

VIRTUAL REALITY AS WORKCELL DESIGN VERIFICATION TOOL

**prof. Ing. Jozef Novák-Marcinčin, PhD.
Faculty of Manufacturing Technologies of TU of Košice with a seat in Prešov
Bayerova 1, 080 01 Prešov
Slovak Republic**

**Ing. Peter Brázda, PhD.
Faculty of Manufacturing Technologies of TU of Košice with a seat in Prešov
Bayerova 1, 080 01 Prešov
Slovak Republic**

ABSTRACT

Virtual reality shows great promises for its usage as a tool for verification of design proposal of new technological systems. Main advantage of virtual reality application usage is possibility of creation and simulation of new technological unit before its realization. This may contribute to increasing of safety and ergonomics and decreasing of economical aspects of new proposed unit. Virtual model of proposed workcell could reveal hidden errors which elimination in later stage of new workcell creation should cause great difficulties. Paper describes process of such virtual model creation and possibilities of its usage.

Keywords: virtual reality, design verification, workcell design

1. INTRODUCTION

The importance of a well-designed new technological system is widely acknowledged. Review of the newly proposed workshop design plays a significant role in supporting correct establishing of new unit. Designers rely on the use of human factors engineering guidelines to support the identification of potential safety issues. By such proposing the key problem is lack of fast and reliable feedback in early stages of the design process.

Efficient verification and validation techniques of workshop design are therefore in high demand. Today, this is done either through a pen and paper verification or verification of a physical mock-up. In the first case, the verification will usually use the results from analysis performed during the design process, which may be imperfect. In the second case, the use of a physical mock-up is expensive in terms of physical infrastructure, in addition to being time and personnel demanding.

VR technology has proved to be a promising, powerful, and cost effective tool in new workplace design work. It enables designers to spend more time evaluating creative new ideas, helping them to identify and eliminate potential problems early in the design process, and enables end-users to actively participate in the design process. However, more knowledge should be obtained about the quality of results from utilization of VR technology in guideline verification.

2. CONTEXT OF VIRTUAL WORKSHOP MODEL CREATION

One of the most useful techniques for acceleration of the design process is virtual model creation. This technique resolves interface dependencies between all system components, thus enabling parallel, rather than sequential, development of hardware and software components of the system. Paper describes creation of workshop model followed by design verification in virtual reality environment. Main goal was to verify proposed arrangement of automatized workplace design in

order to test accessibility of welding robots to workpiece and to confirm spatial set up of whole workshop. Procedure of virtual model creation could be divided into three main steps:

- creation of 2D drawing
- creation of 3D models
- creation of workshop virtual mock-up

First step, the 2D drawing creation was made according to input information in AUTOCAD software. Output 2D drawing tented as basic start point for all other activities for virtual model creation.

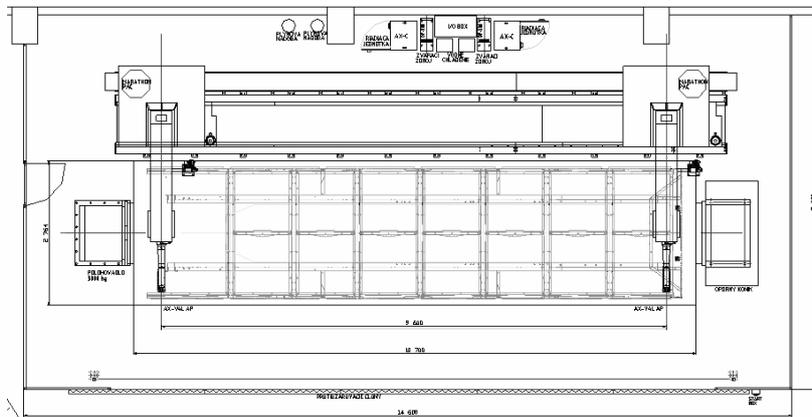


Figure 1. 2D drawing of proposed workshop

Further process consists of creation of 3D models which are based on above mentioned drawings. After model building they have to be exported in generally accepted format in order of their following usage and import in virtual reality system. For 3D models creation was used Pro/Engineer Wildfire 2 and as transfer format was chosen Wavefront format. Model created in this format are described with two files while one held information about measure and geometric characteristics of model the second contains additional information for example about model's material. Selection of this format was because of it support in virtual reality system which was used by this experiment.

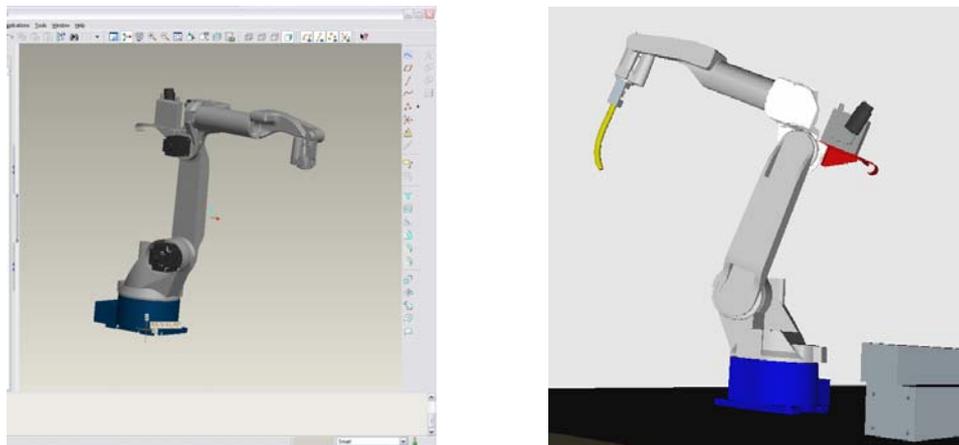


Figure 2. Model of robot created in Pro/Engineer (left) and virtual model in VR environment (right)

3. CREATION OF WORKSHOP'S VIRTUAL MOCK-UP

A complete VR system is a large software system, consisting of many modules. Every VR system contains an object manager, renderer, device drivers, communication module, navigation and interaction module, and, usually, physicallybased simulation, sound rendering, scientific visualization, application-specific modules, etc. The visual part of a virtual world is represented by a hierarchical scene graph. Everything is a node in this graph: polyhedra, assemblies of polyhedra, LODs, light sources, viewpoint(s), the user, etc. Most of the functionality and interaction presented below will operate on the scene graph, i.e., it will, eventually, change some attribute(s) of some object(s).

For creation of virtual reality for verification purpose were used following components:

- virtual reality environment creation system Vizard
- head mounted display Emagin Z800

Vizard system for virtual environment creation is package of high-end graphical tools designated for graphical applications creation including virtual reality, scientific visualizations etc. Vizard uses powerful engine based on object-oriented programming which includes full usage of OpenGL and DirectX possibilities. VR environments created in Vizard environment are optimized with usage of VizardLAXMI tools for achieving of full graphical performance. Selection of this application is usage was because its support of wide range of VR hardware and conversion formats. Output visualization was performed with HMD E-magin Z800. This HMD is equipped with OLED visualization technology with high contrast. HMD has integrated motion sensor for head position and orientation location.



Figure 3. E-magin Z800 HMD

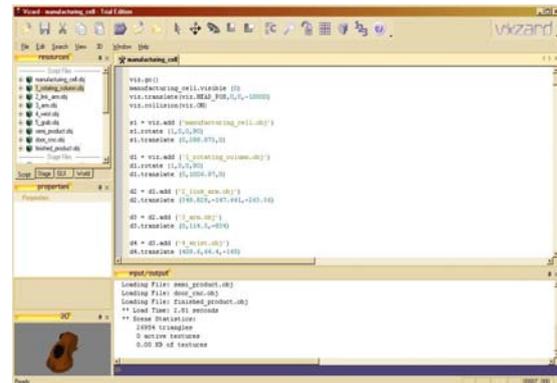


Figure 4. Environment of Vizard system

Creation of virtual environment started with defining of new virtual environment its parameters and behavior. This action was followed by objects importing and their allocation in virtual environment. Arrangement of each object followed primary 2D drawing so the workplace virtual shape was build in 1:1 ratio to its real model. Purpose of our virtual model is verification of design proposal with reference of robot access to workpiece during work mode. In order to fulfill this goal it is necessary to define motion action of robot which can be controlled by user. In this way can designer verify correct proposal of workcell design.

4. VERIFICATION OF WORKSHOP DESIGN IN VIRTUAL ENVIROMENT

One of the main goals of using a VR system for design verification is the potentially high degree of “reality” which can be experienced when immersed in a VE. In order to achieve this, the VR system needs to be able to visualize object behavior at interactive frame rates. Other tasks of a VR system in the context of design verification are geometrical and spatial analyses. In order to check serviceability of a proposal, the VR system has to track the work space necessary for the objects move and it has to report collisions. During verification it is often necessary to simulate kinematics in order to perform a sensible design study. Real-time collision detection of polygonal objects undergoing rigid motion is of critical importance in many interactive virtual environments. In particular, simulation algorithms, utilized in virtual reality systems to enhance object behavior and properties, often need to perform several collision queries per frame. It is a fundamental problem of dynamic simulation of rigid bodies and simulation of natural interaction with objects. Simplified principle of verification of design in frame of object collision detection can be presented:

collision detection within a visualisation loop

loop forever

move objects according to user input

check collisions

if collision detected take appropriate actions based on collision reports

else continue in visualisation

End of visualization

With collisions there are two tasks to be handled: collision detection and collision handling. The former is the general problem of determining whether or not objects penetrate (i.e., “something happened”), while the latter is the problem of determining appropriate steps based on the current collision status, which is usually handled by a simulation module.

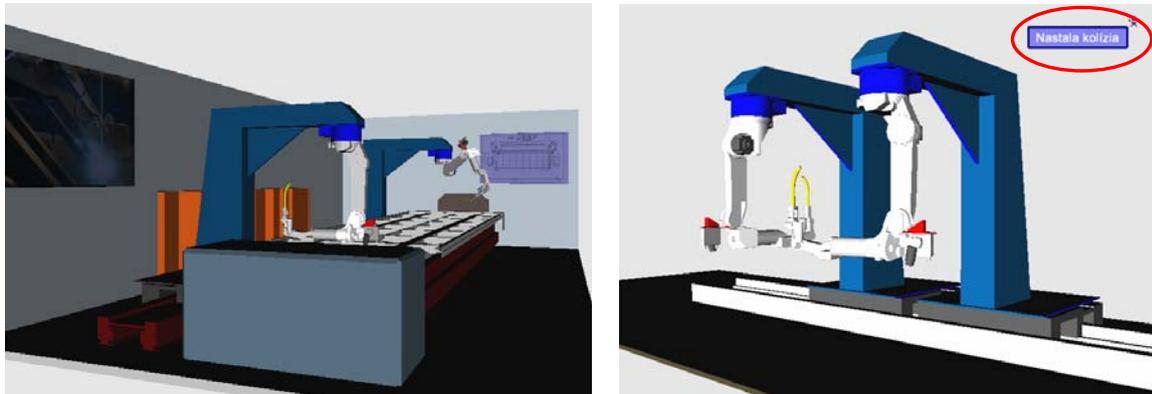


Figure 5. Virtual workplace (on the left) and on collision error message (right)

This application allows verifying spatial arrangement of machines of newly proposed workplace and helps in revealing of hidden errors or may contribute to creation of better alternative.

5. CONCLUSION

Virtual reality is one of the enabling “technologies” for all kinds of physically-based visualization in VR and other applications. Main advantage of virtual reality application usage is possibility of creation and simulation of new technological unit before its realization. Usage of virtual reality in such way as a verification tool can help to minimize errors which may occur by creation of new workplaces. Paper presented simplified procedure of creation of such model with exemplar selection of software and hardware components which is followed by main description of system function principle. It presents step by step actions which have to be done in order to proceed from idea of new workplace thru 2D drawing design and 3D models creation and till import of virtual models in virtual reality environment and virtual parameters set up.

Cultural and Education Grant Agency of the Slovak Ministry of Education supported this work, contract KEGA No. 3/5172/07.

6. REFERENCES

- [1] DAI, F.: Virtual prototyping — principles, problems, solutions. In Tutorial Notes of IEEE Virtual Reality Annual International Symposium; VRAIS '98, USA, 1998
- [2] FIGUEIREDO, M., BOHM K., TEIXEIRA, J.: Advanced Interaction Techniques in Virtual Environments. In: Computers & Graphics, Journal, Vol. 17. No. 6., Pergamon Press Ltd, 1996
- [3] KURIC, I. - MARCINČIN, J. N. - COTETIU, R. - UNGUREANU, N.: Development of Progressive Technologies - Computer Support for Progressive Technologies. International DAAAM, Vienna, 2007, 253 p.
- [4] LIOU, E. P.: Enabling Technologies For Virtual Parts Handling Enviroment. In: Proceedings of NSF Design and Manufacturing Grantees Conference, Albuquerque, 1996
- [5] MARCINČIN, J. N.: Use of the Virtual Reality Technologies in Design of Manufacturing Systems. In: Proceedings of the Conference on „Automation of Technological Preparation of Production“. TU, Zvolen, 1998
- [6] MARCINČIN, J. N. - BRAZDA, P.: Visual Requiremets on Augmented Virtual Reality System. Mechanical Engineering. Anals of the University of Petrosiani. No. 8, Petrosiani, 2006, pp. 73-78
- [7] ONG, J. K. – NEE, A. Y. C.: Virtual and Augmented reality applications in Manufacturing. Springer – Verlag, London, 2004
- [8] TESIC, R. - BANERJEE P.: Exsact Collision Detect Using Virtual Objects in Virtual Reality Modeling of a Manufacturing Process, Journal of Manufacturing Systems, Vol. 18, No.5 , 1999