Original scientific paper
Received:17.08.2024
Accepted:03.12.2024
UDC: 674.021:004.4]:645.45

ENHANCING TIME MANAGEMENT THROUGH COMPUTER SOFTWARE DESIGNED FOR EFFICIENT PRODUCTION IN CUSTOM CABINET MANUFACTURING FACILITIES

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ABSTRACT

The objective of this study is to assess how computer software designed for manufacturing preparation affects the time needed to create comprehensive technical documentation when launching a new product in a microenterprise that specialises in custom cabinet furniture production.

This was accomplished by recording the amount of time needed for standard constructive preparation. This preparation involves creating views, sections, and detailed drawings in AutoCAD based on pre-existing 3D models of kitchen cabinets, followed by dimensioning the individual components and developing a cutting plan using specialised software.

For the same furniture pieces, the time taken to prepare identical documentation using the constructive preparation software called Corpus was recorded. The findings indicate that the use of this software considerably reduces the time needed for constructive preparation.

Keywords: corpus, interactive software, furniture design, constructive preparation, manufacturing methods

1. INTRODUCTION

In recent years, the expansion of construction and the rising demand for real estate have led to a continuous increase in the need for furniture, particularly custom-made pieces designed for specific spaces.

As global consumption concepts evolved, manufacturing a large number of products with high quality has become a commercial target of furniture manufacturers. In this context, systems and software platforms used in digital manufacturing techniques have been developed every other day, and new opportunities have been created. As a result of this, a large number of pieces of furniture with sensitive sizes and complex structures can be manufactured. Digital manufacturing techniques have an important role today for the images in designers' minds to be transformed into designs, to be applied accordingly, and for the furniture to be obtained (Kilic, 2016).

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 are often needs to handle large levels of customisation 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 (Johansson et al., 2016).

The integration of automated equipment and numercally controlled machines has enhanced the entire planning process, beginning with a 3D model created via software that provides all necessary information for the machines to oprate. Numerous software solutions available in the market, such as Corpus, PolyBoard, imos, and HOLZER CabinetControl, are frequently utilised by manufacturers.

The question emerges: Do these software applications simplify or complicate the process? How do they influence the time needed to prepare essential documentation and the occurrence of work errors or utilisation of materials, considering that every component in custom furniture production is distinct and one of a kind?

The first basic and important step in starting the production of custom cabinet furniture is its planning and preparing.

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 (Gruevski, 2000).

When creating the design of the furniture, as well as when preparing the production order, computer programs such as Excel, AutoCAD, SketchUp, 3ds Max, or other software for 3D visualisation 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. (Krstev, 2023).

Using the precise drawings created in AutoCAD, we can produce elevations and obtain the exact measurements of the furniture's structural components. Afterward, we need to document these dimensions in an Excel spreadsheet, indicate which edges require finishing, label each piece, and then generate a cutting list in another software. This list will be used as a guide 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 (Krstev, 2023).

In contrast to the traditional method of working, we can use specialised software to create the furniture in 3D only once and in a single window, which allows us to extract all the data and information required for the production process.

The furniture sector is generally not a lucrative field; advancements in machinery, tools, and production techniques are primarily adopted by other industries like engineering and automotive. There is minimal investment in research, resulting in a lack of readily available data on this subject. However, user testimonials do exist, with many individuals sharing firsthand experiences that indicate a reduction in the time needed for furniture construction and design, as well as increased efficiency [7].

As in every field of industry, even in the furniture manufacturing industry, efficiency is a key factor that affects the performance of the firm's activity. As such, it is aimed at increasing the efficiency of using the time of labour and raw materials. By "using of time of work in the manufacturing process" is intended to achieve that stage of the technological process where the coefficient of utilisation of machinery is to be in such values so the machinery doesn't have idle time during working shifts, and by "utilisation of working time during the assembling process of finished wooden objects" is intended implementation of all necessary operations in such a way as to eliminate as many "minor works" of assembling from the assembling workforce (Thoma et al., 2013).

In this paper, we measured the time required to prepare the production of kitchen cabinets when working in specialised software, Corpus, which is used in Drvodecor Interior Shtip, and compared it with the time required to prepare the same elements in a classical way.

2. MATERIAL AND METHODS

In order to carry out this research, we designed upper and lower kitchen elements in 3D visualisation software (Figure 1). The elements are designed in such a way that they can be upgraded; that is, with small changes and additions to the basic element, we can get a more complex one. This was intended to see how small changes in design affect the production preparation process, as is the case with custom-made furniture. The mentioned changes refer to an increase in the width dimension, the addition of a door or a drawer, structural changes in the attachment of the back, or the removal of the handles and the insertion of a Gola profile.

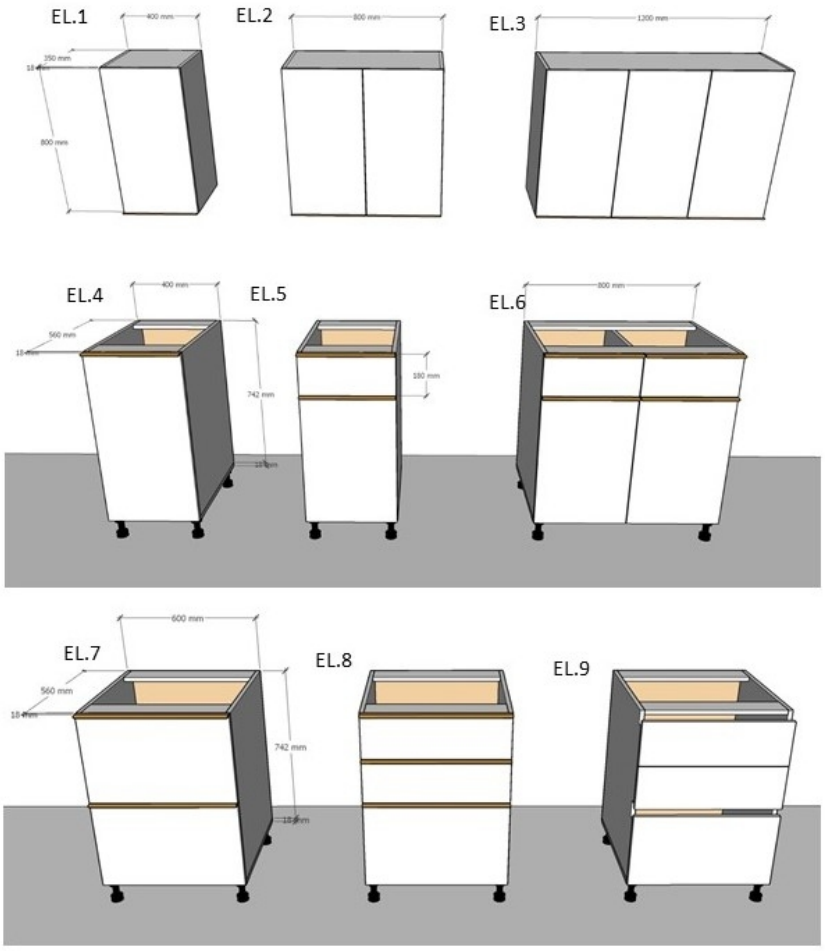


Figure 1: *3D models of kitchen elements prepared in SketchUp, 3D interior design software*

Classic method of constructive production preparation

According to the designed kitchen elements, we made a constructive production preparation, which we carried out in two ways: in a classic way and by using specialised software Corpus, and in both cases we measured the required time for each element individually.

The classic method of constructive production preparation includes several stages, during which different computer programs are used.

First of all, the constructive drawing of views and sections of the elements in AutoCAD is approached. Furthermore, the necessary holes for the appropriate hardware are marked, and elevations with dimensions are drawn (Figure 2).

Based on the drawings prepared in this way, in an Excel or Word table, we enter the dimensions of all the individual pieces in the composition, marking on which side and with what thickness of tape they are edged, what material they are made of, and whether they have any additional processing (Table 1).

In another Excel or Word table, we enter a list of required material and hardware for the entire element, such as the required number of kitchen PVC legs, hinges, shelf brackets, etc. (Table 2).

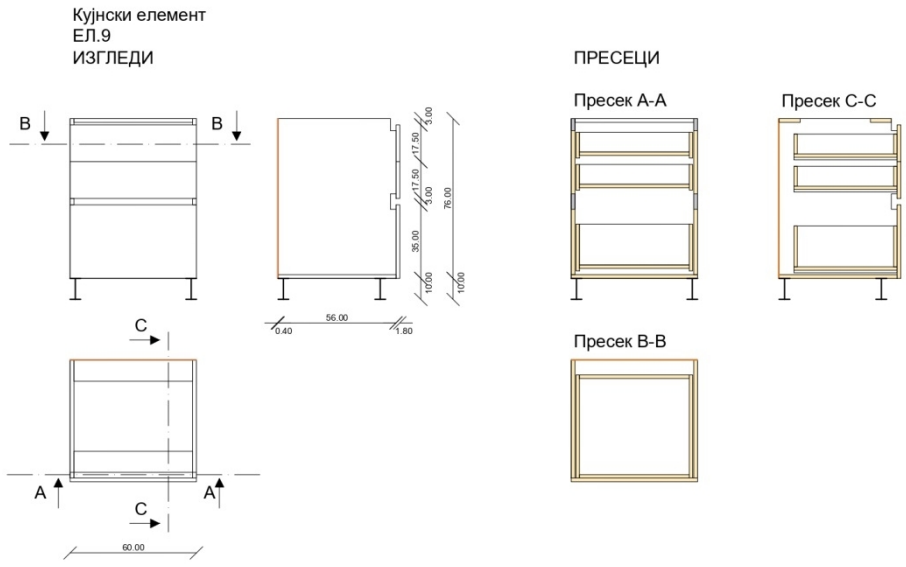


Figure 2: *Views and sections of a kitchen element, prepared in AutoCAD through the classic way of production preparation*

Further, based on the table of dimensions, we enter the dimensions in the cutting optimisation program, Optimic, and the program generates a cutting pattern for us (Figure 3). With the help of that cutting pattern, the necessary material is cut in the production plant.

During the process of work in the plant, with this way of preparing the production, drawings with dimensions for the necessary drillings, as well as for additional processing, such as nut, groove, curve, etc., should be provided. This leaves room for error, as the operator has to read the drawing and trace it onto the actual piece of cut material. Likewise, errors are very likely when entering data into spreadsheets and re-entering it into optimisation software.

Table 1: *Excel table with dimensions and material of the components of a kitchen element-drawer, prepared through the classic way of production preparation*

					ПРОЕКТ:				ПОЗИЦИЈА	
					ПОЗИЦИЈА:				ФИОКАР СО ГОЛА ПРОФИЛ	
БР	МАТЕРИЈАЛ	ДОЛЖИНА	ШИРИНА	КОМ	КАНТИРАЊЕ				ОПИС	ЗАБЕЛЕШКА
					1	2	3	4		
1	Egger W980ST2 18 mm	600	560	1	0,4	0,4		0,4	дно	
2	Egger W980ST2 18 mm	742	560	2	0,4	0,4			страници	засек за Гола профил
3	Egger W980ST2 18 mm	564	100	2	0,4		0,4		туплунг	
4	**Egger W980ST2 16 mm**	522	490	3	0,4		0,4		дно фиоки	
5	**Egger W980ST2 16 mm**	522	94	4	0,4				предно, задно фиоки	
6	**Egger W980ST2 16 mm**	490	122	4	0,4		0,4		страници фиоки	
7	**Egger W980ST2 16 mm**	522	194	2	0,4				предно, задно фиоки	
8	**Egger W980ST2 16 mm**	490	222	2	0,4		0,4		страници фиоки	
9	Egger W980ST2 18 mm	172	597	2	1	1	1	1	фронт фиока	
10	Egger W980ST2 18 mm	347	597	1	1	1	1	1	фронт фиока	
11	лесонит	740	597	1					рухванд	
12										
13										
14										
15										
16										
17										
18										

Table 2: *Excel table with required furniture mechanism for the kitchen element-drawer, prepared through the classic way of production preparation*

	ПОЗИЦИЈА		
	ФИОКАР СО ГОЛА ПРОФИЛ		
БР	ТРЕБОВНИЦА		
	ОКОВ (ОПИС)	КОЛИЧИНА	БРЕНД
1	Иверка 18 мм	1,7m2	
2	Иверка 16 мм	1,7m2	
3	Трака 22/0.4	20m`	
4	Трака 22/1	5m`	
5	лесонит	0,44m2	
6	ексцентар спојки	16 бр	
7	дрвени типли	88 бр	
8	лизгач Блум водилка л=50цм	3 бр	
9	Гола профил Л	0,6m`	
10	Гола профил Ц	0,6m`	
11	ПВЦ кујнски ногарки 10 цм	4 бр	
12	Хол шраф 4*17 мм	16 бр	
13	Конформат 5*45 мм	8 бр	
14			
15			
16			
17			

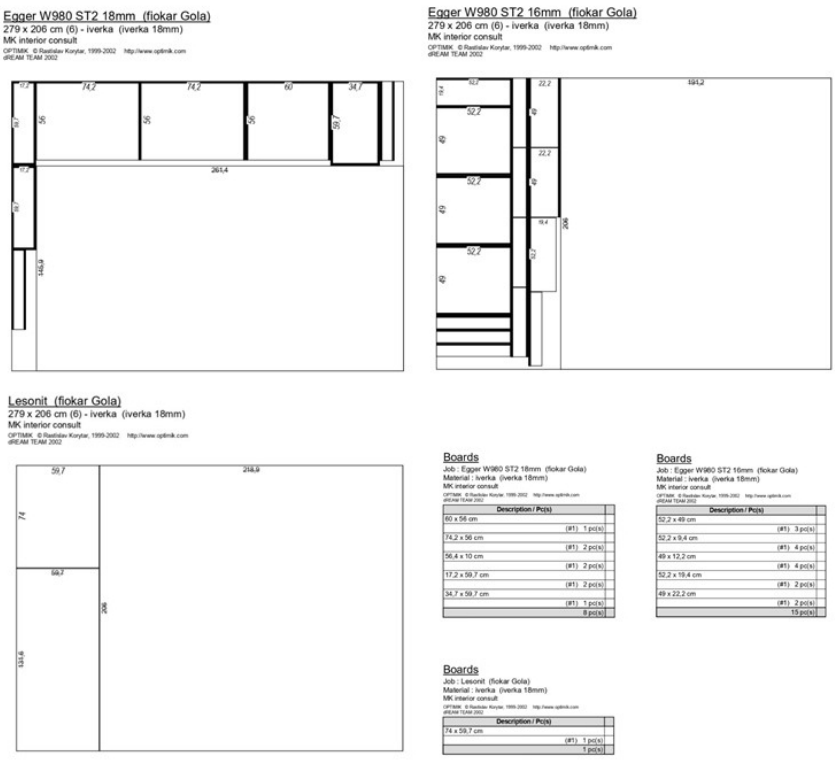


Figure 3: *Cutting pattern prepared in Optimic for the kitchen element-drawer prepared through classic way of production preparation*

Specialized computer software method of constructive 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 (Figures 1, 2, and 3), while, during the preparation of the production through specialised computer software like Corpus, the entire process takes place in one window during the 3D drawing of the piece of furniture, which gives us great visibility and clarity during the work [8].

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.We can also pull ready-made elements from a library that we create and update ourselves, and where we store

elements that are used very often and do not change significantly from project to project, such as kitchen cabinets [9].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 machine. Errors are minimised. Automatically, we receive all the reports that we would need in the further production process: 3D drawing, layouts, a list with dimensions of all components, required fittings, and, if necessary, purchase and sale price (Figures 4 and 5). In this way, there is no room for errors in the production process because all the drillings are already provided.

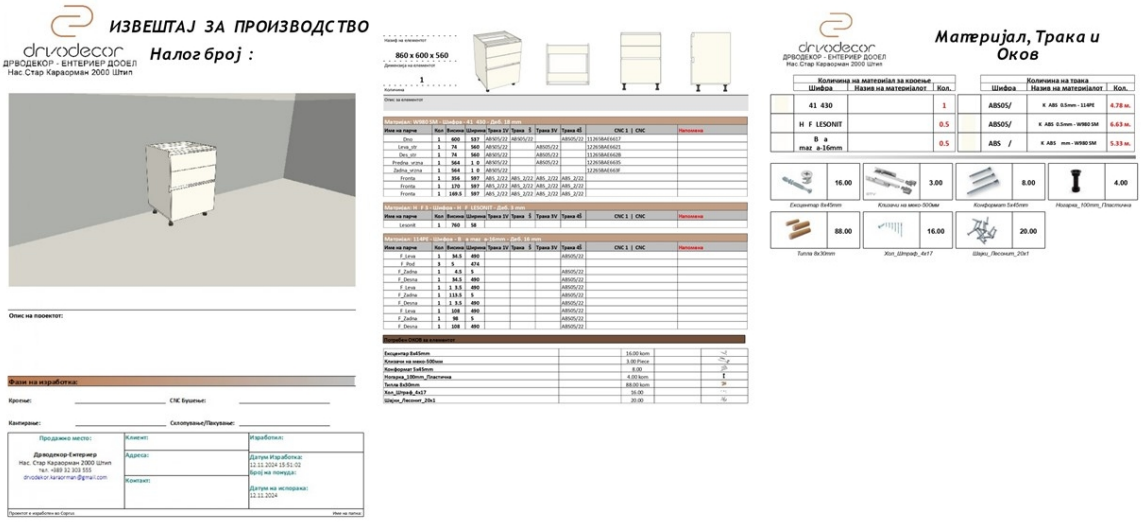


Figure 4*: Complete necessary documentation for the production of a kitchen element, prepared in Corpus*

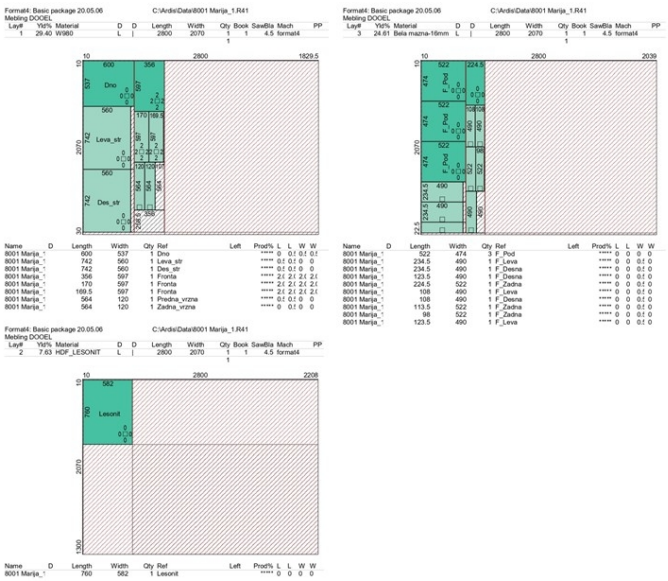


Figure 5: *Cutting pattern for the kitchen element prepared in Corpus*

This part of the research was conducted at Drvodekor Interior Shtip, a company for the production of cabinet furniture, which performs the entire process of planning and launching new products through the mentioned software, so in fact it is a real industrial case of production preparation.

3. RESULTS AND DISCUSSION

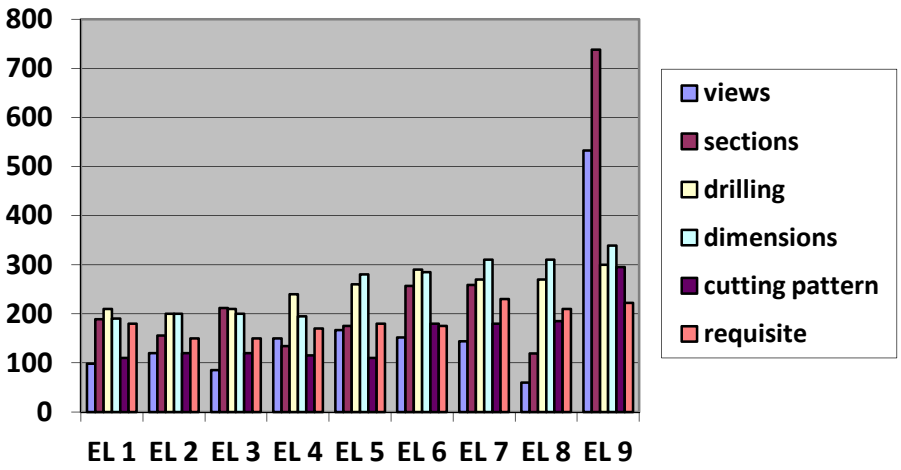
This research will include over 20 pieces of furniture, constructively prepared in several different software programs. The results for these kitchen elements, obtained by measuring the time required to prepare the furniture in Corpus compared to the time for classical construction preparation, are given 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							CORPUS 5 / Time in seconds		
		VIEWS	SECTIONS	DRILLING	DIM	CUTTING PATERN	REQUISITE	TOTAL	DRAWING	CUTTING PATTERN	TOTAL
1	EL.1	98	189	210	190	110	180	**977**	310	110	**420**
2	EL.2	120	156	200	200	120	150	**946**	160	115	**275**
3	EL.3	85	212	210	200	120	150	**977**	380	150	**530**
4	EL.4	150	134	240	195	115	170	**1004**	62	77	**139**
5	EL.5	167	175	260	280	110	180	**1172**	57	65	**122**
6	EL.6	152	257	290	285	180	175	**1339**	166	113	**279**
7	EL.7	144	259	270	310	180	230	**1393**	72	70	**142**
8	EL.8	60	119	270	310	185	210	**1154**	30	60	**90**
9	EL.9	533	738	300	339	295	222	**2427**	447	45	**492**

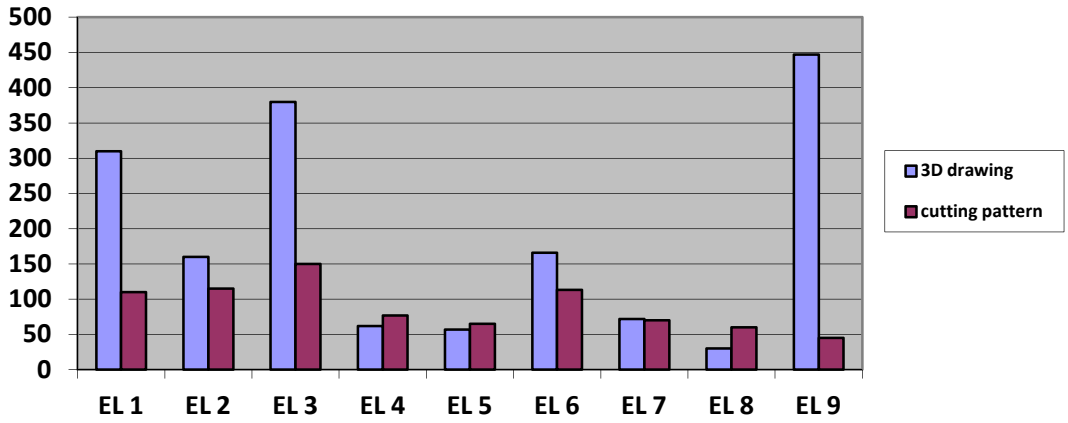
Table 3 shows the times expressed in seconds, individually for each piece of furniture and for each step in the constructive preparation process, both during the classic and during the preparation through Corpus.

Graph 1 shows the time spent during 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, drilling, and dimensioning are the longest steps in time, and the shortest is drawing views.



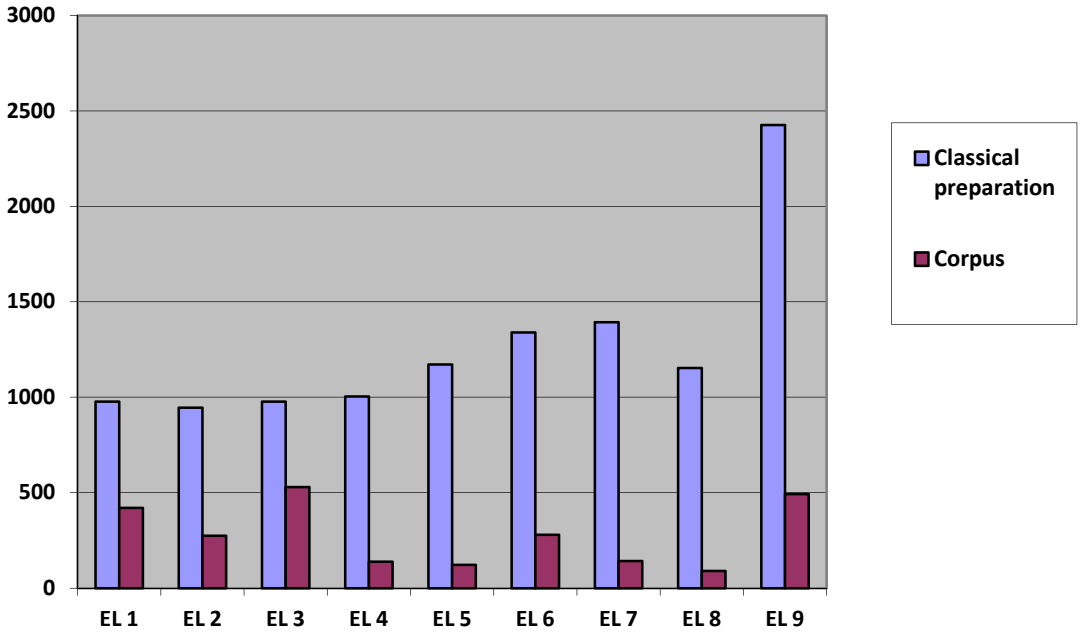
Graph 1: *The time in seconds spent during classical constructive preparation for each piece of furniture*

Graph 2 shows the time spent on preparation in Corpus. 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 as a 3D shape.



Graph 2: *The time in seconds spent during constructive preparation in Corpus for each piece of furniture*

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



Graph 3: *A comparison of total time in seconds spent during classical preparation and preparation in Corpus 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 twice as short when using Corpus. For some pieces of furniture, the time is several times shorter. 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 labour seems to be losing this race.

4. CONCLUSION

The traditional method of preparing production enables us to track the time needed for each specific step and understand the requirements involved. The duration of these steps varies based on the

furniture's design and functionality. Among other things, drawing sections might take the most time for some pieces, while drilling process mapping might be the most time-consuming for others. (see Graph 1).

The preparation for production using Corpus is entirely carried out in a single window during the furniture design phase, resulting in a consolidated timeframe. The only additional step involves creating the cutting pattern and transferring data to the operational aspect, specifically to the numerical machine in production, which takes minimal time (refer to Graph 2).

Graph 3 presents a comparison of the time required to prepare production using both methods. There is a clear disparity, with significantly less time needed when utilising Corpus. For certain positions, the difference is so substantial that it appears human effort may be redundant, suggesting that this competition may already be over.

The manufacturing preparation process facilitated by software like Corpus is handled in a straightforward and transparent manner. By creating 3D models of furniture and selecting appropriate materials and fittings, all essential documentation for launching a new product within a manufacturing company is generated. This is crucial as it provides all necessary calculations and the drawings required for drilling or assembling the components, all by simply modelling the furniture in 3D. The preparation of materials reaches a level that is typically unattainable without specialised software [10].

However, it is important to recognise that Corpus is not an intelligent system; it still relies on human input. Moreover, as artificial intelligence continues to advance in various fields, there may come a day when software in the furniture sector evolves to autonomously handle design tasks.

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