The Dirksen Variations

Towards a Generative Description of Mies's Courthouse Language

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A generative description of Mies van der Rohe's courthouse language is presented in the form of a shape grammar. The grounding of the work is based on a set of 135 sketches produced by the office of Mies during the design process of the Everett McKinley Dirksen United States Courthouse in Chicago, and documented in the Mies van der Rohe Archive at the Museum of Modern Art. The work here postulates a set of 39 unique courthouse designs all showcasing distinct variations of the courtroom type in the Miesian language and re-casts them in two-dimensional diagrams to make their differences and similarities transparent. A series of spatial relations between five types of spaces are extracted, including courtrooms, circulation networks, vertical cores, office spaces, and support spaces, and are deployed to specify the shape rules of the grammar. A set of conventions to specify how the two-dimensional diagrams represent three-dimensional models is briefly outlined to prepare the ground for the implementation of the grammar in a three-dimensional shape grammar interpreter.

Keywords: *Mies van der Rohe, Courthouse design, Generative description, Shape grammar, Ring schema*

INTRODUCTION

The Everett McKinley Dirksen United States Courthouse in Chicago, designed and built by Mies van der Rohe during 1959-1964, is one of the most significant buildings of Mies' output in the United States (Speyer, 1968; Blaser, 1997; Schulze, 1992; Cohen, 1996; Carter, 1999; Lambert, 2001). The building belongs in the mature phase of Mies' work and provides a classic example of skyscraper design following the footsteps of the Seagram Building. Significantly, the Dirksen Courthouse is the only courthouse that Mies ever designed; in that sense, it provides the sole window towards the architect's language, expression and vision of the relationship between architecture and law.

The Dirksen Courthouse is a part of an urban project, the Chicago Federal Center commissioned by the United States General Services Administration (GSA), at the Loop of Chicago. The project consists of two skyscrapers, the courthouse at 30 stories tall and a federal office building at 42 stories tall, and a single story post office in an urban plaza. The two skyscrapers are cast in two long and narrow rectangular building footprints in an L-shape configuration, and the urban plaza connects them both. The post office is cast in a square footprint and resides within the plaza. The plaza is well known as the exhibition space of a famous sculpture, the Flamingo by Alexander Calder. It was commissioned and installed as an integral part of the Chicago Federal Center, under the Art in Architecture Program by GSA (GSA, 2015).

The Dirksen Courthouse consists of various administrative federal offices and the United States Courts. The federal offices are allocated on the floors from second to fourteenth and the United States Courts on the floors from fifteenth to twenty seventh. The whole building can be described as a 4x13x13 rectangular prism. The 4x13 footprint of the building is regulated and generated by the Miesian structural modules: each module measures 28'x28'. Interestingly, the length of the 13 structural modules and the total building height of the 30 stories, with 12' floor-to-floor height, form an impressive front façade, nearly square in its ratio (Speyer, 1968). Since the completion of the Mies' original design, the Dirksen Courthouse was renovated several times to accommodate operational and regulatory changes of the courthouse (Vanderbeke, 1993). This work focuses solely on the original Miesian design of the courthouse.

FORMAL ANALYSIS

A welcome aspect of the formal analysis of the Dirksen courthouse is that its design process is amply documented, and thus it provides an extraordinary opportunity to explore the evolving understanding and vision of the courthouse building type by a master of twentieth century architecture. The corpus of the archived design process consists of 135 sketches and diagrams of plans and sections of various scales and are all archived in the Mies van der Rohe Archive at the Museum of Modern Art (Schulze, 1992).

A brief survey of this collection of sketches and diagrams reveals a set of 39 distinct courtroom plate design variations and seven types of footprints all deploying a common ring schema to resolve the complex relations between courtrooms, support spaces and circulation networks. The ring schema consists of public and restricted circulation networks and defines the inner region and the outer region of the courtroom plate: courtrooms and support spaces in various proportions and arrangements occupy the inner region, and office spaces and public spaces or sky-boxes are arranged along the periphery in the outer region. In addition, the secure circulation network resides adjacent to the courtrooms within the inner region as an independent network, and public corridors occasionally bridge across the inner region depending on the number of courtrooms and the type of footprint. Significantly, this specific type of ring configuration is widely used in contemporary courthouse designs (Economou, 2013).

This work builds upon the archived design process of the Dirksen Courthouse to propose a formal description of Mies' language of courthouse design. The methodology is straightforward: an initial set of 39 sketches and diagrams of courtroom plate design variations is identified among the 135 sketches of the design process of the Dirksen courthouse to produce the corpus of the grammar. These sketches are all scaled, abstracted and remodeled under identical conventions of representation to produce a set of two-dimensional diagrammatic representations of the initial sketches and diagrams (Figure 1). Five functional spaces are foregrounded in the proposed model: a) courtrooms; b) support spaces; c) circulation networks; d) office spaces and e) vertical cores. The 39 design variations are categorized into seven types in terms of their underlying structural grid. The seven types of grids are 4x9, 4x11, 4x12, 4x13, 4x14, 5x10 and 5x15.

The Miesian structural module (s) deployed in the design of the Dirksen Courthouse measures 28'x28', and it is commensurable with the Miesian spatial module (n) measuring 4'8"x 4'8". 36 spatial modules in a 6x6 configuration exactly measure one

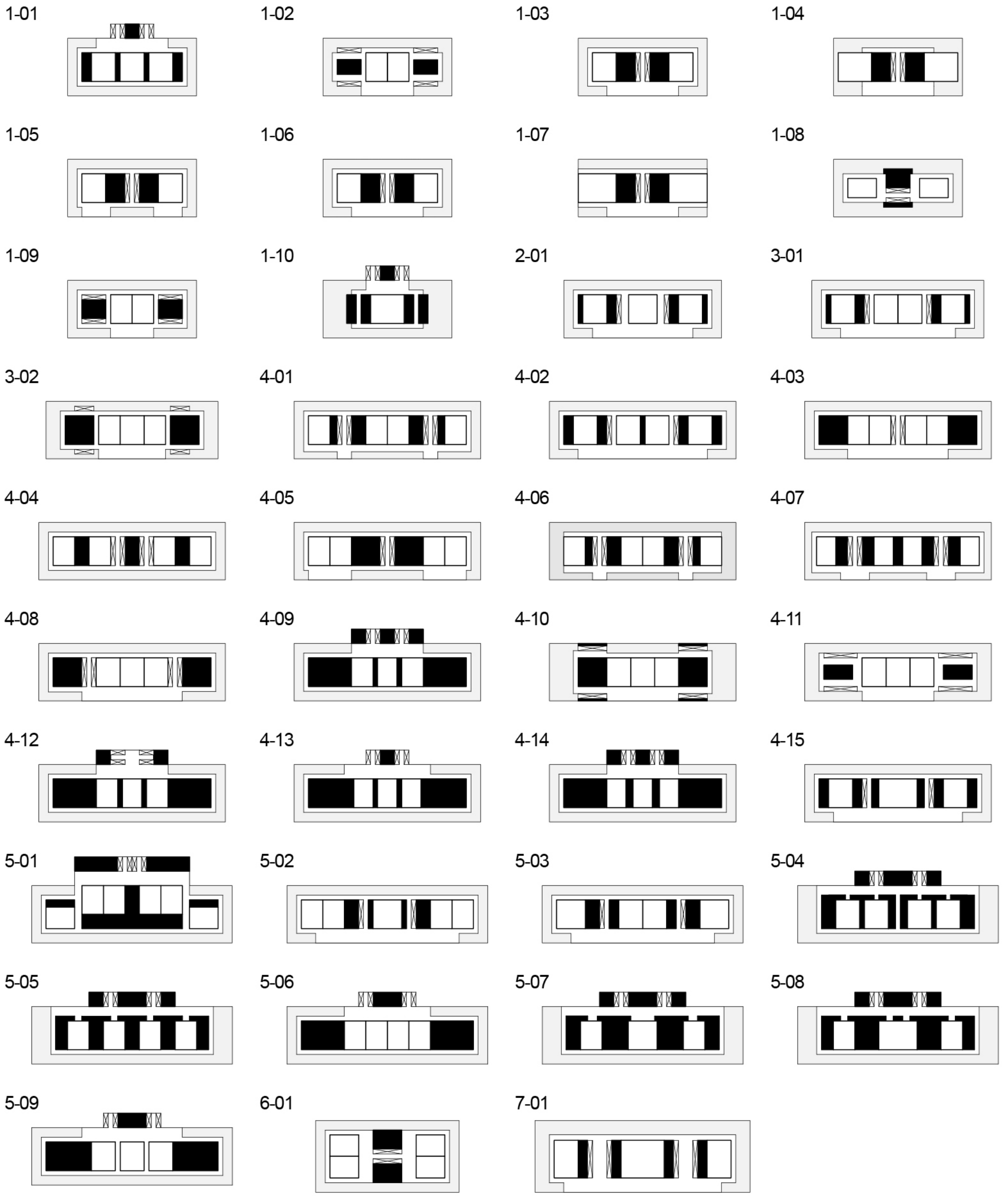


Figure 1
39 remodeled two-dimensional diagrammatic representations of courtroom plate design variations

structural module, 1s = 6n or 1/6s = 1n. The structural module is based on the materiality and construction type of the building, steel framing construction. In 1960s, steel framing construction was an advanced and popular construction method for high-rise buildings. More importantly, Mies became a master of high-rise steel construction buildings after the completion of one of his masterpieces, the Seagram building. It was completed in 1958, six years prior to the completion of the Dirksen Courthouse. The spatial module deployed in the Dirksen Courthouse is one of many variations of the Miesian spatial modules. This particular module, 4'8", for the Dirksen Courthouse design accommodates unique functional requirements of the courthouse. Comparatively, the Seagram building is designed based on the 4'7½" spatial module measuring the 27'9" structural modules which are slightly smaller than the modules of the courthouse design.

The Miesian courtroom plate designs, at all time, maintain bi-lateral symmetry along the central axis in the traverse direction of the footprints. The compositional schema of the inner region is binary: the inner region consists of two types of spaces, courtrooms and support spaces, and the spaces are composed in an algorithmic way respecting three constraints: a valid composition must maintain bi-lateral symmetry, have at least one bridging corridor in the traverse direction of the footprint and have a reasonable ratio between the areas of courtrooms and support spaces. The 39 courtroom plate design variations extracted from the collection suggest that the ratio shall be within the range from 1:0.4 to 1:1.1, and the average ratio is 1:0.8.

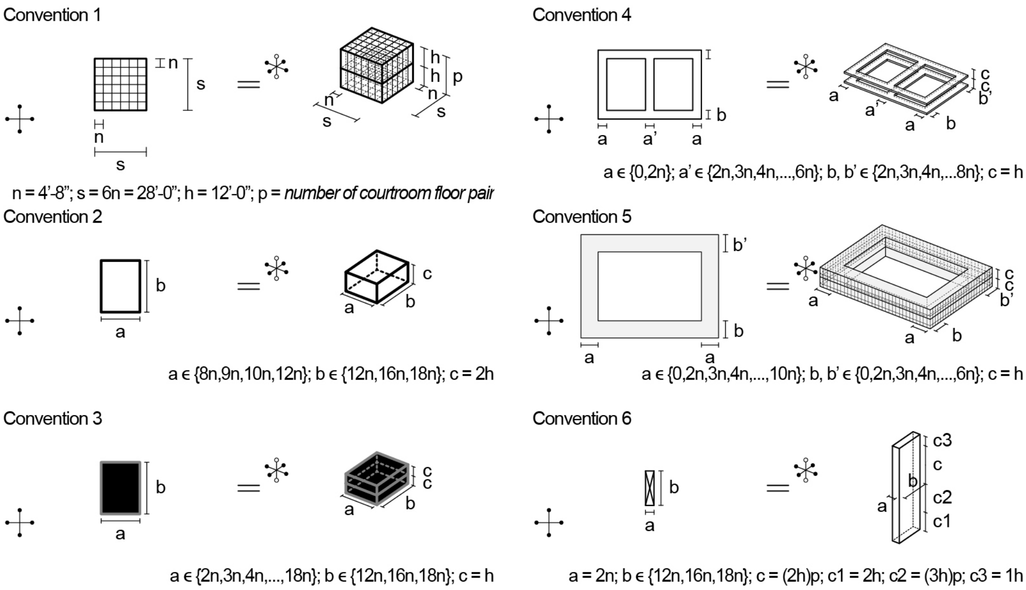
GENERATIVE DESCRIPTION

A generative description of the Miesian courthouse language is specified in a shape grammar with two-dimensional shape rules representing three-dimensional shape rules. A set of conventions of representation is employed to define the correspondences between the two-dimensional shape rules and the three-dimensional shape rules, and to further emphasize the relation between the actual architectural design process and the generative description outlined here. These conventions define six planar and sectional properties and relations between the five types of spaces identified in the grammar (Figure 2): a) a gridded rectangle represents two stacked Miesian structural modules (s), along with the Miesian spatial module (n), the floor-to-floor height (h), and the pair of two floor plates (p); b) a white rectangle represents a double-height courtroom; c) a black rectangle represents two stacked single-height support spaces; d) a white rectangular ring-shape with one or more connections within the ring represents two stacked circulation networks as thin slabs; e): a grey rectangular ring-shape represents two stacked office spaces with mullion details on the peripheral surfaces and f): a rectangle with an X-notation represents a vertical core. This last convention defines four sectional segments of the courthouse including a double-height lobby at the ground level, office floors upon the lobby, courtroom floors upon the office floors and a mechanical floor on the top in 2:3:4:1 ratio.

The 39 courtroom plate design variations specify a finite number of courtroom and support space variations in terms of their width and length. There are 12 possible courtroom variations of and 36 possible support space variations. A set of parameters, all multipliers of the Miesian spatial module (n), describes the variations and ensures that all the variations are configured upon the underlying spatial grid. Four possible dimensions in width and three possible dimensions in length, width $\in$ {8n,9n,10n,12n} and length $\in$ {12n,16n,18n}, generate 12 courtroom variations including 8n:12n (2:3), 8n:16n (1:2), 8n:18n (4:9), 9n:12n (3:4), 9n:16n (9:16), 9n:18n (1:2), 10n:12n (5:6), 10n:16n (5:8), 10n:18n (5:9), 12n:12n (1:1), 12n:16n (3:4) and 12n:18n (2:3). Similarly, 12 possible dimensions in width and three possible dimensions in length, width $\in$ {2n,3n,4n,...,18n} and length $\in$ {12n,16n,18n}, generate 36 support space variations.

The Miesian courthouse grammar consists of five sets of shape rules: a) initialization; b) core compo-

Figure 2
The six conventions:
Convention 1-6



sition; c) boundary definition; d) vertical core definition and e) boundary modification, vertical core addition and finalization. These five sets correspond to five stages of the design process: a) establishing a compositional scheme; b) composing major spaces; c) defining a building enclosure; d) defining vertical circulations; and e) detailing the overall spatial composition.

Stage 1 Initialization (Rule 1-6)

The first set of rules establishes the regulating axis of symmetry and initializes the composition of the inner region. Rule 1 initializes a construction space by generating the origin and the axis. The five subsequent rules produce the core of the inner region of the ring: Rule 2 generates an initial courtroom; Rule 3 generates an initial support space; Rule 4 generates a pair of initial courtrooms; Rule 5 generates a pair of initial courtrooms and a corridor; and Rule 6 generates a pair of initial support spaces with a corridor. All six rules are shown in Figure 3. Under the premise that the composition maintains bi-lateral symmetry, the selection of the initial rule fixes the compositional scheme of the inner region; for instance, generating a central courtroom guarantees that the final composition contains an odd number of courtroom. Also, a pair of parallel lines, perpendicular to the axis of symmetry and adjacent to the generated spaces, is generated and begins an outlining of the circulation ring.

Stage 2 Core composition (Rule 7-20)

The second set of rules continues the development of the inner region composition by adding courtrooms and support spaces in symmetrical ways. This set of rules consists of two types of rules that specify either the addition of spaces to the initial single functional space generated by one of the rules 2-3, or the addition of spaces to the initial pair of functional spaces generated by one of the three initial rules 4-6 (Figure 4). The first type of rules includes the following

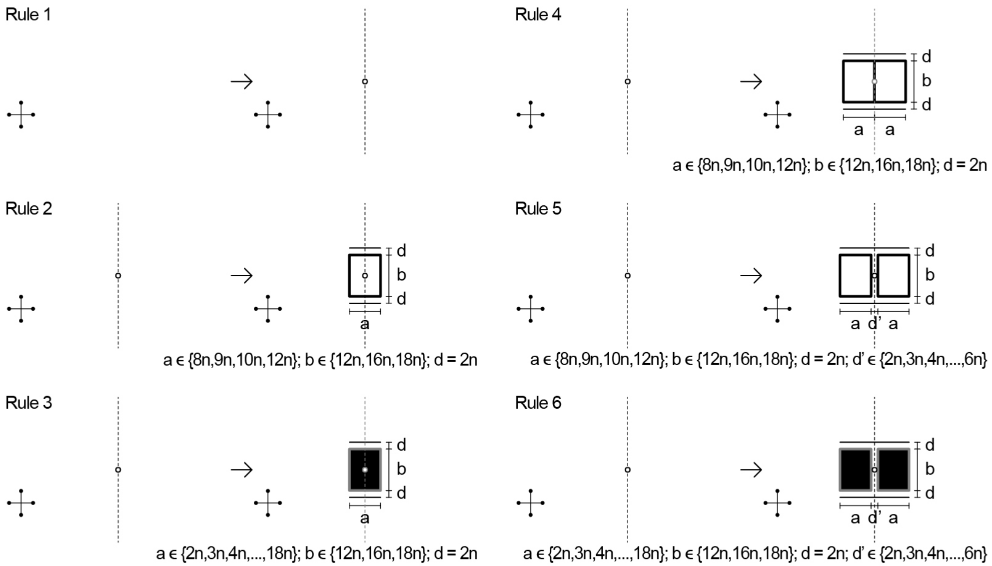


Figure 3
The first set of rules for Stage 1 Initialization: Rule 1-6

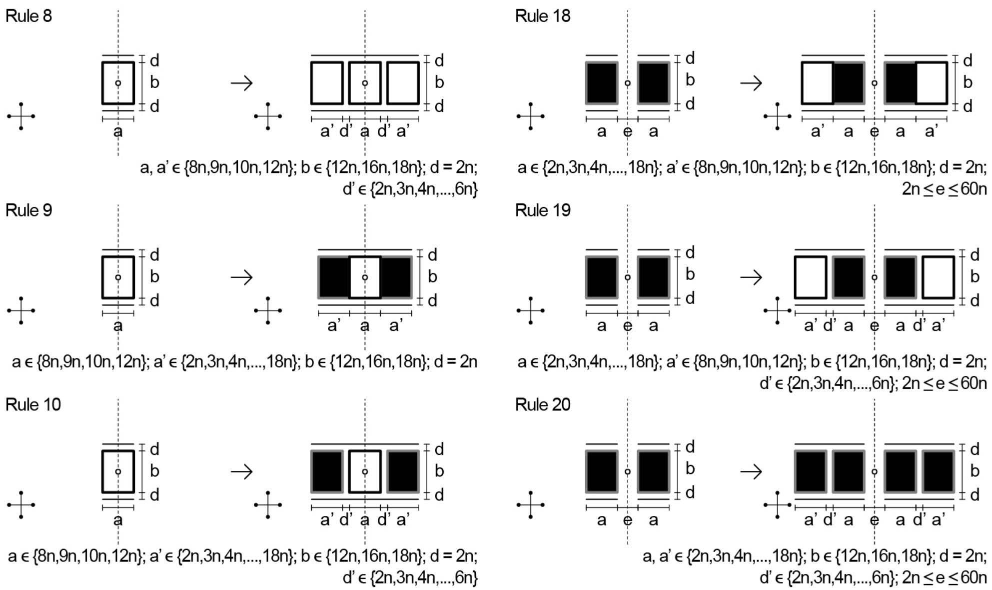


Figure 4
A partial set of rules for Stage 2 Core composition: Rule 8-10 and Rule 18-20

seven rules: Rule 7 adds a pair of courtrooms to the initial courtroom; Rule 8 adds a pair of courtrooms and corridors to the initial courtroom; Rule 9 adds a pair of support spaces to the initial courtroom; Rule 10 adds a pair of support spaces and corridors to the initial courtroom; Rule 11 adds a pair of courtrooms to the initial support space; Rule 12 adds a pair of courtrooms and corridors to the initial support space; and Rule 13 adds a pair of support spaces and corridors to the initial support space. These seven rules recognize the central space generated by one of the rules 2-3, and they add either a pair of courtrooms, a pair of corridors and courtrooms, a pair of support spaces or a pair of corridors and support spaces. Similarly, the second type of rules includes the following seven rules: Rule 14 adds a pair of courtrooms to a pair of courtrooms; Rule 15 adds a pair of courtrooms and corridors to a pair of courtrooms; Rule 16 adds a pair of support spaces to a pair of courtrooms; Rule 17 adds a pair of support spaces and corridors to a pair of courtrooms; Rule 18 adds a pair of courtrooms to a pair of support spaces; Rule 19 adds a pair of courtrooms and corridors to a pair of support spaces; and g) Rule 20 adds a pair of support spaces and corridors to a pair of support spaces. These seven rules recognize a symmetrical pair of courtrooms or support spaces to add a pair of spaces. All 14 rules in Stage 2 also extend the pair of parallel lines generated in the previous stage to continue the outlining of the circulation ring.

Stage 3 Boundary definition (Rule 21-23)

The third set of rules completes the outlining of the circulation ring, and it generates office spaces around the circulation ring and the building boundary. Depending on the final composition of the inner region, Rule 21 completes the circulation ring around the terminal pair of courtrooms, and Rule 22 completes the circulation ring around the terminal pair of support spaces. Both rules complete as well the outline of the circulation ring by adding a pair of brackets to the ends of the parallel lines that are generated in the previous stages. Rule 23 generates a ring-shaped office space around the circulation ring by defining the building boundary as an offset of the outer profile of the circulation ring. The offset is controlled by two parameters: the first parameter defines the offset f in the transverse direction, f = 4n, and the second parameter defines the offset f' in the longitudinal direction, $f' \in \{0,2n,3n,4n,...,6n\}$.

Stage 4 Vertical core definition (Rule 24-26)

The fourth set of rules defines the vertical cores of the building. The vertical cores contain all the vertical circulation spaces and consist of elevators and staircases serving the courtroom plates. The three rules in this stage define pairs of vertical cores in four types of arrangements based on two underlying constraints: a) a pair of vertical cores is adjacent to a corridor; and b) a pair of vertical cores is a part of support spaces whose width is greater than two Miesian spatial modules. Rule 24 adds a pair of vertical cores to a pair of support spaces adjacent to inner corridors, and Rule 25 adds a pair of vertical cores to a pair of support spaces adjacent to outer corridors. Both rules apply to the cases when two pairs of courtroom and support space share a pair of corridors. The third rule in this stage, Rule 26 adds two pairs of vertical cores to two pairs of support spaces adjacent to corridors and applies to the case when two pairs of support spaces each shares a corridor.

Stage 5 Boundary modification, vertical core addition and finalization (Rule 27-40)

The fifth set of rules modifies the boundary of the circulation ring, adds internal and external vertical cores and finalizes generations of Miesian courthouse design by eliminating the labels (Figure 5). Miesian courtroom plate designs frequently feature articulations of the circulation ring by either expanding or compressing the corridor of the building or parts of it on its longitudinal side. The first type of these rules expands the longitudinal side of the ring in four ways. Rule 27 modifies the boundary by a uniform expansion and expands the complete side creating a wider and more welcoming public corridor. Rule 28 modifies the boundary by a central expansion and

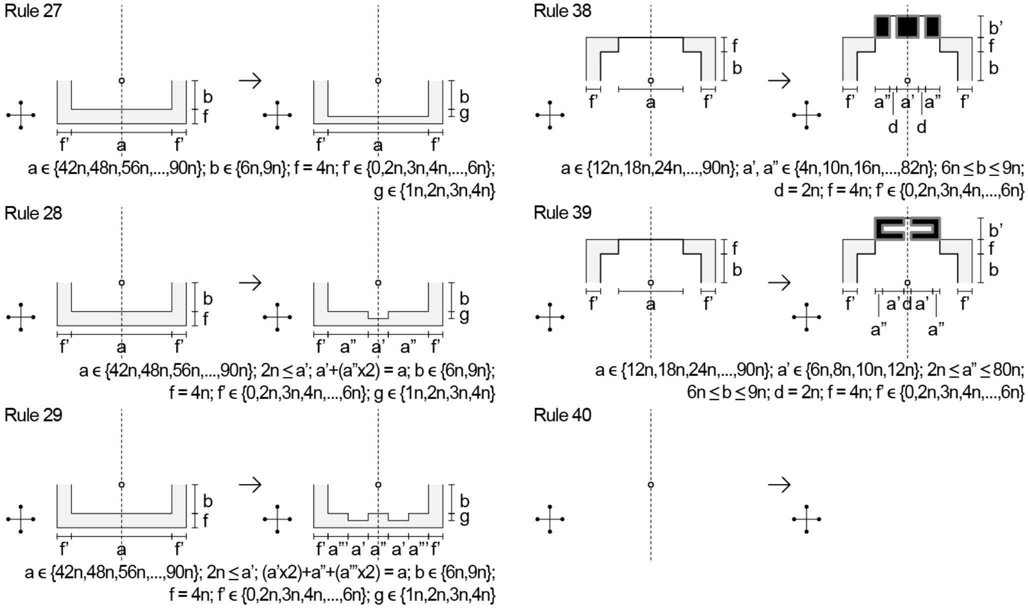
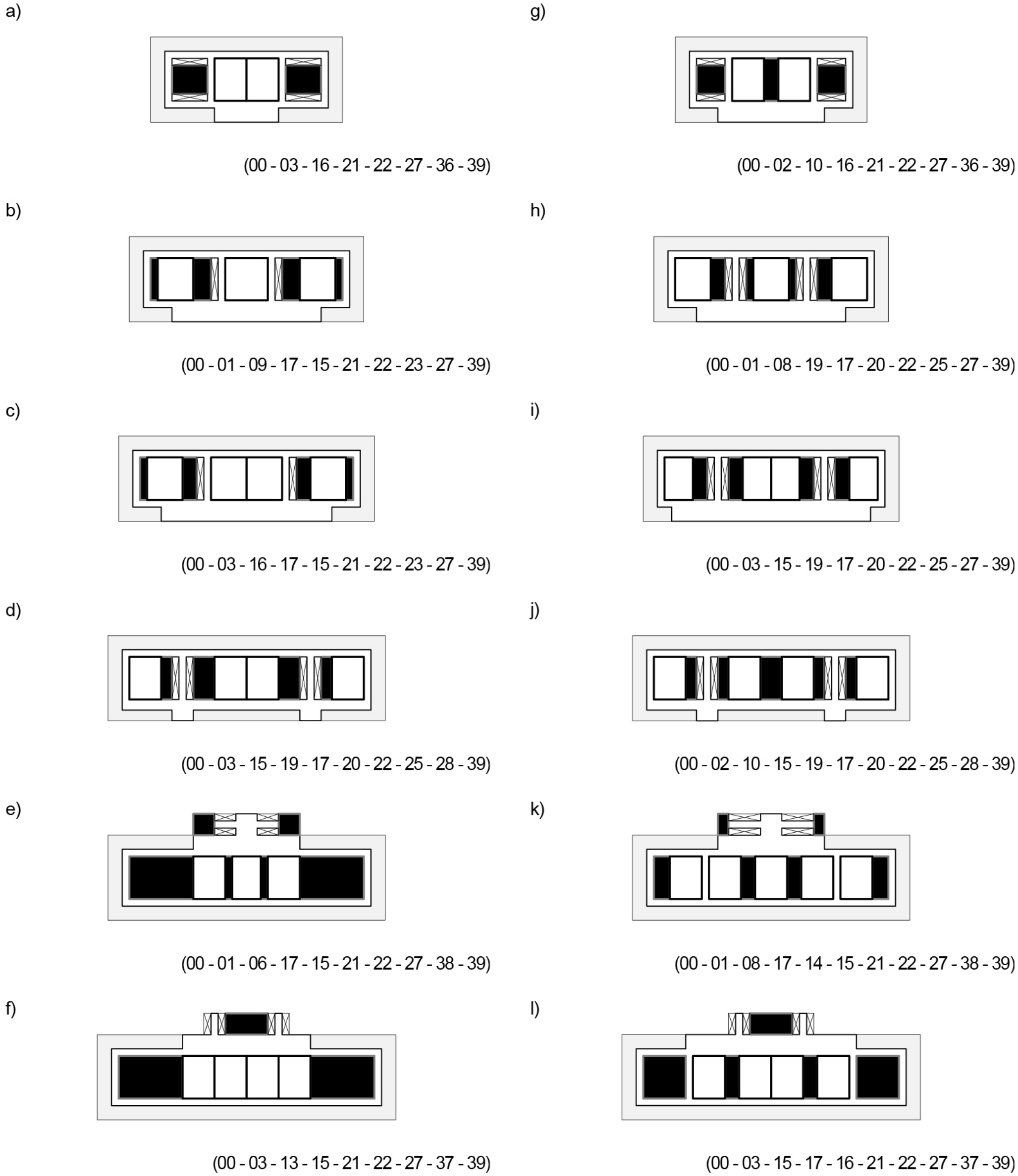


Figure 5
A partial set of rules for Stage 5 Boundary modification, vertical core addition and finalization: Rule 27-29 and Rule 38-40

expands a single-central portion of a side creating a central sky-box or public waiting area. Rule 29 modifies the boundary by a pair of expansions and expands a pair of portions of a side often creating a pair of sky-boxes or public waiting areas corresponding to a pair of bridging corridors in transverse direction. Rule 30 modifies the boundary by corner expansions and expands the two corner portions of a side creating a pair of sky-boxes or public waiting areas at the corners. The second type of these rules in this stage articulates the circulation ring by compressing a longitudinal side of the ring in three ways. Rule 31 modifies the boundary by a uniform compression and adds support spaces. Rule 32 modifies the boundary by a central compression and adds a support space. Rule 33: modifies the boundary by a pair of compressions in a side and adds support spaces. Rule 34 modifies the boundary by corner compressions to emphasize the non-compressed central portion of the side.

The subsequent three rules add pairs of vertical cores to pairs of longitudinally oriented support spaces: Rule 35 adds a pair of central vertical cores to a central pair of support spaces; Rule 36 adds two pairs of vertical cores to two pairs of support spaces adjacent to the inner corridors; and Rule 37 adds two pairs of vertical cores to two pairs of support spaces adjacent to outer corridors. The last two addition rules, Rule 38-39, generate courtroom plate design variations that feature T-shaped footprints and external vertical circulation towers consisting of pairs of vertical cores: Rule 38 adds a pair of external vertical core and Rule 39 adds a pair of external vertical cores in longitudinal orientation. Rule 40 finalizes the generation of Miesian courthouse design by eliminating the labels, the origin and the axis of symmetry.

Figure 6
Sample Miesian courtroom plate design variations generated by the grammar: a) - f) existing variations (1-09, 2-01, 3-01, 4-01, 4-12 and 5-06); g) - l) theoretical variations



DISCUSSION

The work takes on the formal analysis and generative description of one of Mies van der Rohe's masterpieces, the Dirksen Courthouse in Chicago. The analysis is grounded upon a collection of original sketches and diagrams produced by the office of Mies that reflects the design process of the courthouse and initially postulates a set of 39 Miesian courthouse designs based on identified variations of courtroom plate designs from the collection. The analysis further suggests formal and functional specifications of the design language by foregrounding primary functional spaces and identifying a set of spatial relations. The insights from the analysis lead to the formation of the proposed conventions of representation and the generative description of the building in the form of a shape grammar. The grammar is able to generate both the existing Miesian courtroom plate design variations as well as new ones within the language (Figure 6), while the conventions allow the automated courtroom plate design variations to represent Miesian courthouse designs in three-dimensional parametric models. The parsimony and rigor of this initial system of formal description clearly suggest that a great number of design variations are indeed possible. Current work takes on the implementation of the grammar in a shape grammar interpreter, GRAPE (Grasl and Economou, 2013), to fully automate the generation of Miesian courthouse designs in three-dimensional parametric models. A critical assessment of this formal description and its contribution both to the study of the contemporary courthouse typology as well as to the study of the language of one of the masters of twentieth architecture is currently under preparation.

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