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WEB 3D TECHNOLOGIES FOR PRODUCT LIFECYCLE MANAGEMENT TRAINING

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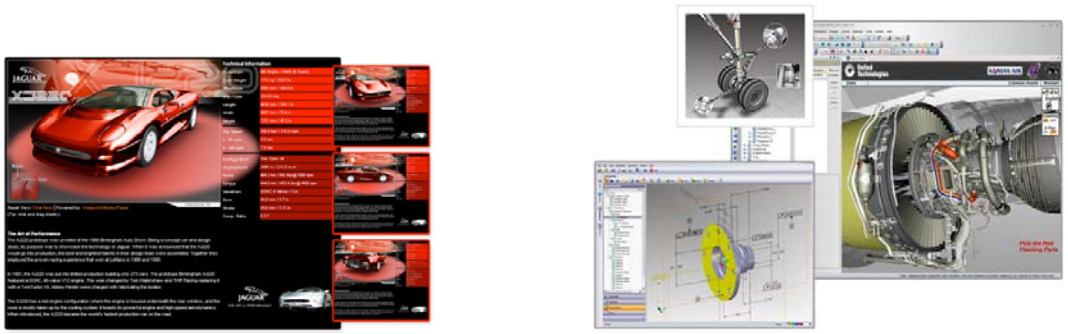
ABSTRACT
The manufacturing market have become today complex and globalized, where product life is rapidly decreasing, product structure is more frequently changed and customer-oriented. To maintain or increase their position on the market, the manufacturers have to develop and produce more complex products in a shorter time. The 20th century technological developments have transformed the majority of wealth-creating work from physically-based to "knowledge-based". Technology and knowledge are now the key factors of production. To meet the challenges of the market it is necessary to improve the design culture providing more innovative design methodologies and tools based on 3D technologies with the appropriate knowledge for the technicians and engineering involved in the product development, overcoming any geographical constraints
The aim of the paper is to define the guidelines to support PLM training with the use of Web3D technologies.
Keywords: Interactive learning environments, Virtual reality, WEB3D, e-learning

1. INTRODUCTION
With the past scientific experiences related to the development of the WEBD distance learning platform [1, 2, 3, 4, 5, 6], it has been found the lack of some professional figures inside the European Union in some main economic sectors of the mechanical industry. The professional figure required must to be able to exploit the new technologies of product development and to share the information to all the participants of a project (industry personnel, co-designer, suppliers...) also overcoming the geographical barriers. These matters are vital to a Small and Medium Enterprises (SME) due to the challenges of the market, who requires better and highly customizable products, developed in shorter times, with competitive prices.
Unfortunately the formative activity in these sectors implies expensive direct and frontal formative methodologies, with the use of equipments, computer technologies, tools, experiences of laboratory hardly replaceable with the techniques of distance teaching.
The use of virtual reality (VR) as an educational tool has been proposed and discussed by several authors [7, 8, 9]. The constructivist fundamental theory motivates educational uses of Virtual Environments (VEs) because it provides an experience close to the direct interaction with the world, and allow the process of knowledge construction that takes place when learners are intellectually engaged in "personally meaningful tasks".

The fast evolution in the computer graphics (CG) tools, and particularly the Web3D tools, allows the delivery of more and more powerful interactive VEs through the Internet, reaching potentially large numbers of learners worldwide, at any time (Fig.1). Therefore, the necessity to facilitate the innovation of the enterprises with new training tools to organize the knowledge, to share the "best practices" and to facilitate the transfer of the information with a distance formative product. The distance formative activity, with the simulation and the reproduction of situations and virtual sceneries, has the objective to conduct technicians, engineers or SME's employee of the mechanic industrial sector to acquire creative planning ability in the main sectors of the European economy, like the industrial mechanics.



a b

Figure 1. – a) Jaguar XJ220 Interactive Showroom – b) Examples of Web3D technical applications.

2. WEB3D COMPARISON METHODOLOGY

In order to create a correlation between Web3D tools and real needs of the customers this paper proposes to employ the Quality Function Deployment [10] approach. Even if QFD is normally adopted to define which are the most important technical parameters that should characterize the development of a new product [11], this paper employs the QFD with the aim to select which are the most important features characterizing a Web3D tool that could be exploited in the distant learning platform to achieve the maximum knowledge transfer.

2.1. Users needs

The first step of the QFD method is based on the identification of the users needs. This information can be collected with a series of interviews carried on a sample of manufacturing and engineering companies that employ 3D CAD/CAM/CAE... tools in their normal activity. In the first step the interviewer gives to the person interviewed the possibility to explain, without specific questions, which are his most important needs to employ 3D tools.

The "Raw Data" collected must be re-arranged in the form of "Reworded Data" so to better express the users needs and to find possible similarities between the information given by different users, thanks to the use of Hierarchical Cluster Analysis [12].

After this, working on the reworded data, it is necessary to ask to every person interviewed to express a relative importance for every different need, employing a scale from 0 to 10. Using the relative importance value, expressed over every need, it is possible to create an organized importance list, like the one shown in tab. 1.

Table 1. Aggregated users need list and relative importance.

User needs	Aggregated customer needs	Importance
Modeling shafts, hubs Modeling cases, prismatic parts	Basic part modeling (BPM)	15
Modeling helicoids, hooks, handles Modeling gears	Advanced part modeling (APM)	15
Metal sheet design Free forms	Surface modeling (SFM)	5
Assembly simple parts	Basic assembly (BA)	15

Assembly different variety of a part Assembly of kinematism	Advanced assembly (AA)	5
Views, Sections, Dimensions and tolerances, Geometrical tolerances	Basic drawing (BD)	20
Collision detection during assembly Find and fix interferences	Digital mock-up analysis (DMUA)	10
Part program definition	CAM basics	5
Shareable tool Portable tool on different OS Customizamble	Tool availability (TA)	10

2.2. WEB3D technical specifications

The second step of the QFD method is the analysis of the Web3D tools capabilities that can be exploited inside the learning platform. Here, a brief analysis and comparison it is carried out.

Table 2. Web3D tools specifications. Legend: Y=yes, N= no NG= not given

Description	**Acrobat 3D**	**Kaon**	**Right Hemisphere**	**HOOPS Stream TK**	**Anark**	**Spinfire prof.**	**Viewpoint**
Data format (**DF**)	3D PDF	XMM 3D PDF	3D PDF	HSF	Proprietary	Proprietary	Proprietary
Precise Geometry (**PG**)	Y	Y	Y	Raster 2D Raster 3D	Y + Tessel.	Y + Tessel.	Precise
PMI	Y	Y	Y	NG		Y	NG
Measures (**MEAS**)	Y	Y	Y	NG	Y	Y	Y
Sections (**SECT**)	Y	Y	Y	NG	Y	Y	Y
Other doc. (**DOC**)	Y	Y	Y	NG	NG	N	NG
Configurations (**CONF**)	Y	Y	Y	NG	Y	Y	Y
API	N	N	Script	Y	N	Y	Y
Supported platform (**PLAT**)	Windows Unix, Linux Mac OS	Same of Acrobat Reader	Same of Acrobat Reader	Windows Unix, Linux Mac OS	Windows	Windows	Windows Mac OS

2.3. WEB3D Ranking

Following the suggestions that could be extracted from the results given by the QFD implementation it is possible to find that the Web3D technical specifications more correlated with the user needs, because show a percentage value bigger than 10% are: Application Programming Interface, Measures, Precise Geometry, Section, Part manufacturing information, Configuration.

To define the Web3D tools that better suit the description are, to each specification is assigned a score: 1 if it is fully supported, 0.5 if it need some programming work to obtain the specification, 0 if not supported, following the description of tab. 2. Each of this value is multiplied by the relative importance level of tab. 3. The results of tab. 4 show that the most suitable tools for the Web3D platform are: Spinfire professional and Viewpoint.

Table 4: Ranking of the Web3D tools.

Description	Acrobat 3D	Kaon	Right Hemisphere	HOOPS Stream TK	Anark	Spinfire professional	Viewpoint
DF	1	1	1	1	1	1	1
PG	1	1	1	0	1	1	1
PMI	1	1	1	0,5	0,5	1	0,5
MEAS	1	1	1	0,5	1	1	1
SECT	1	1	1	0,5	1	1	1
DOC	1	1	1	0,5	0,5	1	0,5
CONF	1	1	1	0,5	1	1	1
API	0	0	0	1	0	1	1
PLAT	1	1	1	1	0,5	0,5	0,5
Rank	81,2%	81,2%	81,2%	57,1%	69,9%	97,4%	88,7%

3. CONCLUSIONS

The methodology applied permit to define the better tool for the development of an interactive Web3D platform for distant training. Further consideration regarding commercial aspect, easiness of programming by the developer..., can be applied in the same way to strengthen the result. To validate the platform, once developed, a testing of the efficacy of the learning material must be performed on a study-case in order to adjust its contents. Indicators must be established through the use of evaluation tests and interviews, for appraising the effectiveness of the new formative distance learning tool and the knowledge transfer, in order to make adjustments and refinements where needed.
Impact indicators should also be defined to evaluate the effects of the transferred knowledge within the target groups considering the increased enterprises competitiveness and profit.

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