VIRTUAL IMMERSION UTILIZATION FOR IMPROVING PERCEPTION OF THE 3D PROTOTYPES

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ABSTRACT:
VIRTUAL IMMERSION (OR VR) GETS INTO ATTENTION OF MANY RESEARCHERS, REGARDLESS OF THEIR ACTIVITY DOMAINS OR INDUSTRY. NOWADAYS, VR IS PRESENT IN ALMOST ANY DESIGN STAGE OF INDUSTRIAL PRODUCT. FOR MORE THAN TWO DECADES, 3D MODELLING IN COMPUTER AIDED DESIGN (CAD) HAD PROVIDED A HELP IN THE ANALYSIS OF THE FUTURE ASSEMBLY/PROTOTYPE. HOWEVER, THE CAD-3D SUPPORT PROVED TO HAVE ITS LIMITS, GIVEN THE SCREEN BI-DIMENSIONALITY. AS AN ALTERNATIVE, RAPID PROTOTYPING INTRODUCES ANOTHER TOOL, 3D-PRINTING, COMPLYING WITH THE NEEDS OF DESIGNERS, ESPECIALLY IN AUTOMOTIVE FIELD. OF COURSE, LIKE ALL TECHNOLOGIES, 3D-PRINTING COMES WITH SOME INCONVENIENCE, AS WELL: SOME PROPERTIES OF THE ROW MATERIALS, AND ALSO THE LIMITATION OF THE 3D VOLUME OF THE WORKING SPACE OF THE 3D-PRINTING MACHINES. BESIDES, VR TECHNOLOGY IS EVEN BETTER KNOWN IN THE ENTERTAINMENT INDUSTRY, WHERE IT FACILITATES THE IMMERSION IN A VIRTUAL SPACE, AROUND VIRTUAL 3D OBJECTS. NOWADAYS, PDP (PRODUCT DESIGN PROCESS), DEPENDS A LOT ON THIS TECHNOLOGY, IMPROVING AND SHORTENING THE DESIGN PROCESS. THIS PAPER PRESENTS THE ROLE OF VIRTUAL IMMERSION IN THE ANALYSIS PROCESS OF AN AIR CAR PROTOTYPE. THIS TECHNOLOGY CAN IMPROVE FEATURES LIKE AERODYNAMICS AND DIMENSIONAL SCALING, THUS OPTIMIZING THE PROTOTYPE STRUCTURE IN ORDER TO A PROPER MOUNTING/DISMOUNTING OF ITS PARTS TO BE PERFORMED, ETC. VIRTUAL IMMERSION COULD ALSO BE SUCCESSFULLY USED FOR THE SECONDARY STAGES OF THE PDP: COLORING, ESTHETICS AND ERGONOMY, OR EVEN THE PRODUCT MANEUVERABILITY BY LEFT-HANDED PEOPLE.

KEY WORDS: VIRTUAL REALITY, IMMERSION, INDUSTRY 4.0, CAD, PRODUCT DESIGN CYCLE

INTRODUCTION

The continuous development of the computer hardware/software industry leads to the performing Product Design Process - PDP of any industrial product. For many years, CAD platforms had offered to their users many 3D modelling powerful facilities, together with a lot of tools meant to improve the visualization and to obtain a more realistic picture of the designed product. Even if all these are mainly the attribute of the design phase, some other innovations follow (like 3D-Printing), aiming to offer a more realistic perception of the future product. Nevertheless, it does not imply the lack of drawbacks: the bi-dimensionality of the

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screen monitor is an important obstacle against the full virtual counterfeit of the future product.

At one moment, 3D-Printing technology seems to be a perfect completion for the CAD-3D. To handle the future product in all dimensional and ergonomic features brings designers closer to the future final product. However, the existent inconveniences push the studies in field forward and require some other even better performing technology. For few years already, a possible answer appears to be the virtual immersion, its combination with CAD-3D, 3D-Printing and VR.

Such a support for the modern PDP addresses the need of design specialists and ordinary users. Nowadays, there are industries requesting the customers involvement within the PDP process. Thus, professionals and non-professionals personnel work together during the design process, from idea to the prototype, and a unitary reasoning finally results[3].

For example, by using CAD-3D technology, people with eye malfunction are still not able to correctly analyze the volumetric solutions. Such an example is amblyopia, quite spread all over the world whereas in different stages, and called the "lazy eye" disease. The person in case is disabled and therefore in impossibility to efficiently see with both eyes. The outcome is the lack of the image depth, or, in other words, its third dimension. Only in Romania, for example, 10% of the population suffers from this disease that alters the human tridimensional sight, irrespective of its severity. Considering the many other eye diseases distorting the human sight, the challenge faced by PDP specialists when analyzing a CAD-3D model on the monitor screen or when viewing a 3D photo/film becomes quite important[4].

On the contrary, by using virtual immersion, the designer can tri-dimensionally perceive the designed product and also its spatiality. Without any doubt, the prototype obtained by means of 3D-Printing brings comparable benefits, the major advantage provided by the virtual immersion is the instant outcome.

The present paper introduces the way that AVRENG (the lab for *Augmented & Virtual Reality for ENGineering*) from the University POLITEHNICA of Bucharest helped the member of its academic team UPBair (participant to the 10th edition of the PNEUMOBIL – the international competition between universities for air cars prototypes), to solve some design problems associated to their prototype by using the virtual immersion. The used VR equipment was based of Oculus Rift glasses and devices.

VIRTUAL REALITY AND PDP PROCESS

Generally, before the scaled prototype fabrication, the designed product goes through several design stages. Usually, all checks and analysis are made on the 3D model, generated by CAD software (figure 1). As it is shown in the above figure 2, the VR technology can be used along almost the entire PDP process, immediately after the 3D model is obtained[5].

ESI Group, *Leading Innovator in Virtual Prototyping Software and Services*, is a pioneer in helping industrial designers and manufacturers to replace the physical assembly

[3] Ghinea, M., Deac, G.C., Georgescu, C. N. *Improving the Image Quality in Virtual Reality for Industry.*, International Journal of Computers, 1, pp.284-289, 2016

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obtained by 3D-Printing or other technologies which replicate stages of the manufacturing process (products fabrication, assembling and/or testing in different environments).

As an important leader in the field of VR industrial application, ESI Group has already launched the idea of a future manufacturing process that implies virtual immersion support. Their product, IC.IDO ("I see – I do") VR, helps making decision especially when it comes about geographically spread operating interdisciplinary teams. Thus, due to the flexibility of the VR technologies, designers replace the physical prototype with interactive digital features Figure 2). As it is shown in figure 3, IC.IDO VR is continuously operational and made use of, not only in the design process, but in the production one as well. Therefore, it proves its utility for the entire modern industry line Industry 4.0[6].

Nowadays, all important producers take into consideration virtual immersion at any stage of PDP process, from ergonomics to CAE or Marketing (figure 2).

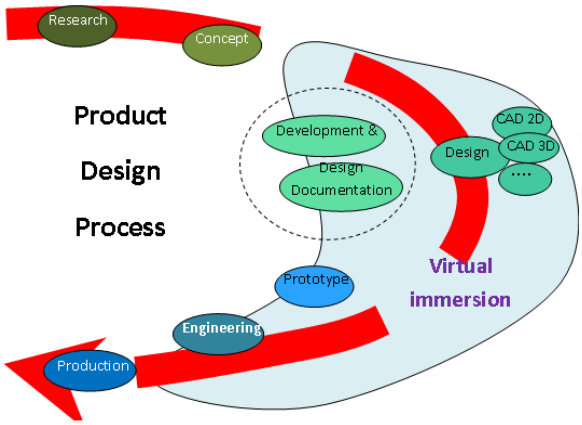

Figure 1. PDP stages and VR influence

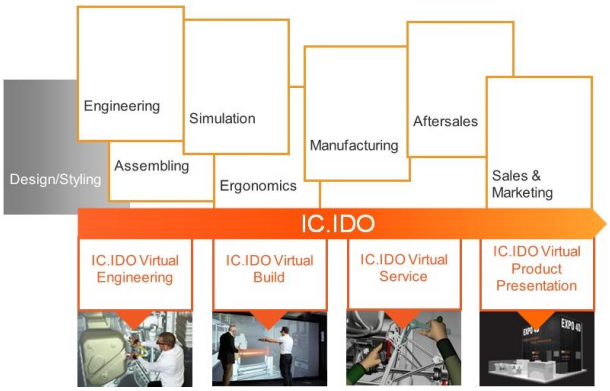

Figure 2. IC.IDO and its influence on PDP

FROM CAD TO VIRTUAL IMMERSION

Developed as different technologies, CAD and VR use different software products. Consequently, it is rather difficult to compare them. Moreover, when using a 3D CAD model in VR, a special conversion is needed. As already mentioned, out of the three types of PDP design soft-wares, one is especially conceived for VR application, the other two needing conversion[7].

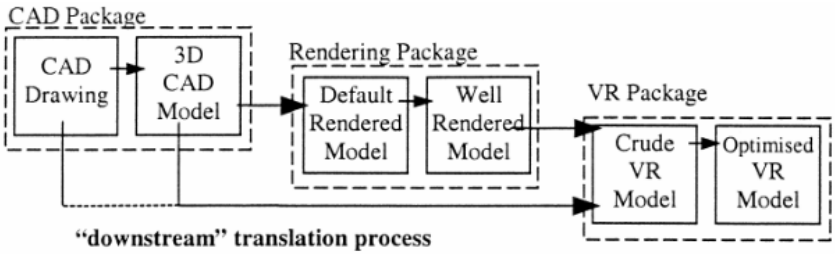

Figure 3. One-way or ''downstream'' process in order to transport the graphic information from CAD software to the VR

Specialists, such

[6] Shawn Wasserman *Can Virtual Reality Help Optimize Product Engineering, Manufacturing and Operations?*, www.engineering.com, January, 29, 2015; https://www.esi-group.com

[7] Shawn Wasserman *Can Virtual Reality Help Optimize Product Engineering, Manufacturing and Operations?*, www.engineering.com, January, 29, 2015; Whyte, J., Bouchlaghem, N., Thorpe, A., McCaffer, R. *From CAD to virtual reality: modelling approaches, data exchange and interactive 3D building design tools*. Automation in Construction 10, pp.43-55, 2000; https://www.esi-group.com

as J. White, prefer one-way or ‘‘downstream’’ process in order to transport the graphic information from CAD software to the VR (figure 3)[8]. The most used CAD software are CATIA, AutoCAD, SolidWorks, Inventor, and the most common graphical files format are: DXF, IGES, STL or STEP[9].

In Romania, CATIA is the software used both by universities and industry. To transfer the information from CATIA to VR, one gets several possible approaches[10]:

1- Using a plug-in for Unreal Engine or Unity (depending on VR application). PIXYZ is such a plug-in used with several VR devices like Oculus Rift.

2- CATIA 3D model saved in .STL format is imported into 3D Studio Max software for more specific modifications (animations, colors, materials) and the file is then saved in FBX format (FBX2014). After that, the model in this new format is imported in Unreal Engine or Unity (for others VR specific operations like rendering or lights).

3- Using FreCAD, 3D models are imported in STEP or IGES format, and then exported in OBJ file format to the Unreal Engine or Unity software.

USING VIRTUAL IMMERSION TO IMPROVE THE DESIGN OF A PROTOTYPE

The 3D model was build in CATIA and imported in VR by means of the above method 2. Using Oculus Rift glasses, the students could improve several air car features such as: mounting/dismounting spaces, shapes of courves, chair position, colours etc (figure 5). Virtual immersion made possible the optimization of the driver position and the routes of the brakes cables, so that not to overlap other functional zones of the air car. All the observed inconveniences were alleviated in the 3D CATIA model. Moreover, during the prototype fabrication, virtual immersion helped techniciens find the most efficient and effective welding of the car structure.

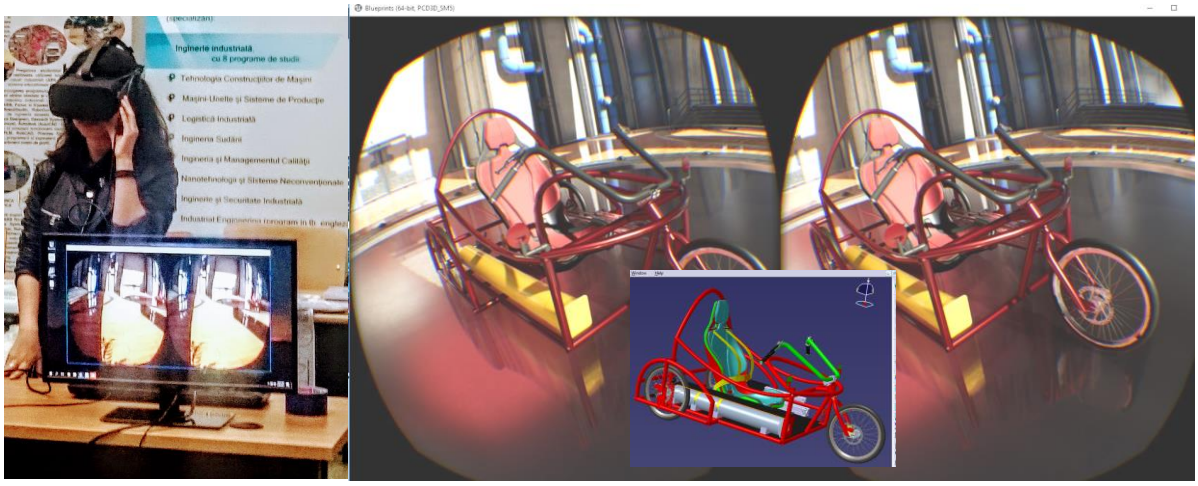

Figure 5. Simplicity of the virtual immersion during the prototype analysis

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CONCLUSIONS

VR has become an important technology for the future of the industrial products manufacturing. Through virtual immersion, by means of systems like CAVE or special glasses, designers could place themselves in front, around or inside of their future product. Grace to these facilities, the prototype of UPBair team (figure 6) considerable improved its performances.

We estimate that in the very next future the VR technology becomes indispensable for the modern industry development. No further than *the fourth industrial revolution*, Industry 4.0, counts VR & AR technologies among its pillars.

Figure 6. The prototype running

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