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VIRTUAL MANUFACTURING AS A TOOL IN INDUSTRY

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ABSTRACT

Virtual Manufacturing (VM) system is a computer system which can understand as a tool, it generates the identical information about manufacturing system's behaviours, states and structure same as it can observe in real manufacturing unit in industries. VM technology can support entirely the manufacturing process of products under virtual environment, laying a strong base for real production activities in the coming days. VM could offers manufacturers, the power to response fast to changes in consumer's preferences. This research discussed the latest technological developments in the area of VM and explain its benefits for industries.

Keywords - Virtual manufacturing; Virtual prototyping; Virtual Reality, Industrial Simulation

I INTRODUCTION

Virtual Manufacturing System is increasing its importance in the field of simulating new manufacturing processes, implementing automated workshops, designing plant facility layouts and workplace ergonomics. Complexities are regularly increasing over the product so it is necessary that the processes should be used having higher technological advancement. A good flexible and agile production is required to fulfill the consumer's demands. Manufacturing industries might be distributed geographically and connected conceptually in terms of dependencies & material, information as well as knowledge flows.

Present competitive market environment, industrialists must know about their processes before trying them in order to get it right the first time. VM environment would provide a computer-based environment to simulate manufacturing processes and the total manufacturing enterprise. VM systems helps to optimize the cost of production, quality and time drivers, achieve integrated product, process and resource design. The aim of this research is to present an updated vision of Virtual Manufacturing (VM) through different aspects.

Virtual manufacturing can also be called "global virtual manufacturing" because with the help of virtual manufacturing cad designers, customers, suppliers, contractors, manufactures, etc. can be in contact via sharing of virtual projects.

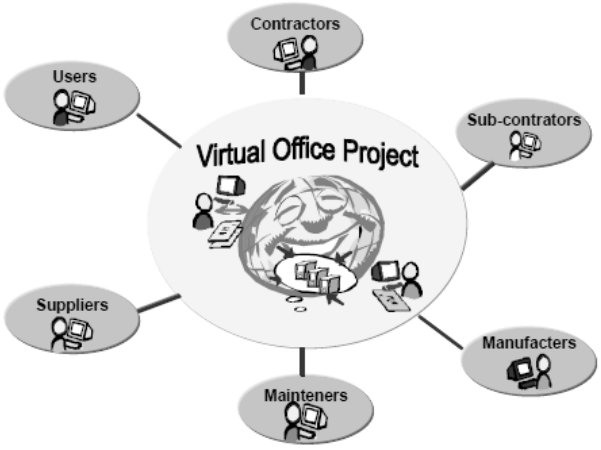

Fig1. Virtual Manufacturing as a Global Interface (Mélissa Saadoun, 2004)

II CONCEPT OF VIRTUAL MANUFACTURING

VM System is a computer based model which represents the precise and whole structure of manufacturing systems and optimize their physical and logical variables in operation, as well as interacting with the real manufacturing world. VM concept is specified as the model of present or coming manufacturing systems with all products, processes, and control data. Before production of the product their verification is performed within virtual manufacturing environment. Virtual environments would provide visualization technology for virtual manufacturing. The virtual prototyping is an important component for the virtual product life cycle estimation, while the virtual factory caters for technological operations needed for fabricating products. Therefore, the developments in the area of virtual prototyping and virtual factory can enhance the capabilities of VM. Major benefit of a VM is the physical system components, such as equipment and materials simultaneously conceptual system components can be easily represented even the creation of VM entities that simulate their structure and function. These entities can be added to or removed from the virtual plant as necessary with minimum impact on other system variable data. The software entities of the virtual manufacturing system have a high correspondence with real system components, thereby lending validation of simulations carried out in the virtual system meant to aid decision-makers in the real system. Thus virtual manufacturing system can be defined in various ways, such are as following-

- VM can be used as an information technology and computer simulation to model actual manufacturing processes for the analyzing and understanding them.
- VM System is a computer based model which shows the precise & whole structure of manufacturing systems and optimize their physical and logical variable in operation, as well as interacting to the real manufacturing system.
- VM is defined as an integrated, synthetic manufacturing environment exercised to enlarge all stages of decision and control. The purpose of VM is to provide a capability for Manufacture in the Computer.

2.1History of Virtual Manufacturing

The most advanced latest form of the Computer Aided Manufacturing (CAM) is VM based on Virtual Reality (VR). The concept of Artificial intelligences appeared already in the 1970s by Miron KRUEGER and Jaron Lanier (1989). In 1990 the concepts of Virtual World and Virtual Environments appeared. The term virtual manufacturing first came into popularity in 1990s as a result of the US Department of Defense Virtual Manufacturing initiative.

2.2Importance of Virtual Manufacturing

VM affect all the activities in industries, from the manner in which market signal are taken into account, its relations to the customers and providers until its internal reorganization or reconfiguration. In particular, there are concerned the proper impact on the company memory, total investment, full design of production; capital cost estimation, total risk management, client interfaces, functionality interfaces, and workshop. Before the advent of virtual manufacturing technology there were lot of wastage of time, money etc. in manufacturing of products and also the efficiency, accuracy was very tough to maintain. Further it can show its importance in various aspects, these aspects are following-

Design aspect

- Conventional paper sheet designing process was time consuming and less efficient.
- Life of these sheets was limited.
- Poor relations and feedback with customers.
- Very confusing if designing object is complex.
- Rapid changes were not possible.

Production aspect

- With "VM" technology it can have virtual prototypes, thus save in time, cost, material etc. which was not possible before VM.
- Future milestones can be easily identified with VM.
- Better material selection.

Management aspect

- Better machine and tooling arrangement can be obtained, thus optimization can be achieved.
- With VM technology other management such as plant-layout can also be done.
- Fast feedbacks from customers.

2.3Tools of Virtual Manufacturing

Every process completes in some steps, similarly there are steps in virtual manufacturing, these steps are the tools of virtual manufacturing and these tools of virtual manufacturing are following-

2D Drafting

2Ddrafting is the computer based generation of two-dimensional digital images of models. These images provide full dimensional information of those models. And also provides different views of objects such as front view, top view, sides view, etc. Now a day there are several software are available in the market for 2D drafting such as AUTOCAD, AUTODESK, DRAFTSIGHT, DOUBLECAD, DELTACAD, AUTODESK INVENTOR, DESIGNCAD ETC.

3D Modeling

3Dmodeling is the process of creating a mathematical representation of 3D surface of object from specialized software. The product is called a 3D model. It displayed as a 2D image through a process called 3D rendering. The model can also be physically created using 3D printing devices. Software used: PRO/E, SOLIDWORKS, CATIA, 3DCRAFTER, AUTOCAD, DRAFTSIDE and CREO ELEMENTS ETC.

Assembly

Already modeled 3D parts are assembled to get final realistic view of object. This also describes the actual location of every part. This also shows the actual location of every part in final object. Software used are same as for 3D modeling.

Analysis

Analysis is done for testing any model under various circumstances which it will suffer in physical world during its implication. "Finite element analysis (FEA)" technology is the best emerging technology for analyzing the products already made in cad software. FEA is a powerful engineering design tool that has enabled companies to simulate all kind of fabrication and testing in a more realistic manner. It can be used in combination with optimization tool as a tool for decision making. It allows to replace the prototypes as virtual prototype, which are cheaper than building physical models, the material waste and the cost of tooling Using this FEA technology it can analyze a model in static, dynamic loadings. It can analyze thermal effects, various fluids behavior etc. using FEA technology. Hence analysis may be of various types:

1) Static analysis
2) Dynamic analysis
3) Thermal analysis
4) Fluid analysis

Simulation

Simulation is the process of projecting real world situations in virtual environment. Simulation is the imitation of the operations for a real world system over time. Simulating something first requires that a model be developed; this model shows the key characteristics or behaviors of the selected physical or abstract system or process. Model representing the system itself, whereas the simulation represents the operation of the system over time Simulation has a wide range of application such as process simulation, inventory simulation etc. It is

mainly used for optimization management. Software used: solid works, pro/e, catia, Indiss plus etc. relation between a virtual simulation process and real operation in factory is shown below.

Virtual Environment

Virtual environment or virtual reality is itself a widespread field. Virtual environment is similar to real environment but everything is virtual not physical, but all systems behaves as the real physical system will work after physical manufacturing. After optimized virtual manufacturing of machine, various studies done on this machine in a virtual environment with real life situations, to know how it will work in real world. In years 1960-1962 Morton Heilig created a multi-sensory simulator. A prerecorded film in color and stereo was augmented by binaural sound, scent, wind and vibration experiences. This was the first approach to create a virtual reality system and it had all the features of such an environment, but it was not interactive.

Modern technology used

There are various technologies for creating a virtual environment but CAVE technology is latest and most advanced technology among all. This technology presented in 1992 CAVE (CAVE Automatic Virtual Environment) is a virtual reality and scientific visualization system. A cave automatic virtual environment is an immersive virtual reality environment where projectors are directed to three, four, five or six of the walls of a room-sized cube. The user wears special glasses, gloves inside the CAVE to see 3D graphics generated by the CAVE. People using the CAVE can see objects apparently floating in the air, and can walk around them, getting a proper view of what they would look like in reality. There are multiple speakers placed at multiple angles in the CAVE, providing 3D sound to complement the 3D video. This approach assures superior quality and resolution of viewed images, and wider field of view in comparison to other technology used for this purpose. Software used**:** CAVELiv, VR Juggler, OpenSG, CaveUT Quest3D etc.

Scope of Virtual Manufacturing

The scope of VM can be to define the product, processes and resources within cost, weight, investment, timing and quality constraints in the context of the plant in a collaborative environment. Three paradigms are proposed as:

Design-centered VM: This type VM provides manufacturing information to the designer during the design phase. In this case VM is the use of manufacturing-based simulations to optimize the design of product. The results of design-centered VM include the product model, cost estimate, and so forth. Thus, potential problems with the design can be identified and its merit can be estimated, In order to maintain the manufacturing proficiency without actual building products.

Production-centered VM: production-centered VM provides an environment for generating process plans and production plans, for planning resource requirements (new equipment purchase, etc.), and for evaluating these

plans. This can provide more accurate cost information and schedules for product delivery, by providing the capability to simulate actual production. The simulation capability to modelize manufacturing processes with the purpose of allowing inexpensive, fast evaluation of many processing alternatives.

Control-centered VM: control-centered VM offers the environment for engineers to evaluate new or revised product designs with respect to shop floor related activities. Control-centered VM provides information for optimizing manufacturing processes and improving manufacturing systems. It is the addition of simulations to control models and actual processes allowing for seamless simulation for optimization during the actual production cycle.

Benefits of VM

As small modifications in manufacturing can have important effects in terms of cost and quality, Virtual Manufacturing will provide manufacturers with the confidence of knowing that they can deliver quality products to market on time and within the initial budget. VM and simulation change the procedure of product and process development. Prototyping will change to virtual prototyping so that the first real prototype will be nearly ready for production. This is intended to reduce time and cost for any industrial product. From the product point of view, it will reduce time-to market, reduce the number of physical prototype models, improve quality in the design phase, VM adds manufacturing information in order to allow simulation of many manufacturing alternatives. One can optimize the design of product and processes for a specific goal (assembly, lean operations) or evaluate many production scenarios at different levels of fidelity. Virtual manufacturing contributes to the following benefits:

Quality: Design for Manufacturing and higher quality of the tools and work instructions available to support production.

Shorter Cycle Time: increase the ability to go directly into production without false starts.

Producibility: Optimize the design of the manufacturing system in coordination with the product design; first article production that is trouble-free, high quality, involves no reworks and meets requirements.

Flexibility: Execute product change overs rapidly, mix production of different products, return to producing previously shelved products;

Responsiveness: respond to customer "what-ifs" about the impact of various funding profiles and delivery schedule with improved accuracy.

Customer Relations: improved relations through the increased participation of the customer in the Integrated Product Process Development process.

IV CONCLUSION

As a conclusion of this paper, it can say that VM is a new revolution in area of manufacturing field. Research have now reached to a point where all (researchers /students/teachers / industries etc.) can use VM. VM can

stimulate the design both for manufacturability and manufacturing efficiency. Nowadays, though there is still a lot of work to do, all the pieces are in place for Virtual Manufacturing to become a standardized tool for the design of manufacturing process:

(i) Computer based VM technology is widely used and accepted
(ii) The concept of virtual prototyping has been widely accepted.
(iii) Industries need faster solutions for cost & time saving, for more accurate simulations.
(iv) Leading industries are already demonstrating the successful use of VM techniques.

REFERENCES

[1]Bowyer, Bayliss, Taylor R. and Willis, A virtual factory'. International Journal of Shape Modeling, 2 (4),1996, p. 215–226.

[2]Glasnevin, Journal of Materials Processing Technology P.1834–1838. Dublin City University, Dublin 9, Ireland, 2004.

[3]Heping Li, Xiaoqiu Zheng. The virtual manufacturing technology application in modern mould. Proceedings of the Third International Symposium on Electronic Commerce and Security Workshops (ISECS '10) *Guangzhou, P. R. China, 29-31,2010, pp. 279-281.*

[4]Iwata, K., Onosato, M., Teramoto, K., and Osaki, S. A. Modeling and simulation architecture for VM system, Annals CIRP (44),1995, pp. 399–402.

[5]Jozef Novák-Marcinčin. Theory and Practice of Virtual Manufacturing, 2001.

[6]Ke-Zhang Chena, Xing-Yang Fengb, Feng Wanga, Xin-An Fengc. A virtual manufacturing system for components made of a multiphase perfect material. Department of Mechanical Engineering, the University of Hong Kong, Hong Kong. Computer-Aided Design 39,2007, PP.112–124.

[7]LEDERER G.: Virtual Manufacturing – Manufacturers Challenge of the 1990s. CIME - Computer Integrated Manufacture and Engineering. Vol. 1, No. 2, 1996,pp. 44-46.

[8]LEE, D. E., and Hahn, H. T., Generic modular operations for VM process . In Proceedings of DETC, vol. ASME Design Engineering Technical Conferences, 1997.

[9]LEE K.: Principles of CAD/CAM/CAE Systems. Addison-Wesley, Reading, 1998.

[10]Lin, E., Minis, I., Nau, D. S., and Regli, W. C., The institute for System Research, CIM Lab. MARCINČIN, J. N.: Application of the Virtual Reality Technologies in Design of Automated Workplaces,1997.

[11]MARCINČIN J. N. - PETIK A.: Computer Aided Manufacturing - inseparable part of CAD/CAM/ CAE chain. InfoWare, Vol. 3, No. 8,1999, pp. 18-20 (in Slovak).

[12]P. D´epinc´ e, d. Chablat, e. No el, p.o. woelk. The virtual manufacturing concept: scope, socio-economic Aspects and future trends. Asme, design engineering technical conferences and Computers and information in engineering conference September 28-october 2, Salt Lake City, Utah, USA, 2004.

[13]Pinfold, M., Chapman, C., The Application of KBE techniques to the FE model creation of an structure, Computers in Industry. vol. 44,2001, pp 1-10, .

[14]R. Radha Ramanan, School of Engineering, Virtual Manufacturing: An Emerging Technology Mercer University, Macon, GA 31,2007

[15]Sung-Chung Kim and Kyung-Hyun Choi, Development of flexible manufacturing system using virtual manufacturing paradigm. International Journal of the Korean Society of Precision Engineering, Vol. 1, No. 1, June 2000.