Art Design Method of Interior Space Layout Based on CAD Drawing

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Abstract. CAD software is a most-used design software for interior space layout. There is a lack of unified standards for interior space layout design and designers often differ in drafting specifications and drafting methods, resulting in interior design drawings by CAD with irregularities and poor drawing output quality, which affects the expression and delivery of interior design. In light of this, this paper studies the visualized expression of CAD interior design drafting through analyzing the design method of interior space layout and CAD drafting strategy. In the current blossom of design visualization and digital media technology, interior design drafting by CAD should focus on the visual expression of CAD drawings, which includes drafting standardization and design drawing visualization that requires designers' professionalism and good drawing habits. Building visualized interior design drawings with use of CAD drawing and editing functions helps strengthen the professionalism, design expression and design competitiveness of interior design drawings.

Keywords: CAD; interior layout; design methods; visualized expression;
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1   INTRODUCTION

At present, the design of interior space layout in China that reflects aesthetic sense influences people's well-being in a significant way. The design of interior space combines function and technique while showcases the unique personality of the designer. But there are also many problems in the design of interior space layout. Legge et al. [1] analyzed the impact of visual acuity or visual field deficits on the ability to judge the size of interior spaces. Firstly, the coordination between the overall environment and building functionalities is rarely considered. The vision of interior space layout designers is not broad enough, and they mainly focus on interior space layout design itself while failing to combine the indoor and outdoor environment and

functionalities of the building in a smooth way. Secondly, designers do not attach enough importance to drafting techniques and standards, resulting in divergence in drafting specifications and drafting methods, which blocks smooth communications among designers. McQuaid et al. [2] analysis of textile technology and design from indoor space to outer space. Kim et al. [3] proposed a multi-stage framework for interior space design, which can flexibly adjust each stage according to the target application site.

Computer simulation is also gradually applied to interior design [4-7]. Ito et al. [8] proposed to use computer simulation for indoor environment design and quality assessment and discussed the development of computer simulation and its application in indoor environment design. Schulz et al. [9] proposed a novel interpolation method for adaptive grids that is both continuous/smooth and local. De With et al. [10] developed a method to evaluate architectural designs based on 1-mSv values.

At present, CAD is most commonly used in interior space layout design. The absence of unified drafting standard of CAD leads to large variation when drawing graphics. Finally, there is a lack of timely innovation of interior space layout design. Good innovations of interior space layout design that keeps pace with the times can show people's material and spiritual pursuit in a better way.

CAD is very powerful in drawing and is widely used in interior space layout design. Based on the artistic design method, CAD layout strategy and visual expression form, this paper elaborates interior space layout design in detail, aiming to promote the application of CAD and improve the work efficiency.

2   ARTISTIC DESIGN METHOD OF INTERIOR SPACE LAYOUT

2.1   Spatial Type Analysis

People shape space, and space shapes people in return. In order to make the interior space more flexible and meet people's varied needs, we have continuously explored and designed a wide variety of interior spaces.

There are many types or categories to classify the space. The building space can be divided into internal space and external space. Internal space can also be distinguished into two categories: fixed space and variable space. In addition, there are several common types of interior spaces, such as structural space, dynamic space, static space, flowing space or shared space. The popular types in recent years include virtual space, visual illusion space, psychological space, auditory space, organic space, positive space and negative space, etc.

Based on characteristics of different constituent elements in interior space layout, the main types of and relationships of spaces are arranged as shown in Figure 1.
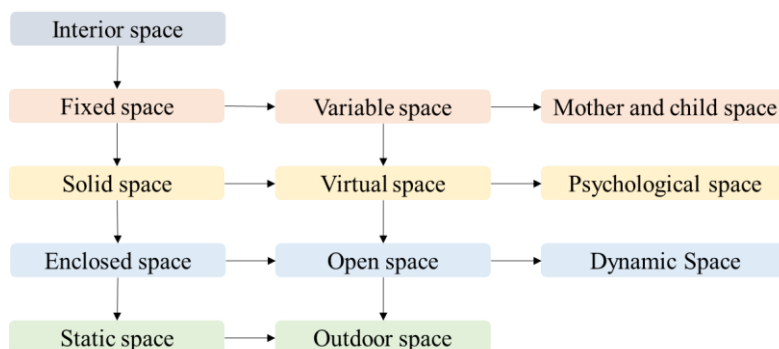

Figure 1: The main types of space.

2.2 Macro Requirements for Interior Space Layout

Interior space design is a spatial art, which is covered under environmental art design. As a environmental art designer, the most urgent task in front of us is how to use and transform the environment in the face of the increasingly serious environmental crisis for human beings. This is the noblest mission of our environmental art designers. Therefore, we put forward two requirements: the first one is to promote "green design"; the second one is to apply the design principle of "sustainable development."

Developed countries have already started the research and practice of "green design" which includes interior decoration materials and the use of greening means in space design. First, interior decoration materials, such as paints, air conditioners, and so on must meet the green requirements by utilizing new techniques. Second, greening means, such as filling the room with green plants to create an ecological environment, are wildly used.

In the mid-1980s, some developed countries in Europe put forward a slogan of "sustainable development". In May 1989, the United Nations Environment Programme issued the "Statement on Sustainable Development", stating that "sustainable development refers to development that meets current needs without impairing the ability of future generations to meet their needs". Therefore, the theme of the future design attaches importance to the sustainable development of ecology, environment, energy, land use, and so on. Designers should not revolve around quick success and immediate future but must establish beliefs of energy saving, full use of indoor space, sustainable dynamics and the coordinated relationships among humans, human-made environment and natural environment. Designers have to consider both the development and the sustainability of the ecological environment.

Modern interior space design should help build an interior space that is development-oriented, people-oriented, technology-guided while showcasing the history of the cultural lineage, the spirit of the times, and environment-friendly ideas. The main purpose of interior space design can be summarized into five pyramidal levels, as shown in Figure 2.
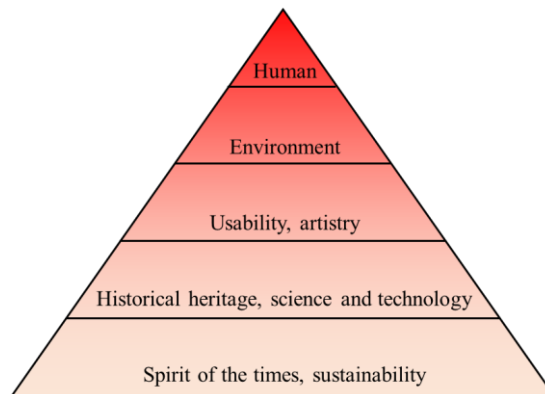

Figure 2: The main purpose of interior space design.

2.3 The Basic Forms of Interior Space

Interior space is perceived as a spatial form. The structure and shape of the space define the purpose of the space. An interior room that is empty and large can form a target centered on itself through the morphological structure, but the large space also has the characteristic of being cut and reorganized into many shapes. This is an important morphological characteristic of modern interior space. The cut part and the cut-out part keep a certain separation and connection with each other. Putting them back together will naturally form a variety of coordination and aesthetic interest of space form.

Architectural interior space forms can be broadly divided into two categories: fixed space and composite space. Fixed space is divided into geometric and non-geometric ones; composite space can be divided into geometric and non-geometric relationships in geometric or non-geometric space, as shown in Figure 3.
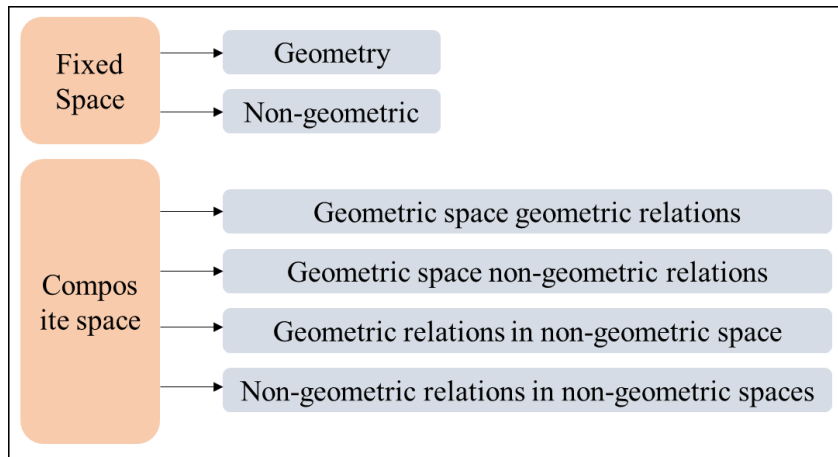

Figure 3: Basic forms of interior space.

2.4 Steps to Design Interior Space Layout

Interior space layout design is a relatively complex task that encompasses technical, artistic elements, and other disciplines. Therefore, it is necessary to plan and arrange this process in advance, manage each phase in a scientific way so as to complete the work schedule within the deadline. It is divided into several phases according to the design method, as shown in Figure 4.

The first stage is the analysis stage. The main task is to make a good design survey and fully grasp the relevant information, including the design purpose and the original building structure drawings, etc., so as to prepare for the formal design.

The second stage is the design stage. The design phase is a critical stage from design to shape, which directly affects the quality, space efficiency and artistic effect of the interior space layout design. This stage of the design process is also very complex and each stage should be both sequential and well planned. The use of CAD and other design software in the process will significantly improve efficiency.

The third stage is the implementation stage. It is to be completed through a precise timetable, the close cooperation of various departments, and careful construction. In order to show the spirit of originality, a designer should not only grasp the mainstream style of the design and related comprehensive knowledge in other disciplines, but also be good at on-site supervision and make flexible plans based on actual conditions.

3 CAD-BASED INTERIOR LAYOUT DESIGN

3.1 Drafting Strategy for Interior Layout Using CAD

The commonly used CAD software and the frequency of use were shown in Figure 5. CAD drafting software has two drawing spaces: model and layout. Designers develop their own drawing style over a long period of time during the project design process, and each person has different habits and preferences. Regardless of the drawing method, the main requirement is to be fast and standard. Layout space and model space are both carriers of drawing elements. A change in a

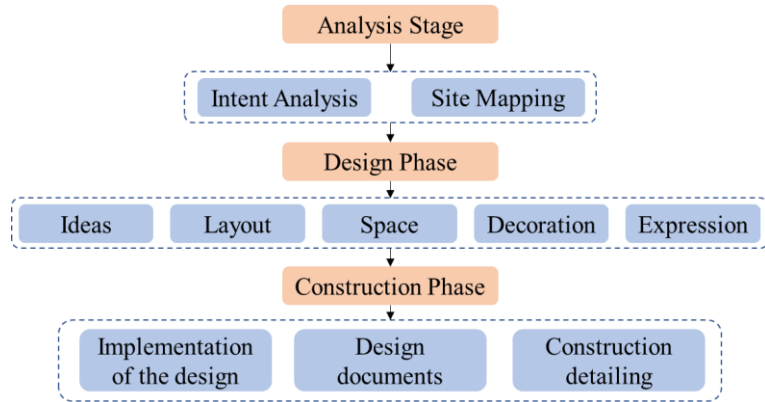diagram often leads to revisions in multiple copies, which lower the efficiency of the drawing very much.

Figure 4: Design steps of interior space layout.

Therefore, many designers classify tasks of interior model space and layout space. The interior model space carries various graphic objects and the layout space carries views, annotations and frames. Designers adjust and arrange views, annotations, and frames in the layout space and optimize drawing size, title bar, model view, etc. during the page setup process.
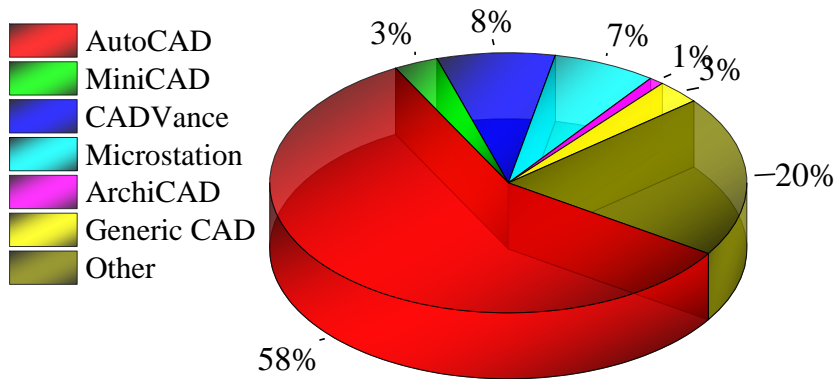

Figure 5: Analysis of the use of cad software.

3.2 Visual Expressions of CAD Interior Design Drafting

The visual expression of CAD interior drafting refers to the use of CAD's powerful graphic drawing function to draw two-dimensional orthographic drawings, combining themselves with a hierarchical expression of points, lines, surfaces and colors to activate the audience's figurative thinking, and give the audience a better understanding and receiving of the design creativity and style performance of the space, thus achieving the purpose of enhancing the expression of interior space design.

Specifically speaking, the visual representation of CAD interior design drafting is achieved in two ways.

3.2.1 Standardization requirements of CAD interior drafting and drawing output

Design drawings are important technical documents for interior space layout design and are the common language for designers to express and communicate. Design drawings must be drawn according to a unified specification. This specification is the national standard for technical drawing and architectural drawing. Designers must draw design drawings based on strict specification cartography. The designer must set up a template file that conforms to the drafting standards before drawing. This is the basis and prerequisite for the visual expression of interior design drawings. Drawings that are not standardized are wrong no matter how prominent the design performance is.

(1) Standardization of CAD interior drafting.

The current interior drafting code in China is "Standard for Interior Decoration Drafting of Housing Buildings" (JGJ/T244-2011), which gives relevant instructions and specific formal requirements on the form, content, relevant symbols and drawing methods of interior drafting.

(2) Standardization of the output of CAD drawings.

The output of the set of drawings requires a uniform size of text and dimensioning style for each drawing, and standardization of drawing lines. As shown in Figure 6.
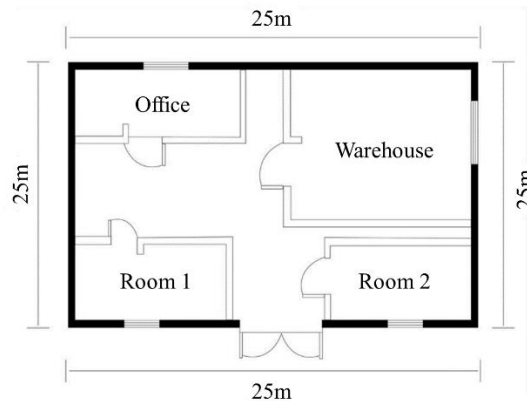

Figure 6：Normalized output diagram of an interior plane.

In summary, the standardized drafting and the standardized output of the interior design drawings themselves have a professional visual representation, which can effectively convey information about the design of the interior space environment.

3.2.2 Pictorial expression of interior layout design by CAD

Pictorial representation is the focus of visual representation. CAD drafting is a two-dimensional projection diagram of an entity. The drawings express spatial relationships in the form of projection lines, which requires a certain amount of spatial visualization thinking on the part of the viewer, who needs to match specific scenes of three-dimensional solid space with two-dimensional orthogonal projection drawings. The pictorial expression of design drawings can convey spatial information to the audience and increase the readability of drawings. The visual performance of CAD indoor drawing can be realized through the professional design ability of designers.

(1) Use different ways of filling and coloring. The designer can draw interior design drawings with certain visual expressions based on 2D projection drawings using CAD commands such as fill and color combined with the laws of formal beauty and color. Such as Figure 7.

As can be seen from the figure, the area filling and color separation help design drawings visually express the layout and the relationship between the primary and secondary of the interior space. Designers need to focus on the color brightness and color chroma when filling the color to enhance visualized performance. Higher brightness and heavier chroma are used to highlight the key performance areas. Attention should also be paid to the relationship between grayscale and

color and simplifying the level of grayscale and the number of colors helps show the general spatial level and structural relationship. The choice of color scheme should match the design theme.
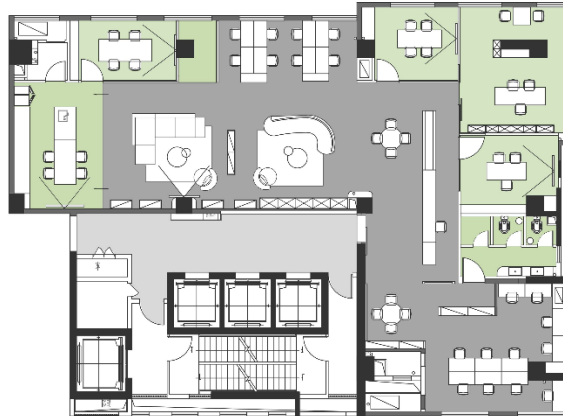

Figure 7: Graphical representation of a residential plane.

(2) Use CAD paste and clipboard commands. Designers can use CAD paste, clipboard commands, combined with post retouching, to put figurative materials images into the two-dimensional drawings so as to draw standardized drawings.

This type of drawing is suitable for highlighting the design concept and the decorative configuration of the interface. The designer should focus on the relationship between color and image when building the drawing. The color should fully express the design theme and the image needs to make a good match between simple elements and complex elements in terms of the overall expression. That is, a simplified background plus a detailed interface or furniture mapping, or, a detailed background plus a simplified interface or furniture mapping, help express the visual effect of the graphic clearly.

3.3 Drafting Skills for Interior Layout using CAD

3.3.1 Creating template file

(1) National standards

As the main technology of interior design, drawing is also a professional language for designers to communicate. In CAD drawing, the designer should design the standard graphic template in advance. However, there is no strict drawing characteristic standard at present, leading to different standards among the counterparts which reduce the work efficiency.

Design drawings are important technical documents for the interior design industry and are the common language for designers to express and communicate. The CAD comes with graphic templates that do not conform to standards in China, so designers should set up template files that conform to Chinese drafting standards before drawing. At present, there is no unified standard for architectural decoration engineering drawings in China, which is basically implemented with reference to the unified standard for housing construction drafting. In engineering design, in order to improve efficiency, strict standards of drawing characteristics are adopted among departments of the same unit, but there are still different standards among the same industry and partners.

The current usage rates of Education and Practice for different CAD software drawing types were shown in Figure 8.
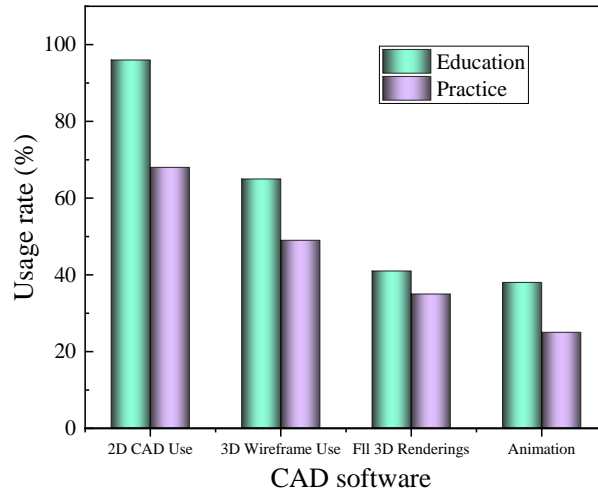
Figure 8: The usage rates of Education and Practice for different CAD software drawing types.

(2) Template files

The following settings should generally be done in the template file: units, precision, layers (color, line type, line width), text style, markup style, composite line style, default line width, default font, default word height, capture type, etc. After defining this information, the designer saves it as a template file. Template files are often named after the drawing size, such as A2.DWT or A3.DWT. It is recommended that the template file be placed in the CAD installation directory so that it can be used at any time. You can also change the installation path in the CAD tab, and you can call it directly in future drawings.

3.3.2 Layout settings

(1) Page setup

The designer needs to first performs page setup if wants to create a new layout. Page setup consists of determining the output device name, drawing size, page printable area, etc. Here, the designer needs to make the printable area consistent with the actual drawing size. If, for example, there is a non-printing area boundary on the page, the designer need to change the upper, lower, left and right boundary values to "0", otherwise the output drawing scale will have errors.

(2) Picture frame setting

The designer has to draw the frames according to the requirements of the drawing size in the page setup. In practice, designers will draw and save some common standard drawing frames as required by the company and refer to them directly into the layout with external reference commands. In the layout space, the drawing frames are referenced at 1:1 size.

(3) Viewport settings

Viewports have a very important role in layout, with functions such as zooming in on a detailed drawing, hiding or showing layers, rotating a drawing, typesetting a drawing, stitching a drawing, and cropping a drawing. Viewports are areas that display different views of the model. Multiple viewports can be created in a drawing, with no overlap between viewports, and if there are changes in one viewport, the other viewports will be updated immediately. And freezing a specific layer in the current viewport will not affect the content in other viewports.

(4) Labeling and labeling style

In the process of drawing, the designer will generally gradually add some text, dimensions, symbols and other markup. Labeling generally only needs to set a style on the line according to the national standard settings without the need for proportional conversion, which leads to less possibility to make mistakes. What is more, you need to set up different styles of annotation according to the scale of the drawing, and set them up as you go. Given that annotation is an

important data expression in CAD, I suggest that annotation is done in the layout space, including lead annotation and other annotation text.

There are two ways to mark up in the layout space: one is to activate the viewport and mark up in the viewport. After the designer activates the viewport, you need to mark up the text in the model space; the other is to mark up the text in the drawing space. These two methods are often used alternately in layout mapping.

3.3.3 Drawing with layout

Designers are used to drawing in the space model, but with the deepening of interior design drawing, it is also very important to draw in the layout space. First of all, drawing in the layout space ought to follow the standard drafting method; secondly, when designers choose layout space for drafting, all drawings can only be made in the layout space, not in the model space. In layout mapping you can improve the accuracy and efficiency of mapping, which is suitable for large scale interior design mapping and welcomed by the majority of designers. The requirements for layers in layout mapping are very strict, and the graphics must be drawn in the corresponding layers according to the functional requirements. As the model space drawing needs to be drawn repeatedly, a revision in one piece calls for repeated changes in all pieces, which reduces efficiency in heavy way. Compared with model space drawing, the other layers will change when you modify one of the layers. It is not only easy to avoid mistakes but also very convenient to operate.

In CAD software, there are two methods: model drawing and layout drawing. Most designers are accustomed to drawing in the model space since they learn to draw in the model space from the beginning. As they learn more and more, they develop the habit of drawing in the model space.

(1) Model space mapping

The designer can start drawing after opening the template file. In practice, it is possible to draw in the model space at will, even ignoring the concept of layers. As long as multiple copies can be made, you can complete any graphics that need to be repeated without the limitation of layers.

(2) Layout space mapping

In the layout space, the designer can create multiple viewports for drawing. When the designer plans the viewport in the drawing, he or she must have clearly defined the content to be drawn for each viewport. First of all, the designer must strictly follow the layer rule in the layout since there are strict specifications and requirements for drawing, especially for larger projects with more complex space structure. Secondly, once the designer chooses to use the layout space mapping method for drawing, then all the operations must be completed in the layout window. For example, if the designer wants to draw a wall, he or she has to find the corresponding wall layer to draw, so that it is easy to control a layer in other viewports to show or hide in the current viewport. Finally, the things scaled in the layout are 1:1, so the probability of error is small.

(3) Model drawing and layout drawing

When undertaking large projects, CAD design and drafting needs not only to be accurate, but also to improve efficiency. Therefore, in the long-term process of design and drafting, designers have increasingly felt the superiority of layout drawing.

Requirements for layers: Model space drawing does not have strict requirements for layers. When dealing with layout space drawing, the designer must strictly follow the functional requirements to draw graphics in different layers to facilitate the control of layer display or hiding by freezing the current layer in different viewports.

3.4 Interior Layout Drawing Method using CAD

(1) Drawing scale adjustment

If the designer wants to produce a drawing in the model space, he must add a frame to the drawing in the model space. The designer has to anticipate the scale of this frame and then adjust the scale of the frame. For graphics drawn in layout space, only the scale of each viewport needs to be adjusted when the drawing is produced. The designer has to use the Mview command to create a new viewport in the completed page. There can be multiple viewports in a page space, and each viewport can be scaled accordingly as needed. The viewport scale can be selected based on the

system's normal scale or you can customize the scale values as needed. It is important to lock the scale relationship after each viewport is scaled, otherwise it will cause the scale to change. The viewport layer should be on a separate layer, or if you don't want to print it out you can put it on the Defpoints layer, which is prohibited from printing in CAD.

(2) Batch printing in the layout

CAD printing is divided into two types, namely direct printouts and virtual printouts, and designers can choose the printing method according to their needs. The main setting in the interior design is the virtual printout. For projects with large volume and many planes, designers will spend a lot of time on printing drawings, and the batch printing method can save designers' time and energy and improve work efficiency. The designer only needs to adjust the drawings in each layout as required, and the computer will automatically print out all the drawings as required, which is very effective when printing floor plans in large quantities. However, batch printing only applies to layouts with only one drawing. There can be multiple layouts in one file, or multiple files can be printed in batch at the same time.

There are also designers who print drawings with the help of batch printing tools, but different printing tools have different requirements for layouts. Some tools can automatically identify multiple drawings in a layout before printing them. Some tools can unify the settings to automatically print. Some tools put can identify multiple drawings of different sizes in the layout and print them separately. It is difficult for one batch printing tool to meet the needs of all designers. Therefore, CAD provides a simple publishing command to realize the function of batch printing, provided that the designer has to standardize the layout for drafting and set up reasonably, so as to create a drawing set or electronic drawing set for batch output to a printer or to PDF file.

4   CONCLUSION

CAD software is widely used by designers in the interior layout design stage, which is a communication channel between designers and A-side. However, the interior space layout design industry lacks a unified drafting standard, especially in the drawing methods. The designers should make full use of the digital image technology including the CAD drawing software to carry out efficient interior design drawings. The designers can better convey the design ideas of the space, and deepen the viewer's understanding and recognition of the space design concept and interior decoration through visualized expression of the drawings. The visualization of CAD interior drawings can enhance the professional competitiveness and added value of the design.

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