Congresso Internazionale Congiunto XVI ADM – XIX INGEGRAF
Congreso Internacional Conjunto XVI ADM – XIX INGEGRAF
Perugia, 6 – 8 Giugno 2007

A NEW SURFBOARDS DESIGN AND MODELING PROCESS

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Abstract
This paper presents the research project "Design of a new Surfboards digital modeling process". This project is financed by the University of the Basque Country, in the University-Company 2005 research program, with the collaboration of the Surfboards factory PUKAS, which is the leader of the European market and has customers all around the world.
The objective of the research team has been to collaborate with the factory PUKAS to investigate the possibility of introduction of a new process of conception, design and CAD/CAE/CAM production of the surfboards by taking care of the technical, economical, logistic and social situation in the PUKAS factory.
This paper focuses on the diversion of new technologies of design such as reverse engineering on the production of Surfboards (scanning, digitalization…). The research team has studied the difficulty and originality on the process of designing Surfboards complex surfaces called “styling surfaces” or “design surfaces”.
This project is developed in the Product Design Laboratory (www.ehu.es/PDL) in the Faculty of Engineering of Bilbao.

Keywords: Digital Design, Reverse Engineering, University-Company collaboration

1. Introduction

The surf company PUKAS reached an agreement with the University of the Basque Country in order to investigate the possibility of introduction of a new process of conception, design and CAD/CAE/CAM production of the surfboards in its factory. This project is carried out within the University-Enterprise program of year 2005, by means of the company and the Basque Government collaboration. Thanks to this project, PUKAS has obtained a detailed study of the present state of the art of the specific software and CNC machines for the manufacture of surfboards, and the necessary technical assistance for the implantation of some reverse engineering techniques in its manufacturing processes.

PUKAS is a company in the surf business, which is dedicated not only to surfboards but also to clothes sales. The company has its own factory for surfboards manufacturing called OLATU [1]. It is the leader in the European market, and it has clients all around the world.

2. Project Objectives

The primary goal of this project has been to study the possibility of setting up a new design and production process of surfboards in the company by the Research Team of the University of the Basque Country, in collaboration with the PUKAS Company. Thus, this study is centered in the study of the several design systems in the present market and their manufacturing in CNC machines afterwards. In such a study of the market, the greatest effort has been centered in the analysis of different surfboards design software, which most of all were linked directly to their own CNC machine.

The present CNC machine in the OLATU factory is the main reason to start up this study because their machine produces a great number of inconveniences to the company due to the peculiar form in which it was created. Apart from the fact that most of the present CNC machines are almost in all the aspects superior to this machine, the biggest problem of this machine is that it is a closed system, which only works with the Surfcad software and it is designed in a way that only the technicians of the Surfcad company are enabled to fix. This is the reason why in case of failure, PUKAS must get in touch with the Brazilian company, and wait for the technicians to repair it and this fact means a waste of time and money for the company.

What gives value to this study is the fact that it has been made independently from the company, without any type of commercial vision on the matter. Once concluded, we have considered other types of influential factors, such as the singularity of the surf world at the time of design, the necessary knowledge level of the shapers (surfboard designers) and the economic, social situation and logistic of the company [2] [3].

While the study of the different software was quite advanced, another way of research was opened and that was followed with great interest by PUKAS. This new line of investigation meant the possibility of implanting a new process together with reverse engineering techniques for the digitalization of surfboards. There were also some objectives with smaller level of priority such as some aid at the time of trying to improve the present CNC machine: we studied the possibility of using another cutting tool and the design and positioning of a sawdust aspiration system non existent at the present time.

3. Analysis and evaluation of the surfboards design software

At the time of carrying the study there were some factors that added some difficulties to the project such as the absence of any user manual, but this deficiency was replaced with another type of resources (human). The intuitive operation with the design programs was at that moment a way to deepen in the study of the internal operation of each program, but also the capacity and facility of the different design software and the possibility of implantation afterwards in a new manufacturing

process [4] [5]. For the different analysis of software, the present program of the company (Surfcad) was taken as a reference and from that point of view it was divided in different categories that were studied so that the other programs could be evaluated and later scored.

Six specific software programs were analyzed for the digital surfboards modeling. 3 were European, 1 Brazilian, 1 Australian and another Hawaiian.

3.1 Surfcad

It is the program that PUKAS uses. It was created in Brazil. This software is old and does not take advantage of the potential of the present computers, but as an advantage it counts with an interface of simple use that has been thought by shapers and that adjusts its measure just the way the shapers must work at the time of designing a surfboard. From the point of view of the design, Surfcad is a unique program, since it works with a series of curves that no other type of software uses. The use of this type of curves in particular (and not the curves used by the other programs) is due to the CNC machine which this software is related to. This machine is not able to machine the sides, so when eliminating the sides from the design the new curves which it works with vary.

Another handicap of this production system is the fact of being a closed system. It is not possible to import nor to exports anything to or from the CAD/CAM system. This is the reason why Surfcad can only work with its own machine and not with any other.

3.2 APS 3000

This specific software for surfboards design comes from Australia [6]. In its working way as in its visual format it is the most similar program to Surfcad among the rest of analyzed programs. Therefore, it shares with Surfcad the problem of taking advantage of the capacity of the computer, and is something out of market in comparison with other programs more updated in CAD as in CAM. An advantage of this software is that it works with the 'standard' curves for the surfboards design, that is to say, that it is able to design the boards in its whole. Its capacity to export and import CAD files in some CAD standard formats must be added. This is the reason why it can functionally seem a program over the Surfcad, but that is not true, because in its drawback we observed a greater difficulty in the design phase.

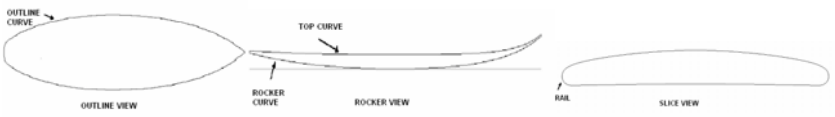

Figure 1: Standard curves and views.

3.3 D.A.T. Designer XP

This Welsh program has been created by the University of Swansea, by Nick Lavery a well known surfer [7]. It also works with the standard curves although it is a much

more developed program that the previous ones. This superiority is observed in aspects such as the type of ground visual aids, 3D presentations and libraries which make us able to introduce some characteristics already saved from the previous designs. Due to these aspects, it takes better advantage of the capacities of present computers.

Although it is a quite complete software for surfboard designing, it presents an enormous disadvantage with respect to the other analyzed programs: it is only a CAD program, which means that it does not have any type of CAM module integrated, and therefore, it is not related to any machine. This means a great handicap for this software, since other software would be necessary in order to be able to calculate the trajectories for the CNC machine.

3.4 KKL Professional Designer 2004

This program has been created in Hawaii [8]. If we do not consider the easy maneuverability that its interface has, it is not a program that contributes to anything compared to the other programs. The surfboard design is also complete and although it also uses the standard curves as it basis of the design, at the time of defining each curve great number of points are used. This is the reason why the design is more laborious and complicated. With a small number of points, we can get to properly define the characteristic curves of the board and thus to define its styling surfaces.

3.5 Shape 3D

Created by French engineers, it emphasizes the technical approach at the time of designing the program, as much by the number of possible options at the time of confronting a new board design as by the modules of 3D representation and CAM that surpass with most of the other programs [9]. The handling is not excessively complicated either, but it cannot be compared to the easiness the Surfcad has. Like most of the programs, the design is based on the standard curves to define the geometry of the surfboards. The use of G code to create the trajectories in the CNC machine makes this software compatible with any type of machine that uses this standard code. This software is also open to export CAD files as well as to import clouds of points. This is the reason why it increases its initial possibilities with the application of Reverse Engineering techniques.

3.6 KM Shape

Although at first sight it seems that it works with the same curves used by most of the other programs, the working way is exactly the reverse one of the other programs [10]. In this software created in Montpellier (France) we work first in 3D and then we go to the curves. The design is excessively complicated in comparison with the other software due to the great number of points used at the time of defining each curve, and because of the amount of curves that are defined in each view. This fact weakens the software since simpler software is sufficient at the time of designing the styling surfaces of the surfboards. On the other hand, the great number of design options, the possibility of using clouds of points from a scanner, the use of G code, and the export and import options of CAD archives make this software feasible to interact with any type of system we need.

3.7 Comparative Table

At the time of trying to evaluate and to score the different software, the evaluation was as impartial as possible, and we created a comparative table. In this table the different characteristics of the analyzed programs were subdivided, scoring the characteristics according to the importance criteria.

Table 1: Weighting Table.

TABLE DESIGN	**10%**	**VISUALIZATION**	**10%**
Starting data	5%	Data in view	1%
2 Boards at same time	1%	Zoom	2%
Photos	1%	Grid	1%
Scanner	1%	Volume calculation	1%
Change possibility	2%	Surface calculation	1%
VIEWS AND CURVES	**15%**	Undo	2%
Num. of views	5%	Unities	2%
Auxiliary views	1%	**3D**	**10%**
Num. of curves	5%	Wireframe	4%
Auxiliary curves	1%	Solid	4%
Curve type	2%	Zoom	1%
Tangents	1%	Rendering	1%
POINTS	**15%**	**CAM**	**10%**
Num. of points	7%	Bench design	1%
Adding/Suppressing	2%	Block design	1%
Manual manage	2%	Tool design	1%
Manage by data	2%	Trajectory design	2%
Manage of tangents	2%	Simulation	1%
MACHINE	**15%**	Export	4%
Yes/No	5%	**PROGRAM**	**15%**
Price	10%	Price	10%
		Country	5%
TOTAL VALORATION			**100%**

Table 2: Comparative Table.

	Surfcad	**APS3000**	**DAT Designer**	**KKL**	**Shape 3D**	**KM Shape**
Board design	6,6	3	3	4,5	8,8	7
Views	6,8	8,2	9,4	8,9	8,8	7,2
Points	9,3	7,4	7,0	7,3	9,0	6,8
Visualization	3,8	7,3	7,3	3,6	8,4	6,7
3D	3,4	0	10	5	10	5
CAM	1,9	5,4	0	0	8,8	8
Machine	5	7,3	0	6,3	5,6	9,3
Program	5,3	4,6	6	5	9,6	6,3
TOTAL	5,6	5,7	5,4	5,4	8,5	7,1

4. CNC Machines

Normally specific CAD programs for surfboards design are usually related to CNC milling machines to machine the boards with the previously designed model. The Research Team has also studied the different machines available in the market that were related to the previously analyzed software, nevertheless we did not arrive at the exhaustive study made with the software. There were many characteristics considered at the time of studying the different machines, but the most outstanding ones were: the capacity to machine the complete design of the board, the possibility of properly machining the stringer of the board (a wood strengthening), the subjection system of the board, the sawdust aspiration system, and, in addition, the technical support and the price of the machine.

Four were the considered machines: Surfcad/DSD shaping machine (this one related to Surfcad software and which at this moment PUKAS has), the APS 3000 machine, 3D Motions Systems CNC Machine related to Shape 3D software and we completed the study with the KMS Milling machine bound to KM Shape program.

Figure 2: 3D motions CNC machine and KMS CNC machine.

4. Reverse engineering in the surfboards manufacturing

It often happens that we do not have the CAD file of the surfboard to be manufactured. Many times the shaper prefers to work by hand directly. He makes a board and when he leaves, it is the own company who needs to copy the board. Some other times a client is so proud of his present board that he wants another identical one. In those cases the used process is to cut the board in different points and consequently to be able to take measures in these key points (except when the shaper is so good that he is able to guess the curves visually). Once the measures of these points are seized, they are manually introduced in the CAD program and we will be able to approximate the CAD design of the board to the real surfboard. This process is quite slow, and it supposes enough effort, in addition to the fact that the model, that has to be cut, is lost. In all this process, the application of new reverse engineering techniques to the manufacture of the surfboards interests PUKAS very much.

When trying to apply this technology of reverse engineering to this process of manufacturing, many factors should be considered. We should decide whether to subcontract the use of a scanner because of its price instead of acquiring it. As the surfboards are great pieces and the necessary precision in these cases is not a determining factor, the needed scanner should be fast in the acquisition of points.

Among the scanners offered in the market those that are more appropriate for this type of work are the scanners using laser technology or photogrametry [11]. The post processing of the obtained surfaces for their application in the CAD design must be also valued because of its complexity.

4. Conclusions

Starting from the fact that PUKAS has considered changing its surfboards manufacturing process, the research team has studied different software for the design of surfboards and also the CNC machines related to these programs. In the category of software, once different software analyzed, evaluated and scored, we conclude that the most complete and advantageous program is the Shape 3D. Its modules of CAM and 3D presentations take advantage of the possibilities of the present computers, and the system of curves and views that it uses at the time of designing the boards is very user friendly. In addition, the interactions with other CAD programs or other CNC machines are assured due to the export formats. The obtained qualifications by the different programs are represented in the following bar chart:

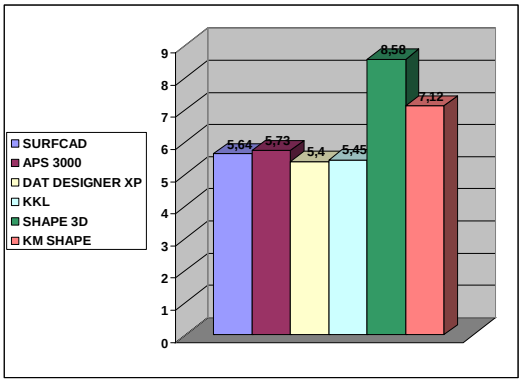

Figure 3: Comparison chart.

In the case of the CNC milling machines the study was not as extensive as in the software one, since it was not a determining factor in the surfboards design and production process. Although all the studied machines were able to machine a board with the sufficient precision, the '3D motions' CNC machine was without any doubt the strongest one and the best prepared of all of them. But its high cost in comparison with the other ones left us a milling machine as KMS as the right candidate as far as quality/cost rate is concerned.

The software and the machines were studied from a technical point of view, without taking into account the particularities that the world of surf could have. Once the study was finished, we tried to introduce in the final conclusions the considerations which they work with in this industry. Since it can seem that a factory that makes the surfboards basically should not be so different from the idea of another one that works with a similar production, the fact is that the work philosophy is totally different.

For example, as PUKAS is a leader company, it works with many famous shapers that are distributed everywhere around the world. Many of these shapers are quite 'old' or do not get used to computers, so any change in the CAD program, could be a major problem and may not be accepted by the shaper. Some do not even accept the use of CAD programs, and this is the reason why they design the boards by hand, and soon they make the board, therefore the factory has to mould the CAD to the design of the shaper. Therefore, the change of the CAD program without the shapers' support is not feasible. Windows is a similar case but for the operating systems, other complete systems exist but due to its extended use a change means more complications and incompatibilities than those which are solved.

The reverse engineering application for obtaining CAD files is currently being studied to see how far we are able to change the present design system in PUKAS. The research team is already working with a fully portable 3D laser scanner (Handyscan of Creaform) which has enough precision (0.25 mm) for this kind of applications. We have conceived a new way of work to integrate in the design process of PUKAS the data or cloud of points obtained by the scanner.

Acknowledgments
The authors of this paper want to thank the Faculty of Engineering of Bilbao for locating the Product Design Laboratory in their facilities and the University of Basque Country for financing this project (UE05/A03).

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