

CONSTRUCTING A VIRTUAL FACTORY USING 3D STUDIO MAX

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Abstract

The interactive visualization of 3D objects has revolutionized such fields as engineering, medicine, entertainment and education. In fact there are a broad range of applications which are used to give virtual world more realistic detail. It is important to design a layout of any factory before physical construction which gives us the ideas about the machine set up, production process, material handling and inventory management of that factory. To consider design alternatives creation of a 3D virtual factory using 3D modeling software and animation based simulation system can provide a fast, effective method of visualizing and experiencing new designs which can be easily modified. In this paper the construction and visualization of a 3D factory of flanges has been described. 3D Studio Max software has been used for this purpose. The objective of the research paper is to create a 3D factory showing a general layout of a flange factory and providing basic concept on the building techniques of 3D virtual world for the new students and trainee. Conversion process of a 3D studio virtual model to an AutoCAD model and Conversion process of an AutoCAD model, applications of factory planning and advantages of virtual reality have also been described in the paper.

Key words: Factory, Modeling, Software, Visualization and Manufacturing.

1. Introduction

Making virtual environment or virtual reality is modern technology to realize the condition of actual model or any future model. A 3D factory as a well-designed and integrated environment is essential for success applications of new technology. In this paper the construction and visualization of a factory of flanges has been described. It is expected that this method is very much useful for construction of a factory and helps to manage diverse information and re-use 3D models. At the design stage of a production system at a factory, designer can evaluate the feasibility design environment, detect the factory and it can be used for factory management. The development of virtual engineering factory is expected to be valuable by means of a 3-dimensional modeling system and animation based simulation package by taking into account the real data of a factory. A 3D model of a factory has been modeled by using 3D Studio Max software. Participant can navigate through virtual factory and examine the virtual factory from different points. Thus 3D modeling and animation based simulation technique provides a fast, effective method of visualizing and experiencing new designs which can be easily modified. Designer can design and see different types of layout of factory before making final decision to choose the best one. The animations of different machines may also successfully be done.

Virtual reality (VR) started from an unknown science and progressed into a highly exclusive, yet known science. The technology was born from the merging of many disciplines including psychology, cybernetics, computer graphics, database design, electronics, robotics and telepresence. Any representation that emulates reality (i.e. a drawing, a photograph, a movie, an audio recording) is, in a sense, a virtual reality. The term Virtual Reality (VR) is used by different people with many meanings. Virtual Reality (VR) is the computer aided simulation of a 3D model that one can interact with in order to get a better sense of object [2]. Virtual reality can also be defined as a synthetic computer generated (and hence virtual) environment within which a person can navigate and interact with the virtual objects as the person would in the real world (reality) [2].

2. Literature Review

Virtual environments are made up of 3D graphical images that are generated with the intention between the user and the objects in that environment. The term virtual environment (VE) describes a computer-based generation of an intuitive perceivable and experience able scene of a natural or abstract environment [2]. VE application will contribute to enhancing the qualities of human-computer interaction, the importance of which, in view of

increasing complex information and communication applications, is constantly rising. Several types of problems can be solved with better visualization support, e.g. issues concerning workshop-layout, production flow, workplace design, etc. Users will get better perspectives if 3D models are used in the planning process instead of traditional 2D models [1]. There are several additional benefits from using detailed visualization in those virtual models. E.g. increase in planning speed, decrease in planning costs, and increase in planning quality are some of the benefits that have been discussed.

Virtual reality originated in 1960's, the person accredited with pioneering the concept of VR is Dr. Ivan Sutherland, who made ground breaking contribution to the computer graphics and immersive interaction at Harvard and University of Utah [3]. He showed that, a person with the aid a light pen could interact with the computer via a display surface. Engineering based applications within all areas of academic, commercial and industrial life are increasing. It is generally acknowledged that most of the growth in the VR industry has been due to the demands for VR in the entertainment sector. In the 1917's, Hollywood started to realize the power of VR in the film industry due to its potential to create extra ordinary visual scenarios. Films such as 'Star Wars', followed by 'Terminator' and 'Jurassic Park' are just some of the films that benefited immensely from VR and computer graphics. Recently Pentagon has conducted a Virtual Nuclear War Game to predict its consequence. 3D digital models can be freely constructed in this virtual environment [4]. From a great deal of digital modeling research in color, material, lighting by Sasada [5], Liu[6] and etc., it can be realize that the simulation is nearly real. This not only enables to receive more feedbacks in the designing process, but also helps non-professionals to fully understand the designing content.

N. Shariatzadeh, G. Sivard, D. Chen I in their paper titled "Software Evaluation Criteria for Rapid Factory Layout Planning Design and Simulation" described the functionalities of software tools which can support the factory layout design process to shorten design time and to identify errors in early stages of design [7]. Tullio Tolio, Marco Sacco, Walter Terkaj, Marcello Urgo in their research paper titled "Virtual Factory: an Integrated Framework for Manufacturing Systems Design and Analysis" addresses the concept of a integrated Factory Design framework providing the capacity of using different and heterogeneous analysis and design tools on the same manufacturing system model in a concurrent and coherent way. This framework is highlighted s a prerequisite condition to tack the co-evolution problem, i.e the integrated management of product, process and production system and their evolution over the time [8]. Sangsu and Sang Do Noh in their study tried to describe the virtual factory implementation strategy (method) of manufacturing companies and the method of diagnosing/evaluating the virtual factory establishment level of a manufacturing company. In addition, a case study of a manufacturing company in Korea was analyzed using the developed diagnosis/evaluation method [9].

3. Construction of a 3 Dimensional Factory

A factory is integrated infra-structure for digital manufacturing including CAD, 3ds Max and simulation models of machines, equipment, work cells, lines and plants. Fig.1 has shown a general procedure to construct a factory. It takes much time, cost and resources, so effective action plans and objectives are essential. To construct a factory in CAD, 3ds Max and simulation model must be implemented. Both modeling works need considerable time, cost and efforts. So technologies developments for an effective measuring and geometric modeling, a knowledge based CAD, 3ds Max and simulation and reuse models are essential. In addition to this technologies, systematic planning, determinations of detailed scopes and model maintenance are also very important.

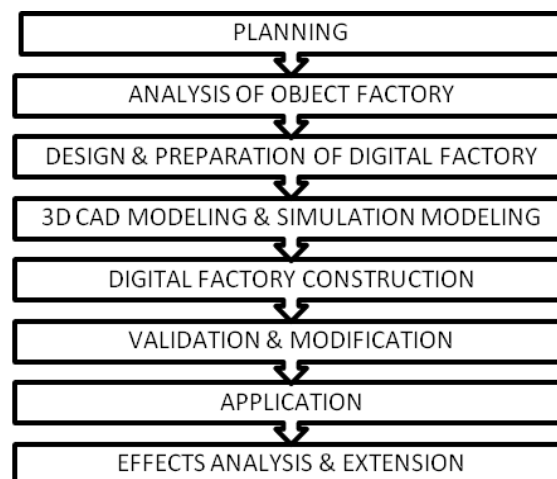


Figure 1: Procedure to construct a 3D factory.

Areas and effects of manufacturing for flange factories are as below:

Environments for 3D engineering design, Design and operation of a factory, Validation and evaluation of products and processes, Line simulations, inspections and quality managements, Visualization of products, processes and resources.

Geometric Modeling

3D geometry modeling CAD system such as AutoCAD is widely used in engineering design. AutoCAD is very suitable as a graphics editor for geometric modeling, especially for 3D geometric modeling. Although AutoCAD is powerful for geometry modeling, it can't be used as the tool for complex system motion verification. AutoCAD does not have the dynamic simulation capabilities. AutoCAD provides some primary 3D objects, such as box, cone, wedge ball etc., which are often used in 3D modeling. In order to create a realistic virtual model of the studio as a 3DS file. Similarly virtual model for modification, the virtual model was imported into AutoCAD as a DXF (Data Interchange Format) file. A DXF file is an ASCH (American Standard Code for Information Interchange) coded file, of an AutoCAD drawing for importing and exporting to and from other software packages [3]. Fig 2 illustrates the process of converting a realistic AutoCAD model into 3D Studio virtual model.

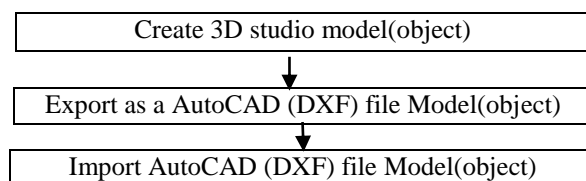


Figure 2(a): Conversion process of a 3D studio virtual model to an AutoCAD model.

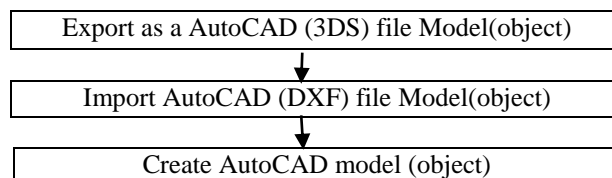


Figure 2(b): Conversion process of an AutoCAD model.

Application of Virtual Engineering Factory Planning

The typical applications of virtual factory planning are:

- i. Planning and verification of machine setup.
- ii. Determination of production sequence of factory machines.
- iii. Analysis of different alternatives of layout of the factory.
- iv. Planning and verification of material logistics.
- v. Agile planning.

Advantages of Virtual Factory Planning

The typical advantages of virtual factory planning are as follows:

- a. More precise planning results compared to conventional tools.
- b. Exchange of knowledge among different experts in the planning team.
- c. Taking into account various influential factor such as workplace safety, accessibility and production tools.
- d. Reduction of planning time and errors.
- e. Planning results can be used for the purpose of training and education.
- f. Documentation of company know-how.
- g. Planning results can be used for the purpose of training and education.

4. Requirements for 3D Factory Modeling

In order to build the virtual factory, which is similar to a real factory, there might be many requirements in modeling the elements of manufacturing system. Among a number of requirements, the authors emphasize that the following three ones are most important to develop a modeling system for virtual factories [10]: **Visualization:** The most important requisite is that a virtual factory should be visualized with reality. With good visualization, one can easily and observes how each system elements work in the manufacturing systems. **Detailed descriptions:** Each elements needs its detailed description, not only for its visualization, but also for calculating a number of its attributes for example when you want to put a work piece into a box, you have to know the shapes and dimensions of the work piece and the box in order to check whether the box can contain the work piece or not. **Flexibility:** The modeling system should present a flexible way of modifying a virtual factory in order to cope with the change of machines, layout and other facilities. Any facility to create computer-generated models of virtual objects and environments that can be interactively explored in 3D and modified and recreated in offers enormous potential for concurrent engineering and for integration of manufacturing activities generally [11]. The designer would be able to quickly visualize the product concept and represent alternative design solution.

The basic requirement for virtual 3D factory facilities planning is, first of all, the availability of all objects in virtual environment. If this requirement is fulfilled simple production facilities planning are possible. The system development was divided into two main parts [12]: **Construction of a virtual environment:** This part provides experience of creating virtual object and placing them in the virtual environment with associated real world. Properties in order to illustrate how models are created. **Use of virtual environment:** This part encourages exploring different attributes of the virtual environment within two broad categories which are factory walk through and visualization of different sections of the factory.

5. Simulation - Using 3D Studio Max

Modeling and editing panel: The cornerstone of 3D Studio MAX is an advanced 3D modeling and animation environment. One can perform 2D drawing, 3D modeling, and spline based animation within the unified workspace. Modeling, editing and animation tools are always available in the command panels and toolbar. **Lights & Camera:** Designer can create light objects using the light category of creating a panel. Ambient light is found in the Environment dialog by choosing Rendering/Environment. The lights can cast shadows, project images, and create volumetric effects for atmospheric lighting. 3D Studio Max also supports real-world camera controls for lens length, field of view, and motion control such as truck, and pan. **Materials:** 3D Studio Max contains a sophisticated Material Editor that floats in its own window above the scene. One can use the Material Editor to create highly realistic materials by defining hierarchies of surface characteristics. **Animation:** The user can begin animating his scene at any time by clicking the animation button. This button can be clicked again to move back and forth between modeling and animation. The users can extensive control over his animation with the 3D Studio Max Track View. This is a window into time where one can edit animation keys, set up parametric animation controllers or display and adjust motion curves for all of your animated effects. **Rendering:** The 3D Studio Max render includes advanced features such as analytical, motion, volumetric, lighting, and environmental effects [11]. A research was done on Design and Development of workshop in 3D environment using 3D studio MAX by Syeda Nusrat Jahan, Muhammad Bayazid Bustami, Ranjan Kumar Das, Dept. of Industrial and production Engineering, Shahjalal University of Science and Technology, Sylhet, Bangladesh in the year of 2006 [13].

Modeling objects in 3D Studio Max: The latest technology in modeling is utilized in this project by combining 3D Studio Max software and AutoCAD with Supers cape VRT for object drawing. 3D Studio Max is a three-dimensional modeling and animation based package. It has the facilities to add, subtract, combine, and can add material to object, to perform 2D drawing, 3D modeling based animation within the unified workspace. Modeling, editing and animation tools are always available in the command panels and toolbars. The designer can draw 2D and convert it to 3D by using tool bars and can view in front view, top view, and in perspective view. This software helps the designer to change an initial profile of a model, thus updating the previous model and its current drawing. Moreover it helps viewing the model at the same time in different ways. Figure 3 shows the overall factory layout and figure 4 shows the office layout. Figure 5, 6, 7 shows the machines used in the manufacturing of flanges and figure 8 shows the warehouse of the factory.



Fig. 3: Factory area.

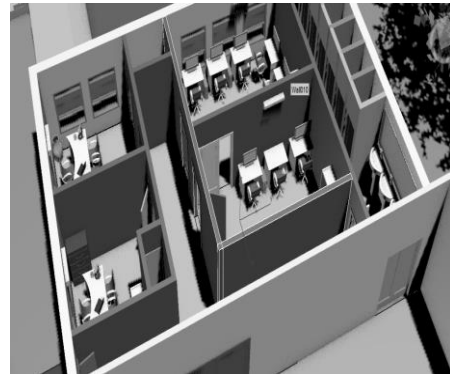


Figure 4: Office layout.



Fig. 5: Drilling Machine.

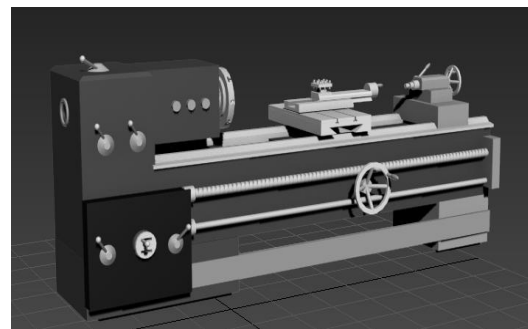


Fig. 6: Engine Lathe machine.

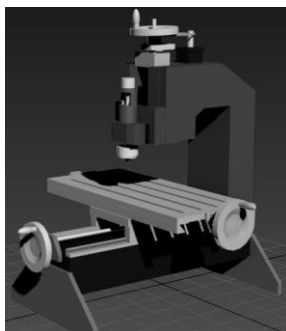


Fig. 7: Milling Machine.

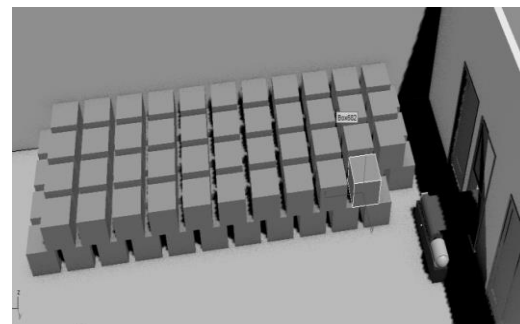


Fig. 8: Factory Warehouse.

6. Conclusion

The initial studies presented in this paper have shown that a realistic virtual model of the factory with high level of details and accuracy. Here a 3D virtual environment and modeling software (3ds Max) is used for effective construction and visualization of flange manufacturing factory. The basic construction method using virtual 3D modeling software has been described here. Also some types of 3D flanges have been cited using 3D Studio Max Software. Presently product are conceptually designed and then modified before making it in real life. So this technology is becoming important in every sector of human needs. This makes important for future designers to design effective 3D factories

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