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A Historical and Critical Assessment of Parametricism as an Architectural Style in the 21st Century

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Abstract: Architectural styles have evolved, with distinct periods marked by unique styles that reflect broader artistic movements. Despite extensive research on traditional and contemporary architectural styles, there remains a gap in understanding the distinctiveness and contributions of Parametricism as a 21st-century architectural style. This study aims to critically examine the emergence and development of Parametricism, aiming to highlight whether it represents a fundamental evolution in architectural thought and practice or primarily a methodological innovation. Through a comprehensive investigation of its formal characteristics, historical roots, and relationships with other architectural movements, this study seeks to discuss Parametricism's unique contributions to modern architecture. This research is crucial as it addresses the underexplored area of parametric design's impact on architectural theory and practice, offering a critical analysis that situates Parametricism within the broader context of 21st-century architectural styles. By clarifying the definition and position of Parametricism, this study aims to enrich both the state of the art and the state of practice in the field, providing valuable insights for scholars, practitioners, and students of architecture. Through this critical assessment, the paper contributes to the ongoing discourse on the evolution of architectural styles, highlighting the originality and significance of Parametricism in contemporary architecture.

Keywords: architecture style; style; parametricism; 21st century; parametric design

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1. Introduction

Over the past two decades, the field of architecture has undergone a significant transformation in design and construction methodologies [1]. Traditionally, architectural design primarily relied on analog tools such as freehand sketching, physical model making, and drafting boards [2]. In recent years, however, the widespread adoption of computer-aided design has become the norm in numerous design firms, profoundly impacting the representation and production of architectural concepts [3]. As we progress, it is anticipated that technological advancements will continue to drive changes in the way buildings and spaces are designed [4]. In order to examine Parametricism's position within this context, it is crucial to consider not only the technological advancements that have facilitated its emergence but also the methodological issues pertaining to the design process itself [5]. Accordingly, this study performs an in-depth exploration of parametric architecture, critically examining its theoretical foundations, historical evolution, and unique characteristics within the framework of modern architectural discourse. This research aims to address the gap in the literature regarding the classification and distinctiveness of Parametricism as a 21st-century architectural style, highlighting its innovative contributions and intrinsic values. By analyzing the intersections of Parametricism with the historical and cultural context of architecture, this study reveals the ways in which contemporary design paradigms are shaped by and, in turn, shape architectural trends. This exploration not only underscores the complexity and richness of architectural history but also offers new perspectives on how Parametricism influences and redefines modern architectural practices. Specifically,

by situating Parametricism within the broader spectrum of 21st-century architectural styles, this research provides critical insights that are valuable for practitioners, architectural firms, and academics. The ultimate aim of this study is to significantly enrich the state of both theoretical and practical knowledge in the field, advancing the understanding of Parametricism's role and impact in contemporary architecture.

2. Research Methodology

The research methodology implemented in this study was meticulously designed to not only grasp a comprehensive understanding of parametric architecture (Parametricism), its historical development, and major milestones, but also to examine its role among contemporary architectural styles in the 21st century. By employing a qualitative approach, the methodology combined an intensive descriptive analysis with a critical literature review, further enhanced by content analysis to scrutinize the results.

2.1. Intensive Descriptive Approach

The intensive descriptive approach, Figure 1, is a disinterested methodology that predominantly seeks to acquire knowledge, namely, descriptions and explanations, about the subject under study without intending to modify it. As shown in Figure 1, the aim is to determine the current state of affairs or the historical progression of the subject. While the methodology may involve collecting opinions on the desirability of the present state, it does not involve planning any improvements [6].

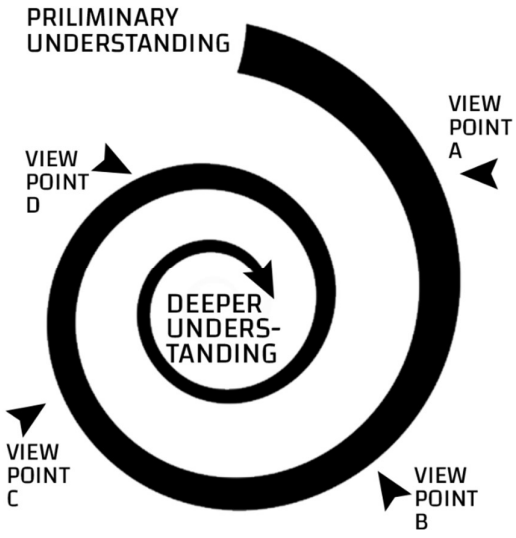


Figure 1. Illustrates the intensive descriptive approach, redrawn based on Pentti Routio's explanation.

2.2. Critical Review of the Literature

A critical literature review was conducted to understand architectural style and Parametricism and achieve the research objectives. As illustrated in Figure 2, this review encompassed the exploration of the concept of style and architectural style and an investigation into the origins of parametric design and Parametricism in architecture. Furthermore, the review examined the various phases of Parametricism and the initial attempts at employing this "style" to understand the presence of parametric design in the realm of architectural theory and practice. In general, the critical review of the literature involved a systematic exploration across renowned databases, including Google Scholar, Web of Science, and Scopus. This rigorous process aimed to collate a broad spectrum of scholarly articles, books, and case studies, organized on a chronological basis to capture the evolution and impact of Parametricism in architecture. Moreover, this study distinguished itself by incorporating practical works from reputable architects, reflecting a dedication to enriching both the theoretical discourse (state of the art) and practical application (state of practice) in the field.

This inclusion of practical examples served to bridge the gap between abstract theoretical concepts and tangible architectural achievements, offering insights into the real-world implications of parametric design principles. All references, whether theoretical or derived from practical architectural works, are comprehensively listed in the manuscript's references section. The selection of these sources was informed by extensive keyword searches, ensuring a diverse and robust foundation for the study's conclusions.

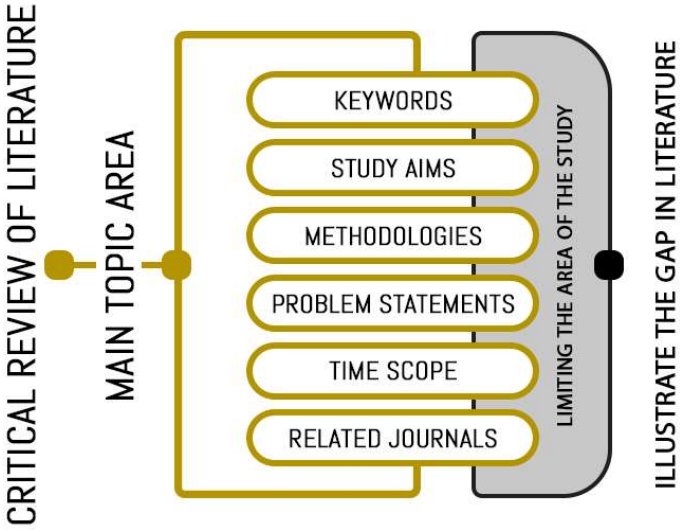


Figure 2. Application of critical review of the literature in this study.

3. What Is a Style?

Style is a multifaceted concept with various explanations attributed to its meaning; a mere discussion of dictionary definitions would be inadequate [7]. Nevertheless, these basic definitions can help clarify and elaborate on the concept in general and the aims of this research [8]. A summary of the definitions from just two dictionaries demonstrates the diversity of meanings attributed to the concept. Koenen and Drewes distinguish four meanings: style as a mode of expression in written words, a general mode of expression in the common features of a certain school or period in art, a habitual way of doing things, and a chronological system like the Gregorian or Julian chronology [9,10]. It offers the following definitions of style [11]:

- The distinguishing way in which something is done, said, written, made, executed, etc.;
- The distinctive character of a particular school or type of music, painting, architecture, writing, etc., or the work of a particular person;
- The way in which literary or musical content is expressed;
- Manner or tone assumed in speech or oratory [11,12];

These lists from just two dictionaries highlight the diverse ways in which style is defined across different disciplines. Although several of these definitions may be deemed irrelevant to this research, enough descriptions remain to cause confusion.

3.1. Values, Definitions, and Understanding of the Style

Architectural design frequently employs recurring patterns and styles to organize systems, leading to design reuse, code reuse, ease of understanding for others, interoperability, specialized analyses, and style-specific visualizations [13,14]. However, architectural styles are largely ad hoc, necessitating a more rigorous basis for understanding and utilizing them [12]. Three approaches for providing this basis are outlined and compared in the paper:

- Style as Language

In this view, the architectural style is understood as a set of grammatical productions, similar to a programming language. Configuration rules are defined as context-free and context-sensitive rules of grammar [15]. A semantic interpretation can be given using standard techniques for assigning meaning to languages. Analyses are essentially those that can be performed on architectural programs, such as checking for the satisfaction of grammatical rules and flow analysis [16].

- Style as a System of Types

In this view, the architectural vocabulary is defined as a set of types [17]. Constraints on these types can be maintained as datatype invariants, which are operationally realized in the code of the procedures that can modify instances of the types [12]. Analysis can exploit the type of system to perform type checking and other architectural manipulations that depend on the specific types involved, such as code generation [12].

- Style as a Theory

In this view, a style is defined as a set of axioms and inference rules [18]. Vocabulary is not represented directly but in terms of the logical properties of elements [19]. Configuration constraints and semantics are defined as further axioms. The analysis takes place by proving a new theorem and extending the style theory [20].

3.2. Architectural Style

An architectural style is characterized by distinctive features that make a building or structure notable or historically identifiable [21]. Generally considered a subclass of visual arts style, architectural styles encompass elements such as form, construction methods, materials, and regional characteristics [22]. These styles often reflect evolving trends, beliefs, and technological advancements [23]. The term "style", derived from the Latin "stilus" via Old French, initially referred to a manner of writing [24]. By the 18th century, it had come to denote a mode of skilled construction or production. The concept of style has diverse applications across disciplines, making a comprehensive review challenging [25]. However, understanding the various definitions and descriptions related to architectural design is crucial for conceptualizing style in this field. Historically, architectural style has fluctuated in its legitimacy and usage [26]. For example, before 1750, architecture adhered to established principles, allowing architects to exercise creativity within recognized rules. The awareness of architectural styles, such as Classical or Gothic, developed long after the structures were built [27].

Style is not inherent in the material but must be interpreted and documented. It was further elaborated on the historical consciousness of style, particularly during the period between 1750 and the early 20th century, when the focus shifted from defining style to selecting the appropriate style for different building types. Architectural education during this period emphasized that style should authentically reflect the building's purpose and was considered the "poetry of architecture" [28]. In modern times, architectural style is often viewed through the lens of abstraction and categorization of design elements [14]. This approach to style, particularly in software architecture, emphasizes the functional and non-functional properties of architectural elements [29–31]. Styles are used as mechanisms for defining the common characteristics of architectures, abstracting the interactions of components by focusing on essential patterns and constraints [20]. This approach allows for flexibility and innovation in design while maintaining coherence and consistency across different projects [32,33]. However, the notion of style as a set of constraints rather than a personalized design process has led to debates within the architectural community. Recent critiques of modern architectural practices highlight concerns about the loss of identity and coherence in contemporary designs. The rise of architectural barbarism was discussed, emphasizing the disconnect between modern architecture and its historical roots [34]. Similarly, Refs. [35,36] explored the philosophical underpinnings of architectural principles in the context of fraud and obfuscation, questioning the authenticity and integrity of current

architectural trends. In this regard, he argued that Deconstructivists share problematic assumptions with other movements like phenomenology, including an anti-visual stance, an overemphasis on language, and a tendency to attribute architectural creativity to collective cultural influences rather than individual agency.

Refs. [37,38] addressed the broader cultural and social implications of architectural styles, arguing for a return to designs that reflect cultural identity and historical continuity. The confused state of architectural research, as highlighted by [39], and the persistence of outdated architectural norms, discussed by [40], further underscored the challenges faced by contemporary architects. Refs. [41,42] criticized the aesthetic failures of modern architecture, advocating for a return to principles that prioritize functionality and human-centered design. In summary, architectural style is a complex and multifaceted concept that encompasses both historical traditions and modern innovations. The ongoing debates within the field reflect a broader struggle to balance the demands of innovation with the need for continuity and coherence in design. The architecture epochs is demonstrated in Figure 3.

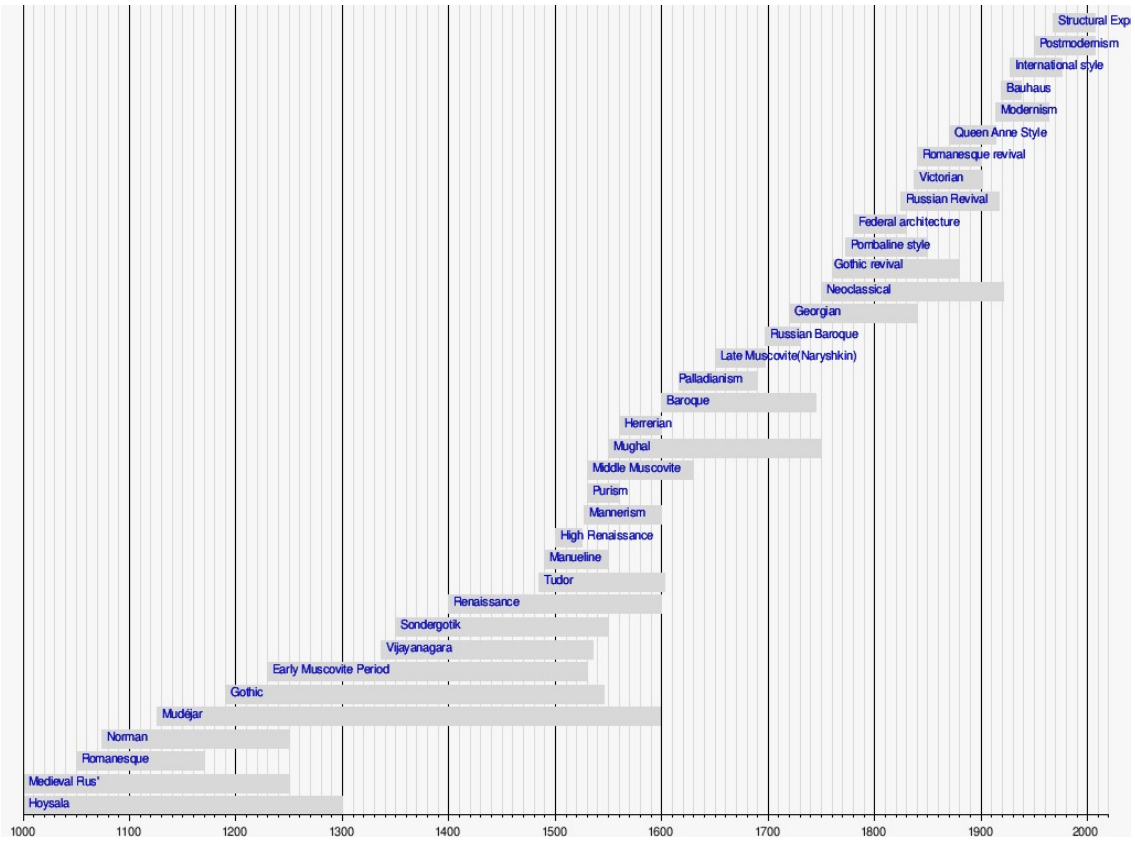


Figure 3. Architecture epochs.

3.3. Twenty-First Century Reconsiderations of Architectural Styles

As the world transitioned into the 21st century, the field of architecture witnessed a profound transformation, influenced significantly by the advent of information technology and a globalized perspective on design. This era marked a departure from traditional paradigms, ushering in an age where the reconsideration and reinterpretation of architectural styles became a focal point for innovation and creativity. Ref. [43] identifies this trend as a reflection of the industry's response to the dynamic changes in societal needs, technological advancements, and environmental concerns. This period of architectural evolution, Figure 4, is characterized by a multifaceted approach toward design, where architects and designers ventured beyond the confines of conventional styles to explore the integration of historic elements with modern aesthetics and functionality. Ref. [44]

highlight the inclination towards modernizing and updating older styles, which was not merely an act of revival but an endeavor to make these styles pertinent to contemporary societal demands. This approach led to the creation of hybrid styles, which melded the essence of different eras and cultures into a cohesive design language, resonating with today's diverse global landscape. Among the various styles that emerged during this period, Parametricism stands out as a distinct movement that epitomizes the twenty-first century's architectural ideology. Defined by Patrik Schumacher and exemplified through the works of Zaha Hadid Architects (ZHA), Parametricism is not just a style but a methodology that leverages computational design tools to generate fluid, dynamic forms and spatial arrangements. This style is characterized by its adaptability, precision, and the ability to create complex, integrated systems that respond to environmental, social, and economic parameters. Parametricism's significance lies in its innovative use of technology to redefine the boundaries of architectural design, making it a pivotal example of how the discipline has evolved in response to the IT revolution. This movement also aligns with the industry's growing emphasis on sustainability, as parametric tools allow for the optimization of materials and energy use, thus contributing to the development of more sustainable design solutions. In comparison to other twenty-first-century styles, Parametricism can be seen as a forerunner in the adoption of advanced digital technologies, setting a benchmark for how architects can harness computational methods to enhance design efficiency and effectiveness. While other styles may draw from historical or cultural influences to inform their aesthetic and functional aspects, Parametricism's foundation in algorithmic processes and data-driven design represents a paradigm shift towards an architecture that is inherently responsive to its context and capable of addressing the complex challenges of the modern world. Moreover, the exploration of traditional or indigenous styles, as noted by [45], further underscores the architectural community's interest in creating spaces that are not only innovative but also culturally sensitive and inclusive. This endeavor to blend the old with the new, the traditional with the cutting-edge, reflects a broader ambition within the field to conceive buildings and spaces that are both functional and aesthetically pleasing while also being mindful of their environmental impact and cultural significance. Figure 4 shows the development of the notable architectural styles through history.

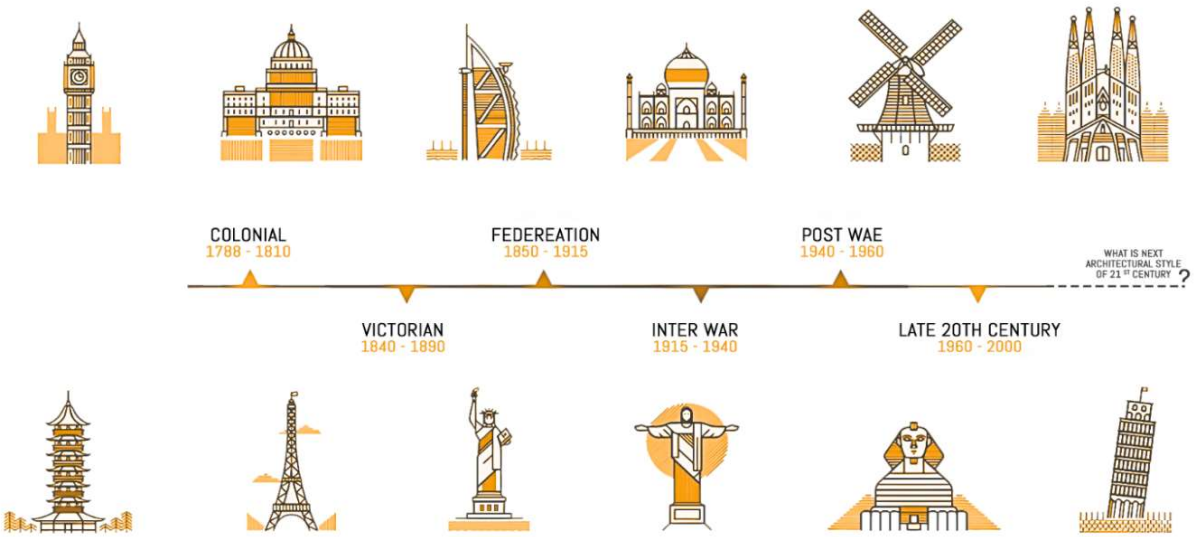


Figure 4. Notable architectural styles grouped by historical period.

4. Parametricism in Architecture

This section explains the roots and antiquity of Parametricism in architecture and provides meanings and sympathies with Parametricism as a recent term in this field. Later, it discusses numerous scholars' clarifications and identifications of Parametricism, finalizing by interpretation of styles and Parametricism and ending with heuristics in

Parametricism. Figure 5 reflects one of the initial efforts to use parametric equations originated in Robert Hook's hanging chain model, which Antonio Gaudí then established in his ideas [46]. It is problematic to distinguish if Gaudí was constrained by the diverse investigators and mathematicians who had previously applied parametric formulas to illustrate geometry [47]. Mark Burry, the contemporary authorized architect of Gaudí's Sagrada Familia, utters that there is for all aims and objectives none composed by Gaudí himself about the motivations, conjectures, and repetition that pushed him to spread the limitations [48].

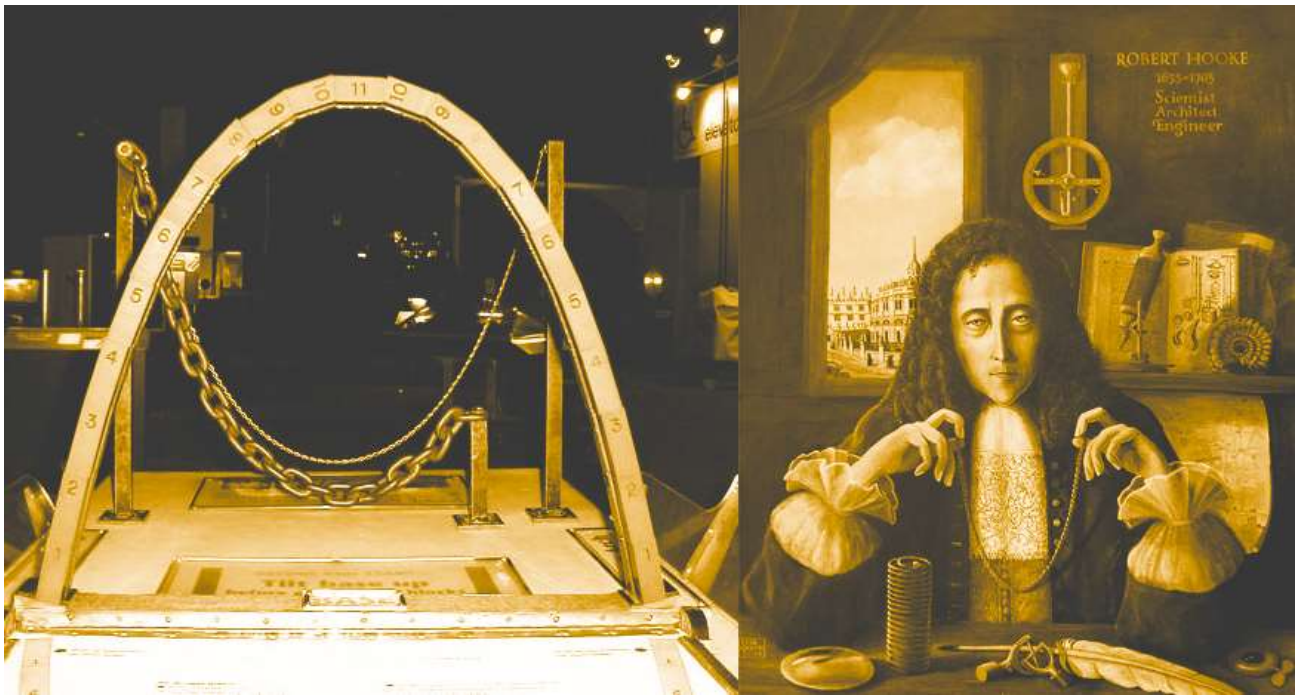


Figure 5. Robert Hook's hanging chain model.

Compared with the first requests of parametric formulas by investigators and geometricians, the advanced progress of Gaudí's hanging chain structure, Figure 6, validates that it figures the parametric consequences [49]. He created a way to inevitably develop the shape of a catenary bend, succeeding the principle of gravitation on strings and leaving behind infinite manual calculations [50]. Figure 6 shows the catenary model.



Figure 6. Antoni Gaudí, the inverted catenary model, and diagram of cables and weights.

In the 20th century, before Zaha Hadid's partner Patrik Schumacher conceptualized Parametricism, one of the first individuals to talk about architectural parameters was Luigi Moretti. In 1958, he created the National Institute for Mathematical and Operative Research for Urbanism (IRMOU), where he researched and tried to progress parametric architecture [51]. In one of his works of literature, in 1940, he decided that" The functional parameters are accurately registered and recognized as the foundation for the expressive game of an architect" [51]. After twenty years, Moretti shared this with the world in his exhibition of "Parametric Architecture and Mathematical and Operational Research in Town-planning: 12th Triennial Exhibition, Milan, Arts' Palace, September–October 1960" (Figure 7). Greg Lynn, Jesse Reiser, Lars Spuybroek, and Kas Oosterhuis were parametric architecture's primary experts [52].

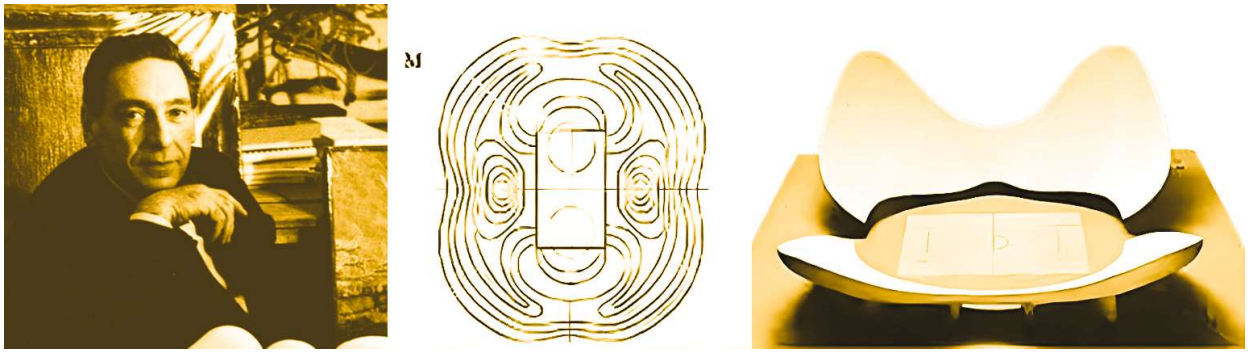


Figure 7. A model of a stadium by Luigi Moretti. Exhibited at the 1960 Parametric Architecture exhibition at the Twelfth Milan Triennial. The stadium derives from a parametric model.

In contemporary studies of Parametricism in architecture, researchers focused on bridging the gap between theoretical constructs and practical applications. Ref. [53] examined the contextual challenges faced by parametric architecture, emphasizing the need for a comprehensive understanding of contextual integration within design processes. Ref. [54] explored the journey from conceptual paper designs to tangible parametric structures, highlighting the transformative power of parametric design in translating abstract ideas into physical reality. Ref. [55] analyzed Luigi Moretti's pioneering contributions to parametric theory, exploring the discrepancies between theoretical aspirations and actual implementation in Moretti's projects. Ref. [56] examined parametric architecture's role in contemporary building design, advocating for a holistic consideration that encompassed social, environmental, and functional aspects. Ref. [57] investigated the intersection of artificial intelligence and parametric design, discussing how AI could enhance parametric exploration and generate innovative design solutions beyond human imagination. Ref. [58] examined the application of parametric methods in designing children's supplementary education facilities, highlighting how parametric design could create dynamic, adaptable spaces responsive to educational needs. Ref. [59] addressed the integration of cultural heritage identity codes into parametric design, proposing theoretical models that combined traditional architectural elements with modern parametric techniques. Ref. [60] investigated the potential of parametric design in shaping new city identities through innovative materials and environmental applications. Ref. [61] explored the rationalization of free-form architecture using generative and parametric designs, presenting methodologies to streamline complex geometric forms into feasible construction plans. Ref. [62] conducted parametric experiments to push the boundaries of architectural form and function, encouraging architects to explore uncharted territories in spatial and structural innovation. Ref. [63] revisited Moretti's views on digital representation in architecture, illustrating how parametric tools could transform perception and interaction with architectural spaces. Ref. [64] focused on the underlying principles and thought processes that drove parametric thinking rather than the visible outcomes. Ref. [65] discussed procedural approaches

in parametric design, emphasizing step-by-step methodologies guiding architects from conceptualization to realization. Ref. [66] explored the use of parametric shape grammars in architectural design, using a district of "Three Lanes and Seven Alleys" in Fuzhou City as a case study. Ref. [67] proposed a pixel-based design approach for patterning dynamic façades, leveraging parametric thinking to create responsive and visually engaging building exteriors.

4.1. Parametricism's Definition

The word "parametric" is derived from the expression "parameter", from the Greek "para", "beside", and "metron", "measure". According to the Oxford Dictionary, its well-known practical definition states that it is a mathematical and calculable factor defining a set and describing a specific scheme of its operation. The parametric expression is strictly related to the parameter, and it defines and describes Parametricism based on a system that expresses a purpose in the procedure of its limitations. Therefore, parametric cooperation ensues in the last iteration. If any of the initial parameters are changed or transformed, the subsequent product will adjust to consider these distinct changes. Ref. [68] wrote in his "Parametricist Manifesto" that: "The important heuristics of Parametricism are completely imitated in the taboos and doctrines of modern avant-garde design philosophy. The Heuristics of Parametricism is a set of guidelines that have been developed over time through various projects across the globe. These heuristics are divided into two categories: Formal Heuristics and Functional Heuristics" [68]. Figure 8 illustrates the Kartal Pendik masterplan in Istanbul.

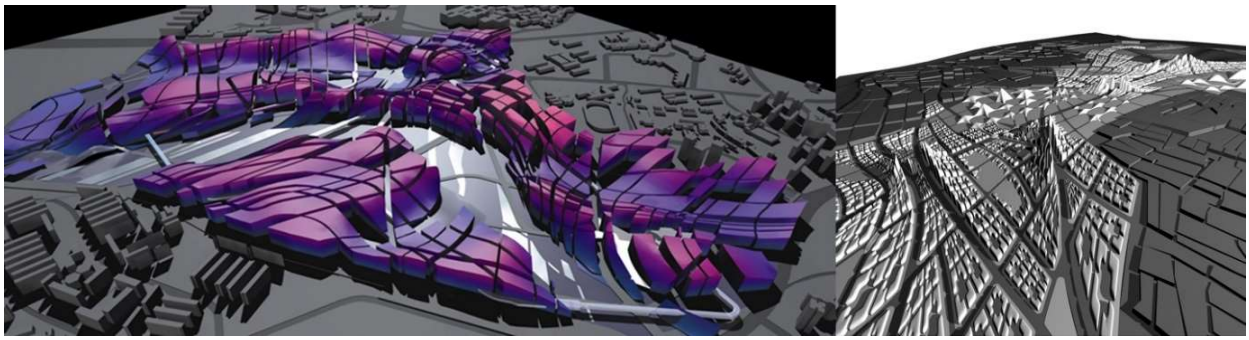


Figure 8. Zaha Hadid Architects, Kartal Pendik Masterplan, Istanbul, Turkey, 2006.

4.2. Scholars 'Arguments on Parametricism

How is parametric architecture different from a traditional one? The whole assembly does not complete parametric architecture; it is produced and distinguished by scripting and writing [69]. By binding structures and building and designing a specific phenomenon, it was easy to create complex forms [70]. Ref. [71] supposed that "calculation is essential for the development of natural systems and forms, just similar to the genetic code, would be the serious cause of the natural system. The physical instructions lead it, and stochastic evolution occurs" [72]. Steadiness is the deepest aim of associative design [73]. It was stipulated: "the parametric technique retains the path of each stage with a variable outcome". It will aid self-organization and morphogenesis. As a growth analogical to procedure and communications, computational understanding allows performative volumes [74]. Previous research asserted that the writing stretches a novel design with subsequent advances [75]:

- Procedure automation;
- Geometry through algorithmic definition;
- Enormous and quick changes of the innovative geometry;
- The ability to speedily gain methods of excessive complexity through frequent geometrical mechanisms.

Ref. [76] stated that in form generation and fabrication, Parametricism is a clever, resourceful instrument for attaining variety and complexity. Zaha Hadid, the Parametricism forerunner and Pritzker Prize laureate, provided sketches regarding parametric design and encountered the outmoded behaviors of architectural design (Figures 9 and 10) She indeed examined and tested the abilities of parametric design, and she generated construction as combined currents of vitality [77].

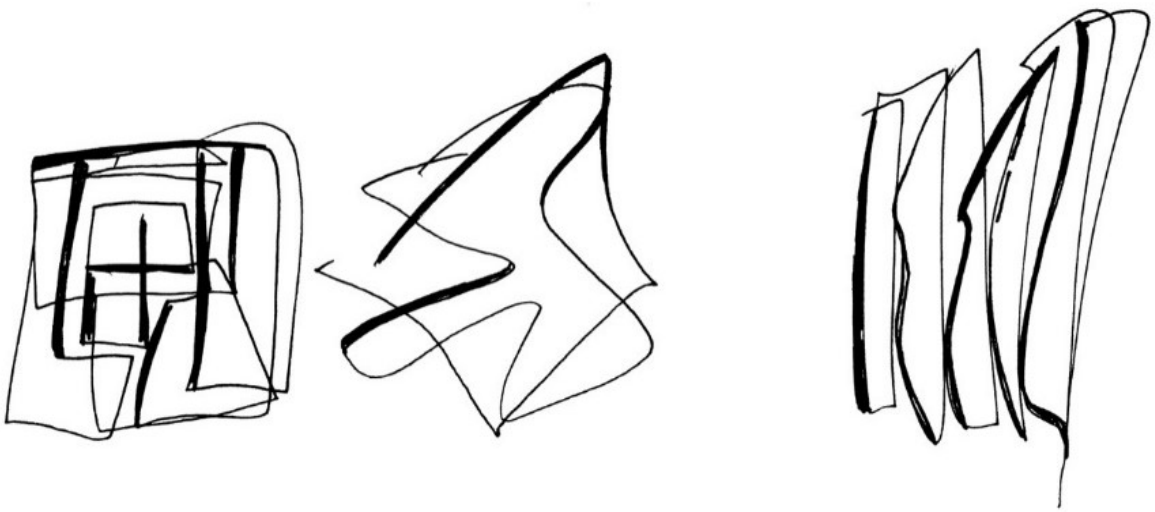


Figure 9. Sketch of Rosenthal Center for Contemporary Art.



Figure 10. Phaeno Science Centre.

By establishing the parametric model, the field of the indicated social communication patterns anticipated inside planned areas ought to be hooked on the architecture design medium [78]. In architecture history, for the first time, the modeling of life processes was consequently developed into a design conjecture [79]. This was made possible by using computational crowd-demonstrating methods through agent-based models [80]. Today, common tools such as processing or design tools such as Miarmy and Implant make social modeling with designed environments accessible to architects [81].

4.3. Bibliometric Analysis

This section reports the results of a bibliometric analysis that explores the evolution, popularity, and scholarly attention given to Parametricism and parametric architecture, utilizing data gathered from approximately 1000 literature sources in the Web of Science database. VOSviewer software version 1.6.2 was employed to analyze these sources, providing insights into the trends and patterns within the field. The study's bibliometric analysis begins with an examination of the number of publications over the years (Figure 11). The data reveal a gradual increase in interest and scholarly output concerning Parametricism

and parametric architecture since the early 2000s. The initial years saw a very low number of publications, with very few papers per year from 2000 to 2008. However, a noticeable rise began in 2009, with the number of publications growing significantly, reaching a peak in 2013 and another one in 2019 with 120 publications. This upward trend underscores the growing recognition and relevance of Parametricism within architectural discourse.

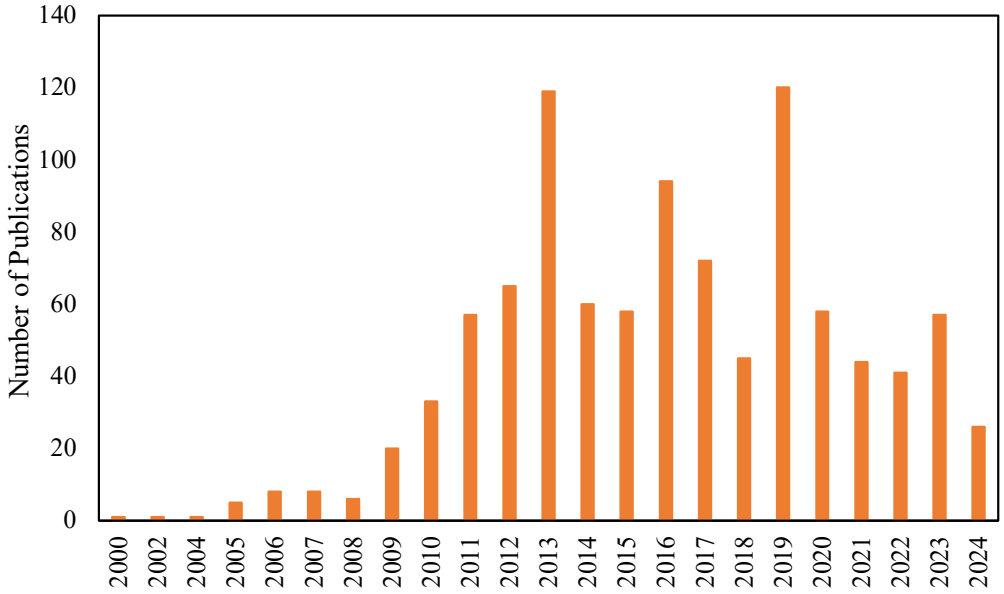


Figure 11. Number of publications on Parametricism and parametric architecture in the literature over the past years.

Further analysis of keyword co-occurrence (Figure 12) highlights the central themes and areas of focus within the literature on Parametricism. The visualization reveals that "parametric design" is the most prominent keyword, closely followed by "parametric modeling" and "design". This indicates that the core interest of the scholarly community lies in the methodologies and technical aspects of Parametricism. The dense interconnections between these keywords suggest a well-developed and interlinked body of research, emphasizing the methodological innovation that Parametricism represents. In terms of publication sources, Figure 13 shows that *The International Journal of Architectural Computing* is the leading journal in publishing research on Parametricism, followed by *The Nexus Network Journal* and *The Architectural Science Review*. This distribution of sources reflects the interdisciplinary nature of Parametricism combining both computational design and architectural theory. Additionally, the frequent appearance of the Education and Research in Computer Aided Architectural Design in Europe (eCAADe) conference indicates the significant role of academic conferences in disseminating research findings in this field. The geographical distribution of contributions (Figure 14) reveals that the United States leads in scholarly output on Parametricism, followed by Italy, Australia, China, and England. This international spread indicates a global interest in the subject, with substantial contributions from both Western and Eastern countries. The dominance of the United States may be attributed to its robust academic infrastructure and its early adoption of computational design techniques.

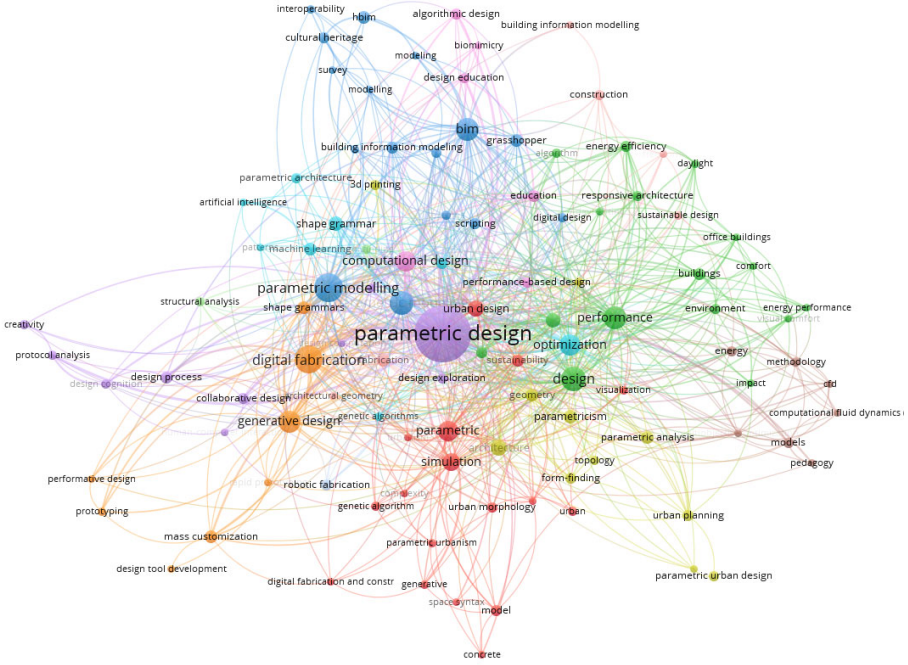


Figure 12. Keyword co-occurrence on Parametricism and parametric architecture in the literature.

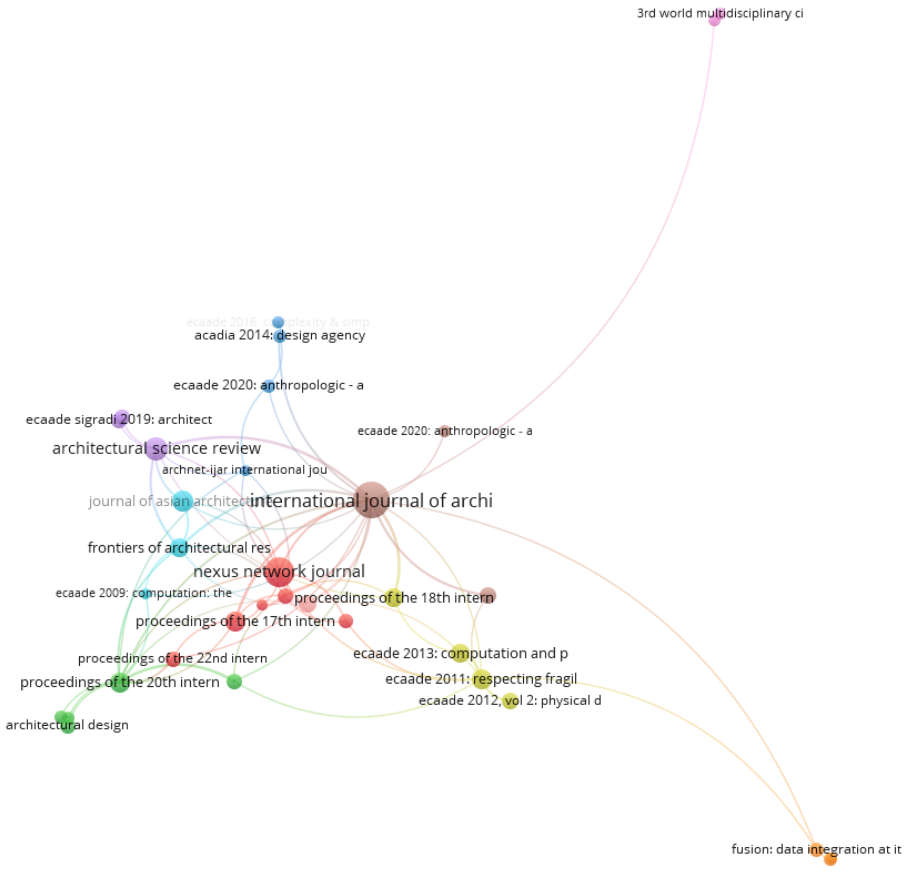


Figure 13. Literature sources with the highest number of publications on Parametricism and parametric architecture.

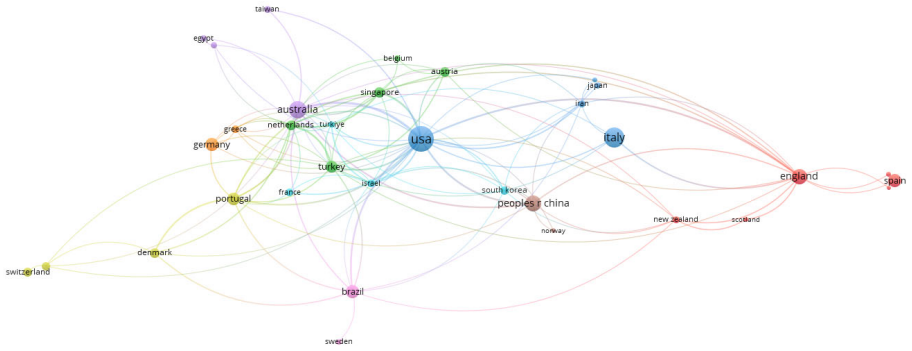


Figure 14. Countries with the highest number of contributions to Parametricism and parametric architecture.

Untimely, this bibliometric analysis highlights a broader impact and integration of Parametricism within the architectural community. The steady increase in publications, especially after 2008 when the term was coined, suggests that Parametricism has moved from a niche methodology to a mainstream architectural approach. This transition is further evidenced by the widespread use of related keywords and the diversity of publication sources, which indicate that Parametricism is being explored from multiple perspectives and disciplines.

4.4. Architectural Styles

Many scholars and researchers have studied Parametricism as a style of architecture. Some of these scholars have focused on the technical aspects of parametric design, examining the algorithms and computational techniques that are used to generate complex forms and structures [82–85]. Others have explored the aesthetic and theoretical foundations of Parametricism, examining how this style relates to broader trends and debates within the field of architecture [86–89]. Many of these scholars have also considered the practical implications of Parametricism, examining how this style is used in the design of buildings and other structures and how it impacts the built environment [90–92]. In general, the study of Parametricism as a style has contributed to a greater understanding of the role of digital tools and techniques in architecture and has helped shape the direction of design practice in the 21st century [91,93–95]. Parametricism within the context of 21st-century architecture is an emergent design paradigm influenced by several key factors, including advanced computational technologies, environmental sustainability concerns, material science advancements, and social and cultural changes [96]. This design approach has evolved in tandem with the development of sophisticated parametric tools, starting from early software such as Grasshopper and Rhino version 1, followed by the implementation of building information modeling (BIM), and culminating in the integration of artificial intelligence and machine learning [97]. By examining various typologies of parametric architecture, from residential and commercial buildings to cultural institutions and infrastructure, we can observe the diverse applications of this design approach [98]. Parametricism's implications span a range of aspects within the architectural field, impacting aesthetics through innovative forms, improving performance and efficiency, and enhancing adaptability and responsiveness to contextual factors [49]. Furthermore, Parametricism promotes interdisciplinary collaboration, fostering an exchange of ideas and expertise across different domains [99]. The exploration of Parametricism as a style or design method within 21st-century architecture highlights its transformative potential and invites a broader discussion of its future trajectory and influence on the built environment [100] (Figure 15).

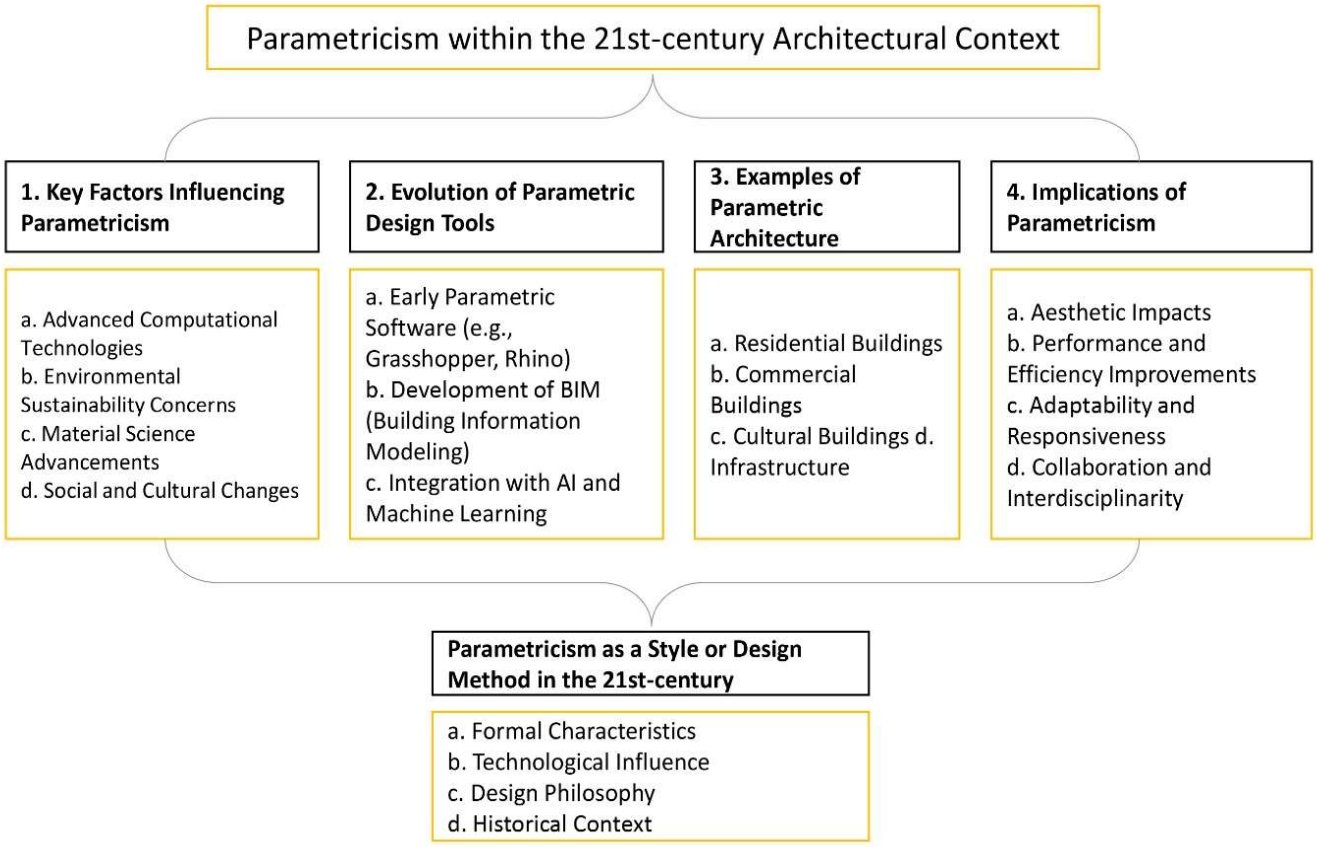


Figure 15. Parametricism within the 21st-century architectural context.

According to Table 1, which was created by the authors based on Schumacher's studies, Parametricism is characterized as an epochal style of the 21st century [101]. Appendix A defines the common styles existing nowadays. It is seen as a competitive style that has replaced Modernism and is considered to be a turning point in the traditional styles of postmodernism [101,102]. Parametricism is a style of architecture that is associated with the contemporary avant-garde movement [93,103,104]. It is often seen as a successor to both post-modern and modern architecture, and the term was coined in 2008 by [68], who is an architectural partner of the well-known architect Zaha Hadid (1950–2016) [86,105]. The origins of Parametricism can be traced back to the concept of parametric design, which involves using equations with adjustable parameters to create and manipulate designs. This approach relies on the use of programs, algorithms, and computers to manipulate these equations in order to generate complex, organic-looking forms and structures [48,106].

Table 1. Classification of styles according to Patrick Schumacher (redrawn by the authors based on [101].

Styles	Epochal Style	Subsidiary Style	Transitional Style
Passive Style	Gothic		
Active Style	Renaissance	Mannerism	
	Baroque	Rococo	
Active Reflective Style	Neo-Classicism		
	Historicism	Neo-Gothic	
		Neo-Renaissance	

Table 1. *Cont.*

Styles	Epochal Style	Subsidiary Style	Transitional Style
Active Reflective Style		Neo-Baroque	
		Eclecticism	
			Art Nouveau
			Expressionism
	Modernism	Neue Sachlichkeit	
		Organicism	
		Rationalism	
		Brutalism	
		Metabolism	
		High-Tech	
			Postmodernism

4.5. Heuristics in Parametricism

Heuristics are guiding principles within the design process, effectively framing Parametricism, a style that Schumacher has significantly developed through his theoretical and practical work [93,101]. These principles are not merely arbitrary but are deeply rooted in the analysis of decades of architectural innovation, including the seminal works of Zaha Hadid and global architectural practices. This analysis helps identify common features and values that have shaped contemporary architecture.

The term "heuristics" specifically refers to the established rules or guidelines that aid architects in progressing projects. These guidelines also help in avoiding regressive design practices that might revert to outdated styles, instead promoting a clear distinction and advancement in modern architectural methods [107]. Establishing a clear research hypothesis in architecture often requires a departure from some conventional methods, embracing new paradigms that foster innovation [106].

The discussion of heuristics in Parametricism can be further enriched by integrating views from various researchers who have explored similar territories. For instance, [85] examined how parametric design thinking is embedded within architectural practice, offering a nuanced look at the decision-making processes in design. Similarly, [96] provided insights into computational design thinking, which aligns closely with the heuristic methods in parametric design by promoting systematic and algorithm-driven approaches to architectural design.

Further, [108] offered a theoretical perspective on the diverse cognitive strategies involved in parametric design, suggesting that such heuristics not only guide the technical aspects of design but also influence creative decision-making. Ref. [109] discussed the implications of performative architecture, a concept closely tied to the heuristic optimization of building performance through design.

In this context, the exploration of parametric and computational design is not just about the adoption of new tools but also about a fundamental shift in the way architectural problems are approached and solved, reflecting a broader movement towards a more data-driven and empirically supported design process [82]. The integration of these methodologies points to a future where architectural design is increasingly responsive to both aesthetic and functional demands, driven by both historical insight and forward-looking innovation [110].

By weaving these various strands of research and practice together, the discussion on heuristics in Parametricism becomes a rich tapestry of theory, methodology, and application that significantly shapes the contours of contemporary architectural thought and practice. Figure 16 shows the parametric architecture design consideration.

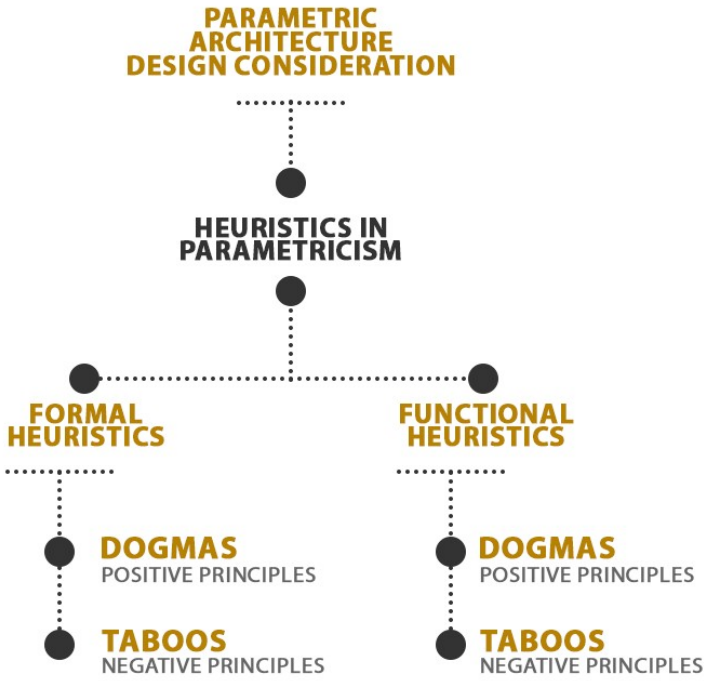


Figure 16. Illustrates the parametric architecture design consideration according to the analysis of the [111].

4.5.1. Functional Heuristics

The functional heuristics of Parametricism include negative principles and positive principles that have evolved since the mid-1990s across many projects worldwide and constitute unifying heuristics [93,112]. The Negative Principles include the avoidance of functional stereotypes (i.e., prescriptive program typologies) and segregative functional zoning (i.e., impermeable separation spaces according to single function allocation). The Positive Principles include networking parametric activity/event scenarios and communicating all spaces, activities, and events [111].

4.5.2. Formal Heuristics

Similar to functional heuristics, unified formal heuristics distinguish Parametricism from other architectural styles [113]. The Negative Principles include avoiding rigid forms that lack malleability, avoiding simple repetition that lacks variety, and avoiding collages of isolated and unrelated elements that result in a lack of order. The Positive Principles include the intelligent information-rich deformation of soft forms, differentiation of all systems through gradients, thresholds, and singularities, and interdependent correlation of all systems [111,113].

Together, the Negative and Positive Principles of Parametricism constitute a set of unifying heuristics that guide parametric architecture's functional and formal design [93]. According to Patrick Schumacher's ambitions and determinations, if someone wants a good design to be documented as Parametricism, he/she should make a deep, thoughtful link with nature so that the structure would produce this site and exemplify the heuristics [84]. In addition, [114], coming from the University of Edinburgh in the United Kingdom, once stated that "it appears as though the arguments Parametricism and parametric bear the identical association that scientism ensures to science" [114]. According to the Oxford English Dictionary, scientism is "An expression applied (freq. in a pejorative manner) to

a certainty in the authority of scientific information and methods; correspondingly to the interpretation that the approaches of education fit physical science can substitute those used in supplementary arenas such as philosophy and, esp., human performance and the social sciences" [115]. Parametricism derives from acceptance of and confidence in the influence of parametric information and determined procedures to substitute them all [93]. Figure 17 demonstrates the Guang Zhou Opera House.

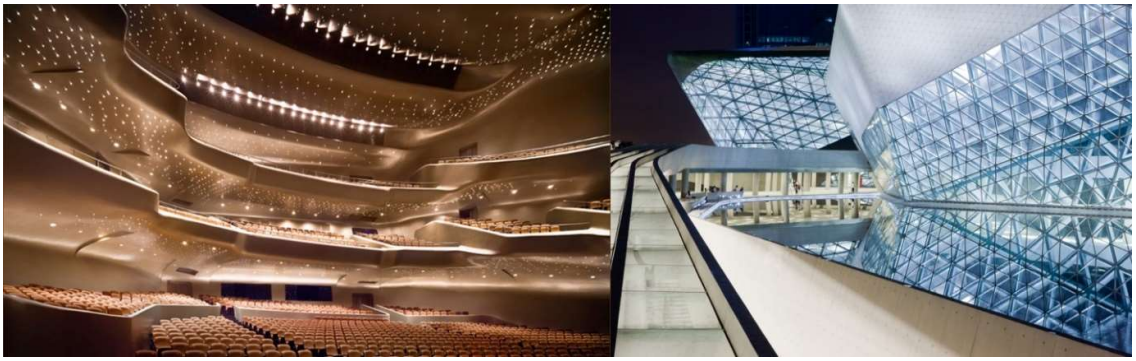


Figure 17. Zaha Hadid Architects, Guang Zhou Opera House, 2003–2010.

4.6. Critical Comparison of Parametricism

This section intends to provide critiques of Parametricism and compare it against another alternative with the ultimate aim of highlighting directions in which Parametricism can be further improved and rendered. Parametricism and Parametric Architecture/Design represent a pivotal moment in the evolution of architectural theory and practice, highlighting a shift towards the integration of computational algorithms and digital fabrication techniques in the design process. The distinction between these concepts, as outlined in Table 2, offers a foundation for understanding their specific applications, methodologies, and implications within and beyond the architectural domain. Parametricism, characterized by its broad theoretical framework, signifies a movement that transcends traditional architectural boundaries, advocating for a design philosophy that leverages algorithmic processes and digital technologies to foster innovation and complexity in architectural forms. This movement, propelled by figures like Patrik Schumacher, aims to redefine architectural aesthetics, functionality, and the very process of design through the utilization of parametric modeling tools and computational strategies. In contrast, Parametric Architecture narrows this broad vision to the specifics of architectural practice, focusing on the use of parametric design principles to craft buildings and spaces that respond to a myriad of parameters and constraints through sophisticated computational models. Parametric Design, meanwhile, extends the reach of these principles across various design disciplines, emphasizing the role of algorithms and parameters in shaping the built environment, irrespective of the scale or context. The discussion around Parametricism, while enriched by its innovative approach to design and architecture, is not without its critics (Table 3). One of the primary concerns raised against Parametricism relates to its design flexibility. Critics argue that an over-reliance on complex computational algorithms and the preoccupation with generating avant-garde forms can sometimes limit designers' ability to respond to the unique needs of a project or to adapt their designs to evolving requirements. This critique points to a potential rigidity within Parametricism, suggesting that despite its technological sophistication, it may lack the practical adaptability necessary in the ever-changing landscape of architectural design. Furthermore, the critique underscores the importance of maintaining a balance between innovation and pragmatism, urging designers to ensure that their reliance on parametric tools enhances rather than constrains their creative and responsive capacities.

Table 2. Comparative assessment of Parametricism, parametric architecture, and parametric design [116].

Aspect	Parametricism	Parametric Architecture	Parametric Design
Definition	A theoretical framework that defines a specific architectural style embracing parametric modeling and computational design.	The application of parametric design principles, specifically within the architectural field, to create forms and designs controlled by parameters and algorithms.	A broad methodological approach utilizing variables and parameters to build and modify digital models, applicable across various design disciplines beyond architecture.
Key Features	Emphasis on algorithmic design processes. Non-linear geometries. Differentiation and variation. Adaptive responsiveness. Digital fabrication. Dynamic formalism. Interdisciplinary collaboration.	Use of digital fabrication technology. Integration of programming languages. Application of parametric modeling approaches for architectural solutions.	Scripting and algorithm writing. Design experimentation and refinement. Cross-disciplinary application (product, industrial, urban planning design).
Focus	Defines a style and movement within architecture and beyond, characterized by the use of parametric modeling tools.	Focuses on the specific application of parametric design concepts to create innovative architectural solutions.	Emphasizes the process of design through the manipulation of parameters applicable in a wide range of design fields.
Technological Integration	Utilizes advanced computational tools and algorithms for creating complex, adaptive designs.	Involves the creation of architectural forms using specific parametric modeling software like Grasshopper for Rhino or Dynamo for Autodesk Revit.	Involves the use of computational tools to explore design possibilities, optimize performance, and generate complex forms across different design areas.
Scope	A broader design movement that impacts architecture and other design fields.	Specifically tailored to the architectural domain, with a focus on creating personalized and inventive designs.	A versatile and methodological approach that transcends architecture, being applicable in product, industrial, and urban design.
Origins and Proponents	Popularized by Patrik Schumacher, emphasizing a new architectural movement via computational design.	Recognized within architectural practice for its innovative approach to design and fabrication.	Broadly applicable across design disciplines, not limited to or defined by a specific movement or style.

Cultural sensitivity emerges as another significant critique of Parametricism. Observers have noted that parametric designs can sometimes appear disconnected from the cultural, historical, and environmental contexts within which they are placed. The global application of parametric principles, without adequate consideration for local nuances, can lead to an architecture that feels alien or inappropriate to its surroundings. This critique emphasizes the need for Parametricism to integrate cultural empathy and contextual awareness into its design process, ensuring that buildings not only showcase technological prowess but also resonate with the local identity and heritage. The human scale and accessibility of parametric designs have also been called into question. The pursuit of grandiose, sweeping forms characteristic of Parametricism can result in spaces that, while visually striking, may feel overwhelming or impersonal to users. This critique highlights the necessity of prioritizing human comfort, scale, and interaction within the design process, advocating for an architecture that, despite its computational origins, remains deeply human-centric. Economic accessibility presents another hurdle for Parametricism. The specialized knowledge and technology required for parametric design can render it an

expensive approach, potentially confining its application to projects with substantial budgets. This limitation raises concerns regarding the inclusivity of Parametricism and its capacity to address a broader spectrum of architectural challenges beyond the realm of elite, high-profile developments. Finally, engagement with criticism is a crucial facet of the discourse surrounding Parametricism. Some critics have observed a tendency within the parametric design community to overlook or dismiss critical feedback, particularly concerning the livability, practicality, and social implications of parametric designs. This reluctance to engage with critique not only stifles dialogue but also impedes the evolution of Parametricism into a more adaptable, contextually aware, and human-centered design philosophy.

Table 3. A brief critical comparison of Parametricism.

Aspect	Critique of Parametricism	Key Benefits of Alternative
Design Flexibility	Over-reliance on complex algorithms can limit spontaneity and adaptability in design.	Allows for adaptable designs that can evolve over time with changing user needs.
Sustainability	Highly complex designs can detract from environmental goals.	Emphasizes efficiency and sustainability through designs inspired by nature, potentially reducing environmental impact.
Cultural Sensitivity	Designs may lack context, failing to integrate or respect local culture and heritage.	Incorporates local materials, techniques, and forms, enhancing cultural relevance and community acceptance.
Human Scale	Some parametric designs can feel alienating or impersonal due to their scale and form.	Prioritizes human needs, comfort, and scale, making spaces more accessible and enjoyable.
Economic Accessibility	The cost and complexity of parametric designs can limit their accessibility to high-budget projects.	Focuses on affordable, low-tech solutions that promote sustainability without the need for expensive technology.
Criticism Engagement	Limited engagement with critical feedback regarding the practicality and livability of designs.	Engages community members and stakeholders in the design process, ensuring that projects meet actual needs and preferences.
Realism and Feasibility	Assumes perfect ease in designing intricate forms with CAD, overlooking software limitations and the rough discretization of surfaces. This idealization can lead to unfeasible designs due to the practical challenges of construction and material suitability.	Prioritizes designs that are realistic and feasible within current construction techniques and materials, ensuring that projects are not only innovative but also practical and executable within reasonable budgets, thus bridging the gap between concept and reality.

5. Influence of Parametric Architecture on Architectural Sustainability

Parametric architecture, as an architectural style, is intrinsically versatile and adaptable, qualities that position it at the forefront of sustainable architectural practices. It provides architects with the computational tools to model, manipulate, and optimize design variables, thereby tailoring architectural responses to both local environmental conditions and material efficiencies. Consequently, Parametricism is not just a stylistic evolution, but a crucial pathway to more environmentally attuned and sustainable architecture [96,109].

5.1. Energy Efficiency through Form Optimization

Parametricism, as an architectural style, is intrinsically versatile and adaptable, qualities that position it at the forefront of sustainable architectural practices. It provides architects with the computational tools to model, manipulate, and optimize design variables, thereby tailoring architectural responses to both local environmental conditions and

material efficiencies. Consequently, Parametricism is not just a stylistic evolution, but a crucial pathway to more environmentally attuned and sustainable architecture [93,109].

5.2. Material Efficiency

Parametricism, with its ability to manipulate design parameters, opens up vast opportunities for architects to delve into a broad spectrum of design solutions and material efficiencies that were hitherto challenging to realize. Through parametric adjustments, architects have the capability to fine-tune designs to align with specific material requirements, thereby minimizing wastage during the construction phase. This precision in material usage and reduction in waste not only lowers the environmental impact but also has economic benefits. Furthermore, Parametricism fosters the optimization of structural performance, leading to designs that fulfill their intended function with minimal material usage. This enhances the material efficiency of the building and promotes a more sustainable approach to construction and design [117,118].

5.3. Adaptability and Longevity

The inherent flexibility of parametric design bestows upon structures the capacity to adapt over time, thereby extending their functional lifespan. Buildings conceived through parametric design principles exhibit an inherent capacity for modification to meet evolving user needs or accommodate changing environmental conditions. This potential for adaptability reduces the need for energy-intensive practices such as demolition and new construction. By facilitating design longevity and flexibility, Parametricism plays a significant role in enhancing the sustainability of the built environment [119,120].

5.4. Responsive Urban Design

In the context of urban design, parametric tools can be harnessed to foster more sustainable cities. By simulating diverse urban parameters—population density, green space distribution, and transportation infrastructure, to name a few—urban planners can utilize these tools to enhance walkability, promote efficient transport, and ultimately, reduce urban carbon footprints.

Nevertheless, while the potential of Parametricism to augment sustainability is substantial, it is critical to acknowledge that the tools themselves are not autonomous agents of sustainable outcomes. Rather, their effective use is contingent upon the architects and planners who wield them. It is the deliberate alignment of Parametricism with sustainability principles that ensures this potent design methodology truly contributes to a more sustainable architectural and urban future.

5.5. Parametric Architecture's Varied Impact on Sustainability

On the other hand, it is essential to recognize that the sustainability of parametric design outcomes is not solely determined by the tools themselves but by how they are applied. Parametric design methodologies offer architects the tools to create buildings that are not only architecturally expressive but also environmentally responsive. The precise manipulation of design parameters enables the optimization of natural light, thermal comfort, and energy efficiency, contributing positively to a building's sustainability credentials. Moreover, the ability to simulate environmental conditions and predict performance outcomes allows for more informed decisions that align with sustainable design principles. However, the application of Parametricism is not without its criticisms. For instance, it is argued that the emphasis on complex forms and innovative facades can sometimes overshadow the fundamental goals of sustainability. High-profile projects by renowned architects have sparked debate over whether the aesthetic qualities of parametric designs come at the expense of practical, sustainable solutions. These concerns underline the importance of grounding parametric design in a sustainability-first approach, where environmental considerations are integral to the design process rather than secondary considerations. Furthermore, the material choices and construction techniques associated with

parametric designs can have significant environmental impacts. While parametric tools enable the optimization of material usage and structural efficiency, the actual construction processes involved in realizing intricate designs can be resource-intensive. Therefore, a critical assessment of the entire lifecycle of parametrically designed buildings is necessary to fully understand their sustainability impact. Parametricism also holds the potential to revolutionize urban design, offering scalable solutions that can enhance the sustainability of cities. Through the strategic planning of urban spaces, transportation systems, and green infrastructure, parametric tools can support the development of more sustainable urban environments. However, this potential is contingent upon a holistic application that considers social, economic, and environmental sustainability dimensions. In addressing the critique of Parametricism's impact on sustainability, it is clear that the discipline is at a crossroads. The path forward requires a conscientious application of parametric tools, where sustainability is not an afterthought but a fundamental design criterion. By embracing this challenge, architects and designers can leverage the full potential of Parametricism to contribute to a more sustainable and environmentally responsible built environment.

6. Findings and Discussion

According to the aforementioned statements, this study came up with some findings through the critical assessment regarding styles and Parametricism, Tables 4 and 5. These findings are as follows:

1. Parametricism reflects a significant evolution in the architectural discourse by incorporating advanced computational tools to create dynamic, responsive, and complex forms that adapt to both environmental and social parameters. This innovative approach demonstrates a clear departure from traditional design methods, suggesting a progressive shift in how architecture is conceptualized and executed;
2. While Parametricism introduces new methodologies through the use of algorithms and digital fabrication, its influence extends beyond mere technical advances. It redefines architectural aesthetics, functionality, and the process of design itself, aligning with broader shifts toward sustainability and adaptability in the built environment. This holistic impact suggests that Parametricism is not just a toolset but a transformative movement in architectural thinking;
3. The adoption of Parametricism has empowered architects to explore new forms of architectural expression and efficiency, pushing the boundaries of what can be achieved in terms of form and functionality. The style's adaptability and precision in design execution have set new standards in the industry, influencing contemporary architectural practices and encouraging a re-evaluation of traditional design philosophies;
4. Despite its innovative aspects, Parametricism faces critiques regarding its complexity and the potential disconnection from local cultural and environmental contexts. These critiques highlight the need for a balanced approach in its application, ensuring that technological advancements enhance rather than dominate the architectural intent and relevance.

These points illustrate that Parametricism should primarily be seen as a methodological innovation. It significantly alters the landscape of modern architecture by introducing advanced computational tools and techniques. This innovation not only equips architects with new capabilities but also challenges and prompts a re-evaluation of the traditional processes and methodologies in the field.

As with many epochal styles, Parametricism has its heuristics. Throughout the study, it is confirmed that Parametricism uses certain principles called heuristics to gain specific design outcomes. The heuristics are divided into two groups: Formal and Functional. Each group includes both negative principles and positive principles that have evolved since the mid-1990s across many projects worldwide.

Table 4. Content analysis of the existing sources according to the process development of Parametricism.

Authors	Year	Phase	Contribution	Explanation
Sutherland	1963	Graphic Interface	Applying changes parametrically with a computer	The first use of parametric design concepts through a graphic user interface system occurred in Sutherland's Ph.D. research, which allowed him to draw with the computer and apply changes parametrically at the same time [121].
Morretti	1971	Interconnected Design	Relationships between the dimensions	Parametric Architecture is the examination of how the dimensions of a design are interconnected and dependent on specific parameters [82].
Kalay	1989	Automated geometric computation	Computational geometric relations	When parameters are altered, the geometric relationships determined by computation are automatically adjusted [82].
Schumacher	2008	Parametricism Manifesto	Certain Principles, "Dogmas", and "Taboos",	The concept of "Parametricism" as a design style was first introduced in the "Parametricism Manifesto" and further explored in subsequent papers and a book titled *The Autopoiesis of Architecture* in 2011. The author outlined certain principles, known as "Dogmas", that must be adhered to in order to create a parametric design, as well as other principles, referred to as "Taboos", that should be avoided [68].
Woodbury	2011	Associative geometry	Exploring connections of geometric concepts	The process of investigating the links between geometric concepts is known as parametric design [122].
Frazer	2016	Evolving process	Adapting itself with newest technology	Parametric architecture is evolving and re-positioning itself as a dynamic process that takes into account the latest technologies, as well as environmental and societal considerations [110].
Oxman	2017	New paradigm, topological thinking	Paradigm of design thinking	Parametric design is considered a novel approach to design thinking. It brings innovative ideas and shifts the focus from typological thinking to topological design thinking in the creative design process, which is considered a significant transformation in the way of design thinking [108].

Table 5. Active reflective styles of Parametricism.

Styles	Epochal Style	Subsidiary Style	Transitional Style
Active reflective Style	Parametricism	Blobism	
		Flodism	
		Swarmism	
			Tectonism

7. Conclusions

In conclusion, this research has effectively addressed a significant gap in understanding the methodological innovations introduced by parametric design, which has rapidly become integral to architectural discourse and practice. This study rigorously examined parametric architecture, commonly known as Parametricism, to highlight its developmental trajectory and its role within the hierarchy of 21st-century architectural movements.

Through a detailed descriptive methodology, supplemented by an extensive critical literature review and content analysis, this research has not only explored but also interpreted the substantial contributions that define Parametricism in the contemporary architectural landscape. A primary objective was to establish a clear understanding of architectural style as defined in the academic literature, enhancing our comprehension of Parametricism's unique methodological contributions among modern architectural styles. Parametricism is characterized by its innovative application of computational design tools such as scripting, algorithmic design, and parametric modeling to create intricate forms and structures. This movement is a nexus of historical insight and contemporary methodological advancement, drawing upon a rich lineage of architectural thought while pushing the boundaries of design and construction through technological innovations. However, the study also acknowledges the challenges and critiques related to the practical implementation of Parametricism. Despite its ability to generate versatile and adaptive architectural solutions, its broader influence on the architectural industry and society remains limited, hampered by criticisms of its heavy reliance on technology, potential for excessive formalism, and, occasionally, a lack of contextual and social responsiveness. These challenges have hindered its full recognition as a definitive "style", often relegating it to the realm of conceptual exploration rather than mainstream architectural practice. Nonetheless, this research posits that parametric architecture, with its foundation in computational design, holds the potential to be acknowledged as a significant methodological innovation across various geographical and cultural contexts. This potential is underpinned by its ability to merge local traditions with global technological advancements, promoting a flexible and adaptive architectural language. Looking forward, the study highlights the need for further investigation into the ethical, social, and environmental impacts of Parametricism. While maintaining objectivity, the study acknowledges the complex ethical considerations surrounding the adoption and implementation of parametric practices, particularly concerning human well-being and environmental sustainability. Future research directions are proposed, including exploring Parametricism's effects on the architectural profession, its integration with advanced fabrication techniques like 3D printing and robotic construction, and its potential to enhance the design of public spaces.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Descriptions of Styles

- Gothic is noted for its verticality and light-filled spaces, characterized by features such as pointed arches, ribbed vaults, and flying buttresses. It originated in the High Middle Ages and is particularly associated with cathedral architecture, reflecting an aspiration towards the heavens and the divine;
- Renaissance is characterized by a rebirth of classical antiquity, emphasizing symmetry, proportion, and geometry in architecture, alongside a focus on humanism and realism in the visual arts. This period marked a departure from the more formulaic structures of the medieval period, favoring a return to the study of nature and classical forms;
- Mannerism is characterized by its artificial (as opposed to naturalistic) qualities, with an emphasis on elegance, elongated forms, and a lack of clear perspective.

- Baroque emerged after the Renaissance, known for its exuberance, grandeur, and drama, as well as its use of contrast, movement, vivid details, and deep color to achieve a sense of awe. Architecture and art from this period are characterized by their emotional intensity, opulent decorations, and dynamic scenes;
- Rococo is known for its decorative art and architecture that is elaborate, ornamental, and light-hearted, with themes often centered around love, classical myths, and nature;
- Neo-Classicism was a revival of the classical styles and spirit during the late 18th and early 19th centuries, emphasizing clarity, order, and symmetry. It was inspired by the art and culture of ancient Greece and Rome, and it was a reaction against the excesses of the Baroque and Rococo styles;
- Historicism represents the use of historical forms and decorative styles from different periods in history, often combined in a single building or artwork. It reflects a romantic fascination with the past and was particularly popular in the 19th and early 20th centuries, leading to the creation of eclectic architecture that borrows from various historical periods;
- Neo-Gothic revives medieval Gothic architecture with a romantic emphasis on individualism and detailed craftsmanship;
- Neo-Renaissance and Neo-Baroque represent a return to the principles and styles of the Renaissance and Baroque eras, respectively, emphasizing symmetry, proportion, and grandeur in the case of Neo-Renaissance, and dramatic effect, movement, and detailed ornamentation in Neo-Baroque;
- Eclecticism is an architectural style that combines elements from different historical styles and periods, aiming for harmony in diversity;
- Art Nouveau is distinguished by its use of long, sinuous, organic lines and was applied most notably to architecture, interior design, and decorative arts.
- Expressionism manifests through the depiction of subjective emotions and experiences over objective reality, often using bold colors and dynamic compositions;
- Modernism is a broad movement that emerged in the late 19th and early 20th centuries, advocating for new approaches to art, architecture, and literature. It rejects historical precedents and traditional styles, emphasizing innovation, functionality, and simplicity instead. In architecture, it is characterized by minimalism, the use of industrial materials, and the idea that form should follow function;
- Neue Sachlichkeit (New Objectivity) refers to a German movement in art, literature, and music of the 1920s that was characterized by a realistic style combined with a cynical, socially critical philosophical stance;
- Organicism celebrates harmony between human habitation and the natural world through design principles inspired by nature and organic forms;
- Rationalism in architecture emphasizes reason and order, favoring a reductionist approach and often employing geometric forms and the repetition of modular elements;
- Brutalism is known for its straightforward, honest approach to form and material, often using raw concrete or other materials in their natural, unfinished state;
- Metabolism is a post-war Japanese architectural movement that explores ideas of megastructures and prefabricated modular elements to accommodate growing populations and changing urban needs;
- High-tech architecture incorporates technology and industrial systems into building design, often showcasing structural elements, mechanical systems, and innovative materials;
- Postmodernism breaks away from modernist principles by embracing complexity and contradiction, often incorporating elements of historical styles in a new context or with a sense of irony;
- Parametricism represents a style within contemporary architecture and design characterized by the use of computer-aided design software to generate geometries based on algorithmic rules that relate to various parameters. This approach allows for complex,

fluid forms and patterns that can adapt dynamically to their context and programmatic requirements;

- Blobism (also known as Blob architecture) is identified by its organic, amoeba-shaped forms that appear to be blob-like or droplet-like in shape. These forms are often created through digital design techniques, allowing for smooth, seamless surfaces and curvilinear shapes that challenge traditional architectural geometry and structure;
- Flodism could potentially refer to a design philosophy influenced by fluid dynamics and the aesthetics of fluid movement. If this is an intended style, it would likely emphasize seamless, flowing forms that mimic the properties and behavior of liquids. However, without more context or standard recognition of the term, it is difficult to provide a detailed description;
- Swarmism might involve design principles inspired by swarm intelligence observed in nature, such as in flocks of birds or schools of fish. This approach could utilize algorithms to simulate the decentralized, self-organized patterns of behavior found in nature, resulting in dynamic, adaptable design systems or structures that mimic these natural processes;
- Tectonism refers to an architectural style or approach that emphasizes the expression and exploration of construction and structure. It focuses on the articulation of tectonic elements and how parts of a building are assembled and connected. Designs in this style show the materials, structural logic, and craftsmanship, often revealing the construction process as an integral part of the aesthetic experience.

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