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IMPROVING TIME EFFICIENCY USING COMPUTER SOFTWARE INTENDED FOR PRODUCTIVE PREPARATION IN CUSTOM-MADE CABINET FURNITURE FACTORIES

Marija Krstev[1]
[1]*Ss Cyril and Methodius University in Skopje, North Macedonia,*
Faculty of Design and Technologies of Furniture and Interior-Skopje
**Corresponding author: ilievska_11@yahoo.com*

Abstract

The goal of the research presented in this paper is to see the impact of computer software intended for manufacturing preparation on the time required to prepare the complete technical documentation during the launch of a new product within a micro enterprise for the production of custom-made cabinet furniture.

For that purpose, the time spent during standard constructive preparation was measured. Standard constructive preparation covers views, sections and details drawing in AutoCAD of previously prepared 3D models of various pieces of furniture, and then dimensioning the constituent elements and creating a scheme for cutting the material in an appropriate software.

For the same pieces of furniture, time was measured during the preparation of the same documentation through several different software intended for constructive preparation, specifically in PolyBoard in this part of the research, as presented in this paper.

The results show that the computer software significantly shortens the constructive preparation time.

Key words: PolyBoard, interactive software, furniture design, constructive preparation, manufacturing methods.

INTRODUCTION

Preparation of production, within a company engaged in the production of the cabinet furniture, is an important introductory step in the overall further work in the process.

The term production preparation refers to the work that a company undertakes within the framework of production planning and management. The task of the preparation of the production is to contribute to the things in the production flow without more serious problems [1].

The preparation of the production starts from an already prepared 3D design of the furniture to be made, which gives us a visual representation of the element with a defined shape, color, direction for the material to be made, overall dimensions, etc. Furthermore, the designer should prepare the given element constructively, dimension it according to the actual dimensions and characteristics of the material, as well as foresee the fittings that it will be used in, both for joining the pieces within the framework of the assembly, and for realizing the basic purpose and function of the furniture.

As the global consumption concept evolved, manufacturing a large number of products with high quality has become the commercial target of furniture manufacturers. In this context, system and software platforms used in digital manufacturing techniques have been developed every other day and new opportunities created. As a result of this, a large amount of furniture with sensitive sizes and complex structures can be manufactured. Digital manufacturing techniques have an important role today for the images on designers' minds to be transformed into design, to be applied accordingly and for the furniture to be obtained [2].

The wood furniture industry has an identified need for technological development in order to stay competitive. Especially the necessity to focus on automation has been identified. In the industry there is often the need to handle large levels of customization at the same time as keeping the

production effective. This requires flexible automation solutions, often described as automated equipment that can rapidly be reconfigured for new products [4].

The use of automated equipment and numerically controlled machines contributed to the entire planning process, starting from a 3D drawing, carried out through a software solution that further generates all the needed information for the machines for work. There are several programs on our market that are actively used by manufacturers, namely: Corpus, PolyBoard, imos and HOLZHER CabinetControl.

The question arises, do these types of software make the process easier or more complicated, how do they affect the time required to prepare the necessary documentation, work errors or the use of material, when it is known that in the production of custom-made furniture, each element is special and unique? As customers become increasingly involved in the manufacturing process of their products, the manufacturing pattern of many industries is leaning towards customization and personalization, with customized furniture enterprises being one of them [6].

When creating the design of the furniture, as well as when preparing the production order, computer programs such as Excel, AutoCAD, then Sketch Up, 3ds Max or other software for 3D visualization are used, but with their application we get only a part of the information that we need, e.g., only a front view, or only a visual and not a constructive solution, etc. [3].

Based on the accurately drawn appearance in AutoCAD, we can draw elevations and get the exact dimensions of the structural parts of the furniture we are designing, but further on we should write those dimensions in an excel table, note which side should be edged on, write the names of the pieces, then make a cutting list from that table in another software, so that the pattern can serve when cutting the board material.

Next, we should make a copy of those sections with inset drilling for the appropriate hardware: hinges, sliders, dampers, structural fasteners, etc. It already complicates the work and requires a lot of work experience of the designer, and further, during the production process, it also requires experienced operators and carpenters who will be able to read those drawings and carry out the required operations [3].

Unlike the classic way of working, when using specialized software like Polybord, by drawing the furniture in 3D only once and in one window, we further have the opportunity to pull all the necessary information and data needed in the production process.

The furniture industry is not a very rich branch; in general, all the progress of machines, tools and production improvement is taken by other industries, such as engineering, automotive industry, etc. Not much is invested in research, so we do not have data ready to use on this topic, but statements of users are available, who claim from their own experience in practice that they have shortened the time they spent on the constructive preparation and design of the furniture and improved the efficiency [7] .

As in every field of industry, even in the furniture manufacturing industry, efficiency is the key factor which affects the performance of the firm activity. As such, it is aimed to increase the efficiency of using the time of labor and raw materials. “Using of time of work in the manufacturing process” is intended to achieve that stage of the technological process where the coefficient of utilization of machinery is in such values so the machinery does not have idle time during working shifts and “utilization of working time during the assembling process of finished wooden objects” means implementation of all necessary operations in such a way as to eliminate as many "minor works" of assembling from the assembling workforce [5].

MATERIAL AND METHODS

Clasical vs. PolyBoard manufacturing preparation

In order to carry out this research, pieces of furniture were selected from concrete, 3D projects were made and grouped in one database, and it was further proceeded to their constructive preparation through the listed software, as well as through the classic way by drawing views and sections in AutoCAD and measuring the time spent.

In this paper only a part is shown, that is, the method of work and the results obtained through the software named PolyBoard. PolyBoard is an interactive design and manufacturing cabinet software, based on a powerful methodological concept. This software supports arborescent cabinet

structures, dynamic material styles and manufacturing methods lists, and recalculates cabinets in real time [8].

This part of the research was conducted at Zlatev Engineering Shtip, a company for the production of cabinet furniture, which performs the entire process of planning and launching new products through the mentioned software.

Also, we have data previously obtained through research carried out through work in another software, called Corpus, used in the regular production line of Drvodekor Interior Shtip and most of the companies in Macedonia, so we will compare the data [3].

Figure 1. 3D models of furniture elements prepared in SketchUp, 3D interior design software, through the classic way of production preparation

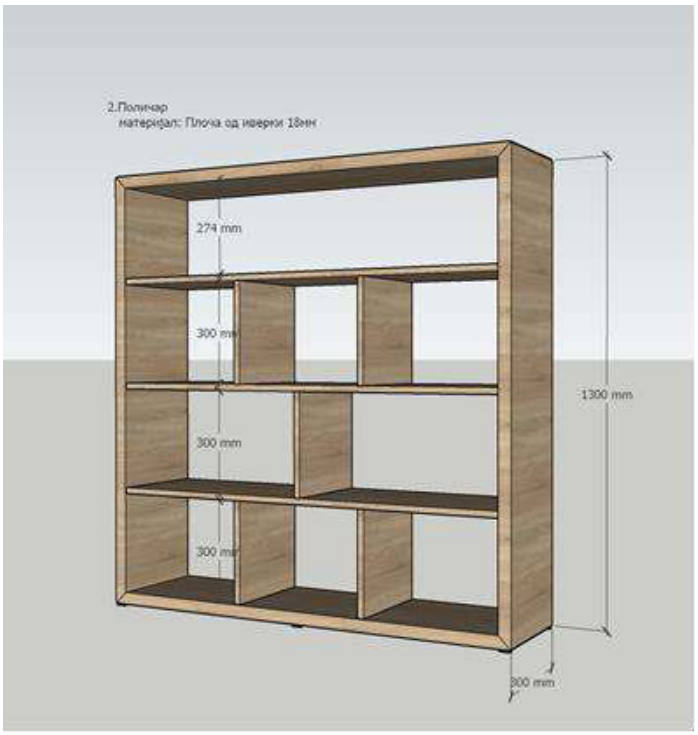


Figure 2. 3D model of a free-standing shelves rack, prepared in SketchUp, 3D interior design software, through the classic way of production preparation

During classical construction preparation, we prepare everything we need as information in the further production process as a separate document, and also in a separate computer program: SketchUp, AutoCAD, Excel, Word, Optimic etc. as shown in Figures 2, 3, 4 and Tables 1 and 2.

Furniture element database contains various pieces of furniture, with different designs and functionality and different complexity in the process of designing and manufacturing. The following are pictures of some of the furniture for which we performed constructive preparation and whose data are shown in this part of the research (Fig.1).

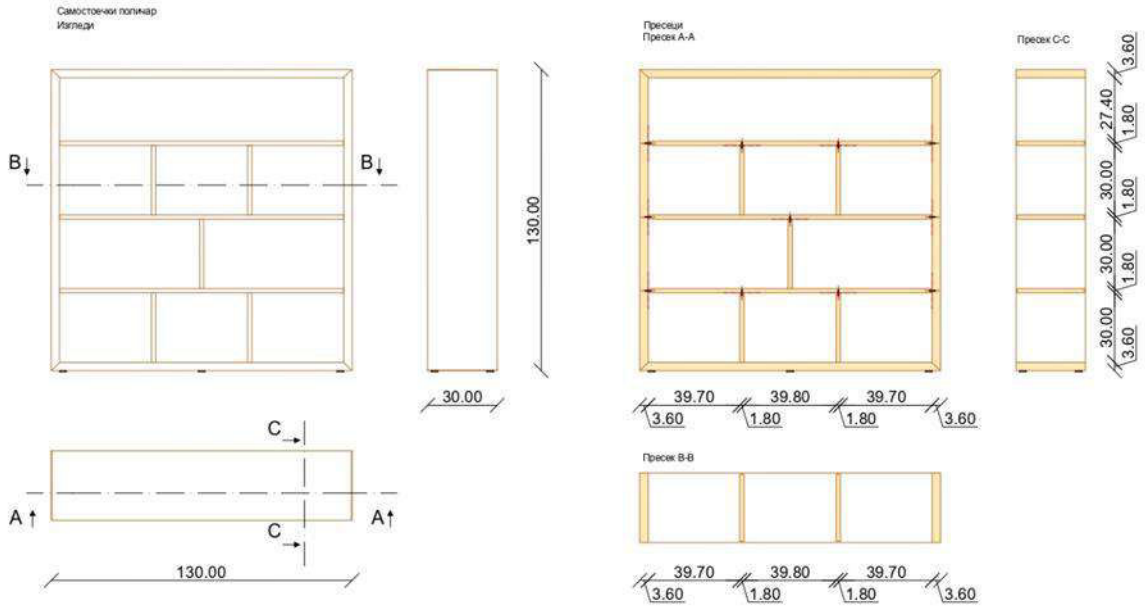


Figure 3. Views and sections of a free-standing shelves rack, prepared in AutoCAD through the classic way of production preparation

Table 1. Excel table with dimensions and material of the components of a free-standing shelves rack, prepared through the classic way of production preparation

					ПРОЕКТ:				ПОЗИЦИЈА 2	
					ПОЗИЦИЈА:				ПОЛИЧАР	
Бр	МАТЕРИЈАЛ	ДОЛЖИНА	ШИРИНА	КОЛ	КАНТИРАЊЕ				ОПИС	ЗАБЕЛЕШКА
					1	2	3	4		
1	Egger H1145 18 mm	1304	310	8					страници, дно, плафон	надмер, т.м. 1294*300*36 - 4 бр, кант 4 стр
2										2 куси стр нагласен гер 3 мм
3	Egger H1145 18 mm	1228	290	3	1		1		фиксни полици	
4	Egger H1145 18 mm	300	290	5	1		1		вертикали	
5										
6										
7										
8										
9										
10										

Table 2. Excel table with required furniture mechanism for the free-standing shelves rack, prepared through the classic way of production preparation

	ПОЗИЦИЈА 2	
	ПОЛИЧАР	
	ТРЕБОВНИЦА	
	ОКОВ (ОПИС)	КОЛИЧИНА	БРЕНД
1	Дрвени бисквити	22 бр	ламело
2	Пластични патуни	12 бр	
3			
4			
5			
6			
7			
8			
9			
10			

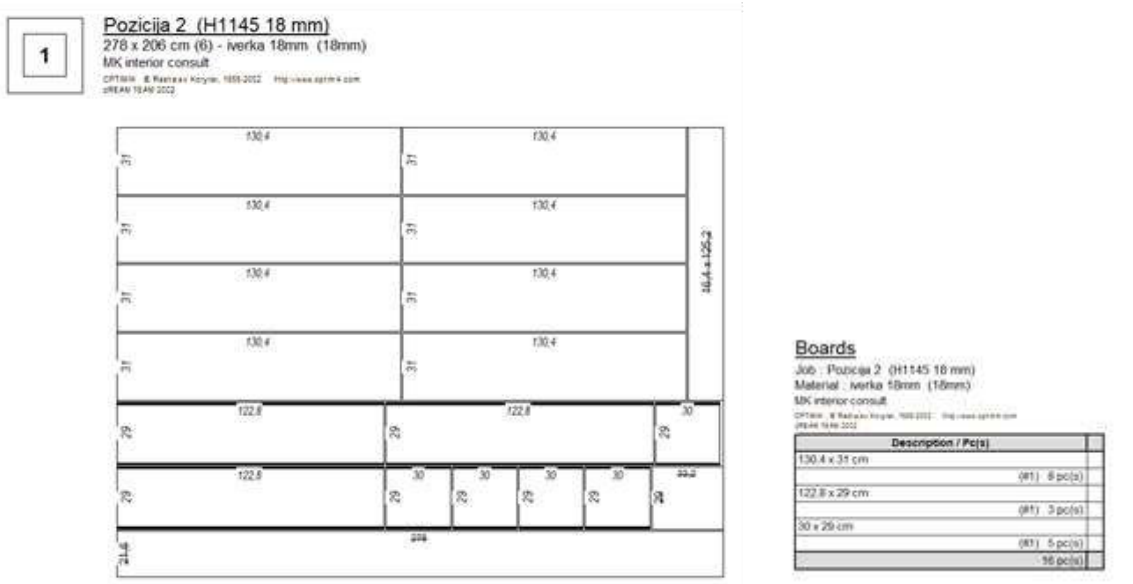


Figure 4. Cutting pattern prepared in Optimic for the free-standing shelves rack prepared through the classic way of production preparation

Working with specialized software is significantly different from the classic way of working. When entering data for a piece of furniture in Polyboard, all work is done in a window where the furniture is drawn in 3D (Fig.5). By selecting any segment of the piece of furniture and clicking on it, we choose which sides will be edged, what material it will be made of, whether there is any additional processing, etc. [3]. With a production order prepared in this way, the material is prepared at a level where no additional calculations for drilling or cutting need to be made during further work, because everything is marked by the machine. Errors are minimized.

The way of working is the same when the production preparation takes place through Corpus. Automatically, we receive all the reports that we need in the further production process: 3D drawing, layouts, list with dimensions of all components, required fittings, and, if necessary, purchase and sale price [9]. What is even more important, it is very simple to change the thickness of the material or the final overall dimension on already drawn furniture, and there is no room for errors in the production process because all the drillings are already provided [10].

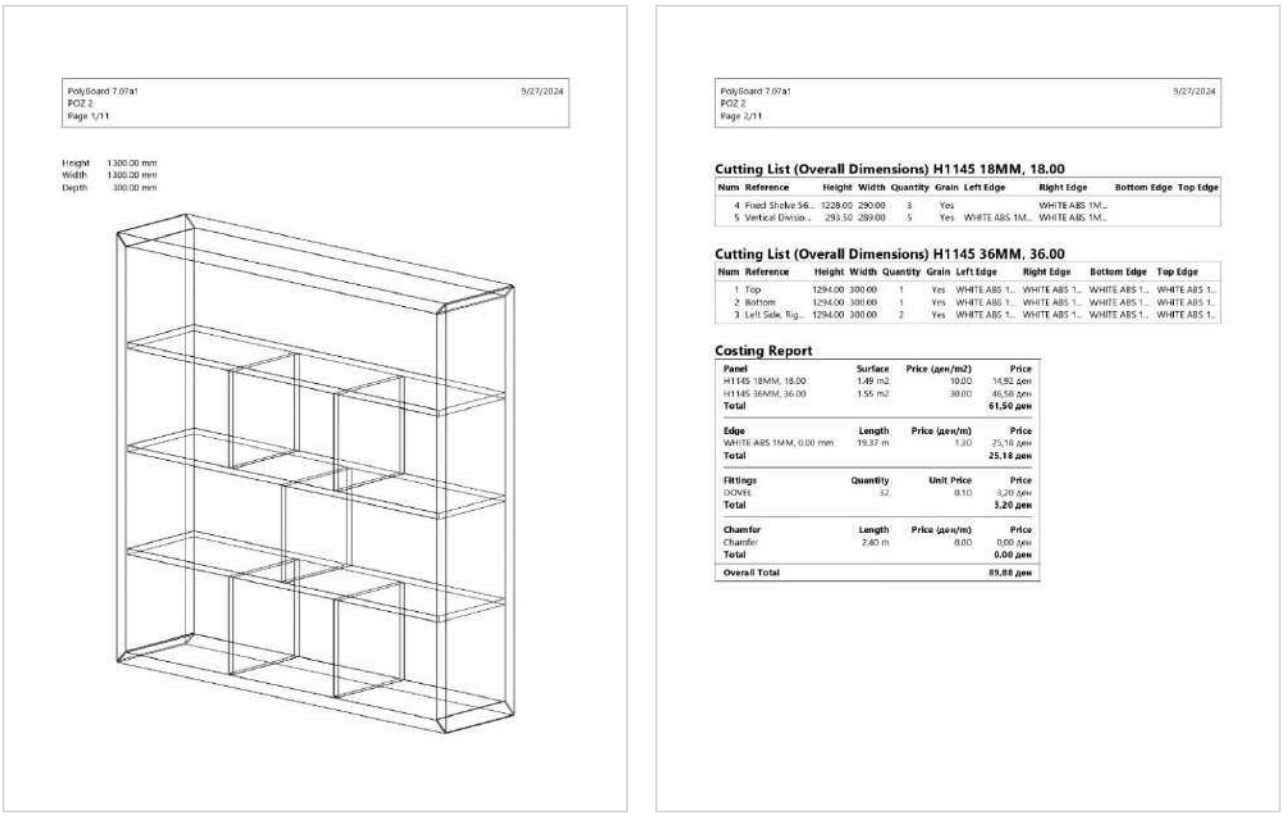


Figure 5. 3D model of a free-standing shelves rack**,** prepared in PolyBoard, including the cutting list and the costing report

RESULTS AND DISCUSSION

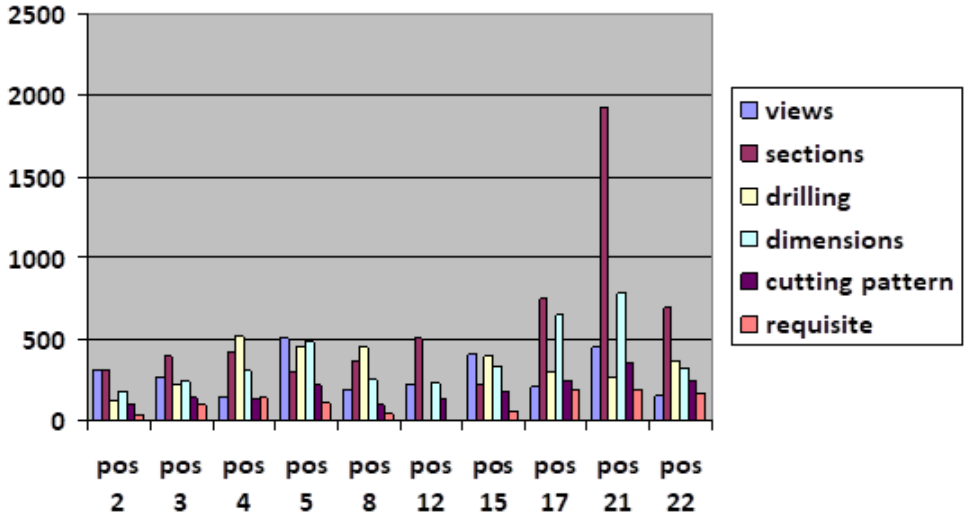
This research includes over 20 pieces of furniture, constructively prepared in several different software packages. The initial results for some of the furniture, obtained by measuring the time required to subfloor the furniture in PolyBoard, compared to the time for classical construction preparation, are given in the tables and graphs that follow.

Table 3. Time in seconds spent on constructive preparation in both ways

No.	FURNITURE		Classical construction preparation / Time in seconds							POLYBOARD / Time in seconds		
			VIEWS	SECTIONS	DRILLING	DIM	CUTTING PATERN	REQUISITE	TOTAL	DRAWING	CUTTING PATTERN	TOTAL
1	Pos. No. 2	shelves rack	310	312	120	180	98	28	1048	465	267	732
2	Pos. No. 8	work desk	184	365	447	250	100	48	1394	163	74	237
3	Pos. No. 12	shoe rack	224	507		236	137		1104	373	170	543
4	Pos. No. 17	office cabinet	214	754	292	652	240	191	2343	1119	215	1334
5	Pos. No. 22	kitchen cabinet	156	692	367	323	240	166	1944	768	190	958
6	Pos. No. 3	double bed	268	395	220	247	142	100	1372	345	72	417
7	Pos. No. 21	kitchen cabinet	454	1929	265	784	356	183	3971	1352	210	1562
8	Pos. No. 4	night stand	145	420	520	312	135	144	1676	295	78	373
9	Pos. No. 5	TV unit	504	294	455	490	221	107	2071	775	180	955

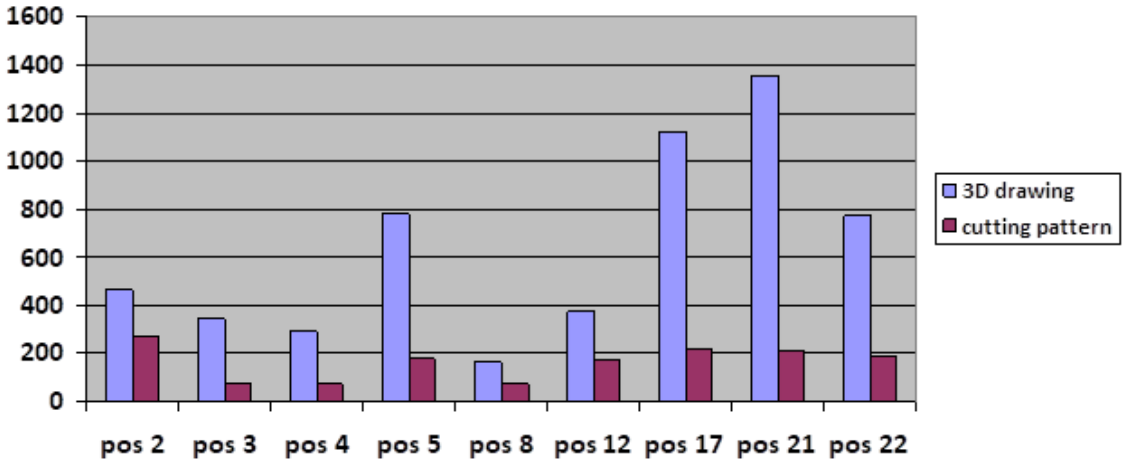
Table 3 shows the times expressed in seconds, individually for each piece of furniture, and for each step in the constructive preparation process, both during the classic and during the preparation through PolyBoard.

Graph 1 shows the time spent during the classical constructive preparation, where a comparison can be made in the length of time required for each individual step in the procedure. It can be seen that the drawing of sections and drilling is the longest step in time, and the shortest is the preparation of the list of consumables, as well as the cutting pattern in an optimization program.



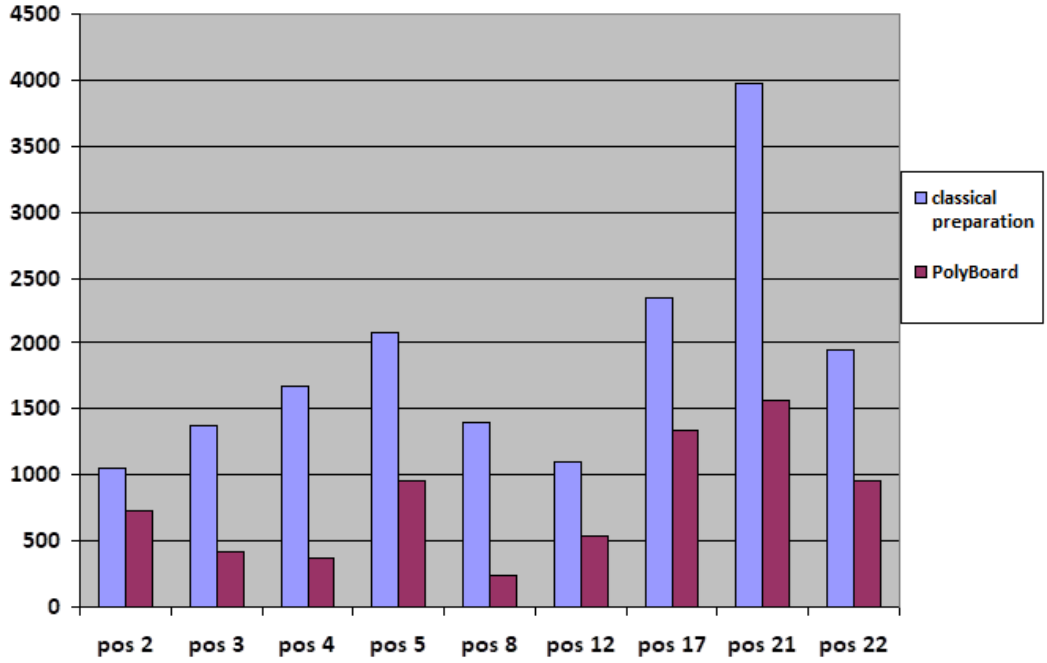
Graph 1. The time in seconds spent during the classical constructive preparation for each piece of furniture

Graph 2 shows the time spent on preparation in PolyBoard. We can notice a significant reduction in preparation steps, because the program allows us automatically to create all the necessary reports with a single drawing of the furniture in a 3D shape.



Graph 2. The time in seconds spent during the constructive preparation in PolyBoard for each piece of furniture

In Graph 3, a comparison is made between the total time spent for each piece of furniture, constructively worked out in the classical way and through the computer software PolyBoard.



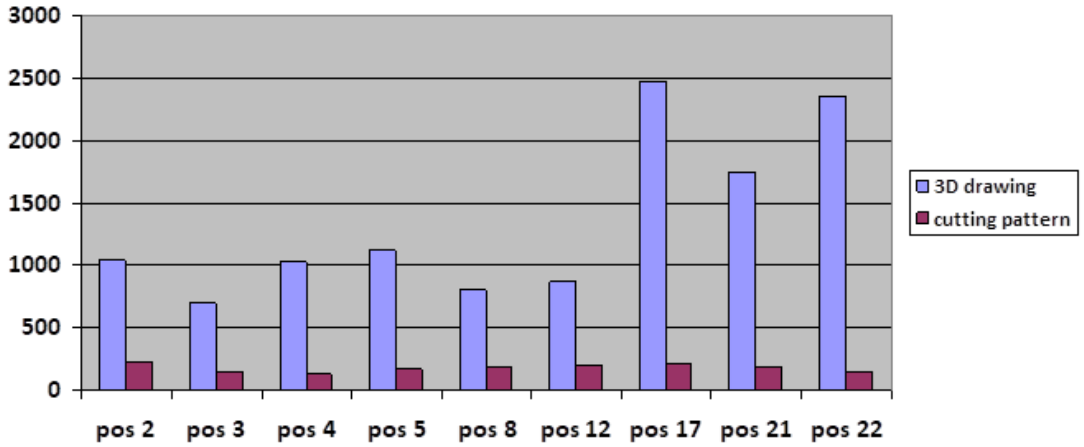
Graph 3. A comparison of total time in seconds spent during the classical preparation and the preparation in PolyBoard, for each piece of furniture

As can be seen from the last graph, for all pieces of furniture, the measured time during productive preparation is shorter when using PolyBoard. For some pieces of furniture, the time is twice as short. Further research and measurement of more pieces of furniture will give us more precise insight and more data to make a clear conclusion, but, so far, human labor seems to be losing this race.

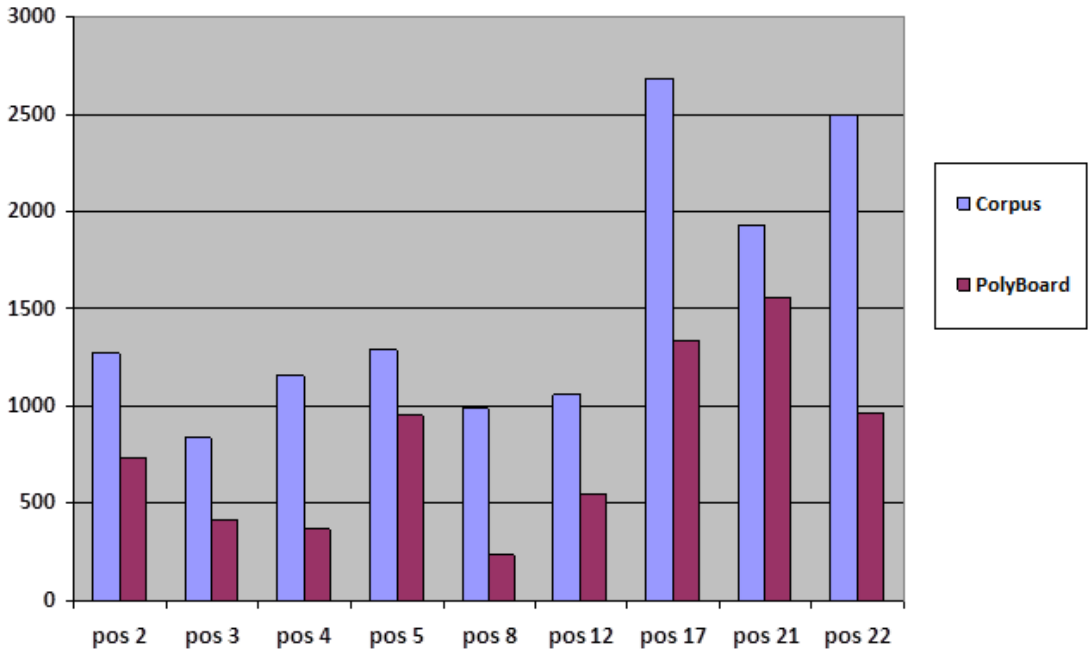
Since we have previously measured the time for the same pieces of furniture in the software called Corpus and have data published at a 6th International Scientific Conference "Wood Technology & Product Design" in Ohrid (2023), we can compare it with data obtained through PolyBoard and see which program runs faster.

Graph 4 shows the time in seconds spent on preparation in Corpus5.

The comparison between the required time in Corpus and Polyboard can be seen in Graph 5. The difference is obvious in favor of Polyboard, but this software is not intelligent, so the willingness and knowledge of the designer who manages the software itself plays a big role. Further research with more pieces of furniture will give us a more reliable picture.



Graph 4. Time in seconds spent during constructive preparation in Corpus for each piece of furniture



Graph 5. A comparison of total time in seconds spent during preparation in PolyBoard and Corpus for each piece of furniture

CONCLUSION

Preparation of the production carried out in a classic way allows us to measure the time required at each individual step and to see their demands. Depending on the design and functionality of the piece of furniture, the duration of the individual steps is also different, so, for some furniture, most time is needed to draw views, for others to mapping the drilling, etc. (see Graph 1).

Production preparation through Polyboard is completely executed in one window during the furniture design itself, and thus we have one total time. A separate step is only the creation of the cutting pattern and the transfer of the data to the operational part, i.e., to the numerical machine in production, which takes very little time (see Graph 2).

In Graph 3, a comparison is made between the times needed to prepare the production in both ways. You can notice an obvious difference and significantly less time required when working with Polyboard. For some positions the difference is so great that it seems that human effort is wasted and this race is already lost.

Manufacturing preparation carried out through software like PolyBoard is performed in a very simple and transparent way, whereby by drawing the furniture in 3D and selecting the materials and fittings, the entire necessary documentation for a new product launch within a manufacturing company is solved. This is very important, because we get all the necessary calculations and all the drawings for drilling or assembling of the elements, only by drawing the furniture as a 3D element, and the material is prepared at a level that we will never reach working without using specialized software [11].

However, we should keep in mind that Polyboard is not intelligent software and is still driven by human capacity. Furthermore, with the advancement of artificial intelligence in other fields, there may come a time when software in the furniture industry will also advance and be able to design independently.

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