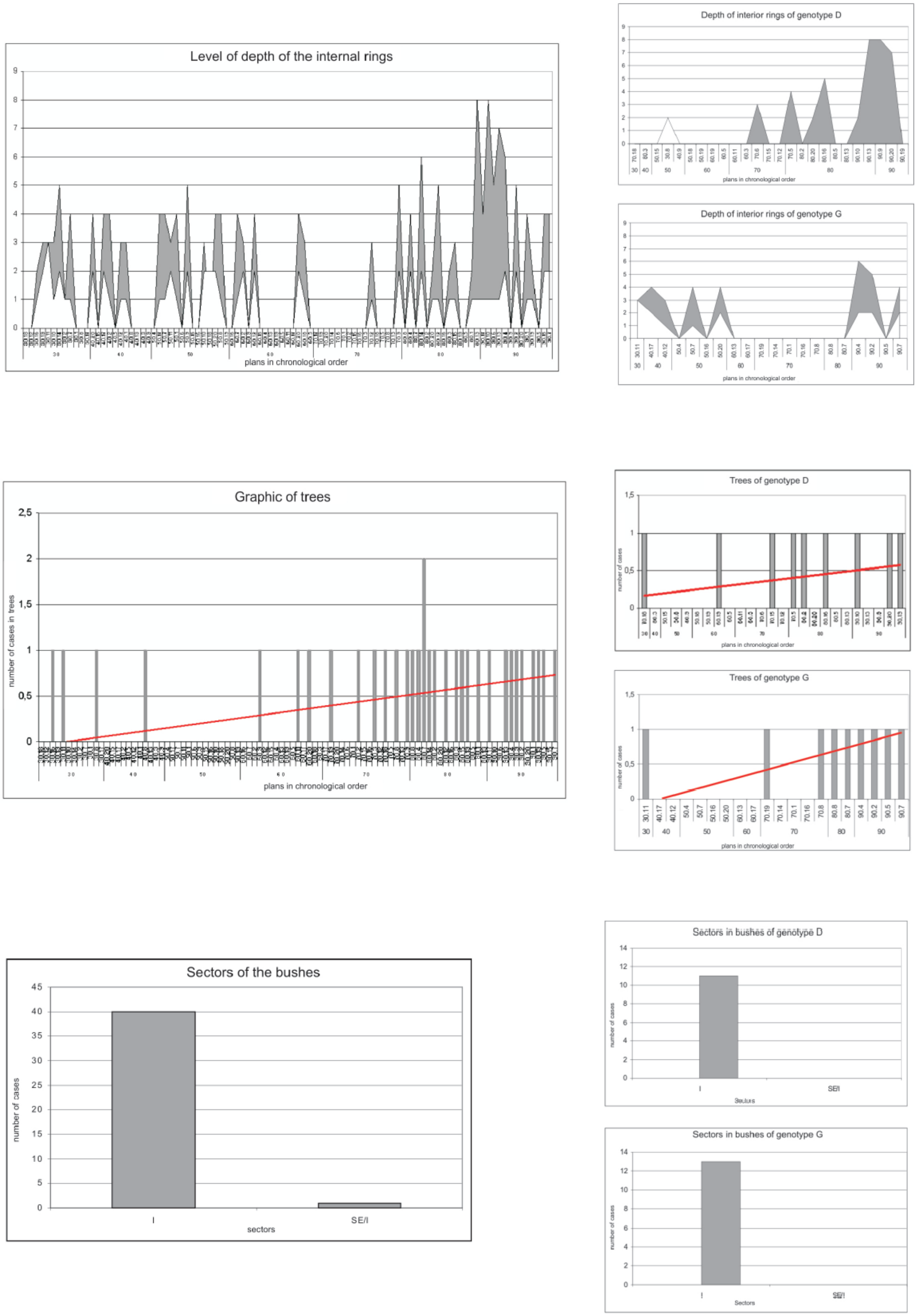


Figure 4 –some Cartesian graphs generated from this table

Descriptive tabulations were also constructed to investigate space-types, convexity, depth and geometric areas. The use of this method to analyze space-types characteristics revealed diachronic transformations which would be hard to identify if the several numerical results were manipulated in another way, with less visual representation. Using the descriptive tabulation logic the table list was generated with the most numerous characteristics from space-types results in two levels:

- General – with quantity of each space-type, total number of spaces, percentages of each space-type per system (see figure 5).

- Sector of activity – with percentages of each space-type for key spaces, for each sector, per each decade.

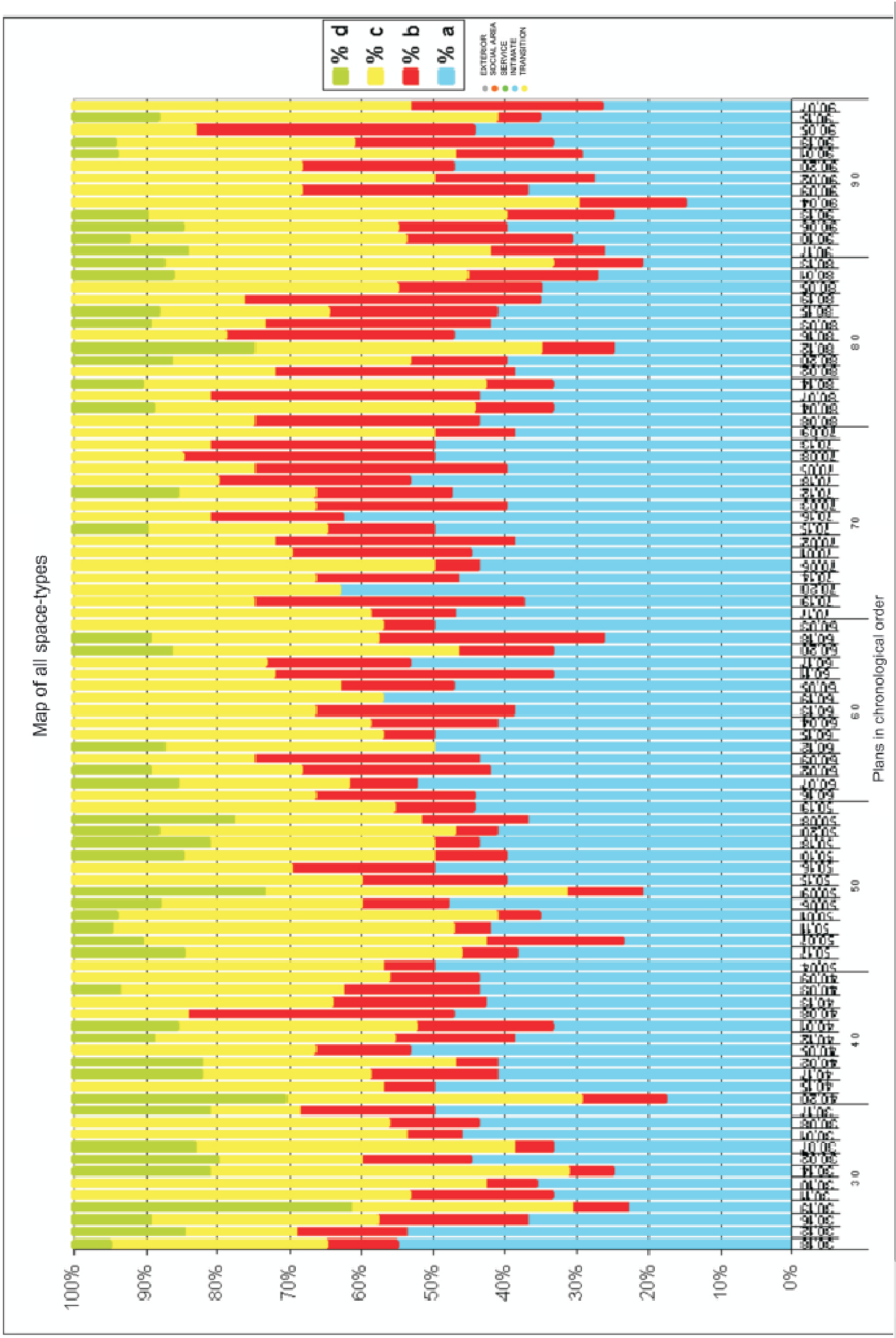


Figure 5 – Map of all space-types.

Graphs resulting from these procedures generate visible movements over time from the numerical abstraction of systems. One example is the clear identification of when and how en-suite bedrooms started to gain prevalence in the samples program, expressed by main bedrooms going down as space-type **a** while en-suite bathroom for the main bedroom goes up, as shown in figure 6. The indication that main bedrooms are a less common space-type because the tendency is leaning towards en-suite bathrooms, is confirmed in graph of space-type **b,** where they appear to grow in the same period of time -this graph was not included in this paper.

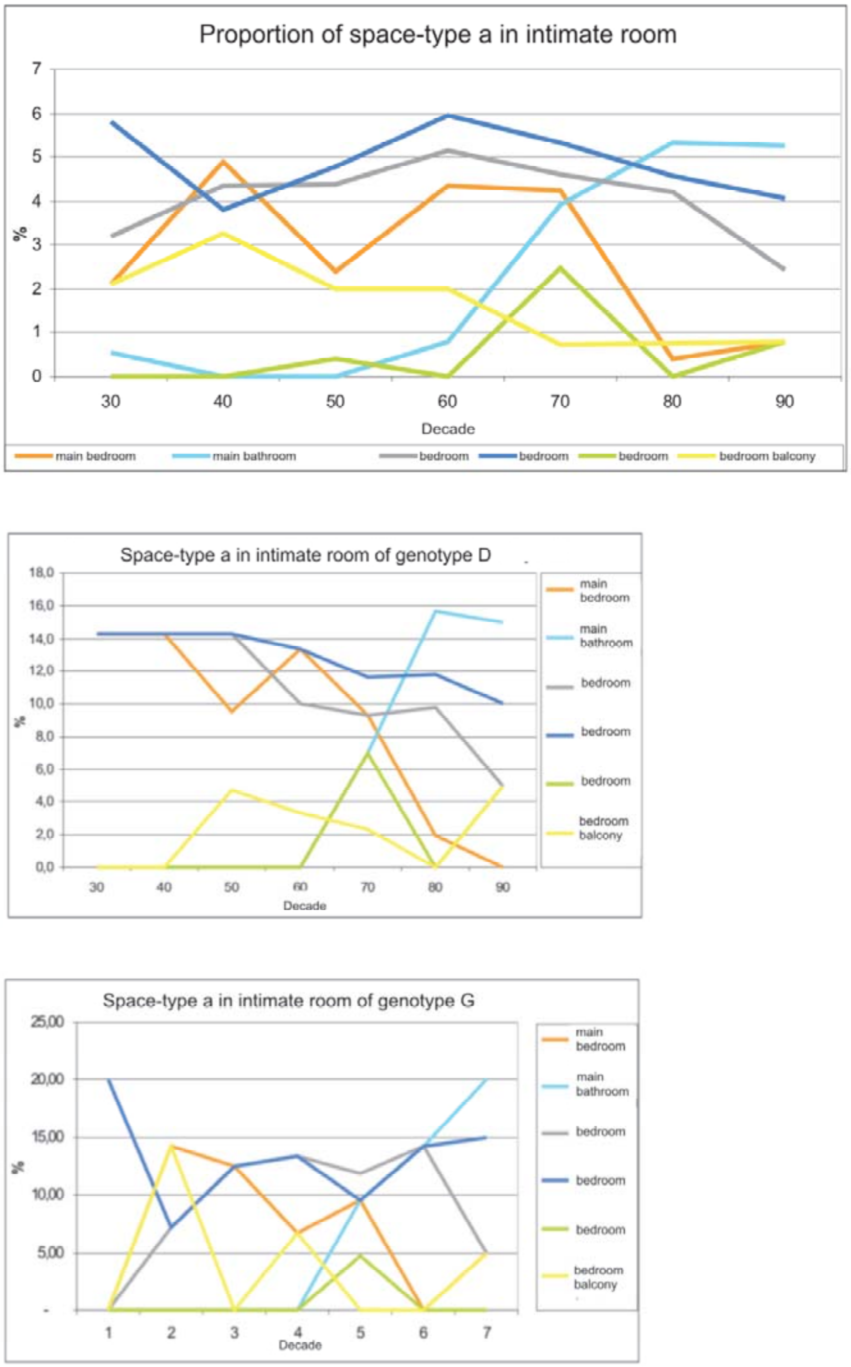


Figure 6 – Space-types of intimate room.

Another example, shown in figure 7, shows the tendency of the maid's bedrooms to transition into en-suite bathroom; they trend to space -type **b** instead of **a,** while the maid's bathroom is the only space that grows as space -type **a** by the end of the century.

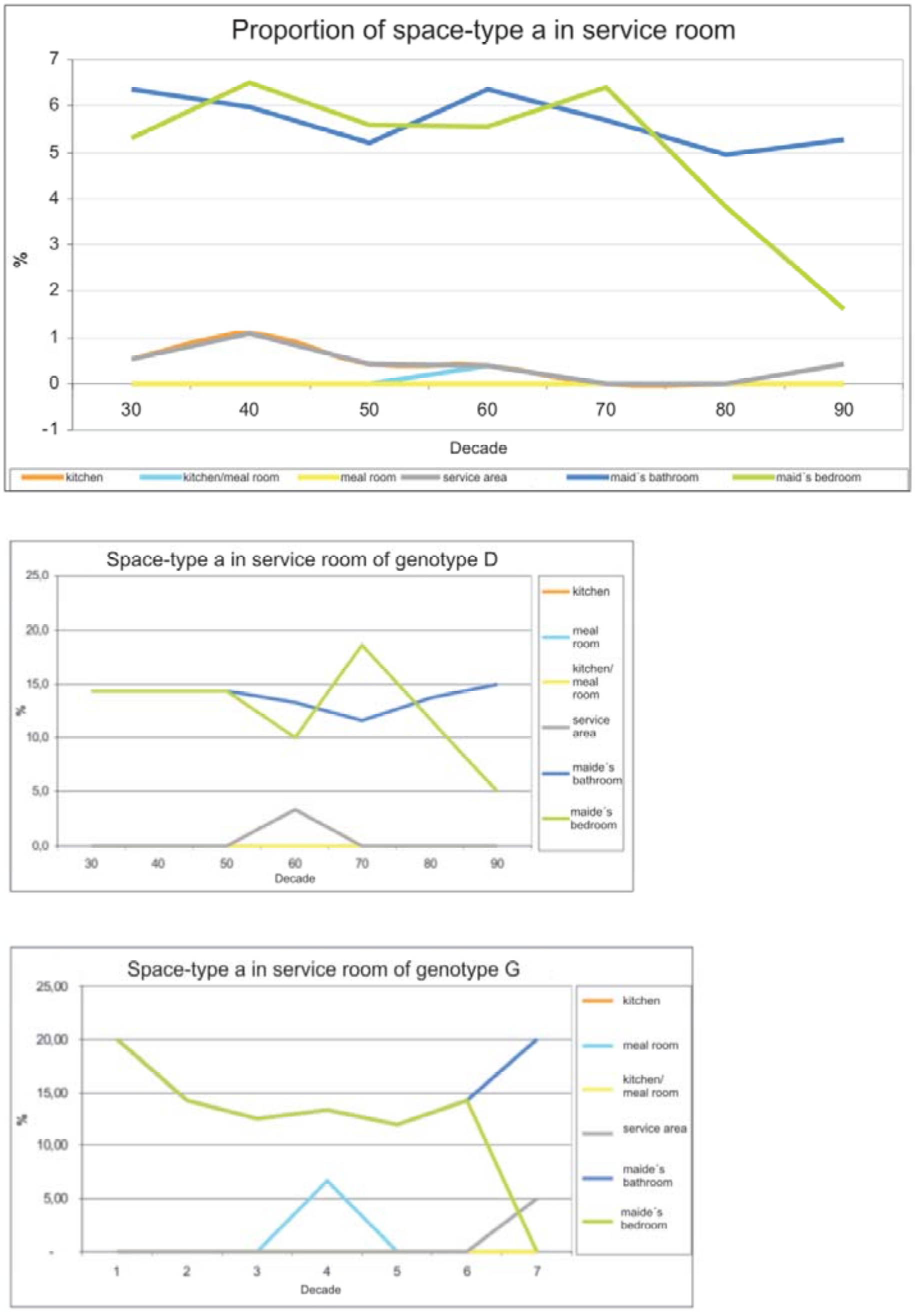


Figure 7 – Space-types of service room.

The study of dimensional areas shows that the increase of apartment size appeared to be related to growth of social verandas in the last few decades, visually described by the tabulations, as seen in figure 8, in their different manifestations in the whole sample and in each genotype.

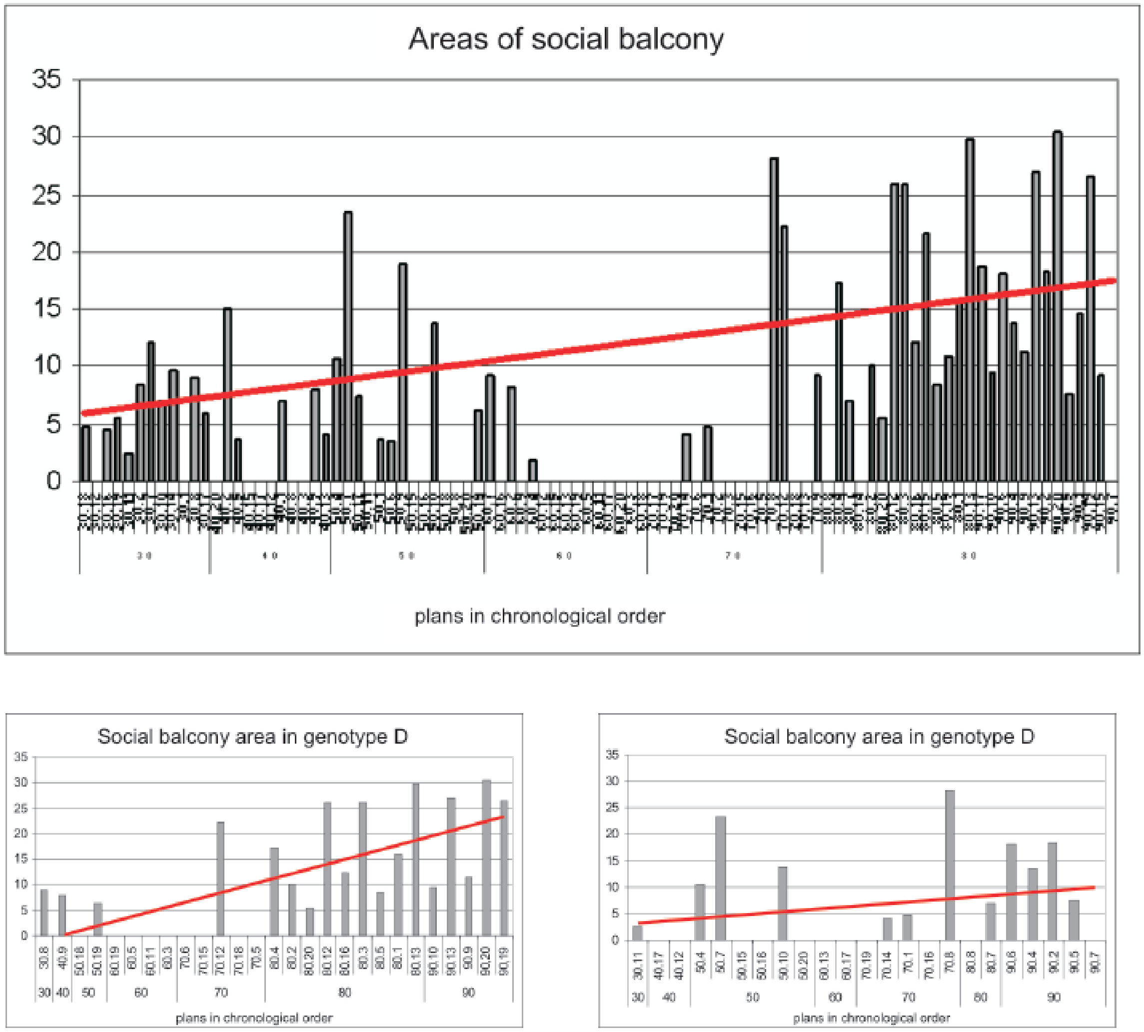


Figure 8 – Areas of social balcony.

5. ANALYSIS OF RESULTS OF DESCRIPTIVE TABULATION AND MUTATING GENOTYPES

Results from the investigation produced by descriptive tabulation method, for various configuration and compositional aspects of spaces of the sample, contributed to confirm characteristics of the mutating genotypes and expanded the knowledge of spatial distinctions between these two structural patterns. This produced more configurational and compositional knowledge, this allowed the association of these patterns and models of social groups.

These results confirm changes in genotypes D and G in distinct periods of time. Genotype D goes through a fluidity tendency, through mobility and higher knowledge between spaces of the house. Genotype G, despite showing some aspects of these characteristics by the end of 20th century, generates many more situations that have more external and internal rings than genotype D, this becomes more pronounced throughout time. The opposite is found in cases of the other genotype.

In genotype D a growth of options for movement through house was observed, this connected circuits and inhabitants use more space, this can lead to an increase of interior areas as time passes. While in genotype G, what tended to increase was the control of people circulation through these rooms.

Nevertheless, the fluidity found in genotype D is not found in all rooms of the apartments. Through out the study Genotype D seeks to isolate service areas more than genotype G, organizing them in sequences. In genotype D the intimate cells start to be distributed more frequently as bushes accessed by corridors, becoming more distant from the rest of the house during the final decades of the century. In genotype G this trend started at the beginning of the study and intensified over time.

In this way, the tendency for fluidity in genotype D happens while the houses maintain, or even increase the separation of spaces for the privacy of inhabitants, isolating their individual rooms and making the presence of servants discrete, as time passes. Other spatial resources utilized to guaranty either distance or interaction between contexts was the growth (or lack thereof) of distance between rooms of the house: in genotype D this manipulation of spaces led living rooms to be found closer to the street, de-ritualizing the transition between interior and exterior of dwellings. This does not happen in genotype G, which maintains the distinction between these two dimensions, while living rooms come to occupy shallower system positions.

Kitchens tended to move closer to the service access to outside in both genotypes, turning into, along with other service spaces, an almost detached area of the dwellings. Privacy is also enhanced, by the crescent depth of bedrooms connections. Again, this strategy happens more in genotype D than in G, so individual worlds of intimate rooms are kept apart while areas usually accessed by non-inhabitants – visitors and maids – become more connected with each other and with external areas; these areas are kept separate in G.

These results were also identified in data produced by the space-types analysis, in which positions related to control – types **a** and **b** – appear more related to genotype G than to D. Both genotypes, in relation to space -types positions, tend towards positions that stimulate increased movement patterns. Again, these positions in genotype D highlight the promotion of knowledge and interaction for apartment spaces and categories, decreasing control relations, while in G space-types guarantee and expand surveillance conditions.

In relation to compositional analysis, information generated seems to delineate genotype characteristics that agree with the data resulting from the investigation of spatial configurations: of structural codes that conserve hierarchical characteristics to genotype G, and inverse trends for genotype D that indicate more fluidity. Apartments from genotype G tended to undergo minimal or no alterations to the convexity and dimensional areas. Their social sectors did not grow significantly nor were there many verandas added by the end of the century. Bedrooms in G did not suffer many convex elaborations of space. These relations were also explored in genotype D, which had bigger living areas with large verandas and cases of convex elaboration of inhabitant bedrooms.

6. LAST SPECULATIONS

Based on a structure of control, with hierarchical differences inscribed in its spaces, genotype G seems to relate to the traditional family model described by Bruschini (1990) as “hierarchical, asymmetric, ritualized”. These results are coherent with the social area being concentrated in the living room, where this genotype is centered in terms of integration, rather than favoring the generation of distinct rooms in this zone – such as lavatories for social zone and verandas. On the other hand, apartments from genotype D seem to dissolve controlling relations through increased fluidity and centrality in circulations, which suggests new possibilities of familiar organization that have been cited by Young and Willmot (1973) and Bruschini (1990), defined –in addition to other aspects identified- as a tendency to "a 'symmetric' structure, with predominance of a equanimity distribution of conjugal papers", characteristics which appear compatible to social rooms of larger dimensions that are less divided convexly.

It seems, that the possibility to verify the tendency for mutation of the genotypes allowed this research to produce valuable knowledge about the two orders that structure spaces in most apartments of the sample. This elaborate data has allowed the understanding of more complex social expressions embedded in spaces, a conclusion that wouldn't have been possible were the genotype characteristics considered as stable aspects along the period of time studied.

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