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Exploring Parametric Concepts and Principles for Furniture and Interior Design

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Abstract

This research explores the incorporation of parametric models into the algorithmic design process, specifically focusing on furniture and interior design. It presents a case of an experimental equation centred around a waffle honeycomb structure. The first part of the article reviews three decades of literature on parametric design, which comprises its background, history, theory, and essential concepts and applications. The second part investigates the parametric design process to uncover its potential for interior design applications. The combination of parametric equations with algorithms through the utilisation of multiple steps, such as conditional loops, efficiently designs intricate systems. An intricate system in parametric design comprises various input parameters, rules, mathematical algorithms, and conditional relationships that interact to generate design solutions. This approach is potentially applied in various design scenarios to respond to specific criteria and constraints, facilitating flexibility, adjustments to potential outcomes, and achieving a high level of detail in the final result. This research primarily concentrates on the identification of parametric design methodologies and the utilisation of parametric equations in crafting furniture and interior designs featuring waffle structures. Furthermore, it introduces a versatile parametric design approach that can be applied to various design tasks, highlights the evolutionary trajectory of parametric design, and offers insights into its potential impact on future design practices. The exploration of the parametric method enhances the understanding of complex design approaches in a more accessible and innovative manner with practical applicability.

Keywords: parametric design, interior design, furniture design, waffle structure, algorithm

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Introduction

The term *parametric* has roots in mathematics, although there was some debate about its historical origin. Parametric equations use one or more independent variables called *parameters*, which are also defined as continuous functions. In addition, this structured approach is used to express the relationships between variables. Parametric design is often defined as an arithmetic concept for generating diverse design options while aiding decision-making in the entire process (Blosiu, 1999).

A parametric equation is a set of quantities expressed as an explicit function of multiple parameters in mathematics. A typical example is the formulae used to determine a catenary curve:

$$x(a,t) = t$$

$$y(a,t) = a \cos\left(\frac{t}{a}\right)$$

These equations capture the properties of the curve through specific parameter values. According to Davis (2013a), a parametric model is a set of equations that expresses a geometric model as explicit functions of various parameters.

Rapid technological advancement is characteristic of the ever-evolving modern-day society. Technology, which applies scientific knowledge to the practical aims of human life, plays an essential role in daily activities. In the early stages, computer designs were limited to only two dimensions. However, it evolved into three-dimensional modelling, including incorporating new features such as parametric models and equation design. The process of three-dimensional modelling through various software interfaces has taken multiple forms; among these methodologies, scripting algorithms play a critical role, enabling computers to be processors, technically referred to as *parametric design*. Therefore, the definition of parametric design revolves around the parameters governing an entity—a set of facts or fixed limitations that establish or constrain the occurrence or execution of something. Parametric design is a distinctive method where features, such as building elements and engineering components, are shaped by algorithmic processes rather than being designed directly and manually.

This research discusses parametric thinking in the design and development procedures, realised through computer programs to process the results according to planned conditions. The primary aim is to produce results by inventing algorithms comprising a sequential communication process in a computer language executed through related programs. This research, which was funded by the Faculty of Decorative Arts, Silpakorn University, Thailand, aims to discuss parametric design concepts and explore effective interior design practices, through a case study of parametric waffle equation for furniture design. Another objective is to delve into the evolving path of parametric design towards contemporary technological advances.

Parametric Design: Origin and Historical Background

The term *parametric* is deep-rooted in mathematics and has been expanded into various fields, including design and architecture. Parameters and rules determine the relationship between design intent and response (Jabi, 2013). This definition emphasises two relevant criteria. First, a parametric equation expresses a set of quantities representing several parameters. Second, the outcomes (set of quantities) are related to the parameters through explicit functions. This point was debated later because some contemporary architects suggested that compositional relations constitute parametric relationships. Parametric equations explicitly express quantities as functions of independent variables, known as parameters (Weisstein, 2003). The historical trajectory of parametric understanding can be traced back to the 19th century, initially inspired by 'the crystal drawings' of James Dana. Dana (1937) accurately used the term *parametric* in its original mathematical sense, including parallelism, intersections, and planes. Over time, this concept evolved, spanning epochs and culminating in the 21st century through the influence of Antonio Gaudí, Luigi Moretti, and Patrik Schumacher.

The first representation of geometry using parametric equations was completed in the 19th century. For example, Antonio Gaudí skillfully designed architecture using parametric and hyperbolic curves. Antonio Gaudí also used analogue systems to design complex structures through parametric experiments. A significant instance is the church of Colonia Guell, renowned for its analogue model that ingeniously featured an inverted structure. Antonio Gaudí exhibited a brilliant application of analogue parametric mechanisms, using a system of strings weighted by birdshot. This inventive mechanism facilitated the design of interconnected arches and vaulted ceilings by pulling weights in an inverted, tension-based model. The reverse structural model aimed to efficiently distribute dead loads within a complex system. A reflective touch was added, with Gaudí placing a mirror at the model's base to visualise the architectural forms while manipulating the load distributions. The use of parametric equations is evident in multiple architectural aspects designed by

Gaudí, prominently illustrated by the adoption of the hanging chain model (Burry, 2011).

Antonio Gaudí further used a mechanical (analogical) model for architectural design, attaching strings with weights to determine shapes for building features, such as arches (Frazer, 2016). Gaudí first designed architecture with parametric catenary and hyperbolic curves. This marked the inception of a transformative approach that continues to resonate within the architectural landscape. The analogue method proposed by Gaudí included the main features of a computational parametric model, including input parameters, equations, and output. The string length, birdshot weight, and anchor point location are independent input parameters. The vertex locations of the points on the strings represent the outcome of the model. The outcomes are derived through explicit functions, specifically comprising concepts such as gravity or Newton's law of motion.

Gaudí skilfully produced diverse model versions by modifying their individual parameters, resulting in structures defined by pure compression. Instead of manually calculating the results of parametric equations, Gaudí automatically derived the shape of the catenary curves through the force of gravity acting on the strings (Davis, 2013a). One of the important parametric processes is 'form-finding,' which consists of comparing a script with a model to find a desired shape or specific constraints. Ultimately, it leads to the final form of a designed object based on these constraints and variables. The critical innovation of the hanging chain model proposed by Gaudí lies in the automatic computation of parametric outcomes.

Another example is Frei Otto, who enlarged analogue computing methods to include minimal surfaces derived from soap films and paths found through wool dipped in liquid. Frei Otto conducted soap bubble experiments, where suspended soapy films and dipped strings were used to create perfect circles, resulting in minimal surfaces. This form-finding method is also known as design experimentation. These methods were revisited by contemporary practices that make use of parametric and algorithmic designs, while the legacy left behind by Otto has recently undergone further investigation (Fiorakis, 2016; Peteinarelis & Yiannoudes, 2016).

In 1940, Luigi Moretti, an Italian architect, introduced parametric concepts in architecture and art. The work and writings of Moretti were dedicated to the systematic study of architecture and gained significant recognition, specifically in Italy. Luigi Moretti defined *parametric* as describing the relationships between dimensions influenced by various parameters (Bucci & Mulazzani, 2002). The application of a parametric design was illustrated through the design of a stadium by Moretti, exhibited at the Milan Triennial XII in 1960. Moretti used this example to show how the stadium form could be derived from 19 distinct parameters, including factors like viewing angles and the economic costs of concrete (Assasi, 2019; Eltaweel & Yuehong, 2017; Moretti et al., 2002). In the five years following the exhibition, between 1960 and 1965, Moretti designed the Watergate Complex, believed to be the first major construction job to make significant use of computers.

As far back as 2000, the availability of computer technology had a profound impact on architects and designers. This technological tool allowed them to analyse and simulate mathematical and natural complexities, practically applied to shape building structures and furniture designs. Parametric programming has become popular among designers through understanding and algorithmic thinking, which proves invaluable in solving design-related problems. A significant turning point emerged in the 1980s when architects and designers started adopting computer software initially developed for the aerospace industry to create movement patterns, particularly *animate form* (Phillips, 2010). It is a term for a class of tools that create or modify design geometry based on non-geometric requirements or constraints on product performance. This iterative design process consists of a program generating outputs conforming to specific constraints and a designer that would fine-tune the feasible region by adjusting input values, ranges, and distribution. The process can transpire within a testing environment or involve artificial intelligence, such as a generative adversarial network. The designer also learns to refine the program (usually consisting of algorithms) with each iteration as their design goals become better defined over time (Woodbury et al., 2006).

The application of parametric design to industrial commodities consists of taking certain elements that influence product modelling as parameters. A logical relationship (algorithm) is established through computer software to construct a digital model, effectively yielding a product design prototype (Sun & Huang, 2019). It is important to recognise that the digitised computational method significantly differs from the ones used by Antonio Gaudí and Frei Otto. Their methodologies relied on physical laws to compute parametric equations, a distinction from the digitised processes facilitated by contemporary computer technology.

The program command operates with mathematical precision to optimise parameter types, capable of solving with one or more parameters. In addition, algorithmic design is not the use of computers to design architectural objects. Algorithmic design entails the systematic and logical application of a step-by-step algorithm or set of rules in creating architectural designs. This process involves leveraging computational tools to generate works and structures. In contrast, utilising a computer for design without algorithmic guidance may entail the use of traditional drafting or modeling tools. In this context, the computer functions merely as a tool for the design process, manipulated by the user. Therefore, in design processes where algorithms are employed, there is a pronounced emphasis on the importance of a structured, systematic, rule-based approach. This emphasis distinguishes algorithmic design from conventional computer-aided design methods. Algorithms allow designers to overcome the limitations of traditional CAD software and 3D modellers, thereby reaching a complexity level and control that exceeds manual human capabilities (Tedeschi, 2014).

The outcomes of this research yielded conceptual design principles through parametric programs. These scripts and equations offer avenues for further exploration, particularly for those inclined toward deeper understanding. It is also a guideline for presenting designs and artworks employing these techniques. The outcome of this knowledge can be applied in the future, presenting a conceptual design that leverages scripting to create shapes using parametric programming. This allows freedom and flexibility to deconstruct and precisely represent the problem with code (Burry, 2011).

Parametric Design Process: Intricate and Dynamic System

The primary objective of this paper is to demonstrate the utilisation of a parametric method to aid in creating and developing design, simplifying the design and product development processes, especially in the interior design industry. With the increasing adoption and growing confidence in integrating computer programming, commonly called 'scripting,' its role in the design process has become more prominent (Burry, 2011). In the design industry, implementing a parametric method is helpful as it reduces work duration and the possibility of error.

Figure 1 illustrates the parametric design process, which commences with creating a simulation model through computer programming, allowing for the manipulation and adjustment of equations. These adaptations cater to diverse factors, including material characteristics, size variations, and connection specifics. The next step consists of the translation of these equations into physical models. These models were created based on the form-finding equations generated through inventive experimentation within the program. The practical manifestation of these models is achieved using 3D printing or laser cutting to complete proof of connection, proper design, and installation. The insights obtained extend to selecting suitable materials for construction and simplifying the entire production process, including precise installation calculations.

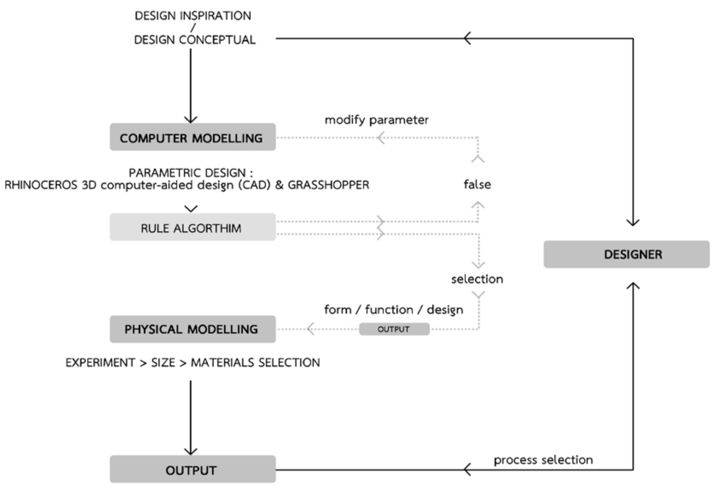

Figure 1
Parametric design process (Image by authors)

This research undertakes an in-depth exploration of this complex investigation, showing the pathway from creative inception to tangible production, all facilitated by the capabilities of a parametric program. The design starts by modifying the digital shape using commands in the parametric program to make alterations in line with the furniture size, materials, structures, and articulation requirements. After the shape has been modified in the 3D modelling, the next step is to create a true-to-life model considering the materials, manufacturing methodologies, and installation techniques.

This research evaluates and develops algorithmic equations using parametric programming in interior and furniture design experiments. Parametric design demands intricate systems comprising various input parameters, rules, mathematical algorithms, and conditional relationships interacting to determine the design process and generate solutions. Consequently, initiating the parametric design process necessitates establishing boundaries and conditions. The research methodology employed for investigating parametric approaches in interior design encompasses the procedural steps delineated in Figure 2.

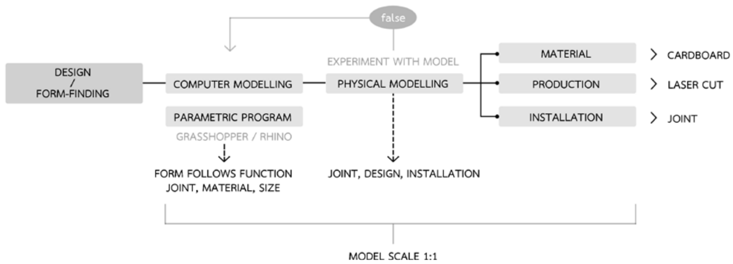

Figure 2
Research methodology to explore parametric approach in interior design (Image by authors)

This article presents a case study focusing on creating equations based on three main elements: parametric programs, waffle structure, and material condition. The procedural stages in the experiment, transitioning from parametric exploration to the practical implementation with a physical model, are illustrated in Figure 3. First, leveraging parametric offers the advantage of creating intricate and dynamic patterns or structures. The parametric program not only displays relationships and equations but also facilitates immediate design work. Second, utilising equations and structures of waffle structure designs proves convenient for installation, showcasing the potential of parametric work in both experimental and practical usage settings. The third element, material condition, is provided by a laser cutter as the research tool. Cardboard is chosen as one of the materials that can be tested for its suitability in producing furniture and various shapes in interior design. Due to its lightweight and environmentally friendly characteristics, cardboard is well-suited for laser cutting. The choice of cardboard also aligns with energy efficiency in the cutting process, as it can use less energy and work faster than other materials. For instance, cutting 3 mm thick cardboard at speed of 10 mm/s will consume 30 watts of electricity, whereas cutting 3 mm thick MDF at the same speed will consume 90 watts. However, using high power can lead to damage, such as burning in wood or other materials. Therefore,

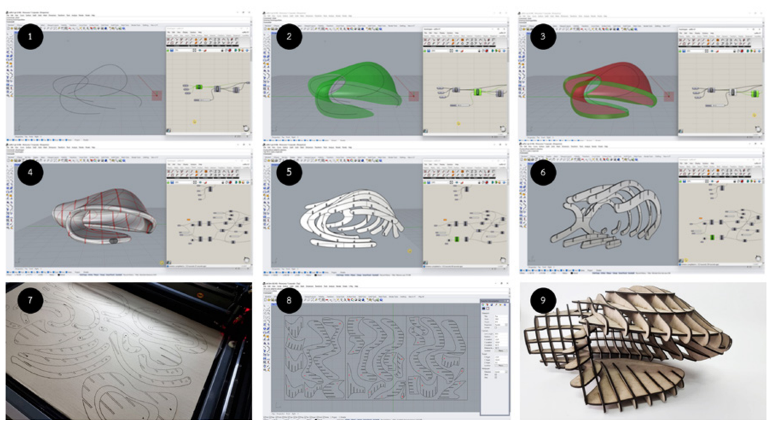

Figure 3
Preliminary steps for parametric design to the experimental process by physical model for waffle structure (Image by authors)

cardboard is considered an appropriate material for this experiment. Considering the advantages of the parametric program, designers can adjust material selection, size, and properties while considering factors like sustainability, ecological impact, and practicality.

Application of Parametric Design: Creative Processes and Possibilities

In contemporary times, the application of parametric design spans across multiple disciplines. Its influence is evident in the following fields: architecture, interior design, decoration, fashion, urban planning, and structural analysis. Parametric design introduces a world of creative and dynamic shapes, often drawing inspiration from nature, and it operates based on algorithmic relationships and interconnected elements. Its versatility allows for generating innovative solutions and handling complex equations, facilitating an extensive exploration of architectural problem-solving through algorithmic methods. Parametric design is widely used in architecture to create innovative and efficient building designs. Architects use this software to generate complex geometries, optimise natural light, control ventilation, and analyse structural performance.

For example, the Heydar Aliyev Center in Baku, Azerbaijan was designed by Zaha Hadid Architects following a competition in 2007. Using parametric tools, the architects meticulously studied surface geometry to establish a cohesive relationship that seamlessly blends the building with its surrounding landscape. This emphasis on continuity and dynamic geometric forms showcases the potential that parametric design offers in architectural practice. It also addresses practical construction challenges, such as manufacturing, handling, transportation, and assembly considerations. The design process accounts for various dynamic factors, including movement due to deflection, external loads, temperature fluctuations, seismic activity, and wind-induced forces. This comprehensive approach ensures that the architectural creation embodies aesthetic and conceptual brilliance and integrates seamlessly with real-world construction demands. Parametric design is not limited to a specific scale and can effortlessly transition from small-scale product designs to expansive projects. The innovative approach of parametric design thinking and modelling technology offers significant applicability in efficiently producing serialised home appliances, furniture, and household items (Sun & Huang, 2019).

Figure 4 is another compelling example of parametric furniture design. It is a small 3D model simulation to show the concept and creative work. The generative form-finding process considers structural efficiency, material properties, ergonomic needs, and production processes. Parametric concepts were employed from the beginning of the entire design to the production process. This method allows for creative innovation and aligns with modern manufacturing techniques. This is evident in the complex and unique shapes created by 3D printing, but this type of method requires a large 3D printer and the resources to print furniture that conforms to the scale and human anatomy.

Figure 4
Furniture design based on parametric design (Photographs by authors)

In parametric art creation, artists tend to use this concept to produce complex and visually appealing artworks by defining algorithms and parameters. Through this process, they can create patterns, shapes, and colours that evolve and change over time or in response to external factors. Generative art could be visualised in interactive installations, digital animations, and sculptures. For example, Figure 5 shows an artwork created from parametric design with coding algorithms. This creative technique, which consists of designing, coding equations, or scripting, commences with Grasshopper, a parametric modelling and visual programming tool employed to structure complex algorithms.

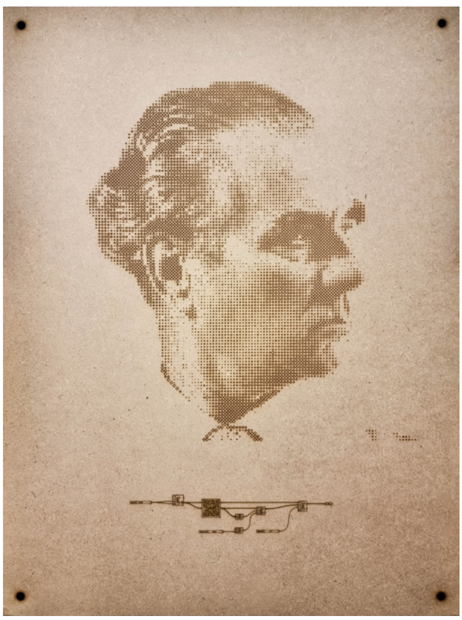

Figure 5
Artwork created using parametric design to generate algorithms from original images (Image by authors)

The creative process starts with converting a prototype image into a black-and-white format. This process allows the computer to compute the distribution of dark and light points within the image. The next step is to create the coordinate points or grids tailored to meet the designer's specifications, while these two values are combined by issuing commands through the computer. Geometric shapes, specifically squares in this instance, are employed to represent the darker areas of the image. The radius from the centre of these shapes widens as the image areas become darker, creating a descending effect based on shading levels. After the designer has formulated equations to guide this creative process, a simulation of the artwork is generated, and the resulting values from these calculations are transmitted to AutoCAD for further processing in a 2D format to determine the scope and size of the workpiece, preparing it for the subsequent manufacturing steps. The final stages involve translating the calculated information into action. A laser cutting machine is employed to engrave the shape of the lines into the wood through controlled electric charges. This process effectively brings the envisioned artwork to reality, translating the digitally generated design into a tangible creation.

Parametric design has broad applications across multiple fields, including design and computational production, urban planning, computational fabrication, landscape and medical device designs, sculpture, and art installations. It enables artists and sculptors to explore intricate shapes that would be challenging to conceive and fabricate using traditional manual production methods. However, by incorporating parametric techniques, they can use computational tools to create shapes with heightened visual complexity and accuracy. The combination of parametric principles with computer technology facilitates the creation of complex and visually captivating designs, surpassing the limitations of traditional manual methods. This symbiotic relationship increases artistic potential, enhancing the creative process and enabling a more refined and sophisticated method of shaping their expressions.

In essence, parametric design empowers creators and designers alike to explore various possibilities, optimise designs, and cater to individual needs or specific contexts. Its integration enhances efficiency, sustainability, and creativity across diverse industries, contributing significantly to both design and technology advancement.

Parametric Design Process in Interior Design: Variety and Optimisation

Parametric design is widely used to create models or solve problems in architecture, interior, and product design. Parametric designs are becoming increasingly popular presently because their tools tend to control the entire process, bringing about diverse possibilities through model generation. The complex systems resulting from parametric design in furniture contribute to various designs, ranging from intricate geometries to flexible structures. This capability allows designers to surpass traditional limitations because the main feature of parametrics is its ability to modify parameters, processed by setting values that respond to factors such as structure, user preferences, environment, and space constraints. Parametric designs often combine functional and aesthetic considerations, requiring designers to strike a balance between eye-catching appearance and functionality.

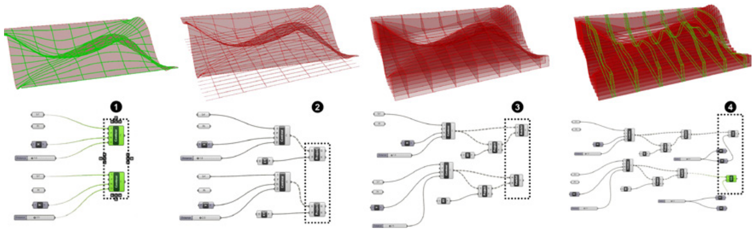

Figure 6
Visual programming language and graphical algorithm editor simulating relation among parameters (Image by authors)

Additionally, it can optimise material use by reducing waste and improving precision, influencing the cost-effectiveness of the production process because parametric design involves algorithms that explore design possibilities based on predefined parameters. This creative approach has yielded numerous innovative design ideas. It also encompasses the integration of advanced technology, such as Computer-Aided Design (CAD), which enhances the accuracy and efficiency of the design and manufacturing process. Figure 6 and Figure 7 illustrate an example of bench design that used parametric calculations to determine the optimal cardboard. This strategic use of parametric design simulation consists of performing calculations before advancing toward the production stage. The carefully adopted approach ensures that the structure and dimensions of the chair are precisely calculated and optimised, producing an efficient and well-crafted final product, involving a physical parametric bench experiment utilising cardboard material (Figure 8).

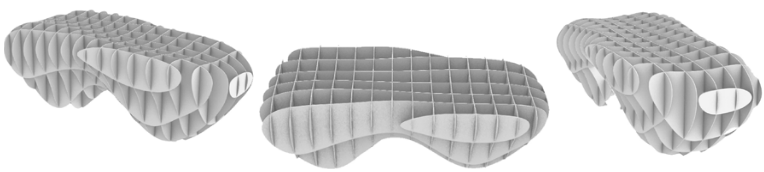

Figure 7
Three-dimensional bench model with the waffle equation (Image by authors)

Parametric design is used to formulate equations and manipulate and create complex connections with various materials. This research

Figure 8
Parametric bench experiment with cardboard material (Image by authors)

focuses on applying this method, specifically in furniture and interior design. Form-finding methods centre on end-to-end digital modelling for this type of work driven by algorithmic thinking, from the digital model to the fabrication process (Figure 9). This includes considering the properties of the materials used and the capabilities of the digital prototyping machine. Designing furniture or products starts with creating a model that establishes significant points or lines to determine the desired curvature. Following this, plane projection lines are extended along the x and y axes, establishing endpoints for the base. Furthermore, the plane projection lines on both the x and y axes are used to determine the endpoints of the base. These lines were connected to generate a surface while increasing the thickness of each sheet. Upon achieving the desired design, the subsequent step (Figure 10 and Figure 11) involves importing a CNC or laser cutting machine for cutting and initiating the assembly process (Figure 12). This facilitates the assessment of the appropriate space or usage.

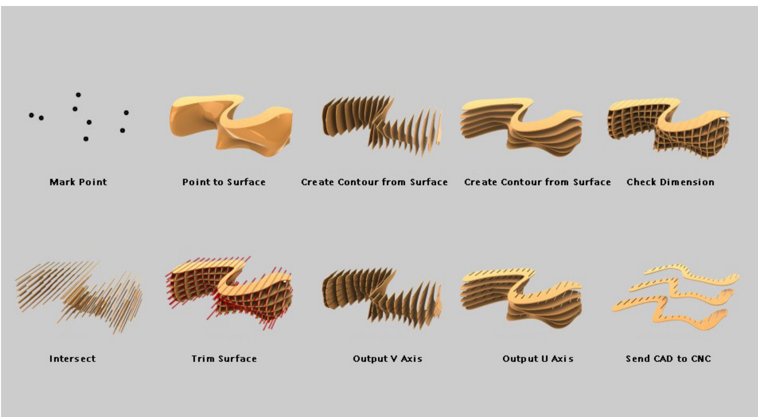

Figure 9
Diagrammatic representation of the design algorithm (Image by authors)

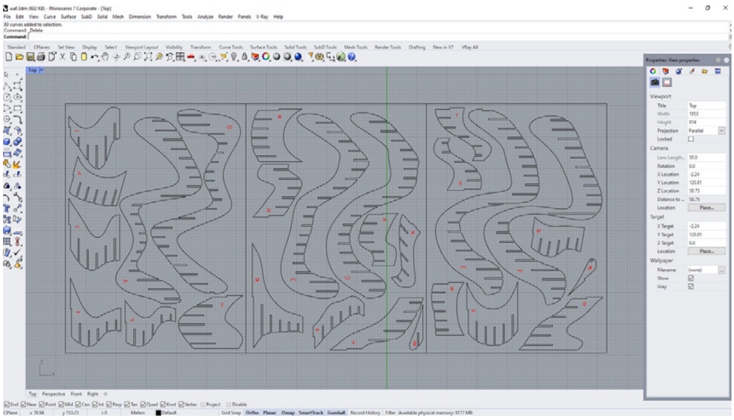

Figure 10
Technical 2D drawing of components from a 3D model for CNC machine laser cutting (Image by authors)

Figure 11
Cardboard material cut by a laser cutter for further assembly (Photograph by authors)

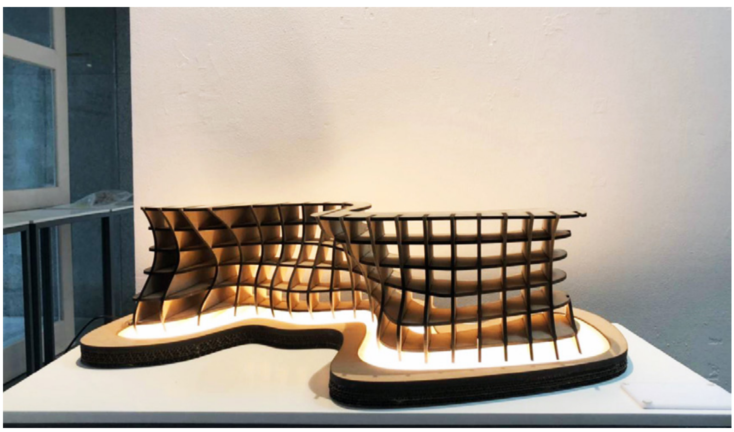

Figure 12
A model in a wooden panel assembling test (Photograph by authors)

The parametric method starts with the creation of points or lines to define the shape of the furniture; these are then inputted into equations to generate the desired form. The program calculates the appropriate proportions for the structure and adjusts it according to the selected material and size. This method tends to create unlimited modular shapes based on simple elements. Designing furniture or home decorations using parametric design has unique dynamics, including setting the frequencies between the compartments to determine the proportions of different objects to fit on the shelf. This process exemplifies a case of parametric design within the realm of interior design (Figure 13). Designing a product and interior spaces through the application of parametric concepts or by crafting an algorithm script requires specific prerequisites and factors to establish the conceptual framework and guide the designer. Designers need to consider essential principles to ensure the creation of practical and viable work. As a result, the primary considerations when writing scripts involve material factors and production tools, which play a crucial role in producing functional and user-friendly works.

Figure 13
Examples of interior design projects using parametric design (Image by authors)

Contemporary Parametric Design Technology: Divergence and Progress

Advancements in technology have prompted a profound shift in the process of furniture and interior design. According to Kolarevic (2001), digital architecture is revolutionising the design and construction processes by seamlessly integrating the elements of design, analysis, manufacturing, and assembly within the domain of buildings, with technology assuming a pivotal role. This led to the transition from manual or physical simulations to the adoption of technology as an essential aid for handling complex calculations and solutions in a significantly short timeframe. Parametric design provides a method for conceptualising and generating innovative design solutions (Lee et al., 2014).

Current technology serves as a fundamental source for computational programs that assist in shaping designs, including various aspects of construction and production. The difference between past and present parametric designs stems from the evolution of manufacturing technology and design methods. In the past, parametric designs faced limitations due to restricted computational capabilities. Designers were forced to rely heavily on manual calculations and physical models, which proved time-consuming and needed the efficiency of modern parametric digital tools (Peteinarelis & Yiannoudes, 2016). In a study by Hamad and Husein (2020), a survey was undertaken to compare parametric design with traditional design tools, aiming to establish a measurement scale for evaluating the creativity of furniture with parametric design. The measurement encompasses creativity indicators recommended by Cropley et al. (2011), which include the following dimensions: innovation, aesthetics, functionality, elegance, and originality. The findings indicate that parametric design tools facilitate the creation of more creative designs compared to geometric design tools. However, contemporary progress has brought about a paradigm shift. The advent of powerful computers and sophisticated software allows designers to use digital parametric instruments that automatically select equations optimised for proportions or production requirements. This advancement has unlocked possibilities, enhanced the precision and speed of the design process, and ushered in a new era of efficiency and creativity in furniture and interior design Hamad and Husein (2020).

Contemporary parametric work has experienced significant advancements compared to the past, particularly in parametric software development. Presently, designers have access to many sophisticated parametric design tools, which contrasts with the past, when its usage was limited to professionals with computational expertise (Kolarevic, 2004). As a result, the current availability of user-friendly parametric software and plugins has facilitated the integration of its principles into the practical designs of professionals from diverse disciplines. Parametric design enables designers to approach their work in a manner that aligns with the nature of algorithms, and computational procedures typically encompass systematic steps and checks to ensure the safety of the created object (Coenders, 2021). With advances in parametric tools, designers can quickly test and evaluate various design variations. This parametric tool can improve designers' ideas in real time, leading to more optimised and efficient designs.

Conclusion: Toward Dynamic and Flexible Interior Design

Parametric design was widely used to explore design possibilities across diverse fields such as engineering, architectural, interior, and industrial designs. By applying parametric equations, designers could create dynamic and flexible designs, proficiently tackle complex problem-solving tasks, deconstruct intricate structures, and present their creations with exceptional precision.

The present research analysed the concept and process of adopting mathematical proportions, commonly known as parametric design, in creating furniture using the waffle structure as an illustrative example. This structure stands out for its ease of disassembly and remarkable load-bearing capacity. From a scientific and mathematical viewpoint, parametric programming yielded significant product design advantages, particularly in furniture and interior design. Its versatile applications include calculations, proportioning, stress analysis, and aesthetic enhancements, all based on the formulation of algorithms, scripts, or design applications. This metric-driven approach allowed for the precise measurement of distances and proportion calculations, resulting in furniture that can be readily disassembled and reliably weight-bearing capabilities.

The incorporation of parametric programming into furniture design showed significant potential for further development. This research presented a critical perspective on designing creative works for the future. It exemplified the application of parametric principles to both structural and furniture design, thereby achieving distinctive identities for interior design. The growing popularity of parametric methods in the future was attributed to their design patterns and efficient production methods, which led to resource and labour-saving, including error prevention. Additionally, the provided scripts or equations served as valuable resources for those interested in further exploring the topic, offering a guide to presenting designs and artistic products using innovative techniques.

Parametric design offers numerous important and beneficial aspects for various design applications, including interior and furniture design. One key feature is its flexibility, enabling easy adjustment of parameters to meet individual needs. This flexibility allows designers to instantly visualise the impact of changes on the final design, aligning it with the designer's intent. Providing a comprehensive user experience, parametric tools allow for faster exploration of design possibilities. They empower designers to create complex geometries that might be challenging or impossible using traditional design methods. Integrating technology, particularly through computer use, enhances manufacturing processes and ensures an accurate design-to-manufacturing transition. Another notable advantage of parametric design is its contribution to exploring new structural solutions. This facilitates adjustments to the structural integrity of furniture or interior designs while simultaneously reducing material usage, increasing material efficiency, and maximising resource utilisation by controlling and minimising waste. Parametric design aligns with principles of sustainable and environmentally friendly design. Moreover, the sustained evolution of parametric methods has influenced various industrial systems, such as 3D printers, to attempt to meet their challenging design requirements. These advancements have given birth to new definitions, solutions, and applications across multiple disciplines, leading to new possibilities.

In summary, parametric tools provide designers with the capability to explore diverse options under various conditions efficiently, fostering creativity and innovation. This capacity pushes the boundaries of design possibilities and contributes to discovering new, effective, and sustainable design solutions.

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