Application of Revit Parametric Massing in Conceptual Design (Postprint)

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Abstract

This methodology leverages Revit's parametric massing functionality to conduct massing studies during the conceptual design phase through parameter-driven adjustments and combinations of massing forms, and rapidly computes building economic and technical indicators by extracting massing data. Subsequently, by utilizing data transfer and graphical transfer from this massing model, we implement cost estimation for the project and simulation of the project's outdoor wind environment. Upon comprehensively obtaining the aforementioned data, we achieve a balance among three datasets—economic and technical indicators, cost estimation metrics, and outdoor site wind environment simulation—through data refinement, thereby realizing data-driven architectural design.

Full Text

Preamble

BIM Forward Design Key Technology: The Application of Revit Parametric Massing in Conceptual Design

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Abstract

This method leverages Revit' s parametric massing capabilities to enable massing studies during the conceptual design phase through parameter-driven adjustments and combinations of building forms. By extracting massing data, it facilitates rapid calculation of key building economic and technical indicators. Furthermore, through data and geometry transfer from the massing model, the

approach enables project cost estimation and outdoor wind environment simulation. By iteratively refining parameters to balance these three critical datasets —economic and technical indicators, cost estimates, and wind environment simulation results—the methodology achieves true data-driven architectural design.

Keywords: Revit parametric massing; architectural conceptual design; economic and technical indicators; outdoor wind environment simulation; cost estimation; data-driven design

Introduction

China' s construction industry is currently experiencing rapid development, yet the application of BIM technology in the conceptual design phase remains in its infancy. While BIM is increasingly utilized during construction documentation and construction phases, its full potential has not been realized across the entire project lifecycle. As building technology continues to evolve, we are actively promoting BIM forward design, which will enable more widespread application of BIM in conceptual architectural design and construction. Central to this effort are the various parametric applications within the Revit platform. This paper explores the application of BIM parametric technology in both conceptual design and green building analysis stages, aiming to achieve integrated cost and sustainable design coordination from the earliest phases to reduce rework and fundamentally improve design efficiency. This work is a companion paper to the Guangdong Provincial Architectural Design Institute' s research project "Key Technologies for Revit Forward Design."

According to relevant surveys, the vast majority of designers currently rely on a SketchUp-plus-CAD workflow during the conceptual phase. The constant cross-referencing between plans and elevations generates substantial repetitive work, leading to significant inefficiencies. Moreover, existing conceptual models cannot be effectively transferred to green building simulation stages, increasing labor costs. The proposed parametric design approach addresses this fragmentation between economic-technical indicators, green building simulation, and cost estimation through seamless data and geometry transfer, thereby enhancing design efficiency in the conceptual phase and achieving true "one model, multiple uses."

1. The Need for Parameterization in the Design Stage

Architectural conceptual design represents the most critical phase in the design process—the transformative stage where every project evolves from nothingness to concrete form, undergoing refinement, validation, and deepening. This creative process integrates engineering, artistry, and economics, and serves as a crucial moment for helping clients align project plans with market demands. The economic dimension must reference design briefs and planning indicators while providing the basis for construction cost estimation. The traditional conceptual design model uses the design brief as input, specifying parameters such as floor area ratio, building coverage, total floor area, and compensatory area. Architects then develop approximate building forms based on these requirements before proceeding with façade and floor plan design. Due to this complex workflow, excessive time is consumed in iterative massing studies. When estimated costs based on the final design prove unsuitable, the scheme must be reworked, further degrading design efficiency through repetitive tasks.

2. Application Value of Parameterization in the Design Stage

When conceptual design is based on Revit' s parametric massing platform, designers can input required massing dimensions and combinations, then obtain specific economic and technical indicators through Excel calculations of these parameters. This approach saves labor, time, and material costs from the outset. Furthermore, it enables multidisciplinary collaboration during the design phase through Revit' s parametric capabilities, allowing fundamental issues to be addressed comprehensively and intuitively from the earliest conceptual stage, thereby avoiding repetitive rework later in the process. This method primarily solves the building form-finding problem, helping architects quickly identify forms that satisfy both design indicators and design intent. Architects can then proceed with more detailed façade and floor plan design only after establishing a massing solution that meets economic indicators, green building requirements, and reasonable cost constraints, thus fundamentally preventing design rework caused by these three factors.

3. Implementation Methods for Revit Parametric Massing in Conceptual Design

3.1 Iterative Design Principle with Green Building and Cost Software By inputting and modifying parametric models and following the process outlined in Figure 1 (Parametric Workflow Diagram), we can rapidly obtain three sets of data: economic and technical indicators, project cost estimates, and site CFD wind environment simulation results. The relationship between these simulation processes is illustrated in Figure 1. Through continuous parameter refinement, we can achieve design optimization that balances all three datasets.

[Figure 1: see original paper]

3.2 Principle of Exporting Economic and Technical Indicators from Revit Parametric Massing Through different Revit family models, we assign corresponding parameter data and attributes to enable shared model parameter data and properties during the design phase. This allows Revit's parametric massing to truly participate in conceptual design (as shown in Figure 2).

[Figure 2: see original paper]

3.3 Steps for Parameterizing Conceptual Design Schemes (Case Study: Xiongdi Tower Project) First, multiple "conceptual massing families" of different shapes must be created based on design intent (Figure 3). These massing families are then imported into the project, and parameters are input to achieve desired scales for each massing model. Through intersection and cutting operations, the overall project form is obtained (Figure 4). Next, functional uses are assigned to massing spaces, floor parameters and shared parameters are attached to each mass, and finally, a parameter schedule for the massing families is exported (Figure 5).

[Figure 3: see original paper]

[Figure 4: see original paper]

[Figure 5: see original paper]

Table 1: Project Massing Parameter Schedule

3.4 Steps for Obtaining Economic and Technical Indicators from Revit Parametric Massing Following the steps in Section 3.3, parametric massing data is obtained. Required technical indicators such as floor area ratio, building coverage, total floor area, and compensatory area are then input into a pre-formulated economic and technical indicator spreadsheet. Using Excel' s data linking functions, the indicator results are automatically calculated (as shown in Table 2).

Table 2: Project Economic and Technical Indicators

After completing this setup, adjustments to building form no longer require manual recalculation of relationships, making this approach significantly more efficient than traditional polyline area calculations.

3.5 Advantages, Disadvantages, and Solutions in the Revit Parameterization Process **3.5.1 Advantages:** Revit can rapidly generate floor plans from conceptual massing families and automatically calculate total floor area within each mass. Areas with different functions or compensatory areas can be segmented through cutting operations to ensure no duplicate calculation of the same parameters. Buildings of the same calculation type can be created using a single massing family to obtain total area sums without requiring multiple floor area 叠加 calculations.

3.5.2 Disadvantages: Revit cannot automatically generate floor slab schedules; it can only generate massing schedules that require manual area summation. The system can only identify floor areas for each individual massing family, necessitating the creation of multiple families for area calculations. Massing family creation may consume time and requires designers to have a certain proficiency with Revit. Calculation precision may not reach the level of 2D CAD calculations; achieving precise values requires creating highly detailed massing models.

Solutions: To address the limitation of manual area summation from massing schedules, we can manually link spreadsheet files and embed formulas to reduce manual effort. Given the repetitive nature of creating parametric massing models for each project, establishing a parametric massing model library would enable direct reuse in future projects, saving time for other design phases. Since Revit differs from traditional design software, improving overall staff proficiency is essential for effectively applying Revit parametric data in conceptual design.

4. Methods for Outdoor Wind Environment Simulation and Project Estimation Using Revit Parametric Massing

4.1 Key Steps for Importing Revit Parametric Massing Models into CFD Software Due to Revit's limited export formats, direct interfacing with CFD software is not possible, requiring AutoCAD as an intermediate platform. The RVT model is first exported as a DWG file (Figure 6), then converted to IGES format in AutoCAD, which can finally be imported into CFD software.

[Figure 6: see original paper]

Using CFD software for outdoor wind environment simulation, we determined that the building massing has a wind speed amplification factor of 1.55, which complies with green building design standards. If the amplification factor were excessive, parameters could be adjusted in Revit and the process repeated to rapidly obtain updated wind environment performance (Figure 8).

[Figure 8: see original paper]

4.2 Key Steps for Importing Revit Parametric Massing Data into Excel for Cost Estimation Using the economic and technical indicators obtained from Revit parametric massing, we import these into a cost estimation spreadsheet to generate total cost estimates, achieving data transfer. In this table, "economic indicator (yuan/m^2)" is a constant, "quantity (area)" is the independent variable, and "cost (RMB: ten thousand yuan)" is the dependent variable, enabling automatic investment estimation with each iterative optimization. The cost estimation spreadsheet can be templated for future projects, allowing direct import of Revit parametric massing schedules for convenient reuse. This solves the problem of cost engineers spending excessive time and effort recalculating project costs due to design modifications, as illustrated in Figure 9.

[Figure 9: see original paper]

Conclusion

As architectural design is closely related to project quality, serves as the presentation of conceptual design effects, and provides the foundation for subsequent construction documentation and construction phases, its importance cannot be overstated. To ensure construction projects meet basic requirements and enable smooth progression of later-stage work, Revit parametric massing in the conceptual phase must achieve a certain level of accuracy. Designers must develop building forms that satisfy project technical indicators, thereby avoiding rework caused by non-compliance and saving time, effort, and financial resources while ensuring the project remains within its scheduled timeline and protects the interests of all stakeholders.

Leveraging the capabilities of new-generation software and integrating multi-platform functionalities enables exponential improvements in work efficiency through data and geometry transfer. Many projects face tight schedules and heavy workloads during conceptual design, making designers prone to calculation errors and omissions. This method effectively mitigates such issues, achieving parameterization, automation, and computational efficiency beyond basic data input. By delegating complex tasks to computers, designer productivity is significantly enhanced. During implementation, clear division of labor and responsibilities between designers and cost engineers must be established to ensure effectiveness and facilitate smoother design workflows.

Note: Figure translations are in progress. See original paper for figures.

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