

# A Case Study: Projecting Images for Designing Interior Panels using Parametric Modeling Tool

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## Abstract

This paper aims to describe a case study of parametric interior design based on BIM (Building Information Modeling). As the practical use of BIM-based design grows, its influence expands into the field of interior architecture design. BIM makes possible to check various design plan, reach decision making in an effective way, and change design plan in an efficient method. Therefore, BIM is also promising field in interior architecture design. However, compared to other fields such as architecture, engineering, and construction (AEC) industry, there have been less research and projects on BIM in the field of interior architecture design. For increasing the feasibility of adapting BIM in interior architecture design, this paper describes a case study-projecting images for designing interior panels using parametric modeling. This process needs elaborate, delicate, and precise steps for harmonious output. For steady using of the building, users look forward to the design plan which can be variable and changeable according to user's preference and the environment. Therefore, demand for parametric design in the interior design part such as panel pattern design for various decoration is growing. The process in this paper deals with an advanced phase which is effective in decreasing time consumption and useless part of the traditional process. Finally, this paper suggests the possibility of using BIM in the interior design process and field where BIM can be applied.

## Keywords –

Parametric Modeling; BIM; Interior Design; Automated Design Process

## 1 Introduction

The word “Interior Design” was meaning of the minimum essential room for human living. [5] These days meaning of “Interior Design” is transformed into the place where residents reveal their personality and characteristic. As a result, according to a different user

and changed interest about interior design, remodeling of interior emerged as a main part of the interior design. [6] For remodeling, objects such as furniture or decorations which have variables are in a better position than fixed objects for parametric design. Therefore, a crucial part in interior design of building depends on how much this space is favorable for new use after once occupied. Unlike exterior part, the interior is the abutted part where directly connected with users' life. Interior design must be varied by users' preference and environment. Parametric design is emerging as a practical alternative in changeable and diverse design part in the interior design field.

The parametric design makes designers to change their work and make their own algorithm much easier for effective way of their design work to make final output. As another way of parametric design work, it generates families and collections of families that display different result according to the input value. [1] If there is certain output which user want, objective and mathematic algorithm prevents consequence get too far off from the result that user want. Computer's data calculating process is used for those algorithms. [2]

BIM is used for extensive fields such as architecture, engineering, construction, and facility management (AEC-FM) industry. Naturally, in the field of interior design, BIM has positive effects on toward improving efficiency in design and construction. Nevertheless, BIM in interior design has insufficient researches and practical uses compared with other fields. Because of requisition of an elaborate scheme and relatively small scale project, the interior design process is not familiar with BIM. However, graphical programming environment in BIM authoring tool and relevant algorithm generating function in BIM visual programming environment could be an advantage for growing effectiveness in design and construction of interior design. [7] Accordingly, this paper introduces a way of the practical using method of BIM in the interior design field and suggests the feasibility of BIM application for the supportive design process.

## 2 Background and Objective

Previous interior design process reflects designer's prompt preference according to circumstances and environments and goes along without standard library of the application object. However, advent of BIM cause emerging of formation about standard definition and library of interior objects such as furniture, window, and door. Interior design of high LoD (Level of Detail) which considered as impossible in BIM modeling tool is now became possible because of High LoD objects in the library. Owners of object -usually design companies- in library gradually upgrading their product's information for usability and coadaptation for various BIM modeling project.

For the useful, smart and variable LoD (Level of Detail) object of interior decoration, parametric property plays a leading part in object property. Parametric property is essential element for represent geometry which generated by parameters and rules. Parameters and rules also can show the relationship between geometry and other object. Therefore, geometry is automatically updated in real time by operation of user or alteration of relationship. LoD about parametric property can be defined by user's needs and status of modeling. For quick modeling, the level of the parametric property will be low, and for the high quality of modeling, the level of the parametric property will be high.

Above all process, this paper is dealing with the improvement of effectiveness in the process of decorating design wall by BIM and parametric modeling. Therefore, simple process for demonstration part of this study is as follows Figure 1. Authoring tool and algorithm generator both are based on BIM. By using two methods, process will start from generating prototype of panel and end by QTO (Quantity Takeoff). Exact example of input in the process will be made by BIM authoring tool as we called BIM modeling environment.

On authoring tool, application object must be selected in the project and parametric property must be defined on the interior panel in the family editor. Algorithm generator accepts input value from authoring tool for node combination which can draw out the final output from the design process. For lead high LoD quality till the end of design construction process, deduction of not just output but also quantity take-off is necessary. In conclusion, this paper aims to describe an effective way of applying BIM on interior design to expanding usability of BIM to small project.

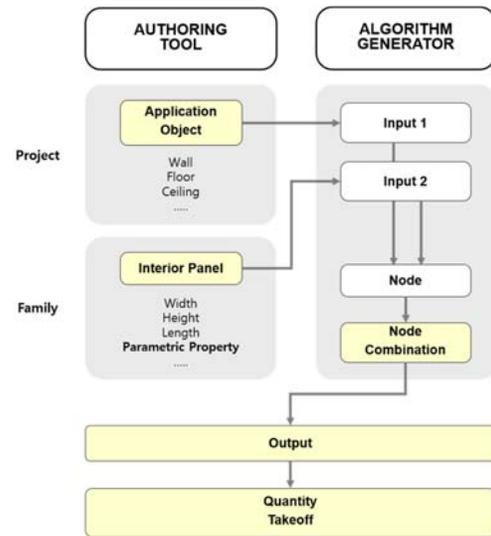


Figure 1. The relationship between BIM authoring tool and algorithm generator in the demonstration.

## 3 Analysis of preceding research and example

### 3.1 Tendency of research related to Interior design and BIM

Thanks to BIM extending its influence into interior design field the number of the related research paper is increasing. However, compared with another main part of BIM, such as Architecture, research papers are short of the number. (Figure 2.)

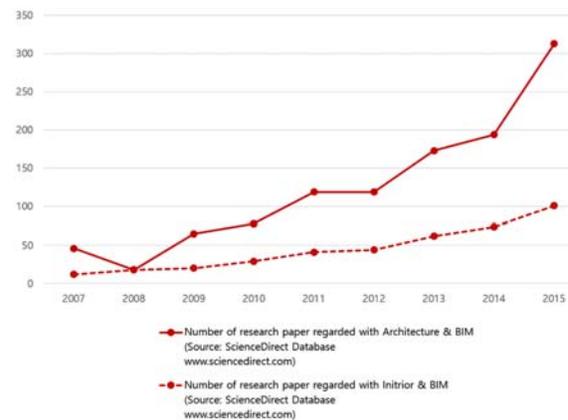


Figure 2. Comparison between the number of research papers of BIM related to architecture and interior (Source: ScienceDirect Database) [3]

There are several main fields which should be deal with large scale in architecture is arousing BIM related studies such as Energy performance assessment, identification of safety hazards and site safety. [8] In the field of interior design, because of BIM' s capabilities of analyzing and simulating system, green energy and design practice. [9] At construction step of interior design, generation of BIM model is expected to play an important role for communication between designer and constructor and improved productivity. [10, 11]

Among interior design process, decorative steps are showing the particularly weak development of BIM research and study. The decorative part in the interior design process are especially easy to interpose creativity and idea where machine and technology yet cannot handle. However, for shortening the construction period and efficient work processes, the introduction of BIM approach seems unavoidable.

### 3.2 Practical use of parametric modeling in interior design

Decorative interior panel design can be found in lobby or showroom of public facilities such as exhibition area and theatre. In commercial facilities, corporation or retail shop use interior panel design point in their lobby or representative spot to make visitor an impression of their brand image. In residential space, because of waterproof function, this design can be found from mosaic tile decoration of kitchen and bathroom. This interior panel strategy often found at the place where people's attention is converged.

Table 1. Examples of practical use of parametric design in interior design

Project name	Space type	Used software	Application purpose
Gravity Fields [12]	Gallery Lobby	Rhinoceros Grasshopper	Exhibition work
Toolbox Office [13]	Office	Grasshopper	Interior design point
Parametric Furniture [14]	Exhibition Hall	Rhinoceros Grasshopper	Parametric furniture

Interior panel pattern design distorted if even one of the panel is arranged in wrong place. Therefore, the design process must proceed in the exquisite and accurate way. However, in the as-is design processes, which depends on designer's visual perception and sensation from experience, it is easy to arouse error in the final result.

Table 1. describes examples of practical use of parametric design in interior design. Representatively Rhinoceros and Grasshopper used for generating parametric algorithm and geometry. The parametric design seems to be used for exhibition work, design point, and furniture design. Various parts in interior design are using the parametric design for a decorative reason.

## 4 Projecting images for designing interior panels using parametric modeling

### 4.1 Process for demonstration of designing interior panel pattern based on 2D image

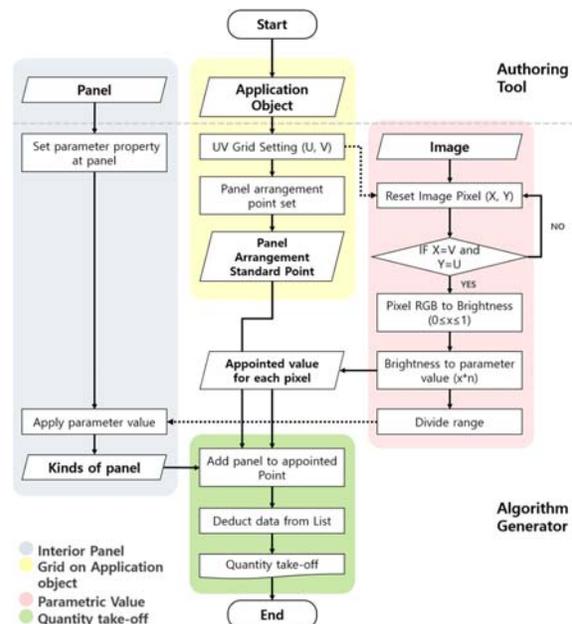


Figure 3. The overall process for a demonstration of pilot tests about the interior panel.

The aim of this process is to make the reduction of time to design and construction and minimization of possibility that error can occur for effective work by projecting a pattern from designated images to design interior panels using a parametric modeling function from BIM authoring tool and algorithm generator.

The as-is design process of interior panel depends on designer's visual perception from image and sensation from experience. This process describes the way of projecting images to design interior panels using parametric modeling. Using BIM application, this process involved design process analysis color and brightness from image automatically. Analyzed result is

substituted on the parametric property. According to each value that assigned on the pixel, every interior panel will be placed on the right spot.

Practical use of BIM decreases deficiency during construction and time consumption. Another virtue from BIM is unconstrained quantity take-off after conclusion deducted. Quantity Takeoff is an important part in the design process for connecting design field and construction field. If there is no much communication between both parts, final output will be deteriorated and lost from the output which user expected. To prevent those problems, design process in this paper largely use BIM authoring tool and algorithm generator. Figure 3. is the overall process of demonstration. BIM authoring tool is role as platform for design process and gathering of outputs. BIM algorithm generator starts to emerge for much wider variety of geometric modeling and information management.

#### 4.2 Generating prototype in BIM authoring tool

BIM authoring tool including Autodesk Revit-3D knowledge-rich parametric modeling systems- role as a system for generating a prototype of the interior panel as family and parametric property in the family editor. [4] Before using algorithm generator for panel pattern, three steps need to be done in BIM modeling system. 1) Set of application object 2) Create panel 3) Set parameter property on panel, those steps will be executed by project and family editor in Autodesk Revit.

In this paper, basic model in Revit which used for educational propose is selected for the application object as seen in Figure 4.. Side wall next to hallway in educational facilities is the proper background for panel design because this wall could be seen from the upper floor throughout void between both floors.

A prototype of the panel has a circular hole in the middle of the panel. Figure 5. is different parametric property of panel which the value of the radius of the panel. According to the radius of the hole in the panel, each panel displays correspondent pixel's data. Figure 6. is applied property value in Family types dimension property. Gathering of every panel on assigned spot with different parametric value will show one completed panel pattern design.

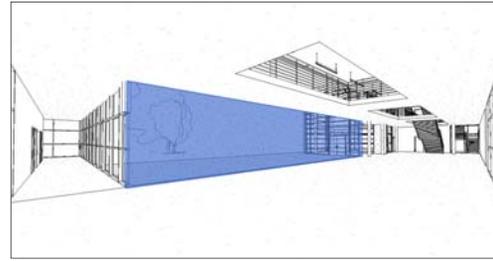


Figure 4. Application objects in facility

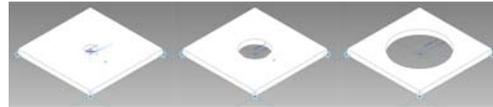


Figure 5. Interior panels with different parameter property (from left, Panel Radius=200, 500, 1000)

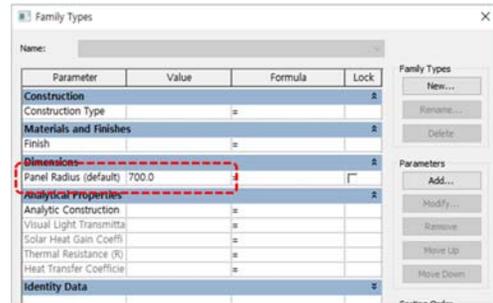


Figure 6. Interior panel's parameter property (Panel Radius) in Family types and value.

#### 4.3 Generating algorithm using graphical programming tool

Each node can expose the result of the process immediately. At the same time, if there are some problems in node combination sequence, problem nodes change their color and show an error's contents. Visual effects during the process make course deduct conclusion much fast and flawless. Accurate result by Dynamo will be drawn by nodes and connections which also operate well only when the proper type of string or formula is entered in. These system makes user know the most direct procedure of Dynamo and finds themselves more effective way to solve the problem.

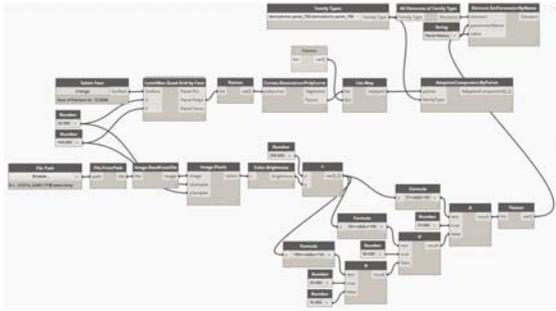


Figure 7. Dynamo, open source graphical programming tool and computational design application for design.

Every node combination and nodes have input and output value as seen in Figure 7., and every value also can be input value of another node. For the arrangement of interior panel node combination largely divided into five parts.

- Set grid on application object: For the arrangement of the panel, the proper number of U and V values are needed to generate a grid for showing the 2D image. If the too small number is entered, it is hard to recognize what user wanted to show because of each panel represent too many pixels.
- Get parametric property in family type: To control the radius of the hole in the panel, its family type must be brought as family type. Through name string, 'Element.SetParameterByName' node find parameter which has same string of name.
- Image's brightness to a parametric degree: This step project 2D image and automatically analyze color value from the pixel on the image and change color value to brightness value between 0 and 1. To deal delicate value of brightness effectively, multiplication node is needed to amplification. Multiplied values are added to parameter property.
- Apply panel to point: Each point of the selected face, parametric panels will be placed with finalized panel radius. Each panel which has their own panel radius locate definite point.

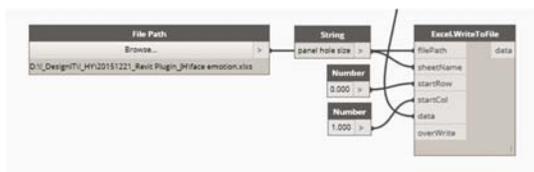


Figure 8. Node combination for quantity take-off in the final process of pilot test.

- Quantity Takeoff: For the effective construction of

interior panel design, the data source for the constructor is important for communication with the designer. As seen in Figure 8., node 'Excel.WriteToFile' creates data table depending on selected information. The input of data will be the number of a panel according to kinds of the panel. To arrange panel on the right place, this node creates another sheet for panel plan. The advantage of a data table which set by selected data from user generates plenty kinds of the data sheet for preference of constructor.

## 5 Parametric interior panel pattern design and arrangement system pilot test

### 5.1 Different output by input image

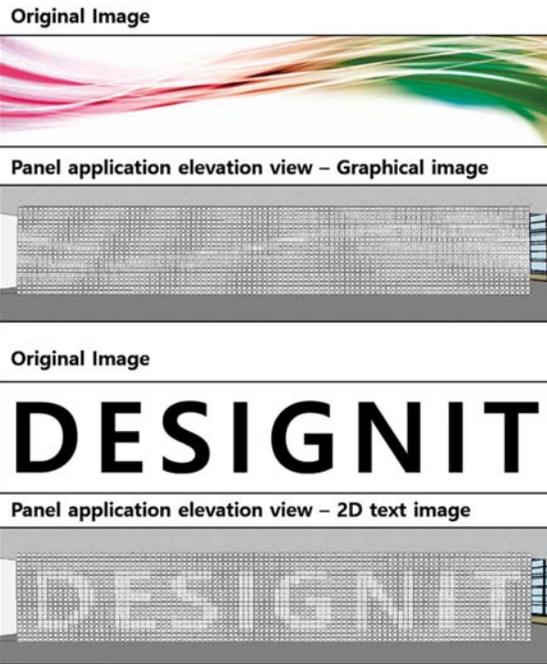


Figure 4. Different output by different entered image by the user.

By different images entered by user draw out the various final result. As Figure 9., the first original image has diverse color in a single image while the second original image has only two colors which derived from 2D text image.

To generate proper output for final, setting kinds of panel step is important. If only two panels arranged for a first original image which has several colors and

brightness value, panels could not show softness of wave which the first image tried to reveal. Proper value selection related with image's color and brightness is needed for high quality of the final result.

## 5.2 Different output by LoD of parameter property

Figure 10. is dealing with parameter property's LoD for a design wall. In the low level of detail, wall used 4 kinds of panel (Panel Radius=10, 30, 50, 70), and high level of detail wall used 7 kinds of panel (Panel Radius=10, 20, 30, 40, 50, 60, 70)

As seen in detail view, detail part of swoosh wave in the original image represent different LoD. For the high quality of the final result, the user needs to enter the large number for kinds of panels.

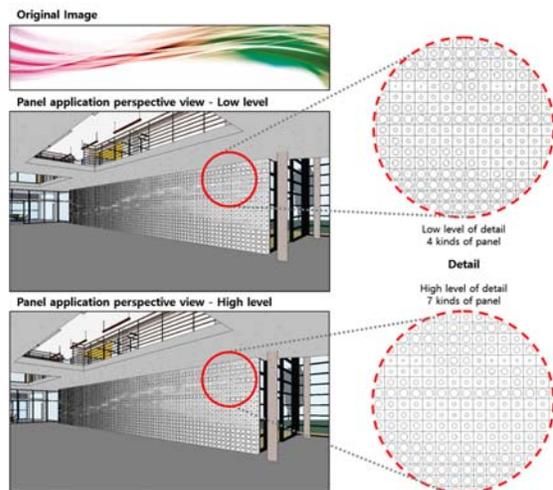


Figure 5. Difference between high level and low level of panels

## 6 Conclusion

This process has advantages on reducing time consumption and errors which can occur during process. BIM in interior design role as controller and manager of detailed building element. Even if this paper's pilot test is limited on interior panel, there are much feasibility of application of BIM at interior design elements.

Various design tools are coming up for new design paradigms. The trend of design is following parametric design depends on changeable and adaptive geometry. This pilot test is not just for dealing with panels having limited physical characteristics. This paper attempting for further develop for the arrangement of a various object such as space object, a collection of specific

objects according to assigned algorithm. For the start of the further study, this case study uses BIM authoring tool and algorithm generator for parametric modeling to propose a new way to design interior panels from an image.

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