Developing Intelligent Interior Design Decoration Components by BIM Technologies

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Abstract. This study develops intelligent interior design components that enhance design communications, based on the concepts and technologies of the building information modeling (BIM) to resolve data inconsistencies in relevant graphics of an interior design project. The developed intelligent decorative wooden walls possess intelligent dynamic correlation functions, with parameters that can control the wooden wall material, size, and restrictions. This study identified that the graphical data inconsistency problem was resolved, and effective communication was promoted among the participants who were involved in the various stages of an interior design project.

Keywords: BIM, building information modeling, interior design.

1 Introduction

Traditional execution process of interior design project relies on two-dimensional drawings. However, when 2D view is used to express construction entity of interior decoration, often, it has pretty many simplification, omission and confliction. Especially, when design modification are taken during the project process, the negligence and errors of description update may highlight the problem severity of contradictions and inconsistencies on drawing related information even more.

In recent years, Building Information Modeling (BIM) takes the new concept of consistency of whole project engineering life cycle information exchange, multi-disciplinary integration and cross-phase collaboration communication method. It can provide effective communication and coordination mechanisms of whole project. Therefore, the study goal is to develop an intelligent interior design decoration element with design communication efficiency aiming at the inconsistent information problems related with general interior design project execution via BIM concepts, methods and techniques.

2 The Practices of Carpentry Decoration Wall

With the research schedule limitations, this paper uses carpentry decoration wall as discussion objects. Carpentry decoration wall plays roles of compartment, decorative

decoration and accommodating utilities, information, communications wiring and other related functions. It is designed by designer, constructed by carpenter master and piping configuration is finished by related operation personnel.

2.1   Carpentry Decoration Wall Design Practice Interview

Carpentry decoration wall design practice interview in the study invites 4 professional interior designers. Main points of the design practice interview are design type and category, construction position, application range, typical decorative wall molding and drawing description of decoration carpentry wall in design stage. The design practice interview results are summarized as in Table 1.

Table 1. Summary of Design Practice Interview Results

Design Type	Perpendicular Wall	Two-sided Partition Wall
Design Category	Depending on the attached construction, wall width can be divided into two design categories: 1).equal to wall width, 2). Less than wall width.	
Construction Location Type	Constructing on original wall in the space, it can be divided into 4 construction location types: Left, center, right and full wall width, as in Figure 1.	Constructing on room width (depth), it can be divided into 4 construction location types: Left, center, right and full room width, as in Figure 2.
Typical Decoration Wall Molding	It takes even separation or partition for width or height of wall surface, and creates simple and refreshing shape and three-dimension effect after being separated by concave joint emphasized line of plywood or skinning plywood. See Figure 3. Typical Decoration Wall Molding.	

| Left | Center | Right | Full Wall Width |

Fig. 1. Construction Location Type of Perpendicular Wall (Plan Sketch)

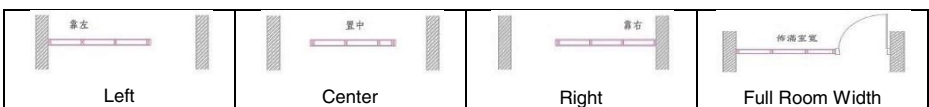| Left | Center | Right | Full Room Width |

Fig. 2. Construction Location Type of Two-sided Partition Wall (Plan Sketch)
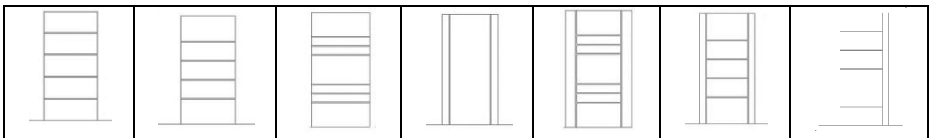

Fig. 3. Typical Decoration Wall Molding (Facade Schematic)

2.2   Carpentry Decoration Wall Construction Practice Interview

Construction practice interview in the study invites 4 professional carpenter masters, and all of them have more than 25 years of business experiences and interior decoration engineering contractors. Main points of the construction practice interview are commonly used materials and specifications, size limits, structure type, design drawing description and actual construction differences of decoration carpentry wall. The construction practice interview results are summarized as in Table 2.

Table 2. Summary of Construction Practice Interview Results

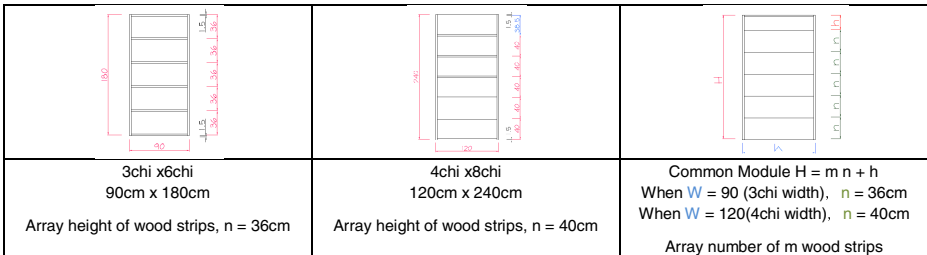| Design Type	Perpendicular Wall	Two-sided Partition Wall
Commonly used materials and specifications	Wood strips: generally adopted 1.2cun x1cun Plate: No matter for Perpendicular Wall or Two-sided Partition Wall, the generally used plate is 2fen plywood or 2fen Calcium silicate board (which shall be adopted when it has fire 0 proof regulations). 2fen Calcium silicate board: 3chi x 6chi (90cm x 180cm) 2fen plywood: 3 chi x 6 chi (90cm x 180cm), 4 chi x 8 chi (120cm x 240cm). See Figure 4 on detail.	Wood strips: generally adopted 2cun x1cun
Design drawing description and actual construction differences	As all wood strips structures of decoration engineering are restricted by two kinds of commonly used plate specifications, i.e. 3 chi x 6 chi and 4 chi x 8 chi. Therefore, the construction method of wood strips structure has fix construction mode and formula rule for reference (Figure 5 and Figure 6). This is the necessary professional knowledge for interior design related employees. Unless the carpentry wall has complicated shape and structure, which requires sectional detail drawing for expression, the drawing description may simplify and omit sectional elevation drawing or detail drawing if it is general carpentry wall.	

3chi x6chi 90cm x 180cm Array height of wood strips, n = 36cm	4chi x8chi 120cm x 240cm Array height of wood strips, n = 40cm	Common Module H = m n + h When W = 90 (3chi width), n = 36cm When W = 120(4chi width), n = 40cm Array number of m wood strips

Fig. 4. 3chi x6chi and 4chi x8chi Ply Wood Specifications

L = W	L≦2W L = a + p + 2d	2W<L<3W L = a + W + p + 2d	3W< L L = a + 2W + p + 2d
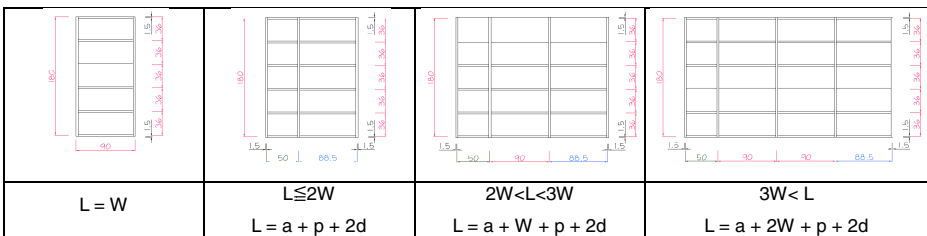
Fig. 5. Modular Analysis for 4 Types of Wood strips Structures(3chi x6chi Perpendicular Wall)

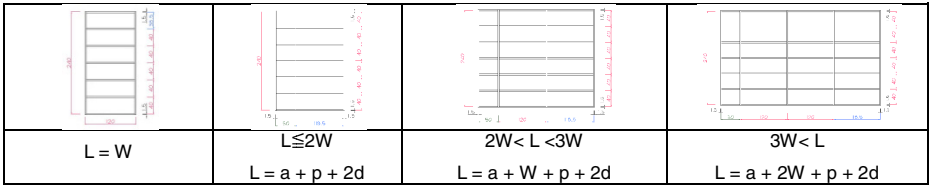|			
L = W	L≦2W	2W< L <3W	3W< L
	L = a + p + 2d	L = a + W + p + 2d	L = a + 2W + p + 2d

Fig. 6. Modular Analysis for 4 Types of Wood strips Structures(4chi x8chi Perpendicular Wall)

3   Developing Intelligent Interior Design Decoration Carpentry Wall Element

The study takes Autodesk Revit BIM development tool to develop intelligent interior design and decoration carpentry wall element. Revit takes Families as construction core of BIM and uses parametric modeling techniques and 3D visualization design. The development of intelligent interior design and decoration carpentry wall element in the study takes the families of Revit BIM as basis. With the above stated carpentry wall design and construction practices interview, the paper makes the following illustrations for the development of intelligent interior design and decoration carpentry wall element.

The system development divides intelligent decoration carpentry wall element families into 4 hierarchies: A).material (Sub-layer Families), B).decoration plate (sub-layer nesting families), C).frame structure (sub-layer nesting families), D).carpentry wall (parent nesting families), as in Figure 7. It has 3 types of nesting families, i.e. single material families, assembled group to form decoration plate modeling, frame structure and carpentry wall. Furthermore, it is subdivided into 7 types of families: 1).basic material families of wood strips and plate, 2).typical decoration plate partition and even separation families, 3).basic frame structure families, 4).plate width frame structure families, 5).perpend wall families 6).two-sided wall families, 7).decoration wall families, as in Figure 8. The 4 hierarchies and the 7 types of families are the results of system development in the study: interior design intelligent decoration carpentry wall element.
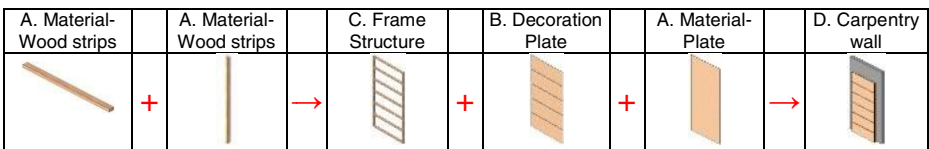
A. Material-Wood strips		A. Material-Wood strips		C. Frame Structure		B. Decoration Plate		A. Material-Plate		D. Carpentry wall
	+		→		+		+		→	

Fig. 7. Interior Design Intelligent Carpentry Wall Element (4 Hierarchical Families Structure)

A. Basic Material---Wood strips Families (Sub-layer Families)						
Gxwood strips	Gxwood stripsar	Gxwood stripstb	Gywood strips	Gzwood strips	Gzwood stripsar	Gzwood stripstb

C. Frame Structure						
Basic Frame Structure Families (Sub-layer Nesting Families)			Frame Structure Families (Sub-layer Nesting Families)			
Z1E frame L	Z1E frame M terminal dedicated	Z1frame right end dedicated	1 frame	2 frames	3 frames	4 frames

A. Basic Material-Plate Families (Sub-layer Families)						
Front and Behind FB of Cl2 Silicon	Front and Behind FB of Cl2 plywood	Front and Behind FB of C－2 plywood	Front F of Cl2fen single plate	Front F of C－2fen single plate	Front and Behind of Cl veneer	Front and Behind of C－veneer C

B. Decoration Plate-Typical Decoration Plate Partition and Even Separation Families (Sub-layer Nesting Families)						
Even height separation	Partial even height separation	Height partition	Width partition	Height and width partition	Width partition and partial even height separation	Width partition and partial even height separation

D. Carpentry Wall Families-Single Plate Decoration Wall (Parent Layer Nesting Families)						
Even height separation	Partial even height separation	Height partition	Width partition	Height and width partition	Width partition and partial even height separation	Width partition and partial even height separation

D. Carpentry Wall Families (Parent Layer Nesting Families)						
Perpend Carpentry Wall				Two-sided Partition Wall		
Single plate width L=W	Double plate width W<L ≦2W	Three plates width 2W< L ≦3W	Four plates width 3W< L ≦4W	Side	Center	Full

Fig. 8. Interior Design Intelligent Decoration Carpentry Element

4   System Assessment

The study takes system using assessment via 4 interviewed interior designers and the staffs and other total 32 related employees introduced by the 4 interviewees. The system function assessment is taken in questionnaire method. It discovers except the interviewees are not adaptable to Revit standard interface with too small system interface body size, the rest are all accepted good results, no matter in operation method, design communication efficiency, consistency of drawing description, easy-learning and easy using, and integrated performance of system functions. The 4 hierarchies systems and 7 types of families' loadable nesting families developed by intelligent interior design carpentry wall element in the study can all achieve positive and effective assessment to promote effective design communication.

5   Conclusion

The paper discusses how to assist participants to provide intelligent interior design and decoration element with communication efficiency and solve inconsistency problems of related drawing description in interior design project via the concept and techniques of BIM. The study results and conclusions include:

1. BIM provides cross-industry and cross-stage cooperation and management behavior and process, as establishment, changes, operation, analysis, design communication and maintenance of product life cycle information.
2. Families are the core techniques of BIM, and Loadable families provide the user with intelligent elements with customized shape and simple structure or compose parent layer nesting families by several modular sub-layer families.
3. The study developed intelligent interior design carpentry wall decoration element has intelligent correlation function. When a parameter is modified, all related 2D and 3D drawing description will be updated consistently and simultaneously.

References

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