

# Development of Wall Jib Crane Design System Based on Visual Basic.NET

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**Keywords:** wall jib crane; module division; development of design system; VB.NET

**Abstract:** This paper introduces the basic principle and method of module division. Based on the structure analysis method, module division of the wall jib crane is done. The product design system of wall jib crane is established by the Autodesk Inventor software. The data base system depends on Excel. The secondary development platform is provided by Autodesk Inventor software and the development language is VB.NET which is based on object-oriented programming. Finally, the wall jib crane design system is developed.

## Introduction

In the modern production workshop, material handling generally relies on the overhead travelling crane and the column type cantilever crane. As we all know, overhead travelling crane has great advantage in bulk material handling. However it cannot take every station into account. The column type cantilever crane is suitable for small batch material handling, but it can only work within a certain range due to the limit of cantilever radius. Wall jib crane is a new type of lifting equipment, which travels on the track installed in the workshop. The material handling is achieved by the electric hoist. At the same time, Wall jib crane has lots of outstanding features such as compact structure, flexible action, simple operation, high efficiency, saving spaces and so on. What's more, it could overcome the defects of that two kinds of material handling machinery above. So it has excellent application prospect.

## Wall jib crane module division

**Modular Principle.** Based on the analysis of product function and structure, we could adapt modular principle to decompose the product into several modular parts that are functional, structural independent but with standard interface. Then different types of products could be designed frequently by the selection and combination of different modules. Modularity has the excellent characteristics of standardization, serialization, generalization, economization, integration, compatibility and correlation.

There are two main types of product module partition method: structure analysis and functional analysis<sup>[1]</sup>. Structure analysis method is based on different parts and their objectively topological constraints of the product structure. It is mainly suitable for mature and classic products that with obvious structure features. This method emphasizing the module geometry and physical independence is established on the basis of the structural design of components. Functional analysis method is used to divide products which are relatively function independent according to

the function composition and connection of different product parts. Because of its emphasis on the independence of the module function, it is mainly applied for function analysis and concept design of the previous product design stage.

The five principles of product module division should be followed are shown as follows<sup>[2]</sup>:

1. The modular independence and integrity in terms of function and structure.
2. To improve the versatility of the module, interface elements should be easy to get connected and separated.
3. The stability of module interface elements.
4. The internal parts of the module should be associated closely to ensure the module stability.
5. The association between the modules should be as little as possible to ensure the independence of modules.

**Wall Jib Crane Module Division.** According to the structure analysis method, wall jib crane is divided into five modules: electric hoist module, cantilever beam module, pillar module, walking cart module, auxiliary facilities module. The specific contents of each module are shown in Fig.1. Among them, the electric hoist used in the electric hoist module is used for lifting heavy objects, and the hanging walking part is used for controlling the electric hoist and the heavy object to walk along the track of the cantilever beam. The box girder and steel rail in the cantilever beam module supporting electric hoist and heavy, and provide for the walking track. Reinforced bar used to strengthen the bearing capacity and bending performance of the cantilever beam. The limit device is used to limit the running position of the electric hoist. The column module mainly plays the role of fixed support. On the whole mobile module of wall jib crane.

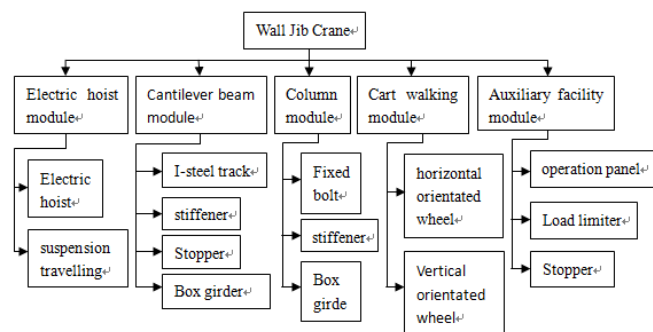


Fig.1 The wall jib crane module division

### Development of Wall Jib Crane Design System<sup>[3]</sup>

The product design system of wall jib crane is established by the Autodesk Inventor software. And the development language is VB.NET which is based on object-oriented programming. Object oriented method is a top-down design means by decomposing the complex problem smaller one gradually, and finally we could achieve the desired effect of "divide and conquer". At the same time it is also a modular design thought<sup>[4]</sup>. Object oriented design is the most effective program design method for complex problems. The secondary development of Autodesk Inventor is based on COM technology. With the help of Inventor API function interface, the application developer can achieve their secondary development purpose<sup>[5]</sup>.

**Database Usage Technology.** In the product design process will produce a large amount of data, these data are various and indispensable, and the application of database technology can facilitate the management of data. Database software mainly has Excel, Access and SQL Server and so on, which excel has the characteristics of flexible, simple, more suitable for small database. Through the VB.NET can be a very good realization of Excel of secondary development, so the use of Excel as

wall jib crane design system database. The following is the VB.NET using COM way to link to the specific steps of the Excel database:

- (1) COM component reference.
- (2) Linking to the data source and opening the Excel database objects.
- (3) Opening the parameter record object with the tab page.
- (4) Recording the object with parameter.
- (5) Closing the database and releasing the memory.

**Automatic Generation Technology of Engineering Drawings.** Inventor has the function of conversion from 3d model to engineering drawing. And the conversion is associated with model changes. However the conversion and the view layout, dimensioning, comments adjusting are not realized automatically but by manual. Therefore, Inventor and API VB.NET can be used comprehensively to label the engineering drawings, and adjust the view layout, dimension and so on to meet the industry standard automatically. The engineering drawing automatic generation technology mainly includes: the production of engineering drawing template and the automatic generation of Engineering drawing.

**Production of Engineering Drawing Template.** When the three-dimensional model of Inventor is transformed into two-dimensional engineering drawing, engineering drawing template is needed. So the quality and efficiency of the engineering drawing can be greatly improved. According to the design requirements of the product, the size of the engineering drawing template is A0-A4, the main processes of template production are as follows:

- (1) Set the layer

To set the required layer including contour lines, dotted lines, the center line layer, marking layer, annotation layer, etc., according to the layer's functions and the corresponding settings.

- (2) Edit drawing

Diagram the drawing frame which meets industry standards and enterprise standards and make good title block accordance with the requirements.

- (3) Setting options

To set the content of the options according to the requirements of the drawings, open the Inventor system **【management】—【style and standard】—【style editor】**. Completion of the size of the line, arrows, units, accuracy, font, view, and the view, tolerance and process requirements, profile and other related content settings.

- (4) Link property

Linking to the relevant information of the notes and the structural properties of parts and components in the title bar of the project to realize the automatic connection of parts and engineering drawings, mainly including part code, name of spare parts and materials, etc.

- (5) Save the template

After the completion of the set, the image file is saved as drawing template format (\*.idw). And then the drawing template file should be put in inventor installation directory. So that you can use these good set engineering diagram template directly in drawing.

**Engineering Drawing Automatically Generated.** Engineering drawing is automatically generated by VB.NET and Inventor of API interface to control implementation, the main steps are as follows:

- (1) Establishing new engineering drawings with the engineering drawing template as standard according to parts that needed to be designed, such as the A4 template to build the engineering drawing documents, the program as follows:

`oDoc=oApp.Documents.Add(DocumentTypeEnum.kDrawingDocumentObject,spath1&"A4 template. idw")`.

(2) Make sure that the parts to generate engineering drawings is opened in the background. For example, when we need to open the front part of the cantilever beam components, the program is as follows:

`oPartDoc =oApp.Documents.Open(spath&"xbldb.ipt", False)`

(3) To create a positioning point for the projection view, we should consider the size of the view and its distribution in the engineering drawing, and make the view distribute evenly as far as possible (2,17) as the coordinate point to create the locating point, the program is as follows:

`oPoint1 =oApp.TransientGeometry.CreatePoint2d(2, 17)`

(4) Adding the basic views of the parts and the corresponding projection views, such as to add the main view and left view of the cantilever plate parts, the program is as follows:

`oView1=oSheet.DrawingViews.AddBaseView(oPartDoc,oPoint1,0.25,ViewOrientationTypeEnum.kFrontViewOrientation,DrawingVisualStyleEnum.kHiddenLineDrawingVisualStyle)`

`oView2=oSheet.DrawingViews.AddProjectedView(oView1,oPoint2,DrawingVisualStyleEnum.kHiddenLineRemovedDrawingVisualStyle)`

(5) Adding appropriate dimensions, and adjusting the position of the dimension.

(6) If it is an assembly, there are more needs such as to draw out the serial number, and insert the BOM table.

(7) Adding the technical requirement and decomposition of the content of the technical requirements. Adding the technical requirements to each unit.

Through the above steps we can realize the automatic generation of engineering drawings, and in the generation process the layout view, dimension, material list, technical requirements, such as position are adjusted automatically. So that the engineering drawing layout is more reasonable. Content is clear, quality and efficiency of engineering drawing rate are improved.

**Design System Interface Development.** Wall jib crane system program are mainly developed by software VB. Net and the Inventor modeling software which with rich API function.

Therefore, the secondary development of Inventor can be carried out through VB.NET, which controls the Inventor background process, and ultimately to achieve the automatic operation of the Inventor modeling software.

**System Interface Design.** Clicking **【Enter】** button to enter the wall jib crane product family design system (Fig.2). And clicking **【Exit】** button to exit the system design.

**Work Parameter Setting Interface Design.** The working parameters of the wall jib crane mainly includes: the working load and level, the rated weight, lifting height, lifting speed, a cart running parameters such as velocity. When the selection of working parameters is finished, click **【Enter the module design system】** button to carry out the module design of the crane (Fig.3).



Fig.2 System interface

Fig.3 Parameter setting interface

**Module Design Interface Design.** Wall jib crane module design interface (Fig.4) mainly includes the electric hoist design interface (Fig.5), the cantilever beam design interface (Fig.6), column design interface (Fig.7), gantry travelling design interface (Fig.8) and auxiliary facilities design interface (Fig.9). We could enter the corresponding design interface by clicking different buttons.



Fig. 4 Interface of module design

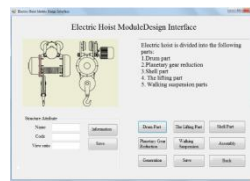


Fig.5 Electric hoist module design interface



Fig.6 Cantilever beam module design

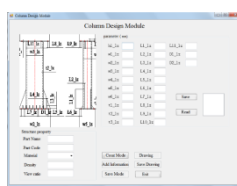


Fig.7 Column design module

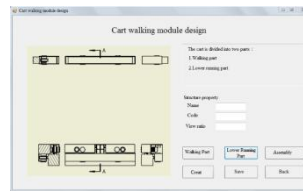


Fig.8 Cart walking module design

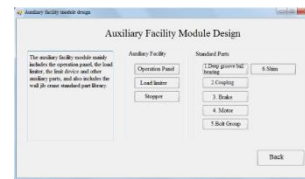


Fig.9 Auxiliary facility module design

## Conclusions

The application prospect of wall line cantilever crane and the basic principles as well as methods of module partition are introduced in this paper. According to this theory, the wall jib crane is divided into modules. The product design system of wall jib crane is established on the Autodesk Inventor software. The data base system is set up depending on Excel. The secondary development platform is Autodesk Inventor software and the development language is VB.NET which is based on object-oriented programming. Finally, the wall jib crane design system is developed. The method improves the wall jib crane design efficiency and quality. Meanwhile, it has a guiding role for the design of similar products.

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