

## A Model Proposal for Store Design with Shape Grammar

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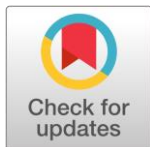
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**Abstract:** With the widespread use of computers, rule-based design methods that can work in harmony with computer logic and can be easily adapted to the computer environment have come to the forefront in the design world. To be able to analyze the logic of a design made with the shape grammar method which is one of the rule based design methods; it is even possible to modify and transform the design, which has been placed on the rule base by removing shape rules, or to create new designs with the same design logic. In this study, some stores that will be exemplary for the store design are examined, analyzed and the system is designed to produce new plan schemes. In this study, it is aimed to produce a program that offers abstract plan alternatives to the designer during the early design process. In store design, clothing stores are emphasized especially due to its intensive use. Within the scope of the study, it is focused on developing a program that produces plan alternatives by using computational power of computer. In this way, it was possible to work on many plan alternatives in a short time during the design process and it became easy to examine large areas. With these alternatives, it is aimed to provide rapid and advance detection of possible problems that may arise. At this point, it is aimed to see a large number of plan alternatives by applying a few rules and to make the appropriate selection among these alternatives.

**Keywords:** Shape grammar, store design, computer aided architectural design.

### 1. Introduction

The trade action carried out by hand carts or by spreading in open spaces has been moved from open markets to closed spaces in parallel with the needs of society, economy and technological developments. With the change of social life, the architectural and spatial structure of commercial buildings began to form. Thus, with the changing trade

structure, spaces were designed for shopping action and these spaces changed and developed and gained their present identities.

Shop design should answer a few questions. These; what the customer comes to the store, the factors that enable the customer to enter the store, and the presence of the

factors that push the customer to buy something. When the customer enters the store, the factors of quality, quality, need, value, price and influence must be met. In this context, store image, architectural design, emblem and interior design gain importance. In addition, perceiving the value given to the customer, design, price, weather and presentation of products in the interior are factors that motivate the customer (Barr, 2003).

The presentation part of the store is provided with the display elements in different units in the interior, starting with the showcase which is the facade. These display elements comprise shelves, stands, transparent display elements and the like. When designing the interior elements of the store, it is considered that they comply with the general concept of the store.

According to Barr (2003), shop interior design should be considered as a whole. When designing, the concepts of goods, customers and concepts should be determined correctly. After these concepts, materials, colors, textures and lighting elements to be used in the store are selected. Some plan types have been reached with the placement of the elements used in designing the store. From these simple plan diagrams, the circulation diagrams are determined based on the positions of the elements used. Thus, these schemes can be developed for store planning solutions.

In computer aided design, the factors that affect the design in the traditional design methods also affect the design and in this process, the communication of the designer with the computer aided design tools becomes important. The chance of the designer to intervene also provides control of the computer-aided design method. The designer has the chance to control which rules, where, when, how to apply, when the process will begin, when it will end. In this way, the decisions are made by the designer and the

control and flow of the design and method are directed. Designer's predictions and perceptions gain importance in the control of these stages. If the designer can predict which forms can reproduce and control the software in this direction, the quality and richness of the work will increase to that extent.

In this study, a rule based design based model has been developed. This model is a program that offers the designer abstract plan alternatives during the early design process. This study, which is an experimental study, focuses on developing this model that produces plan alternatives using the computational power of the computer. In this way, it was possible to work on many plan alternatives in a short time during the design process and it became easy to examine large areas. With these alternatives, it is aimed to provide rapid and rapid identification of possible problems that may arise.

General information about entrance, showcase, safe, storage and changing cabinets is given from the spatial elements that make up the store to be used in the model. Grammar rules were tried to be developed for the model to be developed. The scale of the study was kept small and it was tried to be developed through single storey clothing stores considering that the number of floors and different product scale would challenge and complicate the model at this stage. After creating the model algorithm, the model was developed by using C # software language. Using the model, store alternatives were given on the grid system and design alternatives were produced.

## 2. Shape Grammars in Architectural Design

There are two advantageous aspects provided by shape grammar. The first is its accuracy, followed by a more perfect method of classifying shapes compared to previous approaches. The second is generality, usually

neutral, bending equally to all styles and concentrating on inward features. Both are attentive and eclectic (Wojtowicz and Fawcett, 1986).

Language is an abstract expression to show and define the truth. A language consists of sets of rules that use symbols to express broader meanings (Schmitt, 1988). Language contains the arrangements of the words in the vocabulary. A new sentence is obtained with different arrangements of these words. Similarly, the design is the arrangement of the components, and the new designs may be by arranging and sequencing the components at hand (Wojtowicz and Fawcett, 1986).

The graphical expression of the relationships in an architectural design is the precise, abstract relationship expected from a structure. The graphical expression of relationships can be formulated by using rules to shape a grammar. The grammar is then used to form the language. Traditionally, the use of graphical language means familiarity with expressing relationships with different line types, arrows, blocks, and other similar elements.

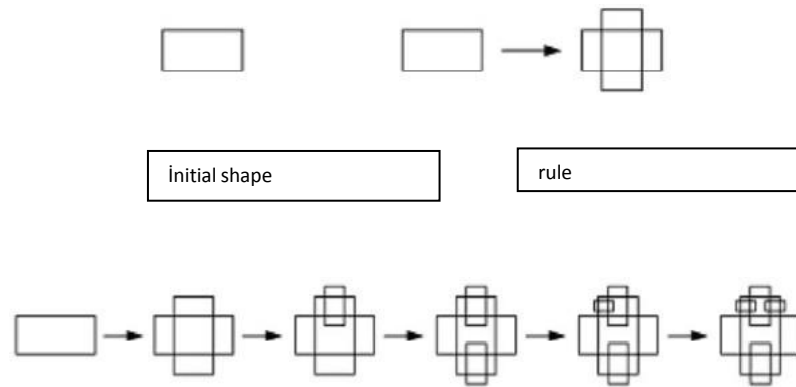
Grammatical rules in natural languages are used to describe how words can come together to form sentences. In the definition of design grammar, the comparison between natural language and design is taken into account. Relationships are defined by the rules that design elements come together to form a design. Shape grammar is an important subset of the idea of design grammar (Gucuyener, 1998).

Shape grammar is a rule-based design method developed by George Stiny and Jim Gibs in the 70s. Shape grammars are a system of rules for creating the language of spatial composition. A language consists of a vocabulary and rules that combine it, as well as a grammar of forms and rules for spatial relations (D'souza 2002).

With the rule-based design method (shape grammar), an infinite number of alternative designs (sentences) can be derived with a finite number of form sets (words) and rules (grammar rules), just as in language. The elements of the shape set can be two or three-dimensional shapes or lines. The designer can associate the forms in the format set with various operations and create different compositions within the framework of rules. As it can be understood from here, the basic unit in the language is the word, forms for architecture.

Syntactically, design can be defined as a combination of shapes and relationships between shapes. Shape grammar is the entire set of generating rules used to produce shape. Shape grammar consists of a shape repertoire, shape rules defining spatial relations, and initial shape in form repertoire. Derivation begins with the initial format and is converted by applying rules. A single shape grammar can produce many forms. (Stiny and Gips, 1972; Wojtowicz and Fawcett, 1986). One of the most appropriate ways to express the principles of the convergence of components in design is to formulate these principles with rule sets. Rules can be expressed both verbally and graphically (Flemming, 1987).

To make design with shape grammar, the initial shape is required. A set of rules, such as shift, mirroring, rotation or addition, subtraction, is applied to this initially accepted shape, and the resulting product is a new shape including the initial shape. In this context, shape grammars offer new and alternative products in the design process. This allows shape grammars to develop a common design language with alternatives instead of a single product at the end of this process. This chain, which can be described as an evolutionary process, is shaped, elaborated and completed by the rules that are applied to the primitive starting shape in certain stages and completes the evolution of shape when the determined rules are terminated (Figure 1).



**Figure 1.** New designs obtained by applying the rule determined to the starting form (Knight, 1999).

The main uses of form grammars can be classified as follows:

- Form grammars can be used to analyze past and contemporary design languages or languages (Analysis grammars).
- Format grammars can be used to create completely original design languages (original grammars).
- Form grammars can be used to derive new design languages from existing design languages (Hybrid grammars) (Colakoglu, 2006).

### 3. Store Design Criteria- Spatial Elements that Make Up The Store

Stores are social, culturally and economically altered sales environments, apart from traditional sales and simple shops. Stores are generally sales units that offer similar product types, where buyers can walk around, examine and try the products and buy them (Aksac, 2006).

Shopping centers are not just the units where a product is bought or sold; they are also designed to allow users to enjoy their free time. Retail trade provides strong community thinking and social interaction for today's ever-evolving global culture. The type of shopping places and the products they sell affect this communication.

According to Barr (2003), the principles that should be given priority when designing the store interior are as follows.

- Presentation of the product and the elements and materials used for it
- Store-customer relationship, store interior can be read
- Color-Material-Lighting
- Architectural

When the architectural and interior design elements are mentioned, the structure of the store and how the space of the store is designed should be understood. In this context, first of all, the outer shell of the store; the city's location, surroundings and façade; then the circulation plan that will bring character to the store's space, as well as the design and relationship of the sales and sales supporters should be examined.

Outdoor planning is important in terms of the location of the store in the city, the reference points in the immediate vicinity and the potential customers of the users. The façade design will affect the store's discernability and attractiveness as it is the first communication element with potential customers (Karacali, 2012).

### 3.1 Store Exterior Facade

The appearance of the stores needs to be carefully planned because it is very important for customers. The external atmosphere of the store is the customer's first idea about the brand and the store. The façade of the store consists of components such as nameplates, shop windows, store entrance, building exterior and parking areas.

The store front is the first point where the customer meets the store. For this reason, it reflects the store image in an effective manner with its general texture and in harmony with its concept. Successful acceptance of the store front depends on its ability to attract the attention of the customer, to direct it to the interior of the store, and to reflect its own identity among other stores. Therefore, the facade design is more dominant than all the factors mentioned to attract the customer's interest (Berman and Evans, 1992).

#### • Store Entrance

Customers get their first impression of the store from the store entrance. For this reason, the store entrance should be designed in a way that will provide security, comfort and convenience to the customer and at the same time direct it inside (Oyman, 2006).

#### • Store Showcase

The showcase can also be described as a mostly transparent display space targeting a shop's audience. In addition to selling its main purpose, the showcase serves two purposes;

- Reflecting store image (identity)
- Provide customer access to the store

### 3.2 Cash Point

Cash point affect shop atmosphere and image in three ways: location, appearance and waiting time. These three issues need to be considered in the design of the in-store cash register.

The fact that the cash point is at the back plays a role in attracting the customer into the store. Shops that sell easy-to-play, attractive and portable products can benefit from placing their crates in the back of the store as well as placing them in front of the store.

### 3.3 Storage Area

The size and number of storage areas varies depending on the store business's sales policy for products: it should ensure that new or unsealed products are stored. The warehouse area is also the area where new products are unpacked, checked and prices are given before they are delivered to the store sales area (Aksac, 2006).

### 3.4 Changing Cabinets

The location of the changing cabinets should be arranged so that the customer can easily detect them. Cabinets should be arranged in such a way that the customer can try the products easily and leave their belongings. Mirrors and lighting should be in the best way to show the product (Aksac, 2006).

As soon as the customer enters a test cabinet, he or she enters purchase mode. Research shows that when a product is given the chance to try it in-store, product sales increase by 100% (Underhill, 2002).

## 4. Application

Within the scope of the study, alternative settlements of entrance, showcase, cash point, storage and changing cabinets, which are one of the spatial elements of the store, were produced. The algorithm of the method used to develop shop design proposals can be generated by different computer programs. The conversion of the algorithm to the digital environment was done with C # program. This program provides the designer

with alternatives to plan schemes in the initial design phase.

The main spatial elements of the store were emphasized within the scope of the model. These are entrance, showcase, cash point, storage and changing cabinets. The rules of coming together of these elements are determined and produced together with the alternatives in the program.

The first step for the creation of the model is to determine the priority criteria and to list the information that may be the basis. In this section, important data to be used for the development of the model is summarized from the examples examined for store design.

- Store type should be determined.
- Sub-data should be entered into the program, whichever of the classifications according to the store type is appropriate. For example, a free plan layout should be chosen for the clothing store.
- Venue data should be entered into the program. In order to work easily in the program, a grid system with defined module dimensions should be defined and space dimensions should be determined here.
- After determining the dimensions of the space, it should be determined where the modules are deaf walls.
- After deaf walls have emerged, showcases or showcases on the main street axis defined in the grid system should be selected.
- After selecting the windows on the main street axis, the windows on the intermediate street axis defined in the grid system should be selected.
- The program should allow the user to make a selection again by asking them if they want another window.
- Once all the walls have been identified (deaf or glass), the program should ask the user how

many entries there are and generate alternatives.

- Once the input is determined, the relationship between the cash register and the input must be defined in the program. The safe compartment should be positioned so that it can be detected from the entrance. The program should provide alternatives to the cash register section.
- The storage compartment should be considered in the same place as the safe for ease of use. At the back of the cash register section, the program should be assigned as a section where only the employees working in the store can switch.
- Room type should be divided according to the type of product sold. The program should generate program alternatives based on the type of product and the percentage distribution of the subtypes within the store, and the user must proceed with the model by selecting one of these alternatives.
- The user needs to be asked about the changing cabinet. How many locker cabins are needed according to the store size should be determined.
- As the program sub-data, locker cabinet dimensions should be entered as 1 meter x 1 meter as standard.
- The locker cabin partition between the male and female sections should be specified by the user and entered as program sub-data.
- The display element (podium or hanger) should be determined for the selected and selected showcase locations in the grid system and the window type and display size should be entered as program sub-data.
- Once the display element has been identified, it must generate alternatives for the program layout and be selected from them.

#### 4.1 Application of the Model

In store design, first of all, the type of store should be determined as the factor that will affect the design. In this context, the product primarily determines what the store sells. Free plan layout for clothing stores was entered as program sub-data.

In the defined grid system, space data were entered into the program. Module dimensions as program sub-data are 1m.x1m. and each column has 5 columns.

By entering the space data to be designed on the grid system, the main dimensions of the space have been revealed. In the model, the letter i represents the interior of the space (Figure 2).

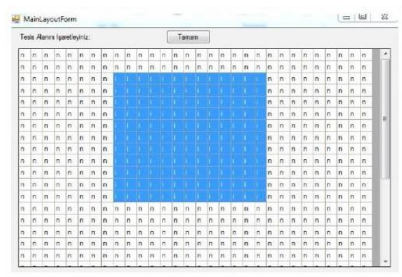


Figure 2. Determination of location data.

Deaf walls in the space were selected by the user and the window was selected in the remaining areas. In the grid system, the main street and intermediate street axes are defined and the window selections in these areas are selected. The screening of the deaf walls is made of black color, the main street showcases are indicated with the letter c and the intermediate street showcases are indicated with the letter r (Figure 3).

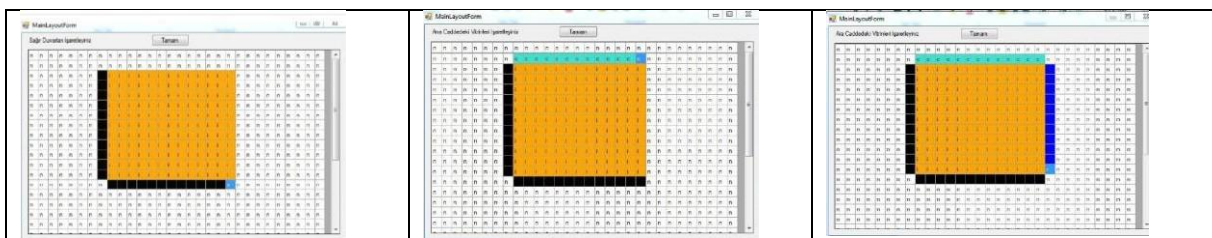


Figure 3. Determination of deaf walls, determination of showcases in main and intermediate street axes.

The user was asked whether the windows were sufficient or not, and the opportunity to return to the program was provided. If yes, go back to the window selection and select again. If no, proceed to the next step.

The entrance doors of the stores are designed to be large in terms of both ease of use and showiness. Therefore, the door size of the model plan 2m. Entered as. The number of entrance doors is selected by asking the user.

After entering the number of doors, the model produced alternatives for door placement and one of them was chosen. The door is represented by the letter k. For the door, the main street is located at the left and the middle street is in the middle (Figure 4).

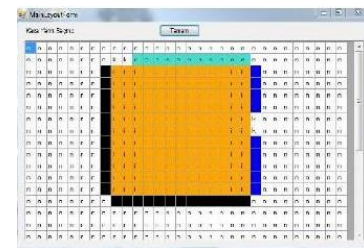
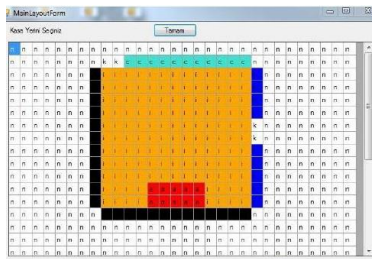


Figure 4. Door selected from alternatives.

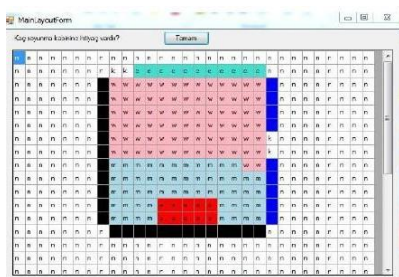
For the position of the safe, it is entered as a sub-data to be detected in the program. In other words, the alternatives that are at the entrance axis of the case are produced by the program and selected. Furthermore, for the store employee, the association of the storage unit with the rear portion of the casing was introduced as a limitation. In other words, when the selection is made for the safe section, the storage area behind the safe will be determined.

Cash and storage areas are indicated by the letter a (Figure 5).



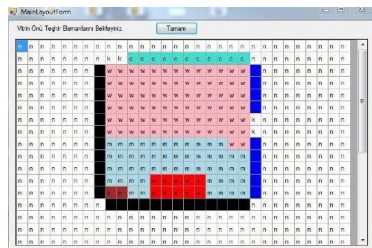
**Figure 5.** Cash point and storage unit selected from alternatives.

The space type is divided according to the type of product sold. In the sub-data of the program, it is stated that the division is 60% female and 40% male. Accordingly, space type alternatives were produced and selected from them. Space division is indicated by the letter w for the female side and the letter m for the male side (Figure 6).



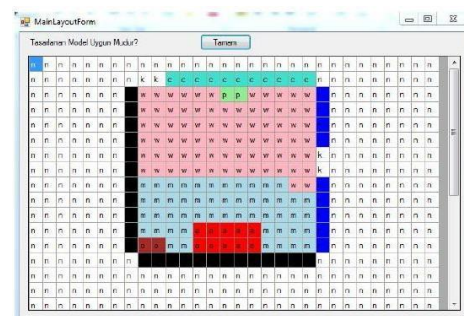
**Figure 6.** Space partitioning from alternatives.

The number of changing cabinets is determined by the user. In addition, how many men and women were divided into sub-data. The locker cabinets are standard 1m.x 1m. A module is reserved for each cabinet. 2 cabins were identified as needed and 1 female and 1 male were divided. The cabin is represented by the letter o (Figure 7).



**Figure 7.** Changing cabinets selected from alternatives.

The user was asked and determined whether the podium or hanger of the display element types for the showcase. In the program sub-data, it was entered that clothing stores will use rear showcase type and there will be a medium-sized display window according to store size. After selecting the display element type, the length of the element was determined and the program was placed alternatively and the selection was made among them. The display element is represented by the letter p for the podium and the letter d for the hanger (Figure 8).



**Figure 8.** Showcase and result product selected from alternatives.

Once all selections have been made, the model provides the possibility to return. After the resultant product has been seen and evaluated, if it is not appropriate, no answer is given to the question asked by the program and a return to the window selection stage is made. If the model is suitable, yes is selected and the result product is saved.

The design alternatives of the spatial elements for a space with two fronts are produced in the program and explanations of each step are written.

## 5. Conclusion and Recommendations

The program is generally open to development and the addition of rules. This model proposal, which was created using form grammar, should be considered as a broader design prototype. Observations related to this



model and objectives for expanding the study in the following periods are as follows;

- Use of computer support in the field of shop design and developed models should be taken into consideration because it produces a large number of alternatives quickly.
- Spatial concepts such as entrance, showcase, safe, storage and dressing cabin, which are vital for store design, are included in the alternatives produced by the algorithm created during this trial process.
- Filtering the produced models according to certain constraints will be an application that will help the designer in the process. These filtering can be done according to spatial elements. For example, the templates to be used to design the case section can be defined by defining the model.
- The program is simply developed on clothing stores only. In future studies, it is aimed to work for all store types by extending the algorithm. In this respect, although the model seems simple, it will be enriched when designed for all types of stores.
- Algorithms can be developed for brand or chain store units. It is aimed to create a template for all internal and external spatial elements of the store and to design the entire store in a very short time.
- The model was examined in a large scale in this study. In the following stages, it is aimed to reduce the scale, for example, in-house planning and planning of all other spatial elements in detail.
- As the constraints and rules used increase, it may turn into a more concrete program. The results obtained by using the design products of the architect or designer in certain design principles can be converted into projects very quickly. This can enable us to obtain store solutions with a variety of alternatives, both faster and cheaper.

## References

- Aksac, H. (2006). Malls; Product-Sales-Space Interaction, Master Thesis, Marmara University, Institute of Fine Arts, Istanbul.
- Barr, V. (2003). Building type basics, Retail and mixed-used facilities, John Wiley & Sons, New York.
- Berman, B. ve Evans, J. R. (1992). Retail Management: A Strategic Approach, 5th Edition, Maxwell Macmillan International, New York.
- Colakoglu, B. (2006). Shape Grammar Lecture Notes, BOM Master Program, Yildiz Technical University, Institute of Science and Technology, Istanbul.
- D'Souza, B. (2002). Shape Grammars and Their Languages- A methodology for product design, Cambridge University Press, New York.
- Flemming, U. (1987). The role of shape grammars in the analysis and creation of design, in Computability of Designs, 245-272, New York.
- Gucuyener, B. (1998). Shape Grammar of the Facade in Bosphorus Waterside, Master Thesis, Istanbul Technical University, Institute of Science and Technology, Istanbul.
- Karacali, O. A. (2012). The Relationship Between Brand Identity and Interior Design in Clothing Stores and Evaluation on a Current Brand, Master Thesis, Istanbul Kultur University, Institute of Science and Technology, Istanbul.
- Knight, T. W. (1999). Shape Grammers: six types, Environment and Planning B, 26, 15-31.
- Oyman, M. (2006). Store Atmosphere, T.C. Anadolu University Open Education Faculty Publication No: 881, Eskisehir.
- Schmitt, G. (1988). Microcomputer Aided Design For Architects and Designers, John Wiley & Sons, New York.

Stiny, G. ve Gips, J. (1972). Shape Grammars and the Generative Specification of Painting and Sculpture, Information Processing 71, Amsterdam: North-Holland.

Underhill, P. (2002). Shopping Science, Soysal Publications Suat Soysal (Trans.), Istanbul.

Wojtowicz, J. ve Fawcett, W. (1986). Architecture: Formal Approach, Academy Editions, London.

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