THE INTERNATIONAL CONFERENCE OF THE CARPATHIAN EURO-REGION SPECIALISTS IN INDUSTRIAL SYSTEMS
6th edition

ASPECTS REGARDING VIRTUAL MANUFACTURING FOR FLEXIBLE CELLS PRODUCTION

Mircea LOBONȚIU[1], Vlad DICIUC[2],
[1]Professor, Ph.D. Eng., [2]graduate student
[1,2]North University of Baia Mare, Dr. V. Babeş Nr. 62A, Romania
E-mail: [1]lobbymi@ubm.ro, [2]vdgreek@yahoo.com, URL: www.ubm.ro

Abstract: *In this paper a few aspects regarding virtual manufacturing and an application for a flexible cell that complies with a production situation are being presented.*
Keywords: *virtual reality, virtual manufacturing, flexible cells production, modeling*

1. INTRODUCTION

In the late 1980's, Jaron Lanier coined the term Virtual Reality (VR) and his company, VPL Research, developed the first commercially available head-mounted display (HMD), a device that provides its user with an immersive virtual reality experience. In the following year, alternative immersive systems like the BOOM from Fakespace or the CAVE system, developed by the University of Illinois at Chicago, reached the market.

These immersive viewing systems present the user with a full scale, stereoscopic representation of a three-dimensional environment that is computer generated. Head-referenced viewing provides a natural interface for the navigation in three-dimensional space and allows for look-around, walk-around, and fly-through capabilities in virtual environments. Realistic interactions with virtual objects via data glove and similar devices support the manipulation, operation, and control of virtual worlds.

With time, the meaning of VR broadened and, as of today, VR is also being used for semi-immersive systems like large screen projections (with or without stereo) of table projection systems like the Immerdesk and similar devices. Even non-immersive systems, like monitor-based viewing of three-dimensional objects, are called VR systems.

The computer made its way up in the manufacturing systems early from its release. The evolution of computer in the past decade led to a considerable evolution of technology of information. The appearance of more powerful computers led to the development of more powerful design and modeling software. The evolution and performance of these software applications reached a level that allows the automobile industry for example to design and manufacture new models in a shorter period of time without even one physical prototype.

The use of virtual prototypes has implications also in the ease and productivity of modifying a product regardless the purpose for the modification (minor changes or optimization of certain parameters).

In figure 1 the influence of a change over production cost with respect to the moment of the change occurrence is presented.

It’s obvious that the modifications operated in the Conceptual and also the Design and Development Phases imply lower costs, consequently the proper moment for any type of changes has to be picked up from this range.

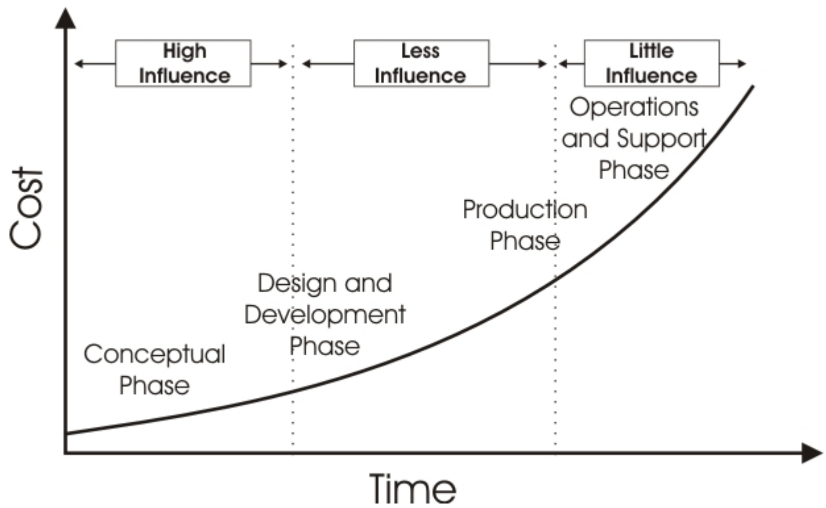

Fig. 1. Influence of a change over production cost with respect to the moment of the change occurrence

2. ASPECTS REGARDING VIRTUALISATION OF PRODUCTS AND MANUFACTURING SYSTEMS

The computer reconstruction of objects and environments has a wide range of applications. Manufacturing and virtual prototyping, reverse engineering, urban design and analysis, architecture, and cultural heritage are just a few examples. Methods to acquire the 3D data and reconstruct shapes have been progressing rapidly in recent years. However, many problems remain to be solved and no approach is suited for all applications and all types of object and environment.

The process of creating 3D models from real scenes has a few well-known steps: data collection, data registration, and modeling (geometry, texture, and lighting). There are many variations within each step, some of which are listed in figure 2.

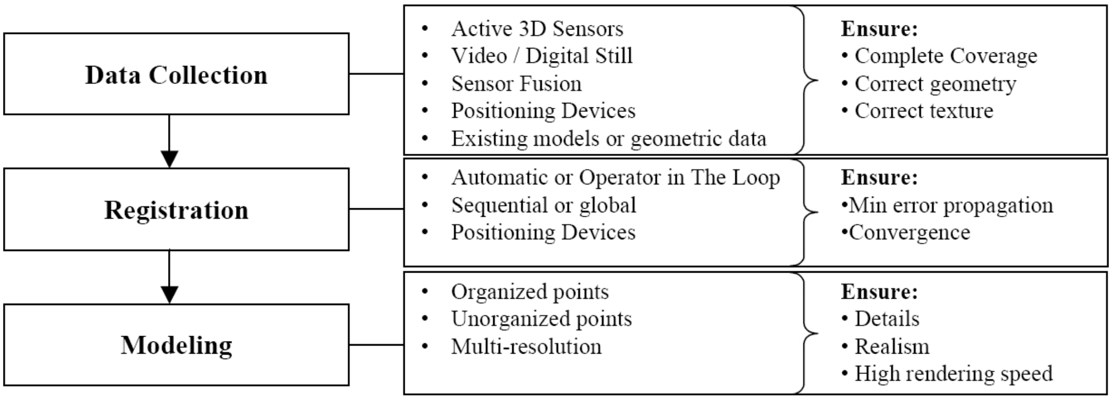

Fig. 2. The three steps of modeling

Approaches that skip the geometric modeling step also exist. For example, panoramas, light fields, and image-based rendering are popular for applications that require only visualization or limited walkthrough. However, the lack of geometric model impedes the accuracy and the freedom to render the environment from arbitrary viewpoints.

Passive image-based methods, mostly based on photogrammetry, have been developed for specific applications such as architecture, engineering, topography, etc.

Approaches that automatically acquire 3D points from a sequence of images at unknown locations, using projective reconstruction, are available. These methods require images taken close to each other (short baseline) in order for the automatic correspondence to work. This makes them more noise sensitive and numerically unstable. However, they can be useful for applications that do not require high geometric accuracy but need realistic looking and easy to create models.

Techniques based on a single image plus constraints were developed for specific objects such as buildings.

The main advantage of all passive image-based methods is that the sensors are inexpensive and very portable. However, due to the need for features, incomplete models may result particularly on irregular geometry or sculptured surfaces.

Active sensors (e.g. laser scanners) have the advantage of acquiring dense 3D points automatically and producing organized points suitable for automatic modeling. However, the sensors can be costly, bulky, and affected by surface reflective properties.

Active methods can be combined with passive methods to take advantage of the strength of each. For relatively simple objects, structures, or environments, most existing methods will work at varying degrees of automation, level of detail, effort, cost and accuracy. However, when it comes to complex environments the only proven methods so far are those using positioning devices, CAD or existing models and operator in the loop.

An important role in model making, especially those used in VR, is played by the VRML Standard. It's the most popular standard used for visualization, VR, and Virtual Manufacturing.

VRML was not created for engineering tasks. The generic concept of VRML took shape when used in fields like architecture, archeology, medicine, multimedia presentations, education and even 3D cartoons.

In the area of CAD and CAM, the CAD model is of overall importance. It is used for a variety of tasks in design, engineering analysis, operational simulations, production, maintenance, and others. In addition, it can also serve as the basic source for creating a virtual model of a product or process (DMU - Digital Mock-up). [Pustai, 2005]

A VRML representation of a product or process is a polygonal approximation of the original CAD model. It is less precise and, often, less detailed. As a virtual model, its purpose is to allow for viewing and interactions with real-time response.

The VRML model cannot replace the CAD model. Figure 3 illustrates that a VRML model can be created from a CAD model (using existing export functions of CAD/CAM systems) and, with additional information, used as a VR application. However, the path is one way only. Interactive changes in the VRML model cannot easily be propagated back into the CAD model. This current drawback is a topic of ongoing research and will find appropriate solutions in the future.

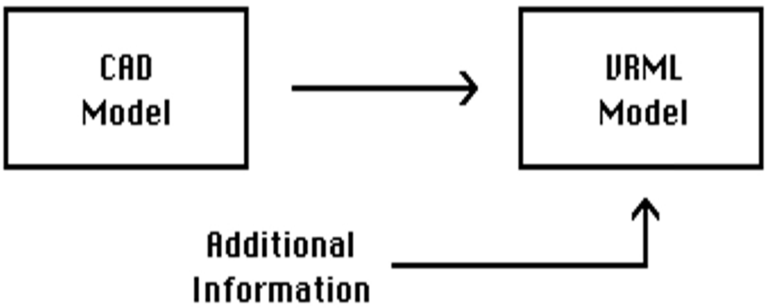

Fig. 3. From CAD model to VRML model

From the Virtual Manufacturing perspective we may say that there are two important directions:

a) virtualization of the product (structure, dynamic, functionality, etc), domain in which North University of Baia Mare had some trials in 1995, when top students included 3D models in their diploma work. TehnoCAD S.A. Baia Mare is currently designing such parts.

b) virtualization of manufacturing systems where the manufacturing process is viewed as a whole, including material flow, designs, implementation, etc. Students from North University of Baia Mare had the opportunity of studying at “Institut für Maschinelle Anlagentechnik und Betriebsfestigkeitder Technische Universität Clausthal” where these types of activities are frequent.

3. EXAMPLE OF VIRTUAL MANUFACTURING SYSTEM

An example of Virtual Manufacturing system is the Virtual Manufacturing-cell. The objective was to design a flexible manufacturing-cell to comply with a daily need. Three different parts had to be manufactured, parts that were supposed to be plasma cut and machined. The system had to be design in order to be able to quickly adapt to a design change and to an increase in the models number.

After computing the needed capacity and productivity, the virtual manufacturing system was designed, visualization was carried out and a few frames are presented below. The complete solution will be available at the conference or at North University of Baia Mare.

Fig. 4. General view of the Virtual Manufacturing Cell

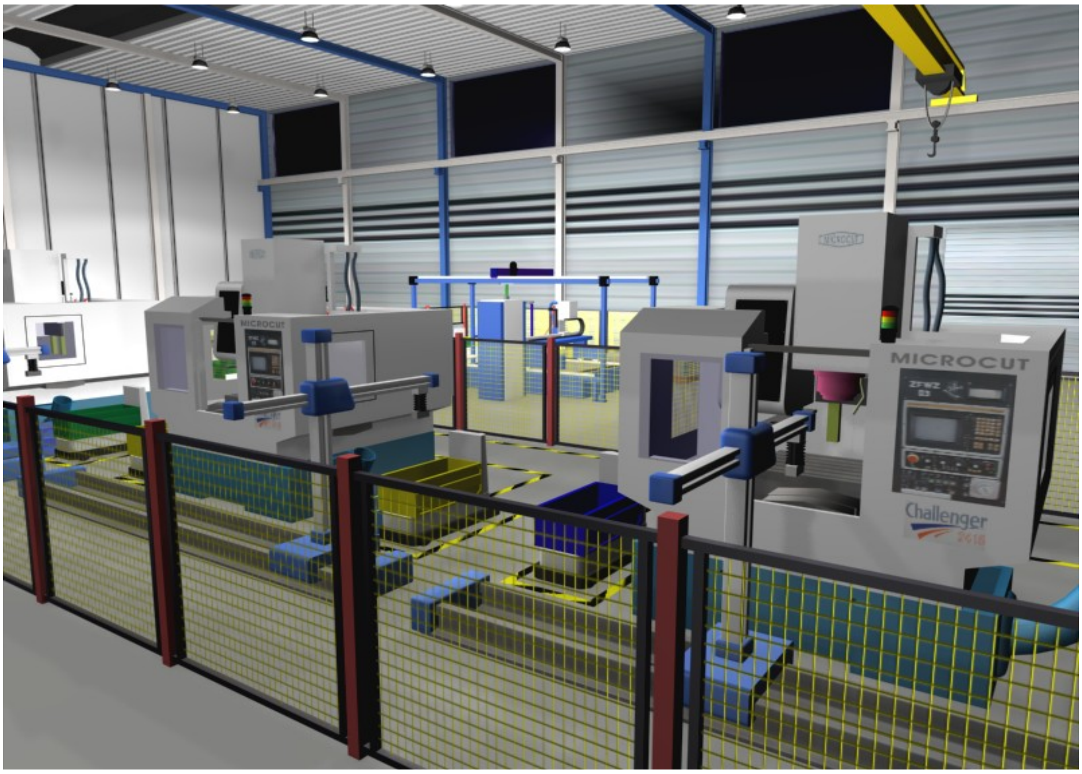

Fig. 5. View of the Virtual Manufacturing Cell

4. CONCLUSIONS

1. Virtual Manufacturing is the ideal solution for checkup, improvement, and development of a product or process. It is necessary to be integrated in the manufacturing process setup systems.
2. Virtual Manufacturing based on CAD/CAM systems allows development in the industry field.
3. Virtual Manufacturing should be included in the educational system as a training discipline.

REFERENCES

1. PUSTAI, V. Metoda "Fabricare Digitală" utilizată la planificarea în sistemele de fabricație din industria constructoare de automobile. In: Buletin Ştiințific. Management Tehnologic. Universitatea de Nord din Baia Mare, 2005, ISSN 1584 – 7306.
2. THOMAS, J.W. Einsatz von Methoden der Digitalen Fabrik dei der Planung von Productionssystemen für die Automobilindustrie. Dissertation an der TU Clausthal, Band 6 der Reihe, Innovationen der Fabrikplanung und –organisation, Herausgeber: Prof. Dr.-Ing. Uwe Bracht, Sheker Verlag, Aachen 2002, ISBN 3-8322-0308-7
3. http://www-vrl.umich.edu/beier/Papers/compit2000/WebBasedVR.htm (13.03.2006)
4. http://www.vit.iit.nrc.ca/elhakim/el-hakim-290.pdf (17.03.2006)