APPLICATION OF AUGMENTED REALITY TECHNOLOGIES IN VIRTUAL MANUFACTURING

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Abstract: *Virtual engineering is currently approached in various ways. Because virtual engineering is an emerging technology, its terminology and definition are not completely established. In manufacturing, the major component of virtual engineering is virtual manufacturing. Virtual manufacturing is defined as an integrated, synthetic manufacturing environment exercised to enhance all levels of decision and control. Augmented reality system generates a complex view where the virtual parts are covered by real elements in the basic working place for the user. It is a mutual combination of the real scene viewed by the user and a virtual scene generated by the computer logical core that augments the scene. Thanks to its possibilities if finds the utilization in many industrial spheres.*
Key words: *virtual engineering, virtual manufacturing, virtual reality, augmented reality*

1. INTRODUCTION

In the conception of computer aided systems, systems of computer support, respectively CA systems most of us consider only computer systems supporting the drawing, design and constructing of parts and products, so these systems which are called CAD systems. CAM systems use the geometrical and other data, which has been gained during computer design of the part, respectively product by the CAD (Computer Aided Design) system. CAM systems are used for simulation and verification of technological processes, too. The main aim of this paper is describe the main features of the Virtual Manufacturing. Virtual Manufacturing use of a virtual reality systems for the CAD of components and processes for manufacturing - for viewing 3D engineering models to be passed to NC machines for real manufacturing. Virtual Reality is technology for presentation of complicated information, manipulations and interactions of person with them by computer. Method of dialogue of person with computer is named interface and virtual reality is newest of row this interfaces (Marcincin et all, 2013).

2. VIRTUAL MANUFACTURING

Virtual engineering is currently approached in various ways. Because virtual engineering is an emerging technology, its terminology and definition are not completely established. In manufacturing, the major component of virtual engineering is virtual manufacturing. Virtual manufacturing is defined as an integrated, synthetic manufacturing environment exercised to enhance all levels of decision and control. It can be classified as design-centred, production-centred, and control-centred. Design-centred virtual manufacturing is a simulation environment for designing and evaluating the manufacturability of a product. Production-centred virtual manufacturing is a simulation environment for generating process plans and production plans. Control-centred virtual manufacturing is a simulation environment for shop floor production activities (Lederer, 1996).
We can also classify virtual engineering in terms of production life cycle as virtual design, digital simulation, virtual prototyping, and virtual factory. Virtual design is done on virtual reality equipment. Digital simulation permits the verification and validation of the product's operation without using physical prototypes. Virtual prototyping builds a simulated prototype that possesses the same geometry and physical behaviour as the real product. Virtual factory is a simulation of factory production line.
The most advanced current form of the Computer Aided Manufacturing is Virtual Manufacturing (VM) based on Virtual Reality (VR). The concept of Artificial Reality appeared already in the 1970s (Miron KRUEGER) and the notion of Virtual Reality was introduced by Jaron Lanier (1989). In 1990 the concepts of Virtual World and Virtual Environments appeared. Virtual reality is defined as a computer generated interactive and immersive 3D environment simulating reality.
VR representation techniques are widely used which means that they develop rapidly. In

product manufacturing techniques and organization, virtual reality has become the basis of virtual manufacturing aimed at meeting the expectations of the users/buyers of products, also as to their low cost and lead time. Virtual manufacturing includes the fast improvement of manufacturing processes without drawing on the machines' operating time fund. It is said that Virtual Manufacturing is the use of a desktop virtual reality system for the computer-aided design of components and processes for manufacture. Examples of application of virtual manufacturing in area of production systems design are on Fig. 1 (Barna et all, 2012).

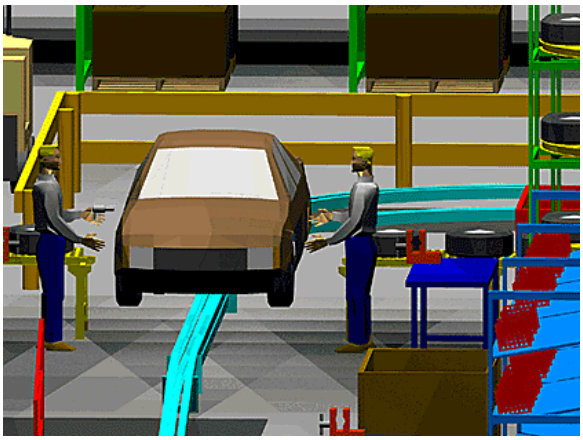

Fig.1. Virtual manufacturing in practice

There are many definition of Virtual Manufacturing (VM). Iwata (1993) defines VM as follows: "A virtual manufacturing system is a computer system which can generate the same information about a manufacturing system's structure, states and behaviours as we can observe in real manufacturing systems".
The report from the 1994 Virtual Manufacturing User Workshop includes an in-depth analysis of VM and its definition: "Virtual Manufacturing is an integrated synthetic manufacturing environment exercised to enhance all levels of decision and control" was annotated extensively to cover all the current functional and business aspects of manufacturing. Also the practical side of manufacturing virtuality is highlighted in this useful analysis. A comprehensive and thorough survey of literature on VM problems relating to production design and control can be found in a study done at the University of Maryland (Marcincin et all, 2012).
The definition of VM given by a Bath University project team deserves attention. According to this definition: "Virtual Manufacturing is the use of a desk-top virtual reality system for the computer aided design of components and processes for manufacturing - for creating viewing three dimensional engineering models to be passed to numerically controlled machines for real manufacturing". This definition emphasizes the functions aiding the machining process (Jedrzejewski. & Kwasny, 2001).
It is unquestionable that virtual manufacturing aids real manufacturing processes and systems and it is perfected as the information technologies, the manufacturing systems and the business demands develop. In this context, Virtual Manufacturing should be recognized as an advanced information structure of Real Manufacturing Systems, which integrates the available information tools and the virtual environment immersiveness to achieve business-manufacturing goals (Marcincin et all, 2013).

3. AUGMENTED REALITY DESCRIPTION

Augmented Reality (AR) is a growing area in virtual reality research. The world environment around us provides a wealth of information that is difficult to duplicate in a computer. This is evidenced by the worlds used in virtual environments. An AR system generates a composite view for the user. It is a combination of the real scene viewed by the user and a virtual scene generated by the computer that augments the scene with additional information. The application domains reveal that the augmentation can take on a number of different forms. In all those applications the augmented reality presented to the user enhances that person's performance in and perception of the world. The ultimate goal is to create a system such that the user can not tell the difference between the real world and the virtual augmentation of it. To the user of this ultimate system it would appear that he is looking at a single real scene.
The discussion above highlights the similarities and differences between virtual reality and augmented reality systems. A very visible difference between these two types of systems is the immersiveness of the system. Virtual reality strives for a totally immersive environment. The visual, and in some systems aural and proprioceptive, senses are under control of the system. In contrast, an augmented reality system is augmenting the real world scene necessitating that the user maintains a sense of presence in that world. The virtual images are merged with the real view to create the augmented display. There must be a mechanism to combine the real

and virtual that is not present in other virtual reality work. Developing the technology for merging the real and virtual image streams is an active research topic (Ong & Nee, 2004).
The real world and a totally virtual environment are at the two ends of this continuum with the middle region called Mixed Reality. Augmented reality lies near the real world end of the line with the predominate perception being the real world augmented by computer generated data. Augmented virtuality is a term created by Milgram to identify systems which are mostly synthetic with some real world imagery added such as texture mapping video onto virtual objects. This is a distinction that will fade as the technology improves and the virtual elements in the scene become less distinguishable from the real ones. Milgram also places augmented reality systems on the low end of the Extent of Presence Metaphor. This axis measures the level of immersion of the user within the displayed scene. This categorization is closely related to the display technology used by the system. Each of these gives a different sense of immersion in the display. In an augmented reality system, this can be misleading because with some display technologies part of the "display" is the user's direct view of the real world. The third, and final, dimension that Milgram uses to categorize Mixed Reality displays is Extent of World Knowledge. Augmented reality does not simply mean the superimposition of a graphic object over a real world scene. This is technically an easy task. One difficulty in augmenting reality, as defined here, is the need to maintain accurate registration of the virtual objects with the real world image. This often requires detailed knowledge of the relationship between the frames of reference for the real world, the camera viewing it and the user (Vallino, 2002).

4. AUGMENTED REALITY APPLICATION

Augmented reality, as a sub-area of the virtual reality, utilizes hardware and software tools for creation of the mixed environment that combines real scene usually present in the form of video sequence with augmented scene consisting of virtual models of additional objects. There are several techniques among those commonly used in augmented reality that are tried to implement into the system of robot programming. The central object of newly created environment was robotic device from Swedish producer ABB - compact robot IRB 140 (Marcincin et all, 2011).

New perspective possibility of displaying the environment of augmented reality is using of special visualization unit, which utilizes the principle of combined glass-mirror medium. The surface of the glass is either half-silvered or there is a half-leaky foil stick on it that creates a reflection and at the same time allows a view to the working environment with no obstacle or decrease of view quality. This commonly available kind of mirror is often used in gaming, medicine or business presentations. By optical connection of two seemingly different views it creates an ideal platform for the creation of a realistic spatial effect. Displaying is a reversed emission of the view to the reflex surface. It can be provided by computer monitor or classical projector placed over the working area. With a development of the projectors and their displaying technologies is possible to use the advantages of LED projecting. In comparison to the classical light projector the LED technology does not generate the luminous cone that would reflect in the form of light spot on the displaying glass. The setting up of whole scene becomes easier as you can mount the devices in the necessary displaying angles without the need to prevent the direct light reflection. On the Fig. 2 is presented use of the half-silvered mirror for presentation of virtual model of industrial robot activity in comparison with real robot workcell activity (Marcincin et all, 2012).

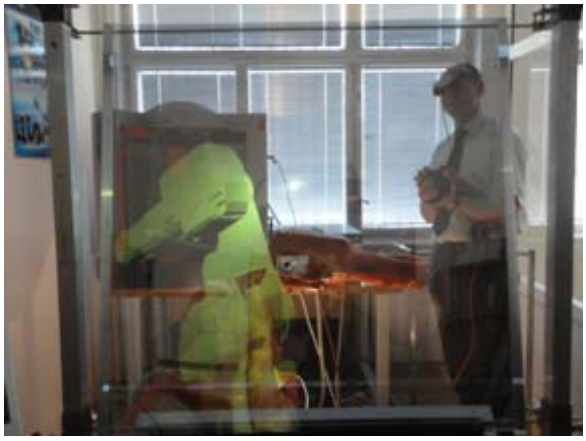

Fig.2. AR environment with industrial robot

This new application has an identical logical core like core which is mentioned in the pages where the process about basic elements of augmented reality assembling is explained by using the special logical elements and loops. The name of this logical script is augmented composite assembling process. Data cell for comparing positional conditions recalculates and evaluates necessary value of the particular

composite ply to follow identification with the real system. Thanks to them, displaying section situated among the comparing space and the positional one generates movement according to trajectory of the composite ply or provides the value of the final vector position (Fig. 3).

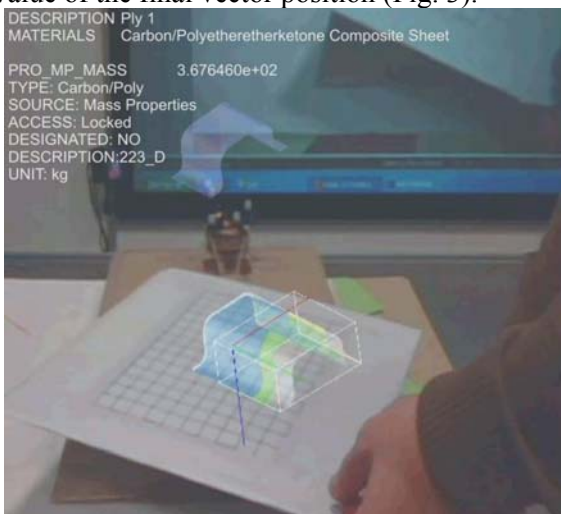

Fig.3. Augmented composite assembling process

5. CONCLUSION

The maximal benefit for production enterprises is reached only by complete application of the computer aided systems to realisation of the product. This means that besides of the design and dimensioning of parts and products also to design of the production systems, design of the production plans, design of the tools and fixtures, realisation of own manufacturing and assembly and testing the product quality. These trends in engineering are converging to a new engineering concept: Virtual Engineering.

6. ACKNOWLEDGMENT

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