



Research on parametric modeling methods for mechatronics cluster library

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Abstract. For the electromechanical family library in the component less, the degree of parameterization is low and other issues, this paper to fan coil as an example, the use of BIM technology for parametric modeling, through the simplification of the model, nested family, write parameters to create a general family library of electromechanical and the family library is applied in a local ethnic research centers, through the example of the validation of parametric general family library is simple, fast, intuitive, and can improve the efficiency of the design, to provide a reference for the application of BIM technology in the construction of the electromechanical industry, with a view to further promote the digitization process of the construction of electromechanical.

Keywords: BIM, Electromechanical, Family Library, Parameterization.

1 Introduction

Today, in the continuous development of the scale of China's construction industry, BIM technology, as an emerging technology of parametric expression and integrated management, is setting off an information-based digital revolution in the construction industry. ^[1] From the perspective of BIM application, parameterization, as its basic feature, is applied in the whole life cycle of a project. Parametric modeling is a modeling method that uses parameters to save digital component information, and new models can be built and analyzed by changing parameter values. ^[2] In BIM parametric modeling, family, as the smallest data unit, is the carrier of parametric information. The diversity and parameterization of families is a direct reflection of the efficiency of the BIM model modeling process, and it is necessary to seek a development path for the development of family libraries.

As an indispensable part of housing construction, the research on BIM electromechanical specialty has been carried out one after another. ^[3] The component library of E&E profession, as the cornerstone of E&E profession, has long existed with the defects of few components, low degree of parameterization, and uneven format, etc. How to create, save, and promote the E&E library is an urgent problem to be solved.

This paper takes the fan coil of electromechanical specialty as the research object, analyzes the intrinsic law of fan coil components, models the electromechanical components parametrically, so as to create a generic family of fan coils, and provides help for the parametric modeling of electromechanical family libraries.

2 Research on family parametric modeling method based on BIM technology

1) In the research of genealogy management methods, Peng Yubing ^[4] introduced configuration management into enterprise-level genealogy construction and management, and established a genealogy configuration structure diagram that contains three levels: the top structural layer, the middle configuration layer and the bottom instance layer.

2) In the localization of the family library research, Chen Lei ^[5] in the Revit civil engineering digital design platform to study the establishment of the Chinese national standard atlas library, the library can enhance the design of the platform software modeling and drawing ability to improve the design efficiency.

3) In the research on the application of engineering projects in the family library, Luo Wenlin ^[6] takes a theme park in Wuhan City as an example to informatize the component models of various specialties to achieve the realization of the value of the data fetching in the process of BIM application. Pang Zhining ^[7] combined with the port project, solved the problem of batch modeling of mechanical parts with the same characteristics, and improved the efficiency of collaborative work of the construction side.

In general, parametric modeling of MEP clusters started late, and a standardized database has not yet been formed, and the application of BIM technology in building MEP clusters is less.

3 BIM parametric electromechanical family modeling process

3.1 Simplified model

The MEP profession has rich systems and complicated equipment, which greatly increases the modeling workload of the BIM MEP family library, and also leads to the excessive memory of the parametric BIM MEP family library. In order to systematically create the E&E component family library, it is necessary to normalize the same type of building E&E components, i.e., different forms of the same type of E&E components are categorized and processed into a single parameterizable family.

This paper takes fan coiler as an example, fan coiler is the end device commonly used in air conditioning system, according to the structure form can be divided into vertical, horizontal, etc., according to the water inlet can be divided into left, right, according to the system can be divided into two-control, four-control, according to the installation type can be divided into the open installation, installation. ^[8-9] Although there are many types of fan coils, their structures, functions, and principles are similar, and the relationship between the dimensions can be established by simplifying the

model and introducing parameters, so as to establish a common family of fan coils. In the conventional design, taking into account the cooperation between the fan coiler and other specialties, the components that have nothing to do with the cooperation such as fans and trays in the fan coiler are omitted, and the information such as the size of the fan coiler (L, W, H), the water pipe interface (D_e), the water pipe connector, the air inlet (b, h), the air pipe connector, and the power of the motor (P) are emphasized. Relying on Revit software, the fan coil general family is constructed according to the relationship of each parameter of the fan coil, so as to realize the purpose of parametric modeling of the electromechanical family library.

3.2 Creating Nested Subfamilies

For the creation of complex families, the use of nested families is a better method. Nested family is a complex component is divided into a number of relatively simple structure, you can use a new family to carry the original family, including all the parameters of the original family, such a hierarchical structure can be better editing and management of the family. For the fan coiler component family, its components are more complex, more parameters, it is difficult to create a one-time complete, so it will be split into three parts: chassis, air outlet, water pipe interface. Among them, the air and water pipe interfaces are nested sub-families, and the chassis family is the body family, with the intention of nesting a number of sub-families into the body family of the chassis. The steps to create a nested sub-family for a water pipe interface, for example, are as follows:

- 1) to "metric conventional model.rft" for the family template to create a new "water pipe interface.rfa" family file. Revit in the family template is equivalent to a template, the template contains the creation of the family and the project application of the information needed to create a family for the parameterization of the family to lay the foundation for the application of the family. Parametric application of the family to lay the foundation.

- 2) Take the (0,0,0) of the family as the coordinate origin to create a hollow stretch. the origin of the Revit family file is the intersection of the two original reference planes by default without modification, using the original intersection as the coordinate origin to prepare for the positioning of the sub-family nested into the body family.

- 3) on the water pipe interface to give the type of parameter (inner diameter D_o , wall thickness t, outer diameter D_e , water pipe interface material), of which "water pipe interface material" for the material parameter type, the rest are length parameter type.

Note that when loading the sub-family "Water Pipe Connector.rfa" into the chassis family, you need to use the Align command in the Edit function to align the water pipe connector to the new reference plane to ensure that the front/back and top/bottom offsets are positioned, and at the same time, lock the position to ensure that the water pipe connector is firmly positioned. The new reference plane can be set with two parameters, "Pipe Offset" and "Pipe Offset", so that you can flexibly adjust the position of the water pipe connection in the project later.

3.3 Writing of family association parameters

In the process of creating a family, based on Revit software, you can realize the family parameter changes to better control the information of the model and enhance the flexibility of the model. Four methods are used to write family parameters in fan coils.

1) direct parameterization method: the "family type" in the Properties panel is the button to add parameters directly. In this function, such as dimensions can be labeled first set the family type, so that you can create a number of dimensions of the type of family, if the size of the more changes can be exported to the family type of txt text editing. In the process of giving parameters directly, you need to set the name of the parameter, protocol, type, grouping, if necessary, you can also set up a tooltip of 250 characters or less. In the fan coiler family, several parameters such as brand, motor power, material and so on are set to meet the need of information change through the direct parameter assignment method. During the setting process of the family parameters, if the parameter needs to be counted in the breakdown table, the shared parameters can be used. If you want to further extract the parameter value from the geometry, you can also use the report parameter. The material parameter in the fan coiler family uses this method to read the area data of the material, laying the foundation for the factory to lay the material.

2) Reference Plane Method: Labeling dimensions on the reference plane can realize parameter-driven dimensions. Reference plane with a green dotted line, is a vertical dotted line of the infinite extension plane, not visible in the 3D view, you can name the reference plane and add sub-categories, in the "is a reference" on the choice of attention do not choose "non-reference", otherwise in the project the Otherwise, the reference plane will not be captured in the project, and then the dimensions cannot be labeled and the parameter changes cannot be realized. In the body family of the fan coil chassis, a large number of variable parameters are given by setting the reference plane, such as the dimensions of the chassis (L, W, H), locking the pre-set reference plane while drawing the tensile contour lines of the chassis, giving the reference plane the relevant dimensional annotation, and then creating the dimensional parameters of the relevant dimensional annotations, which allows you to control the dimensions of the chassis in the three-dimensional model through the input of dimensional parameter values. Note that when setting the dimensions of the reference plane, you need to mark the centerline of the original positioning reference plane of the family and the reference plane set by yourself, and set them to be constrained by each other's equidistant, so as to ensure that in the process of parameter change, the chassis entity is based on the center of the family (0,0) as the reference for the corresponding changes.

3) Reference line method: adding angle annotations on the reference line can realize the parametric drive of the angle. Reference plane with a solid green line, there are generally four planes, respectively, the horizontal plane, the vertical plane, the line for the normal of the head and tail of the two planes, the reference line in the three-dimensional view of the visible, can assist in the realization of the angle parameter change. Such as fan coiler in the left and right two types of water inlet realization. Embedded "water pipe interface.rfa" in the chassis body positioning accuracy and lock, draw the reference line at the same time to give the reference line "water pipe reference line

length" and "water pipe reference line angle "two parameters, these two parameters are expressed in Revit's formula. The angle of the water pipe reference line = if (right, 180°, 0°), and the length of the water pipe reference line = the length of the air conditioner / 2 + the length of the water pipe connection. There are two additional planes at the endpoints of the reference line, and when adding pipe connections, the connections are placed by picking up the side loops of the additional planes. The parameters "length of water pipe reference line" and "angle of water pipe reference line" can realize the left and right type of water pipe connection.

4) Correlation parameter method

Associative parameters are a way to control the relationship of nested family parameters, through the family associative parameters, to realize the nested ontology family and nested sub-family information transfer and interaction, to ensure the consistency and accuracy of the model. Revit in the nested family parameters can be inherited by the nested sub-family of the original parameters, which contain two categories of instance parameters and type parameters. And these inherited parameters can also normally participate in the Revit calculation formula and logic formula, but it should be noted that the unit of the associated parameters need to be consistent. In the fan coil family, the chassis body family loaded into the "water pipe interface.rfa" and "air outlet.rfa" two nested sub-family (Figure 1), the two nested sub-family have a number of parameters, such as the chassis body family of the "water pipe interface 2 length". Water pipe interface 2 length" associated with "water pipe interface.rfa" in the "water pipe interface length" parameter, and water pipe interface 2 length = if (four control, 800mm, 0mm), when the user switches the control type, the user can use the length of the water pipe interface to switch the control type. When the user switches the control type, the user can control the existence or otherwise of the water pipe through the length of the water pipe interface, and realize the switching between the two control types and the four control types.

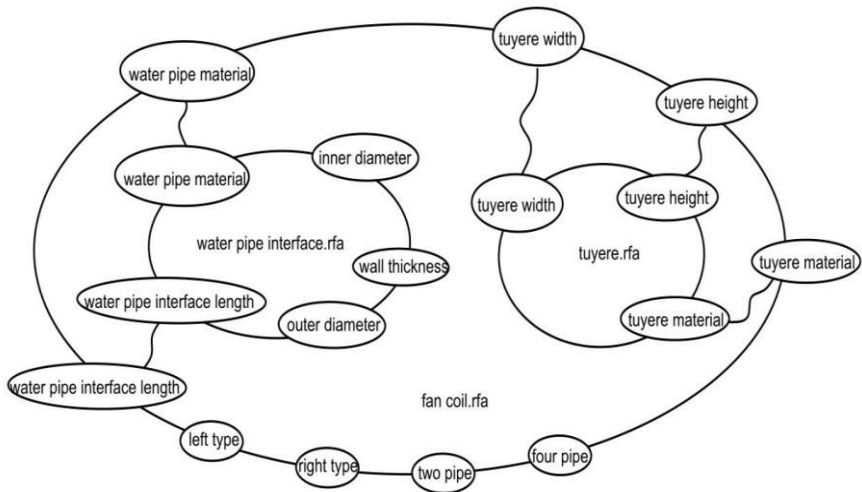


Fig. 1. Schematic diagram of correlation parameters

3.4 Results of parametric family modeling

The unified fan coil model is set up with a good flat expression, and the unused families and types are deleted, so that a generic family of lightweight fan coils can be obtained (Figure 2). The generic family format is ".rfa", and the size is 0.97Mb. 0.97Mb. The family basically meets all the requirements of the user for the fan coiler, when the user loads the generic family of the fan coiler into the project, enter the corresponding numerical parameters to realize the parameterized changes in size, material, brand, water inlet (left type, right type), control (two-control, four-control), structural form (each direction of the air outlet), and motor power.

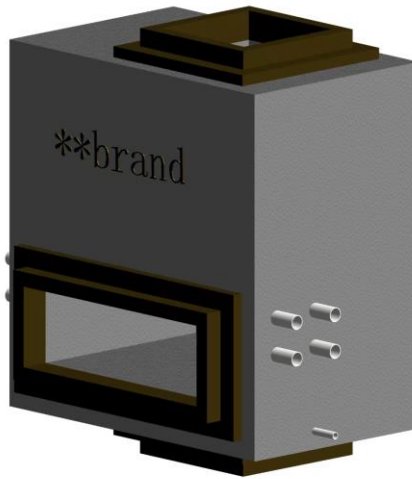


Fig. 2. Generic family of fan coils

4 Formation and application of electromechanical family libraries

Referring to the process of BIM parametric E&M family creation, a common family library for each E&M component can be created according to each specialized drawing set. In the process of creating the family library, due to the large number of electromechanical component family libraries, it is necessary to classify and store the family files, which can be stored according to the three-level directory structure. The first level for the specialty, such as water supply and drainage, HVAC, electrical, etc., the second level for the system, such as hot water heating, air conditioning, gas, etc., the third level for the components, such as fan coils, diffusers, static boxes, etc. Classifying and storing family files can lay the foundation for further expansion of the family library and facilitate future uploading, downloading and retrieval. Upload the classified generic family library in order to form the E&E family library. In order for users to have a better understanding of the generic family before loading the family, set up the main view and

stay on it before saving, which ensures that the main view will be the preview image when the family library is previewed, and a 3D preview can be realized. Generic family library of electromechanical components is the fruit of the creator's labor, in the sharing of models at the same time should pay attention to the protection of intellectual property rights, component library platform should use digital encryption and other security technologies to prevent the leakage of core technologies. The created parametric library platform can be shared among practitioners to reduce duplication of labor and improve design efficiency.

Electromechanical components of the universal family library used in a number of projects, this paper introduces a local ethnic research center as an example, the main function of the local ethnic research center for folk culture display and office. The main function of this local ethnic research center is folk culture exhibition and office. 3 floors above ground, 1 semi-basement, total building height of 21.2 meters, total floor area of 14442 square meters, design service life of 50 years, frame structure, seismic intensity of six degrees. This project uses Revit software to create a BIM model, in which the architectural specialty is the main model, and the remaining four specialties-structural, water supply and drainage, electrical, and HVAC-are linked models (Figure 3). The generalized family library created by the parametric modeling method of the electromechanical family library in this paper is directly applied in this project, in which there are 728 units of electrical engineering equipment, 1,835 units of water supply and drainage equipment, 982 units of HVAC, and 30 groups of fan coils. Although the total number of units of equipment is large, but due to the use of generic family, can realize the parameter change, a generic family can be changed to multiple types, so the generic family used in this project is 427.



Fig. 3. BIM model of a local ethnic research center

From the application cases, it can be seen that the advantages of the universal family library of electromechanical components are fully revealed in the model creation, and its biggest advantage lies in parameterization. The parameterized universal family library can be transformed into a variety of electromechanical component families by inputting preset parameters, which is very convenient for program design and design changes, avoiding the waste of human resources and family library resources, and thus effectively improving the design efficiency.

5 Conclusion

In this paper, the process of parametric modeling of electromechanical components based on BIM technology is studied by taking fan coil as an example. By simplifying the model, nesting families, writing parameters to create a general family library of electromechanical, and apply the library in engineering cases, so that the parameterized general family library is simple, fast, intuitive, can improve the design quality and efficiency of the drawings, and has a certain significance for promoting the digital development of the building electromechanical industry.

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