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Establishing Connectivity Graphs as a Functional Genotypes of Federal Courthouse Buildings

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Abstract
In the case of many institutional buildings, such as courthouses, program and functional requirements present fixed precepts and unwritten demands that greatly affect the spatial layout of the building and ultimately its form. These requirements specify underlying functional structures in courtroom floors, which affect the form and layout of the courthouse building. It is the purpose of this research to identify these functional structures in order to discover commonalities between them and establish them as functional genotype. The research proceeded by selecting twenty-five courtroom floors in different courthouses, and through archival and architectural analysis, the research identified underlying functional structures. The research found that within the analyzed sample 16 courtroom floors adhered to a typical genotype while others followed slightly varied genotypes. It was concluded that courtroom floors adhere to a generic genotype with regard to accessibility and pattern of circulation. Future investigation can investigate how these genotypes can be realized in different geometrical arrangements and accordingly can be used in the design of future courthouses.
Keywords: Strong Program; Genotype; Connectivity graph

I. INTRODUCTION

Authors of [1] noted that there are spatial ideas that underlie the form of urban settlements and that these ideas present common spatial patterns that can be presented as graphs that represent *"…abstract rules underlying spatial forms, rather than spatial forms themselves…"*[1, p 12]. In other words, they specify a genotype i.e. abstract ideas that underlie cultural form,rather than a phenotype i.e. physical materialization of the genotype. [2] noted that buildings of a culturally defined functional type e.g. courthouses, in specific time and space tend to have common underlying spatial properties in the way different functions are spatialized that can also be presented as genotypes.

Courthouse facilities are "strong program" buildings that adhere to a strong and explicit functional program that maintains certain relations and rules where most of what happens inside the building is specified by explicit or tacit rules, and accordingly built into the spatial structure of the building [1]. Accordingly, courthouses facilities are typically conceived as "sorting machines" that exhibit very clear and distinct patterns of circulation as well as strongly defined functional zones associated with these circulation networks[3].Accordingly, it can be argued that underlying the designs of many contemporary courthouse facilities, there are well formulated spatial/functionalstructures and patterns that there is a finite set of these functional structures/patterns. This research, which is directly related and an extension of the work done by [3]in 2006, is exploratory in nature, aimed at uncovering these common functional structures, rendering them explicit rather than implicit, and communicating them as graphs through the analysis of existing courthouse floors.

The value of such work is multifaceted; it captures the actual invariant characteristics of the buildings thus drawing inferences about programmatic constraints and architectural possibility. In other words, the idea of a building program is interpreted not merely as a set of common requirements, but also as a set of common responses, that have implications of the functional and formal configuration of the courthouse building. It renders a clearer and more precise understanding of which aspects of the program have the greatest formal implications on design, and it sets a rational stage for discussing the relationship between functional and formal aspects of the design of institutional buildings.

Section two will present a basic understanding of the Federal Courthouse building. Section three will include the analysis segment, and the final section will include conclusions and applications for future work.

II. Understanding the Federal Courthouse

The design of Federal Courthouse buildings is strongly prescribed by programmatic requirements and design guidelines; specific spaces are developed

to accommodate specific functions which affect not only their internal arrangement but also their adjacencies and links to other spaces. Courthouses are organized into five discrete zones with respect to function, operational needs, and access requirements [3]; a public zone, private zone, secure zone, interface zone, and service zone. The public zone includes all the areas accessible to general public along with attorneys, clients, witnesses and jurors such as a central public hall, circulation corridors and waiting areas, snack bars, etc. The private zone includes all the functions that have a restricted access and are used by particular courthouse users such as judges, jurors, and employees. The secure zone is provided for the movement and holding of defendants in custody; it includes horizontal and vertical secure circulation systems as well as holding areas. The interface zone is the most important zone of the courthouse where the space where the public, private, and secure zones interact, it includes the courtroom and its associated functions. The service zone includes all the spaces that serve to support the other functions: storage areas, mechanical spaces, maintenance areas, and so on.

These zones are served by three separate circulation systems [4][5]: public circulation system, which is an unrestricted circulation system dedicated to the general public. Restricted/private circulation systemaccessing the restricted zone and dedicated to judicial system professionals such as judges, probation officers, court staff, and attorneys. The secure/defendants-in-custody system that includes a 'secure' vertical and horizontal circulation system that connects the vehicular sally port, the central holding area, attorney interview rooms, and the holding areas adjacent to the courtrooms.

Within these zones, functions are divided into two types: functions directly associated with the courtroom are labeled 'low volume' functions, while administrative and social services are labeled 'high volume' functions [6][7]. [5][6][7] encouraged the separation of high volume functions from low volume functions. High volume functions should be located on the entry floor or lower floors to be as accessible as possible to the public. Low volume functions should be located on higher floors to enhance security.[3]argued that these low volume functions that are called courtroom floor set (fig 1) have a common underlying spatial pattern that can be presented as a genotypical graph for courtroom floors.

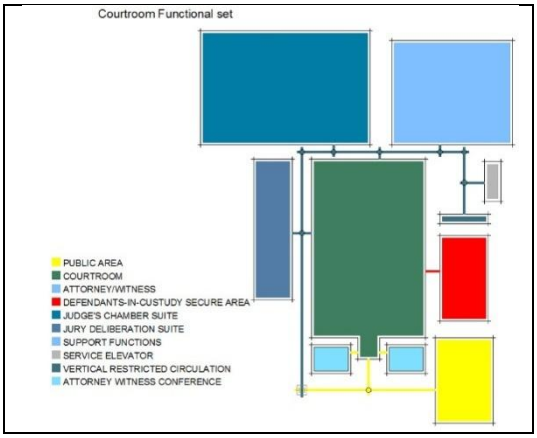
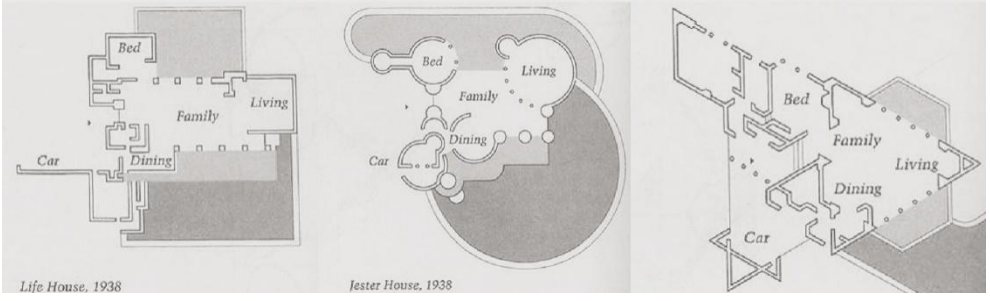


Figure 1 a functional diagram of the courtroom functional set (Source: Author)

III. GENOTYPE: THE CONNECTIVITY GRAPH OF THE COURTROOM FLOOR

Reference [8] suggested that the spatial relationships constructed by building plans can be represented as graphs, whose nodes represent rooms or spaces, and whose lines represent relationships of adjacency or permeability between these spaces. Reference [8] using a diagram of three plans by Frank Lloyd Wright, showed that one of the uses of such graph-representations of plans is to reveal underlying patterns of relationships which transcend evident and striking differences in composition and geometry. Thus, three houses plans according to a rectangular lattice, a triangular lattice and a pattern of intersecting circles all display the same underlying set of relationships between the functional spaces (fig. 2). In the words of the authors *"Objects which appear to be very dissimilar on first acquaintance may be seen, later, to share an underlying structural pattern."*[8 p 27]



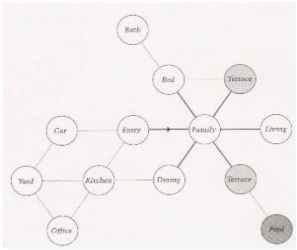


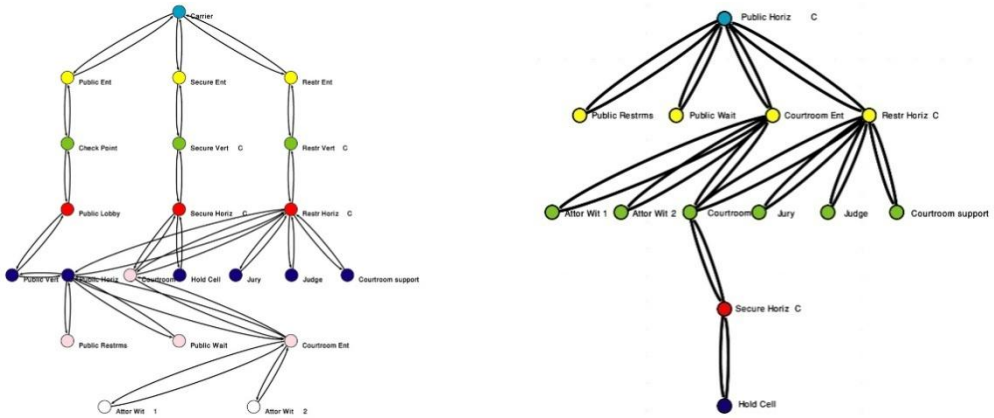
Figure 2three different plans designed by Frank Lloyd Wright that maintain the same spatial relation (Source[9])

This idea has been taken up by [1] where they proposed that the stable patterns of relationships which characterize otherwise diverse plans and forms are genotypicali.e.,they have abstract spatial ideas or deep structures that underlie physical configurationsthat bear on the relationship between the principles that govern building design and the principles, which govern the social relationships accommodated within a plan. In [1] the idea of "stable relationships" can become quite abstract. Thus, the stability they are interested in does not consist in the repetition of the exact same graph of connections under different plan geometries, as with the example of Frank Lloyd Wright houses used by [8]; rather, [1] point to the stability of the rank order of the different nodes of the graph based on a measure of access. The measure in question is widely known as "closeness-centrality" and it describes the minimum number of intervening nodes that must be crossed to reach from one node of the graph to all others[3]. However, in the work of [1], "closeness-centrality" is called "integration". Nodes of the graph from which other nodes are more easily accessible are more integrated. The domestic genotypes identified by the authors are stable inequalities between the integration values of different function spaces such as the "living room", the "kitchen" and the "bedroom".

In the analysis that follows, graphs will be used to represent the essential relationships which are prescribed in design guides earlier, as well as the actual relationships realized in courthouse buildings designed under the purview of these guides. The aim of the analysis is to test whether the requirements of zoning and differentiated circulation result in stable graphs or in stable "genotypes" in the sense in which the term is used by [1].

Figure (3a) depicts the relations between the functions of the courtroom floor and the various circulation systems and the external world as described in [7]. It contains the following nodes: carrier or external world, public entrance, public check point, courthouse lobby, public vertical circulation on entry floor, public horizontal circulation on courtroom floor, public waiting area, public restrooms, courtroom vestibule, attorney/witness 1, attorney witness 2, courtroom, restricted/private entrance, restricted vertical circulation, restricted horizontal circulation, judge's chambers, jury deliberation room, courtroom support functions, secure entrance, secure vertical circulation, secure horizontal circulation, secure holding areas. The graph is arranged so that nodes are aligned according to the number of steps needed to reach them from the carrier. It was produced using "Pajek 1.10", software for graph analysis developed by VladmirBatagelj and Andrej Mrvar and freely available on the web (http://vlado.fmf.uni-lj.si/pub/networks/pajek/).

Figure (3b) shows only the main functional components specific to the courtroom floor set. These functions include: public horizontal circulation on courtroom floor, public waiting area, public restrooms, courtroom vestibule, attorney/witness 1, attorney witness 2, courtroom, restricted horizontal circulation, judge's chambers, jury deliberation room, courtroom support functions, secure horizontal circulation, and secure holding areas. In this case, spaces are arranged according to their closeness to the main public circulation system.



A B

Figure 3 graph A depicts the relationships of connectivity between courtroom set, circulation systems and external world as prescribed in the US Court Design Guide, 2007. Graph B depicts the relationships of connectivity between the functions on courtroom floors (Source: Author)

The question to be examined next is the extent to which these graphs are realized in actual courthouse buildings. The 25 buildings included in the analysis were chosen according to the availability of full architectural plans. They are designed by different architects in different styles over a period of fifteen years in different parts of the United States of America. For security concerns, neither architectural representations i.e. plans nor images or names of courthouses will be declared, only diagrammatic representations can be found in figure 4.

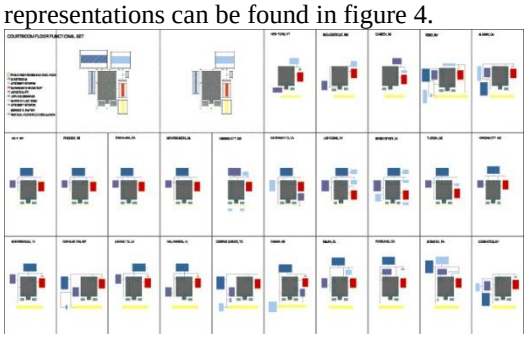


Figure 4diagrmatic representations of the 25 analyzed case studies

Of the 25 courthouses, 16 conform to the graph shown in Figure 3b. The remaining 9 courthouses are described by 6 different graphs. The set of graphs is shown in Figure 5. Graph A in figure 5 represents the generic graph in figure 3b where 16 courthouse prescribe to it, graph B has three cases prescribing to it, graph D and E have two courthouse prescribing to each, while the rest of the graphs have only one courthouse prescribing to each of them. The main conclusion that follows from Figure 5 is the set of relationships prescribed in the design guide are almost universally adhered to by two thirds of the studied sample with almost a third deviating in some respect from the prescription.

The results of the analysis are probed further by looking into the order of integration of the various spaces. This is given in Table 1, which arranges spaces in descending order of integration from left to right. Of course, only the 16 court buildings with identical graphs display the exact same overall order of integration. However, a better understanding can be gleaned by looking at two different subsets of spaces, circulation spaces on the one hand, and main use spaces on the other.

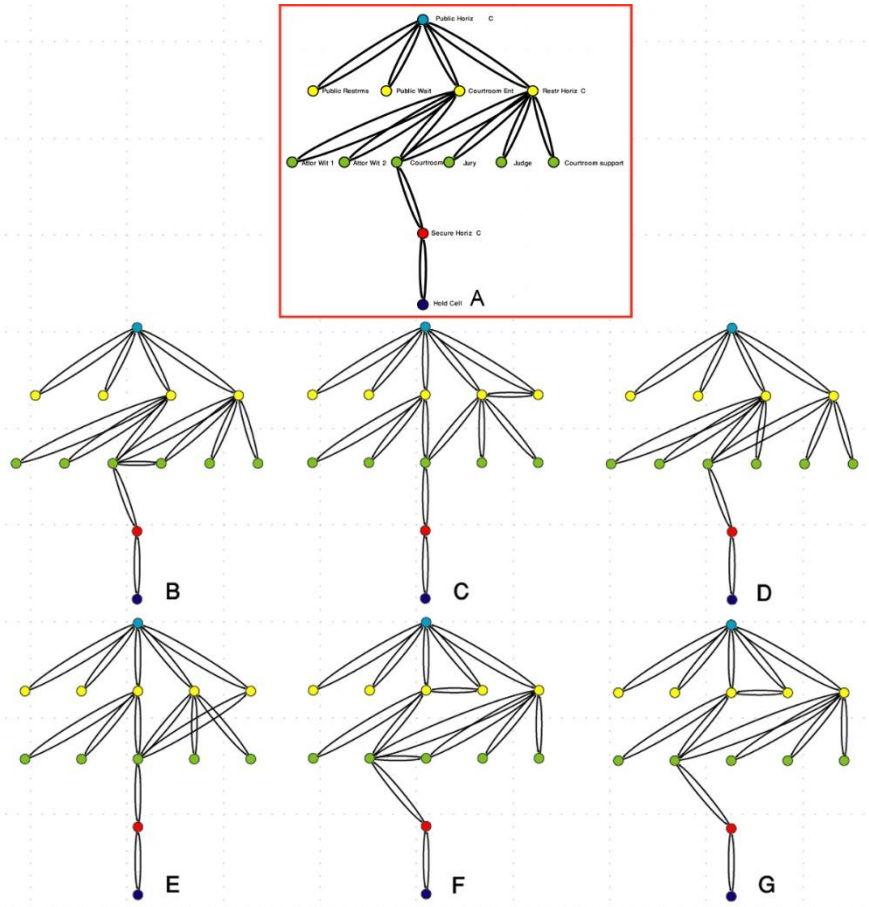


Figure 5 graphs representing connectivity relationships realized in a sample of 25 court buildings (Source: Author)

16 Courts	R. H. Cir	P. H. Cir	C.	C. Ent.	S. H. Cir.	J. D. R.	J. Ch.	C. S. F.	P. Rest	P. W.	A/ W 1	A/ W 2	S. H. A.
N. Y. and A.	C. Ent.	P. H. Cir	C.	R. H. Cir	S. H. Cir.	A/W 1	A/W 2	J. D. R.	P. Rest	P. W.	J. Ch.	C. S. F.	S. H. A.
O & S	P. H. Cir	C.	C. Ent.	R. H. Cir	J. D. R.	S. H. Cir.	P. Rest	P. W.	A/ W 1	A/ W 2	J. Ch.	C. S. F.	S. H. A.
K	P. H. Cir	R. H. Cir	C. Ent.	C.	J. D. R.	S. H. Cir.	P. Rest	P. W.	J. Ch.	C. S. F.	A/ W 1	A/ W 2	S. H. A.
Ch& Co	C.	R. H. Cir	P. H. Cir	C. Ent.	J. D. R.	S. H. Cir.	J. Ch.	C. S. F.	P. Rest	P. W.	A/ W 1	A/ W 2	S. H. A.
Sc	R. H. Cir	P. H. Cir	C.	C. Ent.	J. D. R.	A/W 1	S. H. Cir.	J. Ch.	C. S. F.	P. Rest	P. W.	A/ W 2	S. H. A.
Ta	R. H. Cir	P. H. Cir	C.	C. Ent.	A/W 1	S. H. Cir.	J. D. R.	J. Ch.	C. S. F.	P. Rest	P. W.	A/ W 2	S. H. A.

Table 1 Rank order of Integration of spaces in sample of court buildings

Circulation will be discussed first. In 20 out of 25 cases the order of integration of circulation spaces is: Restricted Horizontal>Public Horizontal>Secure Horizontal. In the remaining 5

cases the order changes to: Public Horizontal>RestrictedHorizontal>Secure Horizontal. Thus, the stability of relationships between circulation spaces is greater than the stability of the graph as a whole. The secure circulation, devoted to defendants in custody, is always the most segregated part of the circulation system. The circulation systems devoted to the public and the judicial staff do not have a stable relationship. There is, however, a very strong tendency for the circulation corresponding to the judicial staff to be the integration core of the building. Most courthouses, therefore, are inhabitant-center buildings, if we follow [1] in calling "inhabitants" those who are in charge of the social knowledge that governs building function.

Turning to use spaces, we observe that the order of integration: courtroom>jury deliberation room>judge's chambers>secure area is stable across all 25 court buildings. Other use spaces, and most notably those associated with the attorneys, have shifting positions. The attorney witness conference room is entered either from the courtroom vestibule in most cases, or directly through the public horizontal circulation (in three cases).

IV. CONCLUSIONS

This paper argued that the design of Courthouse buildings is highly restricted and prescribed according to programmatic requirements resulting in a limited number of functional genotypes that underlie the design of varied physical configurations. Although Courtroom floors analyzed do not universally replicate the patterns of connectivity prescribed by guidelines, there is a universal inequality genotype governing the relationship of main use spaces. Furthermore, there is a very strong genotypical tendency regarding the pattern of circulation. The patterns of connection realized in individual buildings vary slightly. The variation, however, is underpinned by clear genotypical tendencies that are, by the statistical stability, of certain kinds of relationships. These relationships, more than the programmatic documentation, can be construed as the objective "programmatic charge" which constraints the design of courthouse buildings. Thus, it becomes quite evident that the restrictions imposed by the program and the guides are inscribed in the spatial structure of courthouse buildings.

Finding of this paper can be further investigated by enlarging the selected sample either to confirm the finding or enlarge the number of genotypes that can be found. These findings can also in providing a quantitative solid base of comparison between different case studies. Finally, such research can be furthered by analyzing how these different genotypes are geometrically realized in real life or proposed designs.

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