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Designing Products with an Evaluating–Eliminating–Updating Loop Developed with the Pugh Decision Matrix Method: Design Studio Exercises

Pugh/Karar Matrisi Yöntemiyle Ürün Tasarlamak: Tasarım Stüdyosu Egzersizleri

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ABSTRACT

The design studies include the perception of treating a course, whose axis is transferred into practice by the theoretical knowledge obtained. In the current study, evaluation of the design loop of the chosen product, chair, has been realized in an Ecological Design course workshop, which is one of the design studios. Chair elements, which have established a direct relationship with the perception of product design in the interior architecture profession and history of education, were selected as the design product of this study. There has been a need for an effective method to create products within a limited timeframe and a minimal budget by design teams consisting of few members coming together to design a product. The Pugh decision matrix was selected as the product development model forthis study and a six-person expert design team was put together to measure the applicability of the method. Within the scope of this study, the expert design team suggested that the undergraduate students select a recyclable material that complies with the aims and principles of the Ecological Design course and design original chair products with that material. After completing all the stages of the Pugh decision matrix method, the two chair designs created by the students were given scores by the design team members based on the reference visuals with a system called a design loop. At the conclusion of this study, the two chairs produced by the two student groups were realized within three loops (evaluation–elimination–updating).

Keywords: Chair design, ecological design studio, interior architecture education, Pugh decision matrix

ÖZ

Tasarım stüdyoları, edinilen teorik bilginin pratiğe dönüştürülmesini eksen alan bir ders işleme anlayışını içermektedir. Bu bağlamda çalışma, tasarım stüdyolarından biri olan Ekolojik Tasarım dersi atölyesinde gerçekleştirilen ürün (sandalye) tasarım döngüsünü değerlendirmek adına yapılmıştır. Tarihi süreç içerisinde tasarım nesnesi haline gelen ve dönemsel çeşitlilikler göstererek yerini alan sandalye tasarımları, ünlü tasarımcılar tarafından bazı akımların ve ideolojilerin simgesi haline getirilmiştir. Böylelikle, iç mimarlık mesleği ve eğitimi tarihçesinde ürün tasarımı algısıyla doğrudan ilişki kuran sandalye elemanı, bu çalışmanın tasarım ürünü olarak seçilmiştir. Herhangi bir ürün tasarlamak amacıyla bir araya gelen ve az sayıdan oluşan tasarım ekiplerinin minimal bir bütçe ve sınırlı zaman diliminde belirledikleri ürünü ortaya koyabilmeleri adına etkin bir yönteme de ihtiyaç duyulmuştur. Ürün geliştirme modeli olarak seçilen Pugh/Karar Matrisi, bu çalışmanın yöntemini oluşturmaktadır ve yöntemin uygulanabilirliğini ölçebilmek adına tasarım alanında uzman olan altı kişilik bir tasarım ekibi belirlenmiştir. Bu çalışma kapsamında, lisans öğrencilerinden Ekolojik Tasarım dersinin amaçları ve öğretileri doğrultusunda geri dönüştürülebilir bir malzeme seçmeleri ve bu malzemeyle özgün sandalye ürünleri tasarlamaları, tasarım ekibi tarafından istenmiştir. Pugh/Karar Matris yönteminin bütün aşamaları tamamlandıktan sonra, öğrencilerin yapmış oldukları iki adet sandalye tasarımı; döngü olarak adlandırılan bir sistemle tasarım ekibi üyeleri tarafından referans görseller temel alınarak puanlandırılmıştır. Bu çalışma sonucunda iki öğrenci grubu tarafından üretilen iki adet sandalye üç döngü (değerlendirme-eleme-güncelleme) dâhilinde gerçekleşmiştir.

Anahtar Kelimeler: Sandalye tasarımı, ekolojik tasarım stüdyosu, iç mimarlık eğitimi, Pugh/karar matrisi

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Introduction

A well-organized formal education, an accreditation system with an extremely developed and continuously followed undergraduate program provide a guarantee about obtaining knowledge, skills and experience within a suitable period (Kettler, 1994). Basic education in interior architecture includes studio-based studies that provide for a theoretical and applied academic course environment, which operates by examining in detail various aspects of knowledge in design studies, measures different viewpoints of students, and provides opportunities to apply the knowledge gained (Edwards, 1998; Yıldırım & Özen Yavuz, 2008). This relationship between theory and practice, beyond solving a real or hypothetical design problem, by developing exploratory ideas on three-dimensional design and it provides for the passing from emphasis on the static form to the kinetic form (Kirk & Spreckelmeyer, 1988; Nasar et al., 2007).

The experimental nature of the interior architecture studios, especially between academicians and department students to reflect and engage in action and to enter interactions through the design of something provides a deeper and more concrete viewpoint (Anthony, 1991; Brown, 2001; Kliment, 1977). The satisfaction engendered by creating a concrete product at the end of a design and functionally focused study, which is a time-consuming process, is an important output of interior architecture education and, at the same time, of interior architecture studios (Akdemir, 2017; Arslan, 2016; Edwards, 1998; Öztürk, 2016).

In interior architecture education, design, application, and theoretical courses with a holistic approach help students develop a sense of analysis, interpretation, creation, thinking, and transferring thought. In addition, there are courses that support and complement each other in interior architecture education, including applied and theoretical courses. Practical courses, çağin in accordance with the requirements; such as design-technical- material- technology it can be categorized as courses based on important parameters, adopting a holistic and participatory approach. Theoretical courses, on the other hand, are parameters appropriate to the requirements of the age, such as applied courses, and the transfer of the necessary information and documents that prepare the basis for these parameters to the student (Altuntaş et al., 2023).

As stated by Piotrowski (2004), one of the aims of the Ecological Design courses, which are one of the design studios, is transforming waste materials into functional products within the framework of the sustainability concept and thus aiming at a human-centered design. By providing the user with opportunities to experience the products designed, the human-centered design is bound to witness an accelerated growth. This method, which also includesthe user in the design, facilitates the determination of probable needs.

In addition to the human-centered approach, another approach, which is related to the subject of this study, is the “Design Thinking” approach. “Design Thinking” approach presents creative solutions to problems in the design process, from the first stage up to the final stage (Akdemir, 2017).

Various decision-making and evaluation methods are used to complete the design process in the most productive manner. One of these methods is known as the Pugh decision matrix. The Pugh decision matrix advocates creativity at the conceptual design stage and uses impartial evaluation criteria for developing the strongest concepts (Dimancescu, 1992). The Pugh decision matrix is a scoring matrix that assigns scores based on chosen criteria is used for the selection of the strongest concepts (Adams, 2020). Mathematics has important meanings in architecture as well as in every field of life. The esthetics of mathematics in itself is also involved in everything it is used for, say, architecture. There is mathematics in many phenomena of art and architecture such as perspective, symmetry, harmony, contrast, and balance (Atabeyoğlu et al., 2019).

The chair was selected as a design product of the Ecological Design course within the scope of the study, which meets the needs of the study, both functionally and in the context of esthetics. According to Coates et al. (2009) and Russell et al. (1980), a chair is a furniture element that reflects an accepted idea in a clear manner, that is the visual expression of new theories, and that has become a new symbol in the applied arts. According to Külekçi (2018), the design process in reinforcement elements, the correct application of design, the adaptation and durability of design to ecological conditions is an important process that needs to be done professionally, and the most appropriate approaches to human use with the right decisions emerge only in this way.

It was aimed in the study, which covers the human-centered design process, and the design thinking forms in the structure of the Ecological Design course, to evaluate with the Pugh decision matrix method the design loop of the chairs produced by students. In this context, the study by organizing the solution alternative production – eliminating – updating in the design process and by setting forth a new product development model, investigated thoroughly this model with a sample chair design process. Accordingly, within the scope of the design studios, by using the design processes, a new product development model was proposed, which was formed based on the Pugh decision matrix.

Methods

The Afyon Kocatepe University, Faculty of Fine Arts, Department of Interior Architecture and Environmental Design was selected as the work area. This study was carried out during the spring semester of the 2018–2019 academic year in a face-to-face educational environment within the scope of the Ecological Design course education. Two groups of students were selected by the expert design team (who also served as the jury members) from the Ecological Design course normal education third-year level students and the second-year undergraduate students.

The groups comprised students who had the highest general grade averages in undergraduate education. The first design group was composed of four students, whereas the second group was composed of five students. Within the scope of this study, it was requested by the expert design team that the undergraduate students select a recyclable material that complies with the aims and principles of the Ecological Design course and design original chair products with the material. when the design approaches, expressions, and ideologies of interior architects or architects are considered, it is observed that chair elements, which are seating elements, have almost attained the status of a design cult (Bayer et al., 1959; Colombo & Ryecart, 1997; Fehrman & Fehrman, 1987; Kurtich & Eakin, 1993; Massey, 1990; Naylor, 1968; Pepis, 1966; Pile & Gura, 2000; Russell et al., 1980; Savage, 1966; Şahinkaya,

2009; Tate & Smith, 1986; Whiton, 1974). In this context, chairs, by seriously developing and displaying diversity throughout the centuries and by having been included in approximately all the architectural periods, have become the product selected by design teams considering their functional, technical, and esthetic attributes (Arcan & Evci, 1999; Ching, 2016; Doğan & Altan 2007; Madanlar, 2019; Pile, 1990; Sabancı, 1999; Uysal, 2019; Yüksel, 2019).

When designing a product, it provides for it to be planned and systematic within itself at every stage, for the designer or design team to work in a coordinated manner, to increase the pleasure received in the design process and for making evident the dominance of the process (İnan, 1998; Mesher, 2013). First, it is necessary to form a team that has the equipment that would provide contributions in a dynamic manner to the design process for being able to use the Pugh decision matrix method with ease without any hitch. According to this thought, a decision was reached to carry out this study with a design team composed of six persons who were experts in the field of interior architecture and who had an academic identity. The most important factor in making this decision was when determining the design stages to bring together persons who would reduce to a minimum the probable problems that would be experienced in the operation of this process, who were able to collect under a shared thought and thus, it was aimed to provide for maximum productivity through the method.

The Pugh decision matrix method is a suitable method for small design teams with time and budget limitations. The most important element when endeavoring to realize a product design is to think of the design method and process. The Pugh decision matrix method is used in the design process and with design teams composed of few persons for the presenting, eliminating and updating of the products designed and for the preparation to pass to an advancing loop of second, third, and fourth according to the sufficiency of the success required to be obtained from the product and finally to set forth a high-quality product. Every task determines its own number of loops and in this study, as the result of a total of three loops, the final success was reached on the products.

The stages of the Pugh decision matrix method, selected as the product development model and used in the design process in this study are as follows: (1) determining the design concept, (2) determining the design criteria by relating the main headings to each other, (3) determining the design criteria by relating the subheadings to each other, (4) determining the loads of the design criteria, (5) determining reference designs, (6) composing design alternatives, (7) evaluating–eliminating–updating loop of the design alternatives, and (8) presenting the alternatives, which develop positively and which show success.

Conceptual Framework

Design is the action of producing in a manner that includes the criteria of soundness and esthetics by using expertly the means or methods by coming together with the same consciousness or ratio and by breaking down consciously a whole prior to a plan or drawing (Doyle, 1969; Hasol, 2019; İnan, 1998; Mesher, 2013; Pençe, 2014; Simpson & Weiner, 1989). Kettler (1994) stated that by engaging in the traditional learning methods, it would positively affect the design process of learning. It is necessary to be aware of the effects and benefits and that no matter in which field the product is designed, it will always be under changing conditions (Starr, 1963).

The learning by making exercises can be transformed into continuousness, because it plays a significant role in the transition of a student to a professional status (Kettler, 1994). It is necessary to develop the design process with time for manufacturing new products at suitable costs and high quality (Ullman, 1944). Whereas, for this, it is aimed to renew rapidly and to make it more frequent by constituting a regular operation. Whereas this operation is the criteria of the design process itself (Newcomb & Leshowitz, 2017).

In the present day, many types of product development and production models are used having broad areas of use in the design processes. These methods are used in the production of solutions on behalf of product development, such as Quality Function Deployment (Bossert, 1951), Concurrent Engineering (Callahan, 1995), Kansei Engineering (Chuah et al., 2008), Computer Aided Design (Stahl, 1999) and are some of the examples that could be presented for the subject models. The shared aim of all these product development models is to increase the product quality, to decrease the cost, and by keeping the manufacturing period short, to enable the product reachingthe market more rapidly.

The product development model that will be used in this study was explained by Cross (2000) and is determined to be a four-stage design process based on simple foundations and that could be evaluated in the formalistic category. This model, which is shown in order in Figure 1, contains research of the design problem, formation of alternative design concepts, evaluation of the design concepts formed, and finally, communication with the final product.

At the same time, the selected design process has feedback pathways between the formation and evaluation processes also found within Schön's (1987) design process. The main point of this product development model that will be used in this study is at

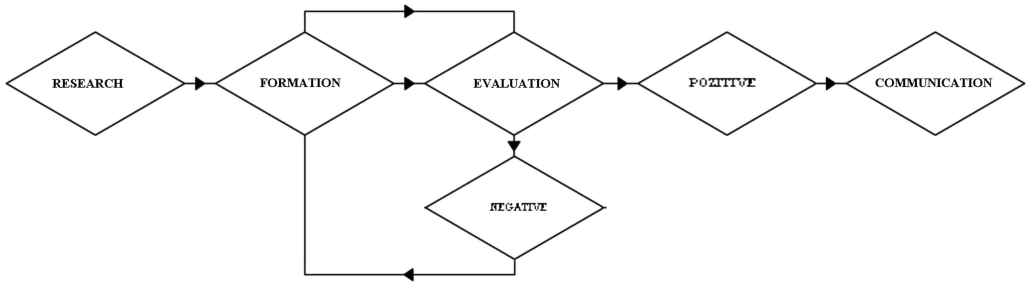

Figure 1.
Four-Stage Design Process Based on Simple Foundations (Cross, 2000).

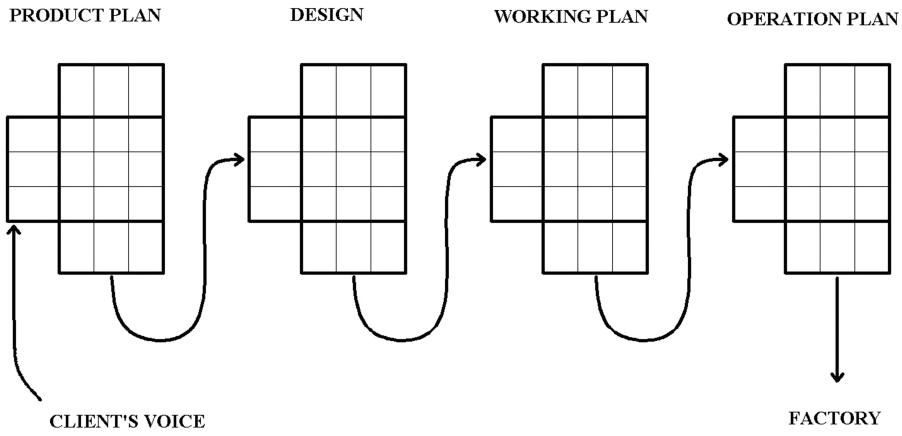

Figure 2.
Basic Structure of the QFD (Clausing, 1994).

the end of the product design criteria that were determined, all the attributes of the final product emerging have been decided and can be explained as the repetitive evaluation process that emerges with the feedback between the concept formation/evaluation processes and these processes.

Quality Function Deployment

The quality function deployment (QFD) method is an analysis method that is valid and acceptable for product analysis. According to a general definition, QFD is a systematic product planning process and development method carried out by an expert team that comes together for eliminating the customer's needs or to define a product or service that would be above this, to design, develop, and produce the existing products or services of enterprises. Quality function deployment is used by the design team for forming the production and operation planning, which defines the design and production process engineering and the factory operations. The QFD method provides a systematic approach in the fields of engineering, design, and production. It is a method that aims to develop the design quality with the objective of transforming to main quality trust points that would be used during production and for the design targets for the customer demands and to have the customer reach a level of satisfaction (Clausing, 1994). The basic operation structure of the QFD method is presented in Figure 2.

Concept selection is the most important development in QFD. Consequently, the most important development is that of the concept-based Pugh decision matrix selection process. Even if it was developed completely independent from QFD in the beginning, it is a process connected to visuals and therefore the integration with QFD was proven very easily. The Pugh decision matrix is developed for the concept selection process, the total system architecture, the subsystem components, and piece-by-piece concepts. At the same time, it can also be used for the selection of production concepts. Furthermore, even if it is called a selection process, it opens the way for producing new concepts that almost did not exist previously (Clausing, 1994; Pugh et al., 1996).

Pugh Decision Matrix

The Pugh decision matrix, which is used for fulfilling the requirements of clients and after a QFD is formed, is a criterion-based decision matrix, which assigns points according to alternatives and criteria for determining which are required to be selected from various potential solutions or alternatives. Technique was named after Stuart Pugh, and it can be stated that it has become a standard part of the science of the Six Sigma method (Adams, 2020). It advocates using impartial evaluation criteria for encouraging creativity at the conceptual design stage and for developing the strongest concepts (Dimancescu, 1992).

The Pugh decision matrix, including Stuart Pugh's own name, is also known by a series of other names such as (1) decision matrix/grid, (2) selection matrix/grid, (3) problem matrix, (4) opportunity analysis, (5) criteria evaluation form, and (6) criteria-based matrix (Adams, 2020). There are some existing advantages in using the Pugh decision matrix method. It permits an analyst to develop the most suitable solution, which is a hybrid of other strong

Table 1.
Sample Pugh Decision Matrix

Criteria	Weighted Points	Reference Concept Product	Alternative Concept A	Alternative Concept B	Alternative Concept C
Criterion 1	4	0	+1	0	–1
Criterion 2	5	0	0	+1	–1
Criterion 3	3	0	0	–1	0
Criterion 4	1	0	+1	0	0
Criterion 5	2	0	0	0	+1
Criterion 6	4	0	–1	0	+1
Positive total			5	5	6
Negative total			–4	–3	–9
General total			1	2	–3

solutions, and to organize in a structured manner the various criteria or attributes of a solution for making an easy comparison. This method facilitates a team-based process for disciplined concept formation and for concept selection.

A Pugh decision matrix example with the most basic attributes is given in Table 1. In the column to the far left of the table, the design criteria that would be considered for the comparative analysis are given, and immediately next to it are the weighted points of the criteria given separately according to the degree of importance for each criterion. According to the degree of importance, 5 is the most important criterion, whereas the lesser valuable ones are shown separately as 4, 3, 2, and 1. The weighted points are listed in the right-hand side Reference Concept Product column and in the Alternative Concept columns.

The Pugh decision matrixes, by comparing the concept alternatives with the reference concept products were scored as positive (+1) if a better design solution was proposed from the reference alternative for any certain criterion, as negative (–1) if a worse design solution was proposed, and as zero (0) if an equivalent design solution was proposed. For example, in Table 1, it was scored as positive (+1) since it presented a better design solution for the Reference Concept Product in criterion 1 and criterion 4 of Alternative Concept A. However, since an equivalent design solution was presented in criterion 2, criterion 3, and criterion 5, a zero (0) was given to the correlation scores. When another Alternative Concept B was studied in detail, since a worse design solution was presented for the Reference Concept Product in criterion 3, it was scored as negative (–1).

The steps for forming the Pugh decision matrix are given below:

- The requirements of the related user or the required criteria should be determined.
- Weight should be developed for each requirement. Weighing these points is optional. Various weighing observations can be used.
- Suitable alternatives should be formed for a solution.
- Basically, one of the alternatives should be selected. This is generally a current situation solution.
- When responding to each alternative's criteria, it should be evaluated according to the baseline, which was evaluated as positive, negative, or equal.
- If the optional scoring mechanism has been used, then the values of each alternative are added, and every value is multiplied with the weight.
- The best elements of every alternative should be combined for the formation of the most suitable solution (Adams, 2020).

Determination According to the Basic Design Principles, Gestalt Principles, and Design Attributes of the Criteria

There is a need felt to evaluate by taking some principles or attributes as the basis in giving meaning to the integral identity of a product and in the analysis stage of the part surfaces of the whole. In the design process of a product, when going from every detail toward the whole, the basic design principles and Gestalt principles, which have in their structure the most important principles for which a need is felt, serve the whole of the design logic, and every piece element forms the whole. Just as Le Corbusier stated, design is from the center toward the outside, that is, the main exit point is at the center of design (Civcir, 2015). On the other hand, just as Wertheimer, the Gestalt theoretician, stated, the Gestalt principles, which were formed on the foundation of visual perception, were intuitively included in a manner in the mind of every individual, because the attribute of the human mind was that every complex image that humans saw has been previously coded and has the structure of definition by reducing to simple the concepts kept in the memory (Çiçek Kurdoğlu & Bekar, 2018). In the design process, just as all these design principles could be evaluated on their own, they can also be used with the correlation of the two principles in a manner that could form the example of this study.

The criteria determined at this stage were selected from among the basic design and Gestalt principles, which have the attribute that would give direction to the chair design loop. It was only limited with the principles used in this study. On the other hand, the other criteria were formed by the design team by considering the design attributes, which were required for a chair product. Two design alternatives were requested from the students within the framework of the criteria determined for the chair that would be produced. The primary aim of the criteria determined was to form an integral effect, both from the functional and the design aspect of the chair that was selected as the product that would be developed, and to set forth a developed product that targeted to benefit at the highest rate in a manner that would address the broadest user group. On the other hand, the point criteria, which are important in the determination of the main criteria and the subcriteria, should establish relationships among one another. It should be possible to revise the determined main and subcriteria by the team, such as adding/subtracting/changing. It is of importance at the advancing stages for the criteria to be understood clearly by the team for not experiencing confusion and for implementing the process soundly. As given in Table 2, they were

Table 2.
Code Numbers of the Criteria Determined Showing to Which Category the Criteria Belong

Category	Criterion	Code
Function/ Functionality	Original product design	110
	Product identity suitable to the aim of use	111
	Acquiring double functionality to the product	112
	Effect of inclusive design	113
Form/Shape	Light–shadow three-dimensional perception of the product	210
	Balance of fullness and emptiness	211
	Ergonomic relationship of the product volume with the user	212
Geometrical Order	Balance of horizontal and vertical lines	310
	Balance of symmetry and asymmetry	311
	Visual hierarchy	312
Composition	Closeness perception of the parts	410
	Effect of visual continuity	411
	Focus point of the whole	412
	Effect of visual esthetics	413
Application/ Production	Usage fragility/flexibility of the product materials	510
	Visibility of the faulty surface of the product materials	511
	Combination and detail points	512
	Share of error in application	513

classified in five main categories and 18 subcriteria after discussing in detail by the team for clarifying the positive and negative meanings expressed for each criterion. The contents of 18 subcriteria and five main criteria were shared within the scope of the Ecological Design course with the students composed of two different design groups.

- First, the contents of the function/functionality category, determined as the first category, were formed by focusing on providing functional benefits at a high ratio of the chair's use that presents practical solutions to the chair as a consumption product. When setting forth the chair product of the original product design, which was functional with the subvariable, it was important to also keep in mind its originality. If its functionality was not fulfilled or took a back seat when going for originality in a product design, then it indicated a problem. Consequently, product identity suitable to the aim of use, which is the second criterion, is one of the most basic criteria. In the context of the user–product relationship of the chair element that provided for the realization of the sitting action, it should be checked whether the sitting section, the leaning back section, the feet, and, if existing, the arm sections of the chair served the purpose within the framework of durability. This situation established a linear relationship in a parallel direction with functionality. When keeping in mind the criterion of suitability to the purpose of use of the chair, by thinking that adding a new function to the product would provide a strong contribution, the third criterion, which was the variable of acquiring a double functionality to the product, was also considered at a correct proportion in the same manner. Furnitures that take too much space in interior spaces that are gradually becoming smaller and not facilitating the user's life (Özçelik & Kaprol, 2017) have increased linearly the interest in chairs that have a double function. It was envisaged that with the effect of the variable of inclusive (universal) design, a high benefit would be provided with the increase in accessibility, especially from the aspect of use aimed at the use by broad groups of the chair design from the aspect of age and disability.
- Under the form/shape category, determined as the second category, the first criterion of this category composed with the aim of making evident volumetrically the shape, exterior lines, and order of the chair was the light–shadow three-dimensional perception variable of the product. What was aimed with this criterion was not only the depth provided by its own volume to a space where a chair element that remained stable on a certain floor but also the relationship between the three-dimensional and two-dimensional perceptions composed with the reflection of light hitting its surface. The balance of fullness and emptiness, which is another criterion, kept in mind the relationship between the order of the chair form. For one of the basic design principles to occur, which was the balance of fullness and emptiness when two-dimensions and three-dimensions were used on the object, then the effect of depth occurring constituted the balance of fullness and emptiness (Gök, 2019). It is thought that the shadow formed by the light reflected to the volume of the mass would provide positive contributions to the perception of depth of the chair. It is thought that the form the chair has is the field of precedence in the volume of the product and ergonomic relationship with the user, which is the final criterion, by departing from the form and shape of the chair designed, in the context of providing suitable ergonomic conditions with regard to the anatomy of the standard user. It is envisaged that while realizing the sitting action of the user related to the depth and width of the sitting section of the chair, for the user to be lost in the chair or not to be able to extend at arm level to the chair arms, if existing, would negatively affect the design.
- At the foundation of the geometrical order category, which was determined as the third category, a balanced unity was sought by strengthening the visual communication through a massive integrity and the circulation constituted by every part used on the surface of the chair design. The criteria of this category were generally constituted with the adaptation in the chair design to some principles, included in the basic design and Gestalt principles. In this context, the attributes pertaining to shape related to length, direction, limitation, and movement were sought, which was composed at the foundation of the visual narration language and at the criterion of the balance of horizontal and vertical lines, which were determined as the first variable. The use of vertical and horizontal lines in a rhythmic manner would display a dimensional effect on the chair surface and by forming zigzag reflections, it would acquire movement on the surface and in this context, it is thought that the organization could be made more meaningful. The balance of symmetry and asymmetry, which was the second variable, constituted a harmonious unity of the symmetric and asymmetric order for the distribution of weight of the elements pertaining to form related to the division at the horizontal and vertical level within itself. It was envisaged that the symmetrical balance composed with the location and shape on the surface composition of the chair would give the feeling of soundness and monotony, whereas the asymmetric balance would give esthetically the feeling of activity and originality. The visual hierarchy variable, which was the final criterion and one of the Gestalt principles, was constituted with the aim of expressing the regular unity appearing with the ordering by connecting to one another according to the degree of importance of the functional, formal, and symbolic elements included within the design organization of the chair. It is thought that in this order, with the provision of superiority of the elements, whose measurements, color, texture, and structure are different, that is, with the formation of visual hierarchy, it would acquire a significant place in chair design (Okuyucu, 2011). On the other hand, it was determined that the formation of the difference and contrast of the structures of elements used within this repetitious order would be the cause of the perception of a complex image, since the element forming the most contrast would have a high accent; this situation would also strengthen the focal point.
- Formed under the composition category determined as the fourth category, it was aimed to serve the integrity of all chair criteria and for no criterion to be incompatible with each other. It was necessary to consider the distance between each other sourced from the location where the parts were located, not with the shape of the parts forming the chair element, for the perception of closeness of the parts formed in this direction and the first criterion of the category that was desired to be explained with variables. It was envisaged that objects that were closer to each other were perceived as groups at the visual level and this visual unity, by forming a positional concern (Mennan, 2009), would not assist in giving meaning to the product. A repetitious order was expected among the pieces forming the chair with the effect of the visual continuity variable. It was thought that this repetition, together with the use of elements of similar shape, would constitute a strong unifying strength on the integrity. It was envisaged that this feeling of

continuity that would be sought in the elements forming the chair would obtain greater visual gains with the shadow relationship formed by the light striking it. It was thought that it would provide positive contributions to the design of the point by drawing attention with the aim of getting rid of the feeling of monotony on the chair composition with the focal point variable of the whole. Together with the gathering under the framework of other criteria, the effect of the visual esthetics variable in the most general expression was set forth with the evaluation of the effect of the visual sense effect of the design. It was thought that it was necessary to consider during this evaluation whether visual integrity has been provided within itself by the composition. On the other hand, it was expected that the esthetic attributes would be perceived with the same values from different points of view and positions by the eye looking at the chair. Otherwise, it would be accepted that this situation indicated a problem. Visual experiences were sought with the visual esthetics effect criterion, such as superior high-quality, arousing curiosity, and contributing to the identity of the product by acquiring a new style.

- Under the application/production category determined as the fifth and final category, place was given to subvariables that would facilitate the production stage of the product designed and that would provide for the use of the product emerging for an extended period. It was envisaged to acquire flexibility to the corrugated cardboard material design with the fragility/flexibility criterion of the product materials used, for students to make the designs with ease, to reduce the economic costs to a minimum, to be environmentally friendly, to be recyclable, to reduce manpower and to provide for easy application. There was place in the flawless design idea within the scope of the visibility of the faulty surface variable of the product materials. Even if the concept determined is holistic and pertaining to design, problems are experienced that pave the way for material losses and time losses with the thought of the form of applying the material details. Combination and detail points treat the visibility of the fine calculations. It was expected to plan and bring together the values calculated for each part in a manner that would compose the volume of the chair element. There were also shared attributes in situations where combination and detail points were required for the share of error in application, which was the final criterion of the category. Some chairs that were designed and produced did not remain fixed and can be folded, can be moved or brought to different angles, or had the attribute of being able to provide various uses. In situations like these, even the slightest calculation error that would be made could be the cause of the chair not fulfilling its function and aim. The slight number of unit varieties of the chair element pieces and the existence of monotonous combination relationships would reduce to a minimum the errors in application.

Situations of the Reciprocal Relationships of Criteria (Correlations)

In the step after the explanation of the criteria in a clear and understandable manner, the six-person design team came together and evaluated individually by analyzing every criterion with the dimension of the relationship with the other criteria. All dual criteria have relationships at different degrees with each other. After analyzing the criteria relationships, it was determined by the design team if the dual criteria relationships were negat ive/ineffective/positive.

In this context, the correlation term treated expressed a measurement of the change of two variables together (Şen, 2020). According to Ezekiel (1930), in situations where the relationship between two variables were not defined clearly and in a reasonable manner, the correlation method was developed with the aim of eliminating this problem, since it was difficult to determine the average relationship (Ezekiel, 1930). On the other hand, the most important point that should be considered in this situation is the necessity of not evaluating the cause–result relationship when determining the correlation situation of the criteria, because correlation does not provide information about the cause and result relationship between two variables. That is, the size of the dimension of effect of the x variable and the y variable is attributed as correlation (Şen, 2020).

Deciding on the Criteria Correlations

Studying in a detailed manner the relationships with each other of the determined criteria played a direct role in the scoring that would be given by the design team to the criteria relationships at this stage. First, the matter that should be taken into consideration is the scoring between the two criteria and the question, Are the relationships of the criteria evaluated as positive/negati ve/ineffective? This process was evaluated individually within the design team. Subsequently, six separate scores were given for evaluating every dual criterion and written one by one. Within these scores given, those whose scores were ineffective were not considered for the evaluation. The average of the positive and negative scores given was taken within them. If the result appearing was positive and if it remained above +0.5, then these values were rounded to a large value. However, if it was +0.5 and below, then it was rounded to a small value (Table 3).

As the result of the evaluation of the relationships with one another of these 18 subcriteria, a total of 153 correlation values were determined for each dual criterion. A total of 92 correlation values were obtained with 26 strong positive, 19 positive, 26 ineffective, 14 negative, and 7 strong negative. Additionally, in the evaluation of the relationship of two criteria, since contrasting views emerged as the result of the scores given within the team, it could constitute problems in the design process by showing that the criteria or the relationships were not understood well.

Weighting of the Criteria

The relative weight among the 18 criteria was dependent on these crude criteria. When determining what sort of weight effect there would be on the design process by establishing a strong/weak relationship between two criteria, since the criteria have been calculated on absolute values, the fact that it was positive or negative did not constitute any effect. On the other hand, besides the crude criteria weights, with the relative criteria weights also entering the loop together, the intensification of the calculations

Table 3.
The Interval Values Used in Transforming the Raw Criteria Weights of Scores Given to Criteria Relationships

Interval Value	Degree	Direction of Proportion
{+2.00, ... , +1.51}	+2	Strong positive
{+1.50, ... , +0.51}	+1	Positive
{+0.50, ... , –0.49}	0	Ineffective
{–0.50, ... , –1.49}	–1	Negative
{–1.50, ... , –2.00}	-2	Strong negative

Figure 3.
Dual Criteria Relationship Direction and Weighting.

would be the cause of a decrease in the focus, which was design, and the scoring of "3 (very important), 2 (moderately important), and 1 (slightly important)" in the Pugh design matrix model was preferred.

Since it was expected that there would be a significance shown in the relationships among the criteria, even if slight or even if a lot, the relative significance was taken into consideration, not the basic significance. The evaluation of the double criteria in the Pugh decision matrix model used and proposed in this study, was evaluated in the following manner: –2 (strong negative), –1 (negative), 0 (ineffective), +1 (positive), +2 (strong positive).

Additionally, by taking into consideration the meanings of the representative figure numbers used for the numbers were determined by taking the dimensional concept as the basis. Place was given in the Pugh decision matrix table to the shapes that represent the numbers. Considering what has been stated, the code number of every criterion, the relationship direction of the dual criteria, the crude weights, and the relative weights have been presented in a detailed manner in Figure 3.

Determination of the Reference Visuals of the Criteria

There was also a need for visual support on behalf of being able to set forth free of defects what was wanted from each design criterion for advancing without problems according to what was wanted by the products developed with the Pugh decision matrix method. If a criterion included two contrasting meanings in a positive and negative direction, then it would pave the way for confusion in understanding the criteria. By taking this situation into account, care was taken to select criterion visuals that define a single situation. Consequently, at this stage of the design process, reference visuals were selected that would express every one of the design criteria. The basic matters considered in the selection of reference visuals of the design criteria can be listed in the following manner: (1) for it to reflect a single criterion, (2) for it to be clear and understandable, (3) for it to be a clue in situations of confusion, and (4) for it to assist in the design solution (Figure 4).

Very comprehensive research was undertaken by the six-person design team for selecting the reference visuals for the 18 design criteria and the pool of alternative visuals were constituted in a careful manner. There were matters that were considered in the resource scanning applied in the selection of the alternative visuals. A pool composed of a total of 291 visuals was constituted by selecting (1) 54 visuals from the famous chair designs by famous designers and architects, (2) 117 visuals from the award-winning chair designs from the award competitions, such as iF World Design Guide and Yanko Design, (3) 101 visuals from the chair designs obtained from foreign sources, and (4) 19 visuals from the chair designs on Internet websites.

It was clearly emphasized that the members of the design team followed a path with the elimination method by discussing and evaluating within the subject in the selection of the 18 reference visuals, which are given in Figure 1, from within the 150 alternative visuals. The most important point here is that the reference visuals selected had the affecting strength to a significant degree on the structural and design attributes of the recent design products. Furthermore, the numerical expressions included under the reference visuals in Figure 4 were determined in the manner of Number of the Criterion Represented/Number of the Reference Visual Alternative. The final decision was made by the design team within many visuals presented for each criterion. It was targeted to reduce to a minimum the confusions within the design process with the numbering method.

Evaluating–Eliminating–Updating Loop

The two chair designs made by the department students were scored by the design team members with a system called design loop. This loop functioned as follows: first, the two design products presented by the department students were coded as A and B. Every jury member included in the design team gave scores to these two products by constituting an evaluation table, which included the design criteria; the reference visuals, which represent the design criteria; the crude weights of the design criteria; and the relative weights, which have been determined up until this stage.

The values used in the scoring system were –1 (unsuccessful), 0 (equivalent), and +1 (successful). The design product evaluated was scored separately for each criterion. Whereas the most important point here was the knowledge that the design products were measured for success within the framework of each criterion. To determine this, the relative weight scores were multiplied by the evaluation scores given by the designers. To give an example, the 1A coded design product, located in the first loop, was evaluated as 0 (zero) by the T-1 (Designer-1) from the aspect of Original Product Design criterion. Since the relative weight of the

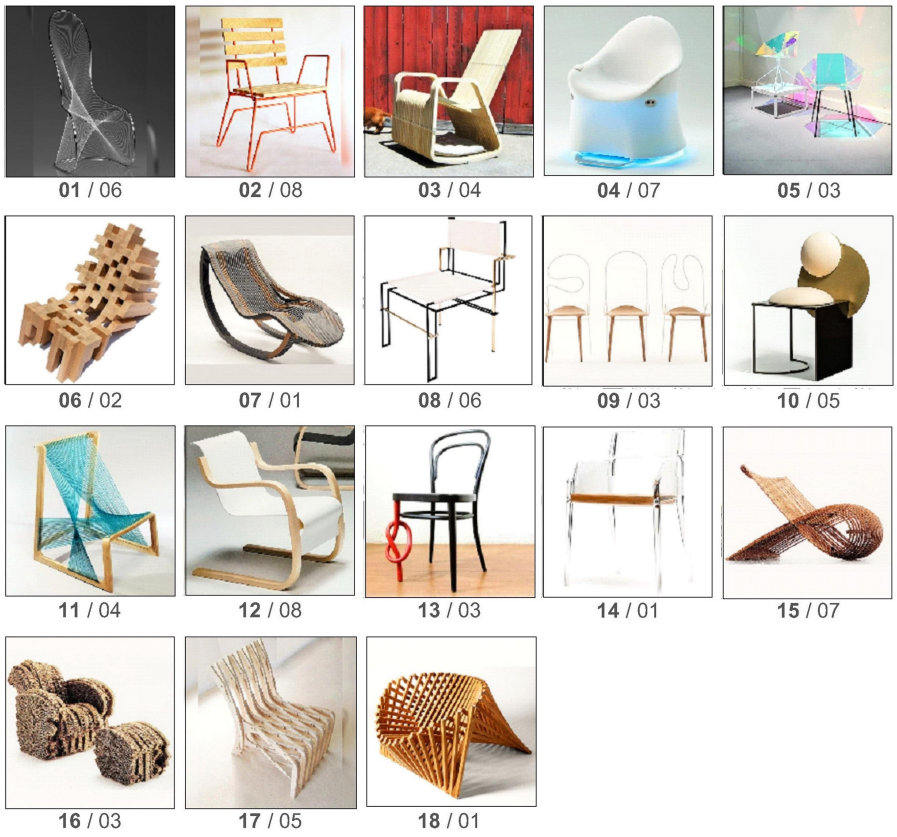

Figure 4.
Reference Visuals of the Design Criteria.

Original Product Design criterion was 3, by multiplying the 0 with the 3, the 0 value was found. Consequently, the score given by T-1 within the scope of this criterion was 0 (zero). At the conclusion of a scoring system that operated in this manner, every positive and negative value that emerged was added and the general scores appeared for the design alternative. Subsequently, by taking the arithmetic average of these general scores, the total final scores obtained in that loop by the design product became known. As the result of these scores, it was determined whether to proceed to the next loop. In each loop, by taking the scores received by the design products as the basis, the required updating was made and by reaching success, new products were presented. It was completely variable in how many loops a design product would obtain success. It was envisaged that as the designs that overlap with these criteria, by taking into consideration the design criteria, then the loops could be repeated in fewer numbers, and it would be easier for the products to obtain success.

First Loop

The evaluation stage of the chair products designed passed in the first loop. At this stage, the design development of two separate products and designed by two groups of students were examined in detail. First the 1A coded chair design, which was the first design product, was evaluated by the jury. This product was designed and produced by four people selected from the third-year students in the Department of Interior Architecture and Environmental Design at the Faculty of Fine Arts of the Afyon Kocatepe University. On the contrary, the 1B coded design element, which was the second design product, was designed and produced by five students in the second group. The front view, the left side view, and the upper view together with measurements of the chair are presented in Figure 5. Just as with the other design alternatives, the product measurements have been given in centimeters by designing with one-to-one measurements suitable to human anatomy.

In the evaluation of the 1A and 1B coded design alternatives included in the process, the scoring system used in the first loop by the jury members is presented in Figure 6. Accordingly, the general score average received by the 1A coded design product that measured its success validities was -20.0 and the general score average received by the 1B coded design product was –23.0. It was observed that these scores, which were obtained by evaluating according to the reference designs, were unsuccessful. Consequently, it was necessary to pass to a second loop.

Second Loop

The 1A coded design product, which was evaluated first by the jury in the first loop, by finding it to be unsuccessful because of the scores received, was redesigned with the 2A code to be developed by the group students. In the same manner, the 2B coded design was the developed condition of the 1B coded design product, which was evaluated in the first loop (Figure 7).

The scoring system used in the second loop was evaluated and included in the process of evaluating the 2A and 2B coded design alternatives. According to these evaluations, the general score average received by the 2A coded design product was –4.5, and the general score average received by the 2B coded design

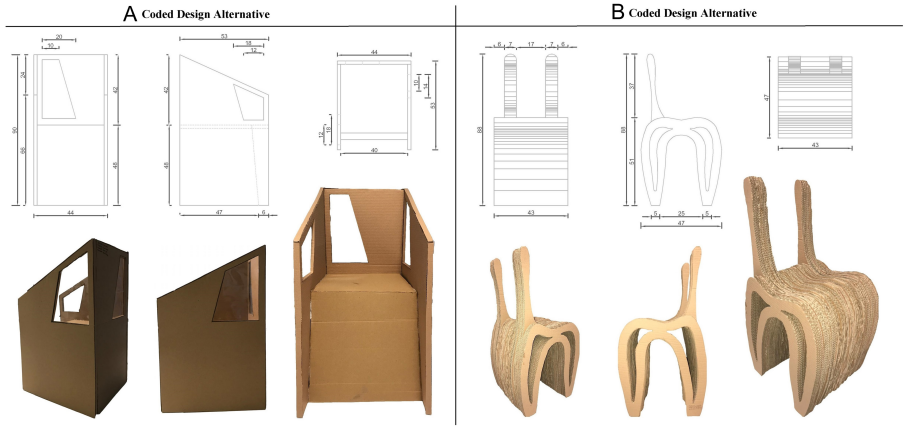

Figure 5.
1A Coded and 1B Coded Design Alternatives.

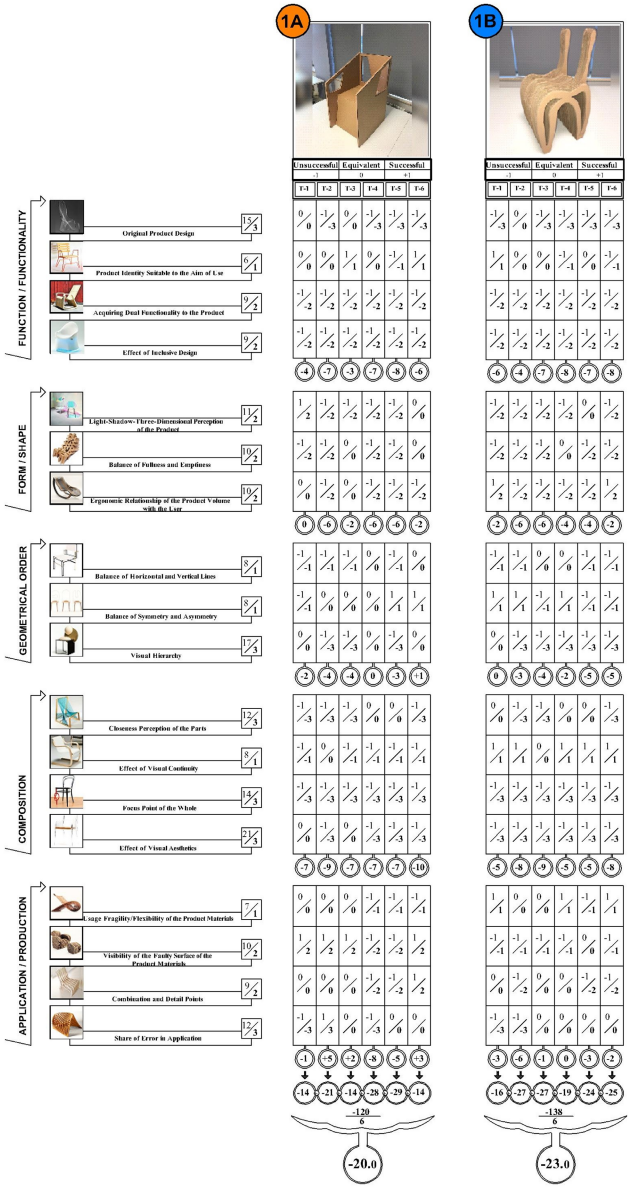

Figure 6.
Scoring Used in the Evaluation of the First Loop of the Products.

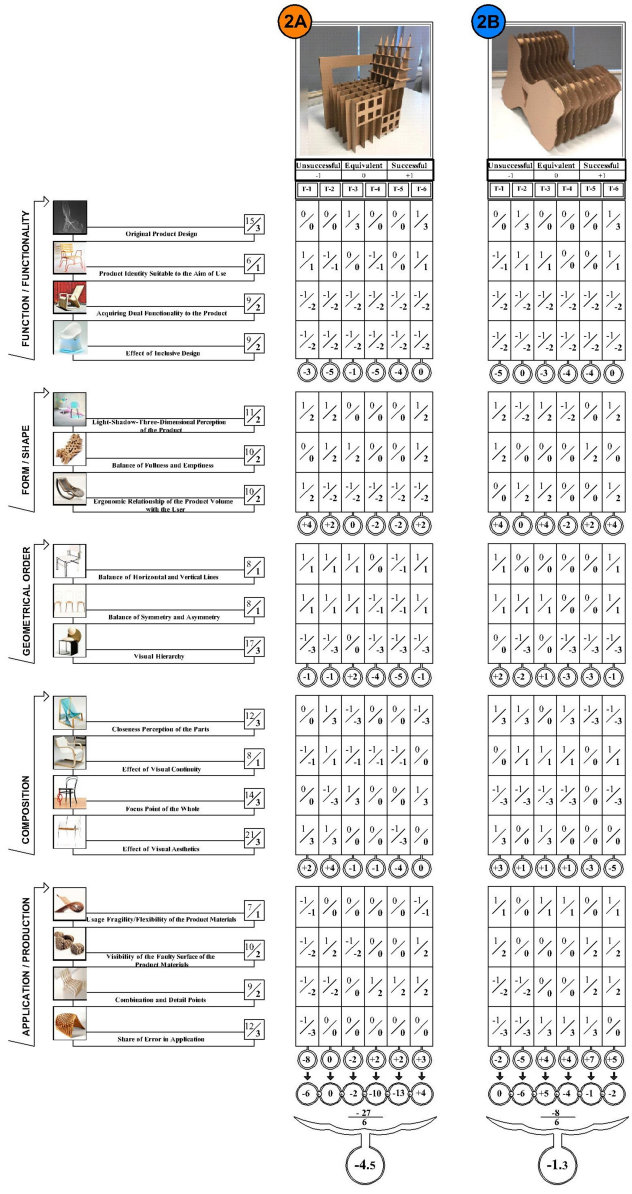

Figure 7.
2A Coded and 2B Coded Design Alternatives.

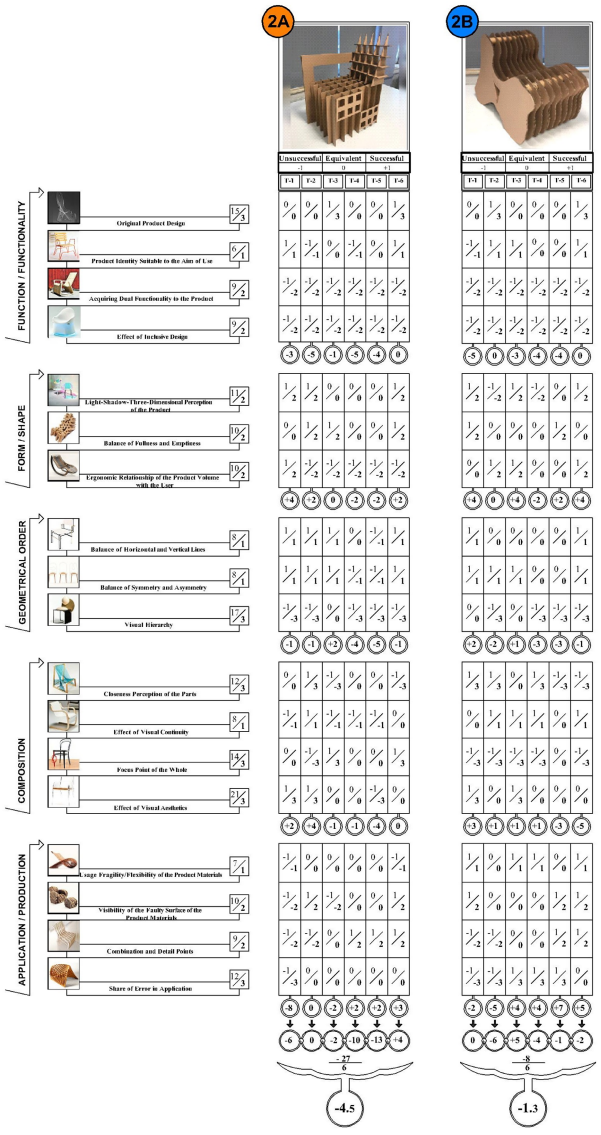

Figure 8.
The Scoring Used in the Evaluation of the Third Loop of the Products.

product was –1.3. These scores obtained by evaluating according to the reference designs arepresented in Figure 8. When these scores were taken into consideration, it was understood that these design alternatives were more successful, but that they still did not obtain sufficient success.

First, it was necessary to reach positive values from negative values to reach the result of sufficient success of the products. If positive values were obtained, and to measure the necessity of whether to pass to a subsequent loop was made by the jury with the numerical values obtained and an evaluation of the products emerging. It was necessary to past to a third loop for this study.

Third Loop

Although the 2A design product, which was evaluated by the jury in the second loop, displayed success at the end by the scores it received, since it did not reach a sufficient level, it was redesigned to be developed by the group students. In the third loop, by giving the 3A code, the design attributes and measurements of the product presented for the evaluation of the jury were developed according to the Pugh decision matrix evaluation table.

It was understood through the general total obtained that the 2B code numbered design product, which was evaluated by the jury in the second loop, displayed somewhat better success compared to the 2A code numbered product. Since this situation was insufficient, the 3B code numbered design alternative was redesigned by the group students and presented in the third loop. The two-dimensional and three-dimensional visuals of the 3A coded and 3B coded design alternatives are presented in Figure 9.

The scoring system used in the second loop and included in the process of evaluation of the 3A and 3B coded design alternatives is presented in Figure 10. Accordingly, the general score average received by the 3A coded design product was +9.3 and the general score average received by the 3B coded design product was +13. It was clearly observed that these scores obtained by evaluating according to the reference designs reached final success according to the design alternatives. Consequently, the design products could finally pass to the presentation stage. Since the 3A and 3B coded products were the final product to display success, it was necessary to present these products.

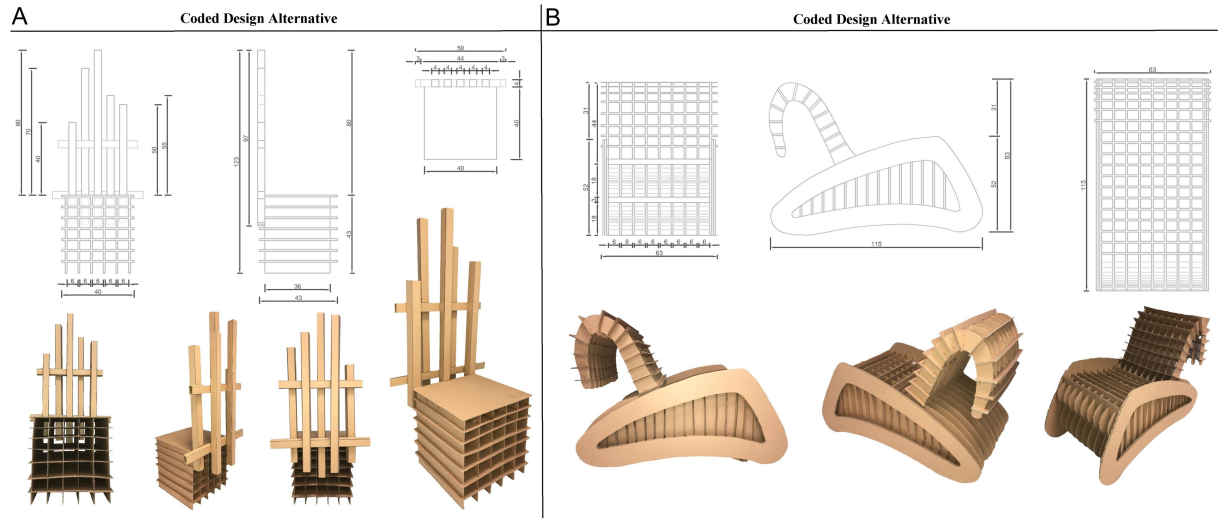

Figure 9.
The 3A Coded and 3B Coded Design Alternatives.

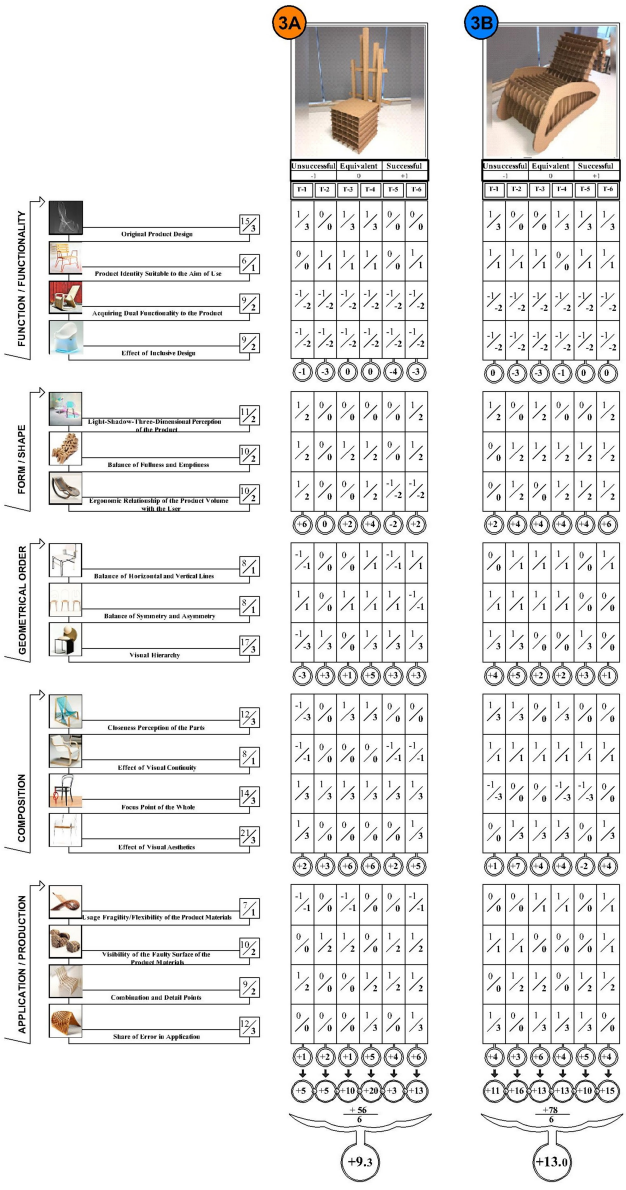

Figure 10.
The Scoring Used in the Evaluation of the Third Loop Products.

Discussion

Chair elements, which hold an important place among the furniture products, and which are used to meet the need for sitting, were used as a means in this context to reflect the historical period in which they were designed and the traces of the architectural style. In this context, chairs were selected as the design product used within the scope of the study. Coates et al., (2009) and Russel (1980), the emphasis that the chair is a furniture element that is a visual expression of new theories that meet needs both in a functional and esthetic context and has become a new icon in applied arts supported the selection of the chair as a design product. The fact that the chair production would be made within the scope of the Ecological Design course brought together different parameters, such as the transformation of waste materials into functional products concerning the design process. In this context, the material used by the students for the chair production was corrugated cardboard that was unsold and thus proved to be economical.

It was observed that in the process of chair design, the use of the Pugh decision matrix method encouraged creativity and teamwork, facilitated the team-based process, advanced systematically the transfer of knowledge, and presented impartial evaluation criteria.

As Cross (2000) stated, by using the Pugh decision matrix method in the chair design process, creativity and teamwork were encouraged, the team-based process was facilitated, information transfer progressed systematically, and impartial evaluation criteria were presented by researching the design problem, creating alternative design concepts, evaluating the design concepts created, and finally communicating with the final product.

With the Pugh decision matrix method, which was used for the first time in the field of interior architecture within the scope of this study, it was determined that the developed design alternatives gave better responses to the design problem at hand.

According to Dimancescu (1992), within the framework of the Pugh decision matrix method, by using unbiased evaluation criteria to stimulate creativity at the conceptual design stage and develop its strongest concepts, the jury member (analyst) was able to evaluate the product by easily comparing various criteria of a solution through a single scoring system called the Pugh decision matrix table and weighting a more objective criterion.

It was observed that knowing the criteria weights made it easier to direct the chair design process and that the students advanced in an easier and more decisive direction.

As Şen (2020) stated, correlation, which is a measure of the change of two variables together, and the fact that the correlation provides information about the direction of the cause–effect relationship between two variables, has enabled students to understand the causes of the negative consequences of the relationships between the criteria more easily during the chair design process and to predict the negative effects of the changes that will be made in terms of other criteria.

The general scores obtained with the positive and negative total easily provided for the determination of which alternatives were successful and which alternatives were unsuccessful. At the same time, the positive solutions obtained for any alternative at any stage provided for adapting to other alternatives at subsequent stages. It was observed that the components and variables forming the chair design problem of the students could be determined and understood and, in this direction, systemized solutions could be produced.

According to Adams (2020), with this method, which allows the analyst to arrange various criteria or characteristics of a solution in a structured way for easy comparison and develop an optimal solution that is a hybrid of other powerful solutions, it has been found that deficiencies in chair design alternatives can be easily identified during the evaluation, elimination, update cycle.

The product development model proposed can not only be used in the field of interior architecture education but also in fields such as architecture and engineering. It is proposed to put to test the applicability of the proposed product development model in different design processes, such as in the fields of architecture

and engineering, not only in the field of interior architecture education, especially because it is proposed that the effectiveness in the design processes having numerous parameters should be studied in detail in the context of other studies.

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References

Adams, C. (2020). What is a Pugh Matrix? https://www.modernanalyst.com/Careers/InterviewQuestions/tabid/128/ID/2159/What-is-a-Pugh-Matrix.aspx

Akdemir, N. (2017). Tasarım kavramının geniş çerçevesi: Tasarım odaklı yaklaşımlar üzerine bir inceleme/Wide framework of design concept: An investigation on design-driven approaches. *Ordu Üniversitesi Sosyal Bilimler Araştırmaları Dergisi*, *7*(1), 85–94. https://dergipark.org.tr/en/pub/odusobiad/issue/28361/301595

Altuntaş, K. S, Yalçınkaya, Ş., & Aydıntan, E. (2023). The adaptation process of the ınterior architecture program into emergency distance education and ımplements. *PLANARCH - Design and Planning Research*, *7*(1), 64–75.

Anthony, K. H. (1991). *Design juries on trial: The renaissance of the design studio*. Van Nostrand Reinhold Company Inc.

Arcan, E. F., & Evci, F. (1999). *Mimari Tasarıma Yaklaşım I: Bina bilgisi çalışmaları/Approach to architectural design I: Building information studies*. Tasarım Yayın Grubu.

Arslan, D. (2016). Yaratıcı endüstride tasarım odaklı düşünce eğitimi/Design thinking education in creative industry. In M. E. Kahraman (Ed.), *Yaratıcı Endüstriler uluslararası tasarım sempozyumu, conference papers* (pp. 68–77). Yıldız Teknik Üniversitesi Basım Yayın Merkezi.

Atabeyoğlu, Ö., Argan, A., & Beyli, K. N. (2019). Altin Oran Algisinin tespit Edilmesinde anket Yaklaşimi. *Ata Planlama Tasarım Dergisi*, *3*(2), 87–95.

Bayer, H., Gropius, W., & Gropius, I. (1959). *Bauhaus: 1919–1928*. Charles T. Branford Company.

Bossert, J. L. (1951). *Quality function deployment: A practitioner's approach*. ASQC Quality Press.

Brown, S. A. (2001). *Communication in the design process*. Spon Press.

Callahan, J. R. (1995). *Concurrent engineering research center annual report 1993–1994*. National Aeronautics and Space Administration, West Virginia University.

Ching, F. D. K. (2016). *İç mekan tasarımı/Interior space design* (B. Elçioğlu, Trans.). YEM Yayınları.

Chuah, K. M., Chen, C. J., & Teh, C. S. (2008). Incorporating Kansei engineering in instructional design: Designing virtual reality based learning environments from a novel perspective. *Themes in Science and Technology Education*, *1*(1), 37–48.

Civcir, E. (2015). *Temel tasarım ve tasarım ilkeleri [Basic design and design principles]*. Akademisyen Kitabevi.

Clausing, D. P. (1994). *Total quality development: A step-by-step guide to world-class concurrent engineering*. American Society of Mechanical Engineers (ASME) Press.

Coates, M., Brooker, G., & Stone, S. (2009). *Görsel İç mimarlık sözlüğü/The visual dictionary of interior architecture and design* (N. Şık, Trans.). Literatür Yayınları. (in Turkish).

Colombo, S., & Ryecart, G. (1997). *The chair: An appreciation (design icons)*. Laurel Glen Publishers.

Cross, N. (2000). *Engineering design methods: Strategies for product design* (3rd ed.). John Wiley & Sons Ltd.

Çiçek Kurdoğlu, B., & Bekar, M. (2018). Bir fuaye alanının değişiminin temel tasarım ilkeleri açısından değerlendirilmesi [Evaluation of the change of a foyer area in terms of basic design principles]. *Uluslararası Sosyal Araştırmalar Dergisi*, *11*(60), 574–582. [CrossRef]

Dimancescu, D. (1992). *The seamless enterprise: Making cross-functional management work*. Harper Collins.

Doğan, C., & Altan, O. (2007). Kamusal alanda oturma eylemi ve ergonomik ilkeler [Seating in public spaces and the ergonomic principles]. *MEGARON Yıldız Teknik Üniversitesi Mimarlık Fakültesi e-Dergisi*, *2*(3), 159–166.

Doyle, R. V. (1969). *Your career in interior design*. Julian Messner.

Edwards, J. K. (1998). *Guide to architecture schools* (6th ed.). Association of Collegiate Schools of Architecture.

Ezekiel, M. (1930). *Methods of correlation analysis*. John Wiley & Sons, Inc.

Fehrman, C., & Fehrman, K. (1987). *Postwar interior design* (pp. 1945–1960). Van Nostrand Reinhold Company, Inc.

Gök, E. (2019). *Güncel konut cephe tasarım anlayışının temel tasarım ilkeleri doğrultusunda Fenerbahçe Faruk Ayanoğlu Caddesi örneğinde incelenmesi [The investigation of the current residential building design concept on the sample of Fenerbahçe Faruk Ayanoğlu street with the basic design principles* (Master's Thesis, İstanbul Ticaret Üniversitesi, Fen Bilimleri Enstitüsü, İç Mimarlık Anabilim Dalı).

Hasol, D. (2019). *Mimarlık denince/When you speak of architecture*. Yem Yayınları.

İnan, Ç. (1998). *Soyut ve somut tasarım olgusunda anlatım yöntemleri [Expression methods in the fact of abstract and concrete design]*. Maltepe Üniversitesi Yayınları, 28-36.

Kettler, K. (1994). *Education for interior design*. John Wiley & Sons, Inc.

Kirk, S. J., & Spreckelmeyer, K. F. (1988). *Creative design decisions: A systematic approach to problem solving in architecture*. Van Nostrand Reinhold Company, Inc.

Kliment, S. A. (1977). *Creative communications for a successful design practice*. Whitney Library of Design.

Külekçi, A. E. (2018). Erzurum'da kentsel mekânlarda kullanılan bazı kent donatı, zemin ve B. elemanlarının ergonomik ve antopometrik yönden incelenmesi. *Ata Planlama Tasarım Dergisi*, *2*(2), 35–45.

Kurtich, J., & Eakin, G. (1993). *Interior architecture*. Van Nostrand Reinhold Company, Inc.

Madanlar, S. (2019). *Ergonomic consumer product design: Principles, evaluation and application* (Master's Thesis). Dokuz Eylül University, Graduate School of Natural and Applied Sciences.

Massey, A. (1990). *Interior design of the 20th century*. Thames and Hudson, Inc.

Mennan, Z. (2009). From simple to complex configuration: Sustainability of Gestalt principles of visual perception within the complexity paradigm. *METU Journal of the Faculty of Architecture*, *26*(2), 309–323. [CrossRef]

Mesher, L. (2013). *İç mekan tasarımında mağaza tasarımı [Shop design in inner space design]* (F. Akder, Trans.). Literatür Yayınları.

Nasar, J. L., Preiser, W. F. E., & Fisher, T. (2007). *Designing for designers: Lessons learned from schools of architecture*. Fairchild Publications.

Naylor, G. (1968). *The Bauhaus*. Studio Vista.

Newcomb, M., & Leshowitz, A. (2017). Rethinking process through design. *CEA Forum*, *46*(1), 42–70.

Okuyucu, Ş. E. (2011). *Çağdaş eğitim yapılarında avlunun göstergebilimsel açıdan değerlendirilmesi [Evaluation aspects of semiological of the courtyard at the contemporary educational buildings]* (Ph.D. Dissertation). Selçuk Üniversitesi, Fen Bilimleri Enstitüsü,)74-77.

Özçelik, Ö., & Kaprol, T. (2017). Dar mekan perspektifinden özgün sehpa ve sandalye tasarımları [Original coffee table and chair designs from a narrow space perspective]. *İleri Teknoloji Bilimleri Dergisi*, *6*(3), 289–300. https://dergipark.org.tr/tr/pub/duzceitbd/issue/33124/363702

Öztürk, A. (2016). Tasarım eğitiminde disiplinlerarası yaklaşımlar ve tasarımcı düşünüş modeli [Interdisciplinary approaches in design education and design thinking model]. *International Journal of Interdisciplinary and Intercultural Art.*, *1*(1), 57–72. https://dergipark.org.tr/en/pub/ijiia/issue/33744 /373760

Pençe, K. (2014). Zarar verme, tüketme, hayatı kolaylaştır. *İçmimar Dergisi*, 4, 49–52.

Pepis, B. (1966). *Interior decoration A to Z* (pp. 25–28). Doubleday & Company, Inc.

Pile, J. F. (1990). *Dictionary of 20th century design*. Facts on File.

Pile, J., & Gura, J. (2000). *A history of interior design*. John Wiley & Sons, Inc.

Piotrowski, C. M. (2004). *Becoming an interior designer: A guide to careers in design*. John Wiley & Sons.

Pugh, S., Clausing, D., & Andrade, R. (1996). *Creating innovative products using total design: The living legacy of Stuart Pugh*. Addison-Wesley Publishing Co.

Russell, F., Garner, P., & Read, J. (1980). *A century of chair design*. Rizzoli International Publications, Inc.

Sabancı, A. (1999). *Ergonomi* [*Ergonomics*]. Baki Kitapevi. 41-48

Savage, G. (1966). *A concise history of interior decoration*. Grosset & Dunlap Publishers.

Schön, D. A. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions*. Jossey-Bass Publisher.

Simpson, J. A., & Weiner, E. S. C. (1989). *The Oxford English dictionary*. Oxford University Press.

Stahl, M. J. (Ed.). (1999). *Perspectives in total quality (Total quality management)*. Blackwell Publishers.

Starr, M. K. (1963). *Product design and decision theory*. Prentice-Hall, Inc.

Şahinkaya, S. B. (2009). *Bauhaus mobilya tasarımının günümüz mobilya tasarımına etkileri [Influences of Bauhaus furniture design on recent furniture design]* (Master's Thesis). İstanbul Teknik Üniversitesi, Sosyal Bilimler Enstitüsü.

Şen, S. (2020). *Eğitimde İstatistiksel Yöntemler [Statistical Methods in Education*]. https://sedatsen.files.wordpress.com/2016/11/7-sunum.pdf

Tate, A., & Smith, C. R. (1986). *Interior design in the 20th century*. Harper & Row Publishers.

Ullman, D. G. (1944). *The mechanical design process*. McGraw-Hill.

Uysal, E. R. (2019). *Endüstriyel mobilya (sandalye) tasarımında sağlamlık ve estetik optimizasyonu [Durability and aesthetic optimization in industrial furniture (chair) design]* (Master's Thesis). Gazi Üniversitesi, Fen Bilimleri Enstitüsü, Ağaçişleri Endüstri Mühendisliği Ana Bilim Dalı.

Whiton, S. (1974). *Interior design and decoration*. J. B. Lippincott Publishers Company.

Yıldırım, M. T., & Özen Yavuz, A. (2008). Future is Today: Benefits and Weaknesses of Architectural Design Education in Remote Digital Environment. 5th International Architecture and Engineering Symposia; Creating the Future – ARCH 08: 5th International Symposium on Architecture & Interior Architecture, Conference Papers, Lefke, Cyprus (TRNC), 4-5 December 2008, pp. 1–10.

Yüksel, M. (2019). *Farklı fonksiyonlara hizmet eden bazı koltuk modellerinin insan odaklı ürün tasarımı yaklaşımıyla değerlendirilmesi [Evaluation of the ergonomic compatibility of different types [of] armchairs with human centered product development approach] (Tez No: 605412).* [Ph.D. Dissertation]. Muğla Sıtkı Koçman Üniversitesi, Fen Bilimleri Enstitüsü, Ağaçişleri Endüstri Mühendisliği Ana Bilim Dalı.