

PARAMETRIC “MODEL FAMILIES” IN THE IMPLEMENTATION OF  
BIM TECHNOLOGIES IN DESIGN PROCESSES:  
A CASE STUDY ON CREATING AN INFORMATION MODEL LIBRARY OF  
NATIONAL-STYLE ARCHITECTURAL ELEMENTS.

<https://doi.org/10.5281/zenodo.17809077>

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### Abstract

This study explores the possibilities of parametric modeling of national architectural elements based on BIM (Building Information Modeling) technologies. The main purpose of the article is to integrate traditional Uzbek architectural ornaments into the modern digital design environment. A library of parametric model families was developed based on decorative brick elements found in traditional residential buildings in the cities of Khiva and Urgench. The created parametric models help to address the shortage of families related to national architectural elements within the BIM environment. They ensure accuracy, consistency, and time efficiency during the design process, reduce human-factor errors, and automate the formation of construction documentation. The results of the study demonstrate that parametric modeling is an effective approach for digitizing national architectural heritage and integrating it into modern BIM systems. This method not only preserves national architectural traditions but also enhances the efficiency of the design process.

### Keywords

BIM, parametric design, model families, Revit, algorithmic modeling.

**Introduction.** Today, the processes of implementing digital technologies in the field of architecture and construction are rapidly developing [1]. In modern design practice, the creation of models is becoming increasingly automated through parametric modeling, generative design, and algorithmic approaches. In particular, the digitization of architectural elements through the BIM environment and the possibility of reusing them based on parametric control have introduced a new stage in design workflows [2].

BIM (Building Information Modeling) is an information modeling technology that enables the creation, management, and analysis of data-rich models of buildings and structures. In Uzbek, it is referred to as “Qurilish ma’lumotlarini modellashtirish” (QMM) [3]. One of the key factors in the effective implementation of BIM technologies is the system of parametric “model families.” Through model families, the elements of a building—such as their dimensions, proportions, geometric form, and material properties—can be automatically managed [4]. This increases the accuracy, development speed, and flexibility of the design process [5]. An interesting aspect is that BIM technologies are used not only by builders and designers, but also by specialists from other fields. For example, in their article “BIM and Wooden Architectural Monuments,” Kozlova T.I., Kulikova S.O., Talapov V.V., and Zhang Guanin state: “When BIM technology was created, it was primarily intended for the design-construction sector; however, its use in historical-architectural activities can radically improve the quality of storing and processing large volumes of information” [6]. They also emphasize the cultural connection between past and contemporary architecture established through BIM [7]. This statement fully reflects the potential of the BIM approach and its applicability across various fields [8].

Heritage enriches modern science, education, and culture. Contemporary civilization recognizes the great potential of cultural heritage and the necessity of preserving and efficiently utilizing it as one of the most important resources of the global economy. The loss of cultural values is an irreversible process that cannot be restored once destroyed [9]. For this reason, integrating national-style architectural elements into design processes through BIM technology is considered a highly relevant task.

The main objective of the study is to create a library of parametric “model families” based on national architectural elements and integrate them into BIM processes.

Elements found in Uzbek architecture—such as domes, portals, arches, muqarnas, girih patterns, and columns—are complex systems not only aesthetically but also structurally [10]. Algorithmic modeling of their formal structure enables the

creation of “data-rich model families,” which allows these elements to be reused within BIM systems [11].

**Methodology.** In the course of the research, observation, comparative analysis, and parameter-based modeling methods grounded in mathematical algorithms were applied, following BIM integration principles. A small-scale research project was conducted to explore the capabilities of parametric model families in the implementation of BIM technologies. A parametric model library of decorative brick Exterior elements used in traditional Uzbek residential architecture was developed in Revit (Figure 1).

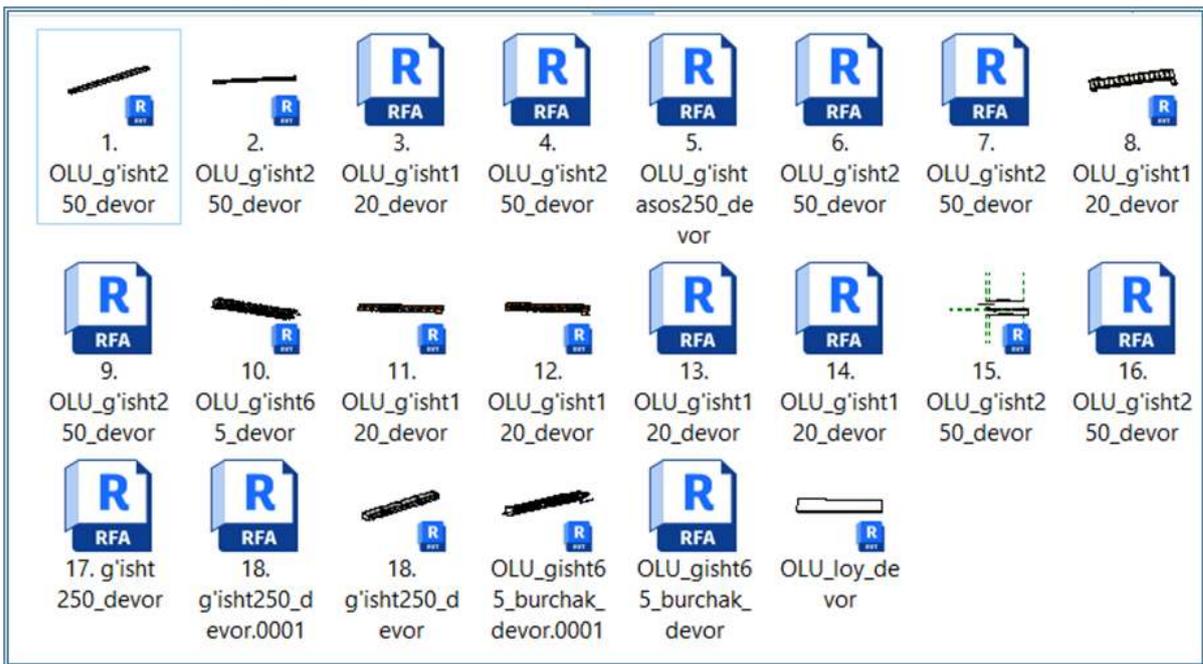


Figure 1. Library of “parametric models” of brick decorative elements from traditional-style residential Exteriors in the cities of Khiva and Urgench.

In the Khorezm region, residential buildings in the city of Urgench, as well as in and around the Ichan Qala of Khiva, were examined; these structures feature old and new Exteriors decorated with traditional brick ornamentation (Figures 2, 3, 4) [12].



Figure 2. View of the Exteriors of traditional-style residential buildings located in



Figure 3. View of the Exteriors of traditional-style residential buildings located in the city of Urgench.

the city of Khiva.

During the observation process, brick ornamentation was found not only on residential buildings but also on the Exteriors of many old shops and madrasas located within the Ichan Qala (Figure 4). This further enhances the scientific novelty of our practical research.



Figure 4. Old madrasa and shop complex located in the Ichan Qala.

During the study of the ornaments, special attention was given to their structure and to the dimensions of the bricks. After the measurements were taken, each brick element was redrawn in AutoCAD (Figure 5).

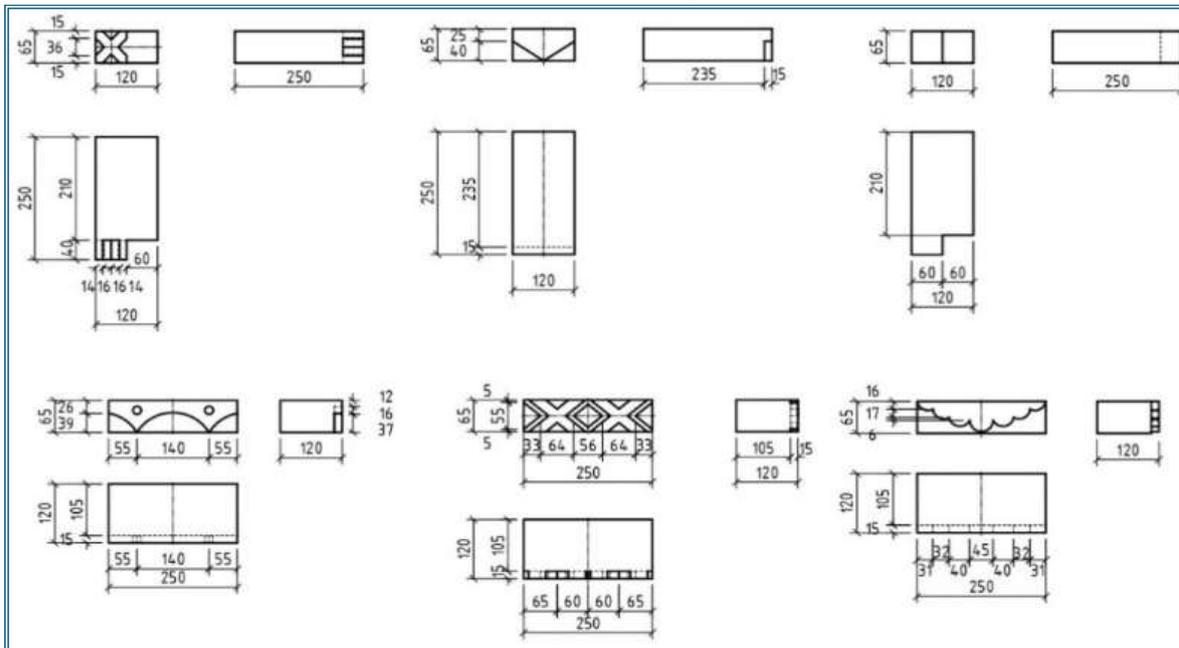


Figure 5. 2D drawings of Exterior elements.

This provides the following conveniences and capabilities during the modeling process in Revit:

**Precise geometric planning.** By drawing the three primary views, the geometric structure is thoroughly examined, which reduces potential issues related to overlooked parts of the object and dimensional inconsistencies that may arise during parametric modeling.

**Maintaining correct proportions.** Ornamental shapes in any decorative element possess symmetry, stylistic harmony, optimal scale, and proportion. During the formation of geometry, it is essential to ensure that these proportions are not distorted. Since the outcome of the study is a parametric model, changes in the model parameters must not affect the optimal scale or proportional relationships of its ornamental forms [9].

**Design coordination.** Before generating a parametric model, it is necessary to plan which parameters the model should include. Based on this, a shared parameters file is created, and the parametric model is constructed accordingly.



*Figure 6. Perspective view of the sample Exterior.*

**Results and Discussion.** As a result of the study, a decorative composition consisting of digital models of façade elements used in traditional residential buildings in the cities of Urgench and Khiva was assembled around a gate and window opening. The developed decorative elements were assigned not only identical geometric properties but also material parameters. During testing, certain structural deficiencies were identified in several models, analyzed, and appropriate corrective measures were taken. It is well known that the Revit platform allows the generation of schedules based on the information included in the shared parameters file. This approach significantly saves time during the design process and reduces the likelihood of human error in preparing construction documentation. At the same time, it was observed that fully parametric modeling of some complex-shaped elements within the Revit environment is limited.

**Conclusion.** The integration of parametric modeling and BIM technologies introduces a new stage in the design of architectural elements. Modeling domes, portals (*peshtoq*), arches (*ravoq*), and *giri*h patterns through parametric control not only ensures their geometric accuracy but also maintains proportional harmony and structural consistency.

This approach helps address one of the major challenges in designing national architectural elements – the shortage of suitable “model families” for the BIM environment. The developed parametric library enables the automation of the design process, saves time and labor resources, and provides systematic storage of construction data in the form of schedules. This research makes a significant practical contribution to the digitalization of Uzbekistan’s architectural school by preserving national architectural heritage in digital format, integrating it into contemporary design practices, and enriching the BIM data environment.

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