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Productive Facade Studies With Rule-Based Design: Ankara Çınar Street Sampling

Kural Tabanlı Tasarım İle Cephe Üretim Denemeleri: Ankara Çınar Sokak Örneği

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Abstract
The architectural design process, which has a multi-component structure, is redefined with technological up-to-date systems in addition to the unchanging basic design principles in the face of changing needs. This change in the design process, with the inclusion of computer-aided productive approaches in the process, provides original and alternative design outputs in architectural formation. In this study, house facades were analyzed with the shape grammar, which is the rule-based analysis method of the detached house pattern in Ankara, Yenimahalle Çınar Street, which has survived to the present day. This detached house pattern, designed in 1948 and after, reflects the cultural, economic, and aesthetic features of the period. It is valuable in these respects and is the first modern construction study in the history of the Republic of Turkey. Although few examples remain today, they are rapidly replaced by high-rise residences. These newly constructed high-rise buildings do not provide a linguistic unity with the texture of the environment. For the sustainability of Çınar Street's architectural values, it is of great importance to determine this grammar and to take it into practice with new technologies. In this study, detached houses on Çınar Street are discussed in the context of architectural language, and the rules of formation are determined. The facades, whose architectural form was determined, were tried to be reproduced using the same rules by computer-aided design. The study aims to be a reference for the facade designs of new high-rise residences and to maintain the urban texture by preserving it. In this context, it will contribute to architectural and social sustainability in today's architecture and designs made using advanced technology.

Keywords: Computer-aided Design, Facade Design, Rule-based Design, Shape Grammar, Social Sustainability.

Genişletilmiş Özet

Çok bileşenli bir kurguya sahip olan mimari tasarım süreci teknoloji ve bilgisayarın tasarıma destek olması ile güncel sistemlerle yeniden tanımlanmaktadır. Tasarım sürecindeki bu değişim, üretken yaklaşımların sürece dahil olması ile mimari biçimlenmede özgün alternatiflerin üretilmesi fikrini doğurmaktadır. Günümüzde mimarlık ürünleri tasarım aşamalarında farklı yaklaşımlar kullanılmaktadır. Kavramsal bağlamda sıra dışı formların üretimine sıkça rastlanmaktadır. "Tasarım"ın bu yöndeki gelişimi, farklı geometrik kurgulardaki formların, dijital tasarım ortamlarında betimlenerek üç boyutlu modellerinin üretilmesi ile desteklenmektedir.Genel bir yaklaşımla, "üretken" olma hali, yaratıcılığın kaynağını gösterme ya da herhangi bir şeyi yaratma gücüne sahip olma olarak nitelendirilmektedir. "Üretken tasarım" kavramı ise, tasarım eylemini gerçekleştiren tasarımcı/mimarın sonuç ürününden çok tasarım sürecinin içeriği ile ilgilendiği yöntem, "üretken tasarım sistemi" ise kullanıcıya bu süreçte destek veren ya da tasarımı bütünü ile ele alan sistem olarak tanımlanabilir.

Mimarın tasarım sürecindeki adımları, bilgisayar ortamında anlatabilmesi için bu adımların net ifade etmesi kural tabanlı tasarım fikri olarak karşımıza çıkmaktadır. Bu algoritmaların en temel niteliği ise karmaşıklıktan uzak, kolay takip edilebilen ve sınırlı kural setleri olmalarıdır. Kural tabanlı bir sistem olan "biçim gramerleri, yaratıcı tasarım pratiği amacıyla, hesaplamalı bir tasarım teorisi sunmaktadır; tasarım dillerini algoritmik bir yapıyla çözümlemeye ve aynı dilde yeni tasarımlar üretilmesine olanak sağlayan bir kural kümesidir.

Cumhuriyetin ilk yıllarından 1970'li yıllara kadaruzanan, genellikle Cumhuriyet ideolojisi çerçevesindegerçekleştirilen yapılar, modern mimarlık mirası olarakdeğerlendirilmektedir. Ankara ili, Yenimahalle ilçesinde yapılmış konut dokusu da bunun bir örneğidir. 1948 ve sonrası yıllarda tasarlanan Yenimahalle ilçesi Çınar sokaktaki müstakil konut dokusu, dönemin kültürel, ekonomik, estetik özelliklerini yansıtmaktadır. Bu açılardan ve Cumhuriyet tarihinin ilk modern yapılaşma çalışmaları olarak değerli bulunmaktadır.Bu çalışmada Çınar Sokak'ta bulunan ve günümüze kalmış olan müstakil konut dokusunun kural tabanlı analiz yöntemi olan biçim grameri ile konut cepheleri analiz edilmiştir. Çalışma temel tasarım prensipleri kapsamında, mimari tasarım üretim sistemleri ve üretimi biçimlendirme sürecinde geliştirilmiş,kural tabanlı tasarım olan biçim grameri çerçevesinde, sokaktaki günümüze kalan yapı cepheleri esas alınarak çalışılmıştır.

Çınar Sokak ve çevresinde de bölgenin merkezi ve birçok yönden avantajlı konumundan dolayı parsellerin değerlenmesi, güncel konut yaşamı gereksinimleri açısından mülk sahipleri ve mirasçıları için müstakil konutlardaki iç mekanların çok küçük olması, sık sık tadilat, bakım gerektirmesi bu konutların hızla yıkılarak apartmanlara dönüşmesine neden olmuştur. Günümüze az sayıda örnek kalmasıyla beraber, Çınar sokaktaki müstakil konutlar yerini hızla yüksek katlı konutlara bırakmaktadır.Yeni yapılan bu yüksek katlı yapılar yerin dokusuyla dil birliği sağlamamaktadır. Çınar Sokak mimari ve sosyal değerlerinin sürdürülebilirliği için biçim gramerinin tespiti ve yeni teknolojilerle uygulamada yer alması büyük önem taşımaktadır. Bu bağlamda bir çalışma yöntemi belirlenmiştir. Çınar Sokaktaki müstakil konutların mimari dil bağlamında biçimleniş kuralları çıkarılmıştır.Mimari biçimlenişi belirlenen cepheler, aynı kurallar kullanılarak bilgisayar ortamında denenmiştir. Yapılan çalışmanın yüksek katlı yeni konutlarda cephe tasarımlarına referans olması ve kent dokusunu koruyarak devam ettirmesi hedeflenmektedir.Alan çalışması iki adımda gerçekleştirilmiştir; üretim ve türetim aşamaları. İlk aşama olan üretimde, müstakil konut dokusunun kural tabanlı analiz yöntemi olan biçim grameri ile konut cepheleri analiz edilerek kural üretimi yapılmıştır. Bu analizde temel tasarım öge ve ilkeleri parametreler olarak kullanılmıştır. Üretim aşaması dediğimiz biçim grammerini oluşturduğumuz ilk aşamada cephe analizi yapılmıştır. Bu analiz sonucu yapı cephesinin karakteristiği ortaya çıkmıştır. Türetim aşamasında ise bu kuralları kullanarak, tekrar eden pencere ve balkonların yinelenmesi sağlanarak, baskın elemanların etkinliği devam ettirilerek bilgisayar ortamında yüksek katlı bir konut cephesi denemesi yapılmıştır. İlk olarak eskiz çalışmaları yapılmış, daha sonra Autodesk Autocad programı kullanılarak cephe modellemesi denemesi yapılmıştır. Analiz edilen iki yapının da modellemesi yapılarak ortalarına yerleştirilen türetim ürününün Showcase render programında renderları alınarak görsel olarak inceleme fırsatı sağlanmıştır.

Kent dokusunun ve sokağın, özgün kültürel geçmişi olarak yapıların varlıklarının sürdürülebilmesi ve geleceğe aktarılması önemsenmektedir. Yapılan çalışmada olduğu gibi tasarım dili araştırmaları ile mimarının çevresel ve sezgisel tasarımındaki farklı olasılıklara ve çözümlerine ulaşabilmek ve aynı dilde yeni tasarımlar üretilebilecek biçim gramerleri tanımlamak sadece birkaç yapıyı korumayacaktır. Yapıların mimarlarını, ustalarını, kullanıcılarını ve anılarını, o konumda kesişen bütün hayatları canlandıracaktır. Biçim gramerleri, gelecekteki mimari yaklaşımlara günümüz ve geçmiş mimari formlarının farklı konfigürasyonlarını tanıma, tasarım geliştirme ve kültürel bellek oluşturma, mimari tasarım çözümlerini kayıt altına alma imkânı sağlayacaktır. Bu bağlamda günümüz mimarisinde ve ileri teknoloji kullanılarak yapılan tasarımlarda mimari ve sosyal sürdürülebilirliğe katkı sağlanmış olacaktır.

Anahtar Kelimeler: *Bilgisayar Destekli Tasarım,Cephe Tasarımı, Kural Tabanlı Mimarlık, Biçim Grameri, Sosyal Sürdürülebilirlik*

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1. INTRODUCTION

The design is a multi-layered, rich texture that deepens and folds as you go into its details and in this world, every period and every architect has their own uniqueness while designing, it has an architectural language.In architecture that evolved and inspired each other throughout history new meanings are added to each vocabulary of language over time *(Cragoe, 2015)*. Architectural languages are interdependent. A new language cannot be created from today to tomorrow, and a new style cannot be born out of nothing. A new style takes time and something from others occurs *(Eldem, 1983)*. Each designer uses subconscious data with different rules by defining a language of its own. According to Chomsky, language is essentially a kind of system of repetitive/routine rules. Although the grammar itself is finite, the language produced is endless. Using finite grammar, new sentences can be created freely. And this feature reveals the creativity of language *(Aksoy, 2001)*. The language of the architect-designer is likewise an infinite number of rules that can produce variation with a finite number of form rules. Although similar techniques are used, these forms are not seen as imitations of each other and a personal language is formed. Forms are "already present" not by their origins, but by the contexts in which they exist, new contexts can be created with images *(Tanyeli, 2011)*.

Architectural analysis shows that the synthesis of singular forms creates structures. It is a viable way to analyze to compare spoken language and architecture when viewed in terms of structural fiction and language. Linguistic production is of different kinds, as in architecture. Bring together products, create different styles, and come together meaningfully, there are studies on the determination of association rules and that there are direct common aspects of these two issues such as being affected by shows. There is no random combination of the elements that make up the language, as well as the architecture, elements are not independent of each other.The combination of elements with different variations leads to the emergence ofdifferent products. Language rules make these variations meaningful products. The results of structuralist linguistics and the methods it uses are also used in architectural analysis *(Fischer, 2015)*.

During and after the Second World War, the private sector created significant capital accumulation and the number of workers increased *(Pulat, 1992)*. In this period, rapid development was aimed after the war, and due to urbanization and shantytowns formed in big cities, the interest in the housing problem shifted from civil servants' houses to workers' houses and slums *(Pulat, 1992)*. Due to the industrial revolution of the 18th century, settlements all over the world have undergone social and physical changes. The transition from the feudal world to the modern world began, migration from rural areas to urban areas accelerated, construction in cities increased exponentially in a very short time, and as a result of this migration, land speculation in the city increased. One solution to this increase in cities is the vertical elevation of buildings *(İlerisoy&Başgül, 2019)*.

1945 is a turning point for Turkey in terms of housing production and owning*(Alkışer&Yürekli, 2011)*. In 1946, the aims of Türkiye Property Credit Bank were redefined as providing cheap loans, producing and selling houses, and supporting cooperatives *(Pulat, 1992)*. Yenimahalle was established for the lower-middle income group in Ankara with the first slum law no 5228 dated 1948 *(Alkışer&Yürekli, 2011)*.So, today these buildings reflects the architectural language of that term.

The detached houses in Yenimahalle, Çınar Street, which are the subject of the study, are also 3-storey type houses consisting of a single independent section, which the state allocated land and placed in 2821 parcels. According to Yılmaz and Sağıroğlu*(2020)*, 81 of them have reached today. The destructive changes that the old-quality buildings were exposed to in the period they were built are about

to erase these structures from the urban memory of Yenimahalle today. It is important to maintain the existence of structures as the original cultural history of the urban fabric, and street and transfer them to the future.

With the computer-aided rule-based analysis method, the new low-rise building facades are modeled with the shape grammar in the design of the building facades. The study is based on the facades of 2 buildings on the street, within the framework of architectural design production systems and shape grammar, which is a rule-based design developed in the process of shaping production, within the scope of basic design principles.

2. ARCHITECTURAL DESIGN PRODUCTION SYSTEMS AND THE FORM-FINDING PROCESS

It is necessary to examine the design process in order to define the problem of design in general and the analytical design approach specific to the architect *(Figure1)*. One of the theories about the working of the process is the "black box" approach and the designer's intuition is to solve the problem by going through an ambiguous process*(Uğurlu, 2001)*.

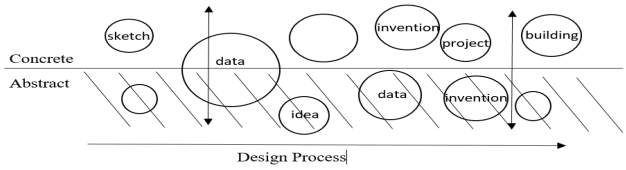


Figure.1 *Design Process (Uğurlu, 2001)*

Design is a subjective, holistic process that is created with the designer's knowledge, experience, and intuition, and cannot be deduced. Contrary to this theory, the "transparent box" approach is a rule-based problem-solving process of design*(Uğurlu, 2001)*.. In this context, action is a systematic, finite, and rational activity, and inferences can be made about the process. The problem is very difficult to comprehend unless it is divided into subproblems, and the designer tries to define the complexity by creating hierarchical subproblems in order to realize the problem; but this partitioning may prevent holistic understanding of the problem.

Different design approaches are used in the creation of today's architectural products. Architectural examples in which extraordinary forms are produced, starting from conceptually very different phenomena, are frequently encountered. The development of new design examples in this way is supported by the production of three-dimensional models of forms in different geometric configurations by describing them in digital design environments.

In a general sense, the state of being "productive" is defined as having the power to create a thing or to reference the source of creativity *(Fischer &Herr, 2001)*. The concept of "generative design", on the other hand, can be defined as the method in which the performer deals with the content of the process rather than the result, and the "generative design system" can be defined as the system that supports the user in this process or handles the design completely. The productive capacity of the system is determined by the designer's innovative products and the development of design orientations *(Fischer &Herr, 2001)*. The fact that the design problem is a complex process in which subconscious decision-making mechanisms at different levels from aesthetic decisions to standards requires designers to make only complex cause-effect relations, adaptive thinking processes, and intuitive decision-making. *(Herr, 2002)*. The generative design system should be suggestive, adaptive and unrestricted in order to support this process.

The generative design system should inspire the user to make inferences, move ideas to new contexts, and be able to generate and express alternatives in similar contexts. These designs occur with the use of information technologies and various forms of expression and production techniques *(Avital, 2007)*. These are:

Visualization: The system should be able to work in coordination with human-oriented visualization tools and should be multi-dimensional. In this way, object/

designs/inspirations can be perceived from many different perspectives and the research can be made from different points of view.

Simulation: The generative design system should be able to cooperate with existing/ possible simulation tools and measure its reaction to multiple situations. Thus, the adaptation of the design object to changing conditions/situations can be measured or observed.

Abstraction: Generative design should provide different degrees of transparency and allow objects/processes to be perceived at different levels. Increasing or decreasing transparency is necessary to differentiate and comprehend the basic characteristics of the object/process.

Adaptation: A productive system should allow and be adapted to the work performed by users of different scopes and backgrounds. Two different aspects of information technologies provide the content that will support systemic flexibility and adaptation.

Customization: The system should be customizable by designers for different users and situations *(since it cannot adapt itself to every situation)*.

Automation: According to the preferences and limitations made by the user, the productive system should be able to change itself and produce solutions in new situations. As seen in Figure 2, it is possible to search for forms according to the changing conditions autonomously with computer technologies *(Figure 2)*.

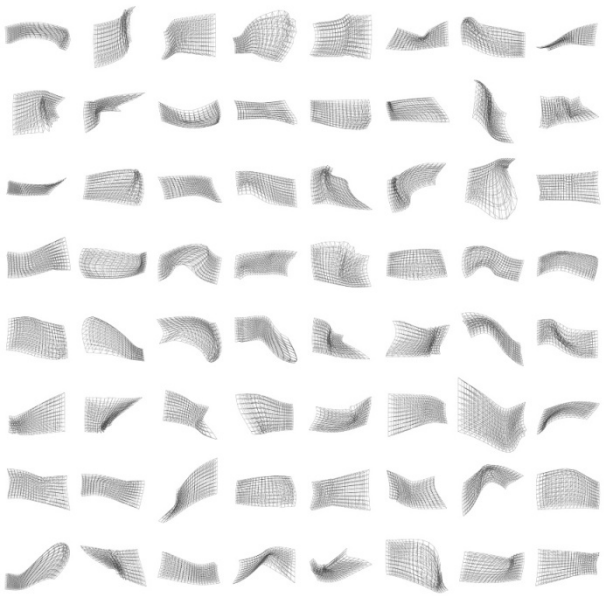


Figure.2 *Example of form alternatives with productive systems approachaccording to the changing conditions, D'Arcy Thompson (URL-1, 2022)*

Extensibility *(open-ended)*: A productive design system is inherently capable of producing different alternatives, as it is an evocative and adaptive system. This production skill is performed by providing the accumulation of knowledge and the storage of experience. Computational sciences allow productive systems to be easy to improve with the following features.

Peer-production: The ability of users or user groups to activate innovative systems and subsystems is an important factor for increasing productivity. Co-production allows innovative ideas to emerge in collaborative processes *(Avital, 2007)*. This complex process of design theory and the formation of intuitive decisions have similaritieswith the complexity theorem. Complexity can be defined as the situation observed in systems where many different and independent variables/factors/ individuals have nonlinear and parallel relationships *(Herr, 2002)*.

The concept of computer-aided productive design aimed to use computational sciences as variation generating systems to create large solution sets and obtain unexpected alternatives and facilitate the discovery of alternative solutions in design. In productive design, algorithmic methods are often used to generate a set of

alternative solutions based on predetermined goals and constraints that the designer evaluates to select the most appropriate or interesting one. The power of the computer as a productive design tool derives from its ability to perform tasks based on numerically embodied dimensional or relational constraints. Design decisions that require holistic, contextual understanding and intuition are often left to human designers. Therefore, computer-aided productive design processes allow different levels of automation or user intervention is reduced to certain dimensions in the formation of the system *(McCormack et al., 2004)*.

In the automated productive system model, the user determines the variables, constants, relations, and criteria at the beginning of the process, and after the creation of the process, the productive system alternatives are presented to the user. The user/designer can choose among the alternative*(s)* or change the creation order, allowing the new set to be created. Productive systems that allow user intervention enable designer-controlled creations by enabling design intervention at certain stages of the process.

3. RULE-BASED DESIGN: SHAPE GRAMMAR

Although architecture has an abstract and intuitive side, it has a hybrid structure with a tangible experience and feeling *(Uluoğlu, 2004)*. It has always been difficult to analyze the thinking system of architecture and to observe how the abstract and concrete emerge. Just as words are arranged to form spoken languages, musical works are formed by arranging notes one after another, this is how architecture is formed *(Sanli, 1993)*. Shape grammars offer a unique and computational design theory that is particularly well aligned with creative design practice *(T. Knight, 1980)*. It is a rule set that allows to analyze design languages with an algorithmic structure and to produce new designs in the same language *(Colakoglu, 2000)*. In shape grammars, production starts with a shape, it is a production system in which a finished shape is reached by applying transformation rules based on repetition to the basic shape. Since the 1970s, shape grammar has been used as a method of analysis in architectures where a characteristic form, pattern repetition is seen *(Hadighi& Duarte, 2018)*. Shape grammar, developed by Stiny and Gibs, is used in the analysis and synthesis of design at different scales, from painting to sculpture, from industrial design to urban design, in the analysis of visual arts as a visual calculation system. Stiny *(1980)* defines shape as an axis on the Cartesian system in his/her article as an introduction to shape grammar. As another explanation, shape is a composition consisting of a finite number of basic geometric elements. Relationships between forms are provided by Boolean commands *(join, intersect, and differ)* and transform commands *(rotate, mirror, shift, and scale)*. In the process of combining these commands by applying certain rules; by defining the relationships between each point of a shape with commands, a more productive algorithm, parametric shape grammar, is obtained. Shape grammars are categorized into two separate groups, analysis *(analysis)* and synthesis *(original)* grammars.

Architects consider the production of new objects, their coming together, the interaction and transformations between objects while designing the physical environment. Design theorists have been making efforts for centuries to abstract design knowledge and analyze their relations with each other. The main purpose of these studies is to make the design understandable and workable *(Aksoy, 2001)*. The reason for the emergence of the rule-based design idea is that the architect can express the steps he/she follows while designing in a computer language environment. The most important feature of the algorithm consists of limited rule sets that are far from complexity and can be followed easily. These algorithms, which are similar to recipes, are a system used for the analysis and synthesis of designs. The precise specification of design operations defines an algorithm for these operation sequences *(Özbek, 2004)*.

An algorithm is a formula for solving a problem. However, the main purpose of these processes that make up the design is not to reduce the design to the formula level, but to present new conditions by offering alternative variations. In this set of rules, the system can be reinterpreted, and different products can be obtained with a new configuration *(Yavuz & Çelik, 2014)*.

Stiny and Gips defined shape grammar in the early 1970s as a way of describing and creating a design language that defines the algorithmic structure in accordance with the rule-based structure *(Aksoy, 2001)*. Shape grammar has an algorithmic structure, which is similar to the finding and repetitive use of productive formal formation rules in linguistics. The analysis of this algorithm, which can be defined as the rules that make up the language, allows the understanding of the rules of the language and the production of new ones *(Stiny, 1980) (Figure3)*. Shape grammars create new 'n' dimensional shapes using the shapes in the language dictionary *(Stiny, 1977)*. Shape grammars are a set of shape rules that are applied one by one to produce a design language. It is divided into two as formal, which is the shape production method of the computer, and informal, which is the description of producing form with shapes *(Özbek, 2004)*

Fiction in music and language is also valid in architecture *(Aksoy, 2001)*. The aim of combining the form sets created in shape grammars with grammar with certain rules is the similarity of music and language and their functions. Shape grammar is a tool for describing and generating design languages *(Özbek, 2004)*. A shape grammar is a set of form rules that are applied one by one to produce a design language or set *(Özbek, 2004)*.

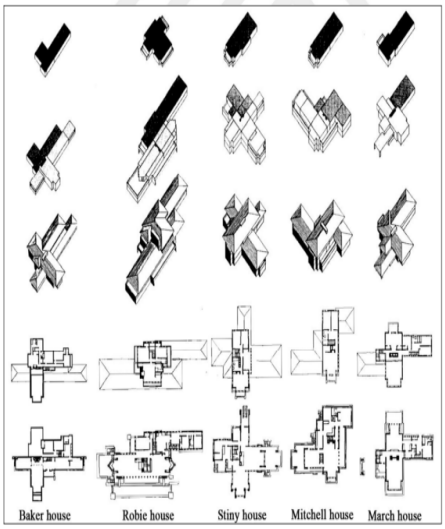


Figure.4 *Manufactured country houses (Koning &Eizenberg, 1981)*

Shape grammar is a system of rules used to abstract and characterize the design rules of languages. Shape grammar is used in architecture, engineering and many arts branches to analyze design languages, understand styles, and create new designs *(Aksoy, 2001)*. The usage areas of shape grammar can be summarized as follows;

1. Examination of existing language, designs, and architectural styles *(analytical)*,

2. Language, type, and style created entirely by the designer from scratch *(original)*,

3. Production of a new language from the existing language by using analysis and synthesis together *(hybrid) (Tok, 2008)*.

The architectural language obtained by analyzing the country houses designed by Frank Lloyd Wright shaped the space volumes symbolized as rectangular prisms, and 89 different houses were derived *(Figure 4)*. With these analyses, Wright's design approach was analyzed *(Güzelci, 2012)*.

Symmetry is used extensively with transform commands applied in patterns of shape grammars, and patterns emerge

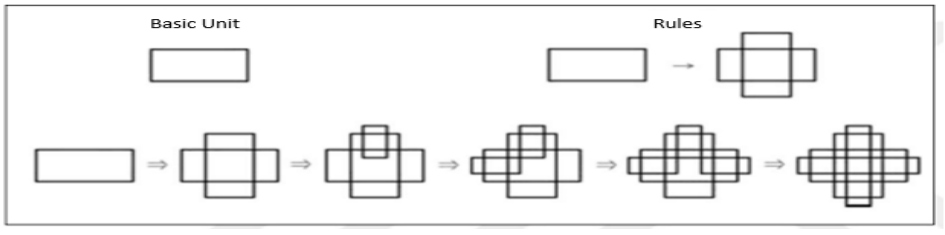


Figure.3 *Derivation of the rectangular initial shape by rotating it 90 degrees and adding it to itself (Knight &Stiny, 2001)*

from symmetry groups. Thus, the formal language is proportionally defined by arithmetic and geometric series *(Knight, 1999)*. A useful feature of shape grammar applications is that they allow backtracking. Within this system of rules, new alternatives can be tried by returning to the previous form *(Aksoy, 2001)*.

The formulation of shape grammars for a design of an existing case or precedent can help designers regenerate parts or a multitude of random whole compositions from which they can select some forms as their final articulations or inspiration resources for future product generation *(Eilouti, 2019)*. Due to the significance of facades as major manifestation media for their designers and main expression tools of architectural concepts and styles, their structures and processes are the target of many shape grammars *(Haegler et al., 2010; Moon, 2007; Riemenschneider et al., 2012)*. An analysis of the geometric scheme underlying the composition of the facades reveals a clear application of a set of well-structured shape grammars. Although a particular grammar may not be directly used by the designer to generate the facades the elevation designs can decipher their designing scheme *(Fig 5) (Eilouti, 2019)*.

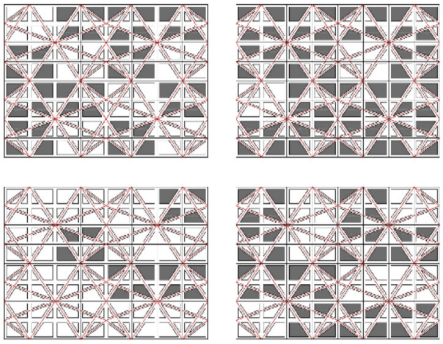


Figure.5 *Possible facade compositions generated by the formulated shape grammars (Eilouti, 2019)*

4. CASE STUDY: ANKARA ÇINAR STREET SAMPLE

The buildings, which are generally built within the framework of the Republican ideology, from the first years of the Republic of Turkey to the 1970s, are considered as modern architectural heritage. The residential patterns built in the Yenimahalle district of Ankara are examples of these. The detached housing patterns on Çınar Street in Yenimahalle district, designed in 1948 and after, reflects the cultural, economic,and aesthetic characteristics of the period. It is valuable in these respects and the first modern construction study in the history of the Republic *(Figure 6, Figure 7)*.

As few examples remain today, the detached houses on Çınar Street are rapidly giving way to high-rise houses. These newly constructed high-rise buildings do not provide a linguistic unity with the pattern of the environment. For the sustainability of Çınar Street's architectural and social values, it is of great importance to benefit from the shape grammar approach and to take it into practice with new technologies. In this context, a study method has been determined *(Figure 9)*. Detached houses on Çınar Street are handled in the context of architectural language and the rules of formation are drawn. The facades,

Figure.6 *Çınar Street, Yenimahalle Ankara (URL-2)*

which architectural form was determined, were tested in the computer using the same rules. The aim of the study is to be a reference for the facade designs of new high-rise residences and to maintain the urban pattern by preserving it. The context here is not the repetition of the old, but modern buildings intended to be built according to the rules of the local texture. Because modern designs are influenced and benefit from current technologies that enable different types of designs to be made. Different designs cause the boundaries of design to expand, new design methods to be tried, and therefore the world of design to develop innovatively in theory and practice *(Ağırbaş, 2019)*.

The case study was carried out in two steps: production and application stages *(Figure 10)*. The analysis phase is important because, according to Ağırbaş *(2020)*, the model analyzer who defines the parts must provide the parts algorithmically so that they work interdependently. Only in this way, a suitable 3D parametric pattern generator can be created that is specific for the particular pattern being investigated *(Ağırbaş, 2020)*. In production, which is the first stage of study, house facades were analyzed with shape grammar, which is a rule-based analysis method of detached house texture. Basic design elements and principles are used as parameters in this analysis. Two factors, namely line and direction, form and dimension, which are basic design elements, were examined. Basic design principles, which are considered as analysis parameters, are repetition, harmony, contrast, and balance, domination, which are examined separately for windows, on mass basis, linear elementsand perceptibility.

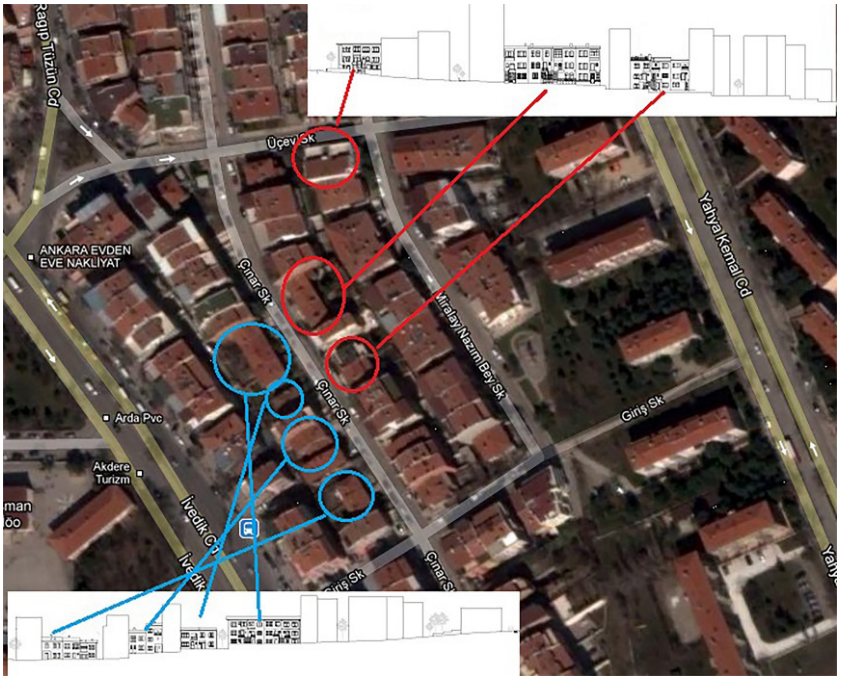


Figure.7 *Çınar Street, Yenimahalle Ankara*
Figure.8 *Çınar Street view (...'s personal archive)*

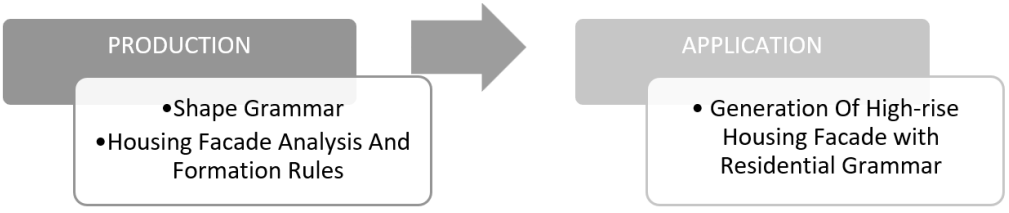


Figure.9 *The methodology of case study*

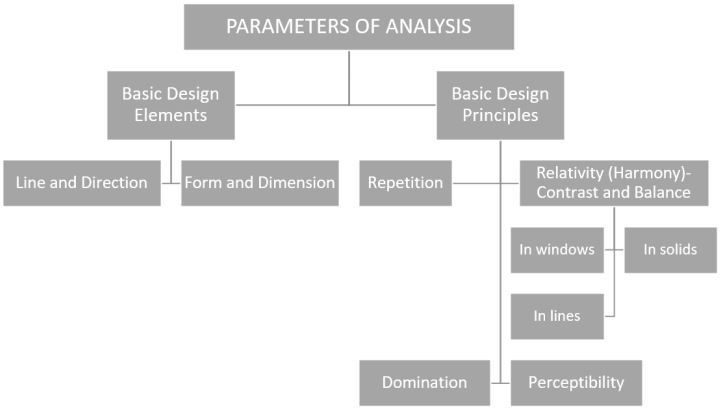


Figure.10 *Parameters of Analysis*

The façades of the houses analyzed in Çınar Sokak are the façades of the houses that have survived to the present day. It is also seen in the street silhouette in Fig 11.

Figure.11 *Street silhouette (adapted from Yılmaz&Sağıroğlu, 2020)*

According to the basic design elements *(Table 1)*, two factors were examined in the buildings. In line and direction as the first factor, the dominant linear elements of the facade were determined. In the second factor, in which form and dimension were analyzed, massive geometric forms *(setbacks, cantilevers etc.)* that were dominant on the facade were determined. According to this evaluation, it is seen that the dominant linearity on the façade is horizontal because the linear elements *(for example, the eaves under the roof)* are dominant horizontally. Angular movement is also seen, the dominance of vertical lines is not seen. In addition, when evaluated on the basis of form, geometric large or small forms are seen, but irregular or natural forms are not encountered.

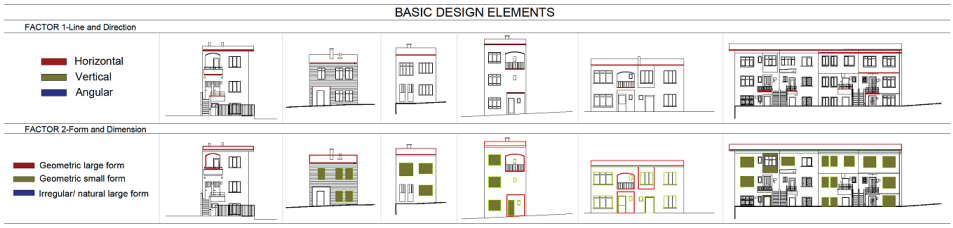
Table.1 *Basic design elements factors and structural analysis*

In the analysis of the repetition *(Table 2)*, which is one of the basic design principles, on the facade, a shape grammar was created on the facade according to the dominance of the element that creates the "repetition". Windows and interior balconies on the analyzed facades are repetitive structural elements. This analysis method is based on observation, and the principle will be used intuitively in the application step.

For harmony, contrast, and balance, the horizontal and vertical axle and center of gravity have been determined on the facade. It has been examined whether the facade is in balance axially. Repetitive facade elements according to basic design principles ensure harmony. The harmony of windows and massive and linear elements were evaluated separately. According to the analysis, repetitive windows provide harmony. On a linear basis, the linear element that passes clearly under the roof is an element that ensures harmony by repeating it in both structures *(Table 3)*. The human physical-mental existence and all organic life tend to achieve balance. If an unbalanced composition is random, whether on the façade or throughout the structure, it will appear discontinuous and therefore useless *(Polat&İlerisoy, 2020)*. In Table 3, it is analyzed how the desired harmony is achieved in windows, solid and linear elements. It was concluded that balance was achieved with contrast.

The basic design principles are interrelated; the repetitive element is felt as dominant. When the Çınar Street structures are examined in particular, the repetitive balconies on the facade appear as the dominant facade element. In detached houses of human scale, the top cover does not disturb people with its lightweight structure, it is the least dominant element of the facade *(Table 4)*.

When the perceptible elements of the facade were examined *(Table 5)*, similar window groups were evaluated together. Windows that repeat at the same rate have a higher perception on the facade. Linear elements form the contour of the building facade.



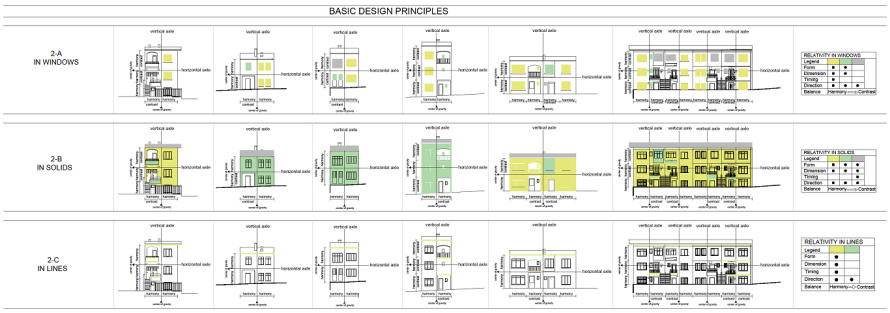


Table.2 *"Repetition" analysis*
Table.3 *"Harmony, contrast, balance" analysis*

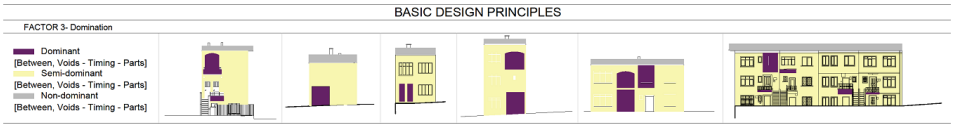


Table.4 *"Domination" analysis*

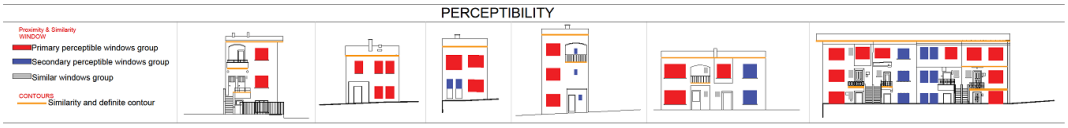


Table.5 *"Perceptible" analysis*

In the first stage, where we create the shape grammar, which we call the production stage, the repetitive and dominant elements of the façade are obtained. The analysis method in this study is to examine the facades based on basic design elements and principles. There is no mathematical rule sequence on the façade. Grammar quality, on the other hand, shows how principles such as dominance, contrast and repetition affect perception and ensures the formation of the same perception in new structures.As a result of this analysis, the characteristic of the building facade has emerged.

In the generation phase, a high-rise residential facade was tested manually by the authors, using these rules, in a computer environment, by ensuring the repetition of repetitive windows and balconies, and by ensuring the dominance of dominant elements. In Step 1, the horizontality shown in Table 1 was used. The dominance of windows is repeated in the first step of the design. In Step 2, the continuity of horizontal lines was again ensured, and harmony was achieved with the repetition of windows and spaces. Step2 has been mirrored in Step3. In the 4th step, these three facade designs are combined. In the last step, Step 5, the units that were combined by reusing the basic design principles were repeated and placed on top of each other.

First, sketches *(Figure 13)* were made, and then facade modeling was tried using Autodesk Autocad program. By modeling both of the analyzed structures, the renderings of the derivative product placed in the middle were taken in the Showcase rendering program, and the opportunity to visually examine was provided *(Figure 14, Figure 15)*.

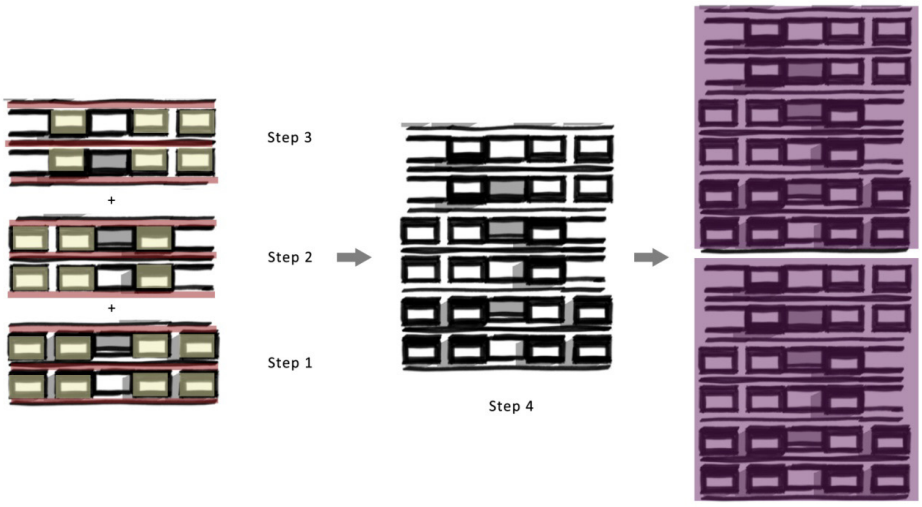


Figure.12 *Steps of generation phase*

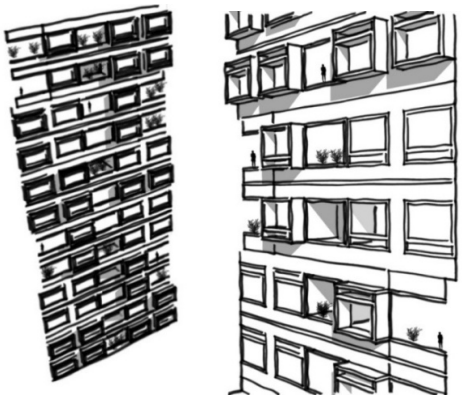


Figure.13 *Sketches*

The use of the horizontal line in the basic design elements analysis, which his factor 1, was continue As seen in the repetition, which is the first factor of the basic design principles, the repetition of the geometric small form which are windows from the form and dimension analysis, which is factor 2, was frequently provided. Harmony, which is factor 2, is constructed in windows, mass and linear elements. This harmony will be achieved based on observation with different examples. The dominance was seen on the balconies and overhangs in the existing structures. For this reason, balconies were also included in the proposed high-rise building, at the initiative of the designer. Since the contrast is also seen in current buildings, shifts were made on the façade. It is aimed to provide the same perception according to the design elements and principles, which are the physical factors that create the facade perception. A proposed building facade design has been developed. It is thought that these suggestions can be replicated and comparisons can be made in future studies.

Çınar Sokak, with its potential reflecting its own period, unfortunately cannot be preserved. It is read that the existing design language is ignored in the buildings that were demolished and replaced with multi-storey buildings, and only a concern for rent is pursued. This is contrary to the

Figure.14 *Application facade product and analyzed two detached house structure renders.*

spirit of the place and far from the context of the design. With this study, the façades of the examples that have survived to the present day have been analyzed in the context of basic design principles, and it is aimed to be a source for new buildings to be built.

Figure.15 *Application facade product and analyzed two detached house structure renders.*

5. CONCLUSION

In the 1950s, immigration, population growth, housing demand and production increased rapidly *(Vanlı, 1995)*. Today, this situation still continues. At that time, as a result of not producing new residential areas, land speculation arose, and build-and-sell, with the demolition of old buildings by contractors and the construction, multi storey buildings, became widespread *(Pulat, 1992)*.

Due to the central location of the region and its advantageous location of Çınar Sokak and its surroundings, the high value of the parcels, the fact that the interior spaces in the detached houses are too small for the owners and their heirs in terms of current housing life requirements, and the frequent renovations and maintenance have caused these houses to be rapidly demolished and turned into apartments. It has been observed that in the new low-rise apartments of Yenimahalle, many facade movements or flat facades that give the impression of a official buildings with only windows, various additions and coatings such as mosaic, wood, composite have been applied. These structures can also be implemented in other cities. It does not reflect the existing linguistic unity of Yenimahalle and Çınar Sokak. When walking at the middle axis of the street, it is clear that the human-scale forms of the detached houses studied, it is considered that the use of parcels of which 70% is green space, the arrangement of adjacent groups, the building orientations, and the grammar of the climate and environmental data with the balcony arch add a functional, economic, aesthetic and original effect to their façades. As historical places, Çınar Sokak should provide information about the period to its visitors and designers, and in order to keep the language and life unity of its architecture, to continue to be a source and archive for new designs, it should be ensured that the owners can make renovations and maintenance, and this situation should be sustainable. Just as they were built with analytical economic models at the time they were built, they should now be supported by various financial models by local governments or conservation institutions or organizations.

The language structure of the facades was analyzed by formulating the production of the housing structures very few of which belong to the mentioned periods of Çınar Sokak, with the basic design sub-algorithms. Facade studies were tried by deriving common parameters and details between each other. In this context, the rule-based design method of shape grammar, which is an architectural language was examined in the study.

As in the study, reaching different possibilities and solutions in the environmental and intuitive design of the architect, with design language research and defining form grammars that can produce new designs in the same language will not protect only a few structures. Shape grammars will enable future architectural approaches to recognize different configurations of present and past architectural forms, develop design and create cultural memory and record architectural design solutions.

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