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## MONOTONY AND REPETITIVENESS IN ARCHITECTURAL DESIGN

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### MONOTONIA I POWTARZALNOŚĆ W PROJEKTOWANIU ARCHITEKTONICZNYM

#### Abstract

Tumultuous history of Warsaw accounts for the specific urban character and pattern with its programmatic instability, incompleteness, spatial disorder, dispersed amorphous growth, morphological entropy and disruptive forces, more inclined toward exceptions rather than norms or systematic city organization. To learn more about architectural beauty from Warsaw specific cityness the paper presents a selected historical architectural style through a use of computation. Chosen examples of 20th century buildings design by Marek Leykam are used to formalize his design style. The monotony of repetitiveness is analyzed, with a use of created tool, and the extend of its complexity is studied. In present times of mass-culture and therefor mass-architecture, recognizable forms, classical formal qualities and even monotony stimulates searches for causes of objective beauty.

*Keywords: repetitiveness, facade, prefabrication, mass-architecture, parametric design, beauty*

#### Streszczenie

Burzliwa historia Warszawy tłumaczy jej specyficzny charakter urbanistyczny i wytworzony wzorec z jego programową niestabilnością, niekompletnością, zaburzeniami przestrzennymi, rozproszonym amorficznym wzrostem, entropią morfologiczną i siłami zakłócającymi, bardziej skłonnyymi do wyjątków niż norm lub systematycznej organizacji miasta. Aby dowiedzieć się więcej o pięknie architektury na podstawie krajobrazu Warszawy, w artykule przedstawiono komputerowe analizy wybranego historycznego stylu architektonicznego. Wybrane przykłady XX wiecznych budynków autorstwa Marka Leykama posłużyły do sformalizowania jego stylu projektowego. Opracowane narzędzie posłużyło do zanalizowania monotonii i powtarzalności a także poziomu złożoności. W obecnych czasach kultury masowej, a tym samym architektury masowej, rozpoznawalne formy, klasyczne cechy formalne, a nawet monotonia, stymulują poszukiwanie przyczyn obiektywnego piękna.

*Słowa kluczowe: powtarzalność, fasada, prefabrykacja, architektura masowa, projektowanie parametryczne, piękno*

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## 1. INTRODUCTION

The perception of the city is a constitutive element of its identity. The appearance and readability of the urban and architectural forms define how the users become aware of the local genius loci or the absence of it. The experimental introduction of the predictable patterns with rhythmic, repetitive structures in accordance with city space mental configurations present in the brain, improve our reception and understanding of the complex urban tissue. The “boring” facades of Procuratie Vecchie in the venetian Piazza San Marco are the idiomatic example of the repetitiveness consistent value for creating the place physiognomy.

In the case of Warsaw, the facade’s readability as facilitator of perception, interaction and participation acts as the city fabric integrating instrument. Where unreadability creates a chaos, readability provides a beauty.

In the Section 2 exploration regarding the beauty of architectural forms are presented. We outline causes of beauty expressed in thoughts of prominent thinkers on that subject. In search for objective beauty we try to find out if architectural beauty can exist in the cityscape composed out of buildings claiming beauty as a novelty and if monotony can be a beauty.

In the Section 3 we present analysis of the uniformity of chosen design style of building facades. The primary element of architectural and urban representation is the facade of the built objects. Therefore four buildings designed by architect Marek Leykam in 1946–1950 – Państwowy Instytut Geologiczny, NIK/Centrala Zaopatrzenia Hutniczego i Węglowego, Ministerstwo Skarbu (competition entry) in Warsaw and Powszechny Dom Towarowy in Poznań, an examples of post-WW II austere unornamented engineering of the architectural skin, are analyzed. A created computer tool formalizing Leykam’s style of façade designs and the results of the analysis are presented. Additionally, the extend of variety of his style is presented through parametric transformations with a use of developed tool. The experimental research results in the set of new architectural objects and explores the adaptability of his style to the contemporary technical possibilities.

## 2. REPETITIVNESS – MONOTONY – BEAUTY

Beauty often is associated with creating compositions using classical formal qualities of rhythm, proportions and symmetry. Vitruvius in the 1st century BC in his treatise described that „Architecture depends on Order, Arrangement, Eurythmy, Symmetry, Propriety, and Economy”, whereas Eurythmy is responsible for the beauty in the composition of all the elements governed by the proportions:

“This is found when the members of a work are of a height suited to their breadth, of a breadth suited to their length, and, in a word, when they all correspond symmetrically.”

Alberti, in his *Ten books* (1452), underlined that “the buildings cannot be beautiful in only one of its parts while the others are neglected”. Therefore, he urged for “harmonization” of all of its components. Introduction of harmony in architectural forms supposedly had to result in “a single, well-articulated body, not a jumble of unrelated fragments”.<sup>3</sup>

In order to relate beauty to formal qualities Francis Hutcheson, in his essay *Inquiry into the Origin of Our Ideas of Beauty and Virtue* (1725), proposed the “ratio of uniformity and variety”.

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<sup>3</sup> Alberti L.B., *Ten Books on Architecture*, Tiranti, London [1452] 1955.

He pointed out that „what we call Beautiful in Objects, to speak in the Mathematical Style, seems to be in a compound Ratio of Uniformity and Variety: so that where the Uniformity of Bodies is equal, the Beauty is as the Variety; and where the Variety is equal, the Beauty is as the Uniformity”.<sup>4</sup> Therefore, to increase the beauty of designs of the same uniformity an increase of the variety is needed and respectively an increase of uniformity of designs of the same variety is needed.

Slyk, by tracing similarities in the architectural designing with music composing, pointed out that “compliance with the principles of harmony guarantees a sense of order and a rich artistic work” but at the same time “architecture refers to the possibility of finding such rules with caution”.<sup>5</sup>

A few architects took the effort to formalize beauty among them Owen Jones, a nineteenth-century theoretician of color and ornament. In his design sourcebook *Grammar of Ornament* (1856) he urges that “all ornament should be based upon a geometrical construction” but compositions should “require higher mental effort to appreciate them”.<sup>6</sup>

Research in formalization of historical styles conducted by shape grammarians lead to algorithmization of the design process which can digitally reproduce buildings widely considered beautiful. Works of Stiny and Mitchell followed by Hersey and Freedman concluded by creating computer program able to automatically generate villas designed by Palladio and thousands of other designs having qualities of his style but never seen before.

Mitchell in his book *The Logic of Architecture: Design, Computation and Cognition* (1990) concluded, his divagations regarding formal value of architectural form, that: “we should not look for a universal definition of aesthetic value in terms of particular formal qualities, but should recognize instead that different people, at different times, will seek and values different formal qualities in composition”.<sup>7</sup>

This contextualization of beauty was also noticed by others who tried to reconcile it with objective and universal beauty. One of the most highly acclaimed English architects in history, Sir Christopher Wren, in his tract on architecture printed in *Parentalia* identified “two causes of Beauty, natural and customary”. “Natural is from Geometry, consisting in Uniformity (that is Equality) and Proportions. Customary Beauty is begotten by the use of our senses to those objects which are usually pleasing to us from other causes, as Familiarity or particular Inclination breeds a Love of Things not in themselves lovely”.<sup>8</sup>

Similarly, French architect of his time Claude Perrault, in his treatise on the five classical orders of architecture (1683), identified positive and arbitrary beauty. The former is a result of formal and material qualities while the latter is related with fashion, custom and usage.

This dichotomy of beauty identified in the Age of Enlightenment is still actual today. Architectural designing closely tied with mathematical and geometric reasoning in CAD environment is trying to defend its Wren’s “natural” beauty and Perrault’s “positive” beauty constantly being confronted by the “customary” and “arbitrary” beauty shaped by marketing industry and global spread of information over the internet. Desire of instant and constant appreciation of works of architects results in dominance of “arbitrary” beauty over “positive” one. Unbalance in the inter-

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<sup>4</sup> Hutcheson F., *An Inquiry into the Origin of Our Ideas of Beauty and Virtue*, Gregg International, Farnborough 1969.

<sup>5</sup> Slyk J., *Źródła architektury informacyjnej*, Oficyna Wydawnicza PW, Warszawa 2012.

<sup>6</sup> Jones O., *The Grammar of Ornament*, Wan Nostrand Reinhold, New York [1856] 1982.

<sup>7</sup> Mitchell W.J., *The logic of architecture: Design, computation, and cognition*, MIT press, Cambridge 1990.

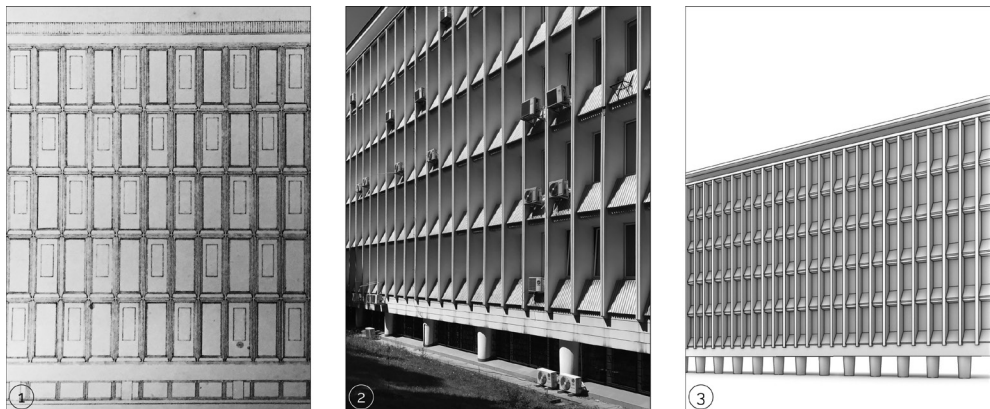
<sup>8</sup> Wren Ch., *Parentalia*, Gregg International, Farnborough [1750] 1965.

play between objective and dependent beauty of one building when multiplied to the cityscape brings chaos. Large variety of architectural forms, according to Hutcheson's theory of "ratio of uniformity and variety", without equal uniformity does not guarantee beauty. Therefore, in the realm of overwhelming variety the uniformity becomes beauty. Objective beauty, common for architectural forms, duplicated among cityscape, without variety, creates uniformity which can lead to monotony. At the same time when variety of architectural forms dominates cityscape then the uniformity becomes the beauty. Therefore, in the context of architectural forms fighting for attention, additionally challenged by mega scale advertisements, classical formal qualities of rhythm, proportions and symmetry becomes natural causes of beauty. The rhythm of repetitive façades, often associated with monotony, becomes an aesthetic quality of silent beauty. In the context of overwhelming variety, monotony becomes a beauty.

In the search for such examples we studied architectural designs of Marek Leykam in the context of rapidly developing city of Warsaw. Beauty of his designs expressed through monotony of façades expresses formal qualities of rhythm, proportions and symmetry. For the purpose of this research we created an algorithmic tool able to reproduce his designs.

### 3. GENERATIVE SIMPLICITY OF LEYKAM'S DESIGNS

The beauty of Leykam's designs is expressed through architectural form where façade is determined by the structural logic. Visible structural rationality, tension between load bearing frame and building face is an element of conservatism and noble classicism. Each of the building's façade is the tectonic expression of clearly adjusted sequences of basic parts and intervals, underlying the sculptural quality of the repetitive structure, repetitional use of construction elements, traditional division into base, corps and cornice. The impressive publicness and legibility of the external surface, composed with limited supplies of building products and materials, is positively responding to the passage of time and styles, in harmony with metropolitan genius loci. The art of repetition and simple rhythmic pattern of addition or subtraction emphasizes the philosophy of monotony as a medium for objective beauty.



Ill. 1. Państwowy Instytut Geologiczny: Leykam's original design drawing (1) (source: Archiwum Urzędu m.st. Warszawy), photo of the building (2) (author: Joanna Giecwicz), visualization of the outcomes of the algorithmic design procedure (3) (author: Krystian Kwieciński)



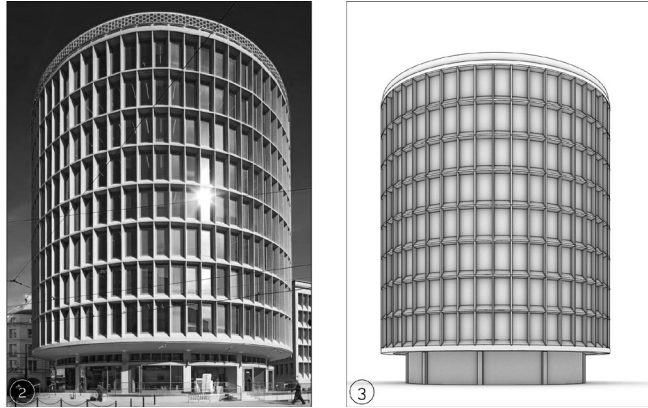
Ill. 2. NIK/Centrala Zaopatrzenia Hutniczego i Węglowego: Leykam's original design drawing (1) (source: Archiwum Urzędu m.st. Warszawy), photo of the building (2) (author: Joanna Gieccwicz), visualization of the outcomes of the algorithmic design procedure (3) (author: Krystian Kwieciński)

In the analyzed corpus of Leykam's designs we included 4 buildings: Państwowy Instytut Geologiczny (Ill. 1.), NIK/Centrala Zaopatrzenia Hutniczego i Węglowego (Ill. 2.), Ministerstwo Skarbu (competition entry) (Ill. 3.), Powszechny Dom Towarowy (Ill. 4.). Analysis of Leykam's architectural designs allowed us to formalize his design style and develop an algorithmic tool that can generate building facades in his style.

The development of the tool was iterative and incremental. Iterative means that it was improved over the time in the trial and error manner. And incremental means that the features of Leykam's style were gradually implemented in the tool starting from simpler design and evolving towards more complex one. We started the formalization of style from (in our opinion) the simplest facade of the Państwowy Instytut Geologiczny Building. When the tool was able to generate virtual model of that facade we proceeded to the next case. On each stage



Ill. 3. Ministerstwo Skarbu (competition entry): Leykam's original design drawing (1) (source: Architektura), visualization of the outcomes of the algorithmic design procedure (3) (author: Krystian Kwieciński)

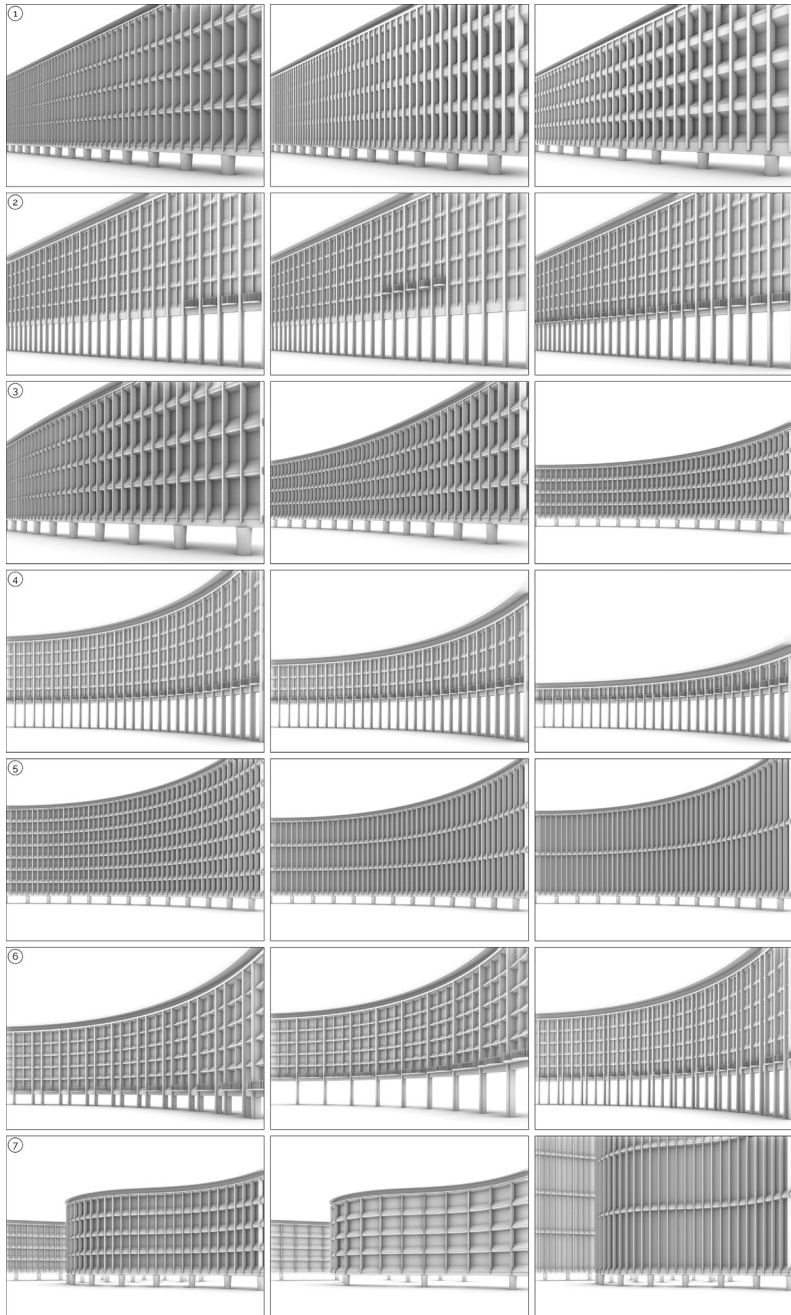


Ill. 4. Powszechny Dom Towarowy: photo of the building (2) source: <https://architektura.muratorplus.pl/zycie-w-architekturze/2012/okraglak-w-poznaniu/782/>), visualization of the outcomes of the algorithmic design procedure (3) (author: Krystian Kwieciński)

of the development we were verifying if the procedure can generate the current facade and all the preceding ones. If it could not generate a new facade, we were improving the tool and modifying algorithmic design procedure.

This process resulted in the development of an algorithm which is controlled by 31 parameters. It allowed us to generate elevations of all 4 analyzed buildings (image number 3 of Ill. 1., Ill. 2., Ill. 3., Ill. 4.). Parameters controlling generation of designs are responsible for various design modifications including: the size and proportions of the elements of a single elevation module, the position and the number of unique modules, the external outline of the facade, the number of stories, the number of stories per one elevation module and the rhythm of the elevation modules.

Developed tool proofed that all the designs included in the corpus are having common features which could be expressed by one design procedure representing Leykam's style. Parametrization of the design rules allowed to generate all the designs in the corpus and revealed differences in their complexity. The simplest rhythm of the façade is represented by Państwowy Instytut Geologiczny (Ill. 1.) and Powszechny Dom Towarowy (Ill. 4.). The corps of the façade is having a single rhythm in both the length and height of the building. Despite the similarity of these two facades, the generation of the Powszechny Dom Towarowy would not be possible without implementing, in the design procedure, the possibility of creating façades on the curvilinear guide line. None of the other designs in the corpus had such feature. The highest complexity of corps has the façade of NIK (Ill. 2.). The double window modules are nested in the main façade modules which are repeated in a single rhythm. Additionally, the corps base line is placed on the ground level and the building base is accentuated through a façade module of the double floor height. Moreover, the monotonous rhythm in the length and height of the building is disturbed with the introduction of the balcony module in place of the double window module. The rhythm of the façade of Ministerstwo Skarbu (Ill. 3.) is not disturbed by any additional modules but this building is composed out of two blocks. One of them serves as a base and the other as a corps. The façade of the upper block is composed of the same rhythm of modules in the height while it's rhythm in the length is doubled in the highest row. The bottom block is having a single rhythm with a modification of the base module between the rows.



III. 5. Visualizations of possible facade variations generated using developed algorithmic design tool. Each row presents three exemplary elevations obtained by modifying the parameters responsible for: the size of the elements of a single elevation module (1), the position and the number of unique modules (2), the external outline of the facade (3), the number of stories (4), the number of stories per one elevation module (5) and the rhythm of the elevation modules (6). Last row (7) presents juxtaposition of possible modifications presented on a curvilinear facade.

Parametrization of building components allows not only to generate accurate results precisely representing each of Leykam's façade, to morph one design into the other and trace the differences in their complexity, it also allows to examine classical formal qualities of his style by generating new designs which were not created by an author. Ill. 5. presents possible facade variations generated using developed algorithmic design tool. For each modification of parameters three exemplary elevations are presented. Modification of parameters allows for change of: the size of elements of a single elevation module, the position and the number of unique modules, the external outline of the facade, the number of stories, the number of stories per one elevation module and the rhythm of the elevation modules. The last row of Ill. 5. presents juxtaposition of possible modifications on a curvilinear facade.

While the generation of the facades in Laykam's style, with a use of developed tool, proofed uniformity of his designs and allowed for exploration of their variety, the generated parametric transformation showed the extent of this variety. Generative simplicity of his style showed endless design possibilities. The architect's sensitivity and ability of employing classical formal qualities of rhythm, proportions and symmetry decides on the objective beauty of the created design. Repetitive vocabulary used with extreme precision and self-imposed mathematical logic, discipline, formal sameness and the cohesive integrity and yet calm, public realm diversity are recognizable signs of author's individuality.

The goal of the experimental transformation is to open the discussion about the necessity of searching for the "ratio of uniformity and variety" in the architectural design and the urban environment created by aggregation of them.

#### 4. CONCLUSIONS

Developed tool, used to formalize Leykam's facades' style showed that all analyzed designs are having common features while having various complexity. It proofed uniformity of his designs and helped to explore their variety responsible for beauty.

Parametrization of the design rules allowed not only to digitally reproduce Leykam's designs but also to explore the extent of the variety offered by his style. Formalization revealed generative simplicity of his style and visualized different design possibilities which were not originally designed by the architect. Generated examples showed many design possibilities available by modifying a few parameters. This experiment showed the influence of chosen design decisions on the extent of design variety inscribed in repetitive and monotony architecture. By incorporating other design decisions, the range of design possibilities of repetitive architecture is becoming endless.

Despite this, contemporary architects experience a strong anxiety, when working on projects based on repeating and using past formulae. The search for "originality", "different from what is already there" is the guiding principle for the choice of new architectural solutions, visible in the cityscape of many cities including Warsaw. Added to this is the old tension between the architect's free creativity and attempts at standardization, prefabrication and parameterization leading to the automation of repetition. Instead of a certain horror of "unoriginality", the acceptance of repeatability is the needed for mass-production of buildings. This conflict has been already present in Bauhaus theories, claiming the use of industrialized production for

modern architecture together with a critical position toward monotony, even denial of existing forms (Corbusier search for “tabula rasa”).

While the question of beauty in the cityscape too often is limited to the beauty of single architectural object when expanded to the urban scale reveal the interplay between uniformity and variety. Proposed, by Hutcheson, the ratio of these two to formalize “Beautiful in Objects” fits well to describe “Beautiful in City”, where beauty is constantly being reformulated, modified and attacked. Dynamic changes in the urban fabric, by introduction of new architectural objects reformulates the beauty of the whole and each existing building. Introduction of a new design can change uniformity and variety of existing beauty. Within a huge uniformity increase of variety leads to an increase in beauty but in the realm of overwhelming variety the uniformity creates a beauty.

The political reading of repetitiveness and monotony means the democratic emphasizing of non-hierarchical structures.

With the use of new technologies architectural mass-production, optimization, customization the unrepeatably, unique, different is a new field of creative possibilities or should 90% of our buildings be apparently the same? Do we accept the prioritizing of repetition with its consistent formal lexicon as development strategy, facilitator of social connectiveness, expression of publicness, readability of urban forms, because it corresponds to the repetitive patterns already present in the brain? Is repeatability producing the total legibility useful for more and more mobile societies?

The conclusion should remind the one from Bauhaus introducing the building industrialization and the repetitive elements with the belief that this is the promise of a better society. If so, the forgotten search for the beauty in architecture is the theme of this research and the task for the future.

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