(REFEREED RESEARCH)

AN INVESTIGATION ON THE CUTTING PARAMETERS FOR VARIOUS TYPES OF FABRICS

FARKLI KUMAŞ TİPLERİNDE KESİM PARAMETRELERİNİN BELİRLENMESİ ÜZERİNE BİR ARAŞTIRMA

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ABSTRACT

Same type fabric and same cutting plan can be cut in different methods by using computer aided fabric cutting systems. This is possible with changing the parameters inside the program which is operating the cutter. In this research; the effects of cutting parameters on the cutting quality and the cutting duration were analyzed. In this study, six different cutting having different models and fabric characteristics were examined. During the study; it was seen that same parameters can sometimes be used while cutting of different fabric types; but change in the parameters is required generally according to fabric, model, marker plan and spreading. Especially, while determining vacuum intensity that will be applied to the cutting of the different type fabrics, fabric air permeability were measured and the correlation between fabric air permeability, spreading height and the vacuum intensity that will be applied were presented. Fabric type, marker plan, spreading height and clothing model characteristics are determinative elements for determining cutting parameters. Cutting efficiency and quality can be increased and possible defects can be prevented with changing the cutting parameters by the operator.

Key Words: Computer aided manufacturing (CAM), Computer aided cutting system, Cutter, Cutting parameters, Fabric cutting.

ÖZET

Bilgisayarlı kumaş kesim sistemlerini kullanarak aynı cins kumaşın, aynı kesim planının farklı tekniklerle kesimi yapılabilmektedir. Bu olanak bilgisayarlı kesim sistemini çalıştıran program dâhilindeki parametrelerin değiştirilmesiyle mümkün olmaktadır. Bu araştırmada; kesim parametrelerindeki değişimin kesim süresi ve kesim netliğine (kalitesine) etkileri gözlenmiştir. Uygulamada; farklı model ve kumaş özelliklerine sahip 6 ayrı kesim süreci incelenmiştir. Çalışma boyunca, farklı kumaş tiplerinin kesimi sırasında bazen benzer parametrelerle çalışılabilirken çoğu zaman kumaş, kalıp, pastal ve serim özelliklerine göre parametrelerde değişiklik yapmak gerektiği görülmüştür. Özellikle farklı tipteki kumaşların kesiminde uygulanacak vakum şiddetinin belirlenmesi sırasında kumaş hava geçirgenlikleri ölçülmüş ve kumaş hava geçirgenliği ile uygulanacak vakum şiddeti arasındaki bağıntı ortaya konmuştur. Kesim parametrelerinin belirlenmesinde kumaş cinsi, pastal yerleşimi, serim ve giysi model özellikleri belirleyici unsur olarak karşımıza çıkmaktadır. Kesim parametreleri operatör tarafından değiştirilerek kesim veriminin ve kalitesinin artırılabildiği ve olası hataların engellenebildiği saptanmıştır.

Anahtar Kelimeler: Bilgisayar destekli üretim (BDÜ), Bilgisayar destekli kesim sistemleri, Cutter, Kesim parametreleri, Kumaş kesimi.

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1. INTRODUCTION

Computer aided design and computer aided manufacturing systems were started to develope in the early 1970s. These systems were being used only for pattern grading and marker making initially (1). Modernization of cutting department began with spreading machines and continued with computerized marker making systems. Finally it has been going on with the cutting process, which takes more time and needs more labor. As a result of previous researches, for improving the cutting speed and the quality of cutting process, it was observed that, fabric cutting must be done by cutter working in a controlled manner instead of workers. As a result of this research began in the 1970s, "Numerical-controlled cutting machines-NC Cutters" was developed. This system is based on the transmission of cutting plan, prepared by CAD system to a cutter head. This cutter cuts them by moving on the spread surface (2).

The aim of this study is determining the effects of cutting parameters on cutting time and quality. The process, which is written below, is followed in the process of cutting with the computer aided cutters.

Spreading: Fabric spreading is performed according to the marker plan that is prepared by model and pattern department.

Transferring and getting the marker plan: Marker plans are transferred by a floppy disk or a network connection. After the transfer, the marker plan is opened to start cutting process.

Changing the parameters: The cutting parameters must be changed according to the model features, the number of layers and fabric properties for the maximum cutting quality and efficiency

Placement of the fabric in cutting window: Layers on spreading table is placed on the cutting window by pulling it manually.

Covering the cutting window with polyethylene foil: the cutting window is covered with a polyethylene foil to demonstrate the desired effect of applied vacuum.

Applying the vacuum: The vacuum is applied in the proportion according to entered parameters.

Referencing: Referencing is done manually or automatically for superposing of fabric with marker plan.

Beginning of cutting: After referencing, cutting process is started by a command of the computer

Loading of cut fabric pieces: After completing the cut pieces in cutting window, cut pieces are loaded by conveyor belts to the collecting area.

Collecting the cut pieces: The cut pieces in the collecting area will be taken to shelves for labeling process.

1.1. Parameters of Computer Aided Fabric Cutting System

Computer aided cutters have parameters, divided into 8 main groups:

- General Cutting Parameters
- Notch Parameters
- Cutting Layout Parameters
- Transfer Parameters
- Reduction in Common Lines Parameters
- Speed / Acceleration Parameters
- Knife Frequency Control Parameters
- Sharpening Parameters (3)

1.2. Data for Determination of Cutting Efficiency

Data, that shed light on cutting efficiency and cutting quality, can be taken from the computer which directs the cutter in computer aided cutting systems. Statistical analysis can be done according to these data. The most efficient data during evaluations are shown below:

- Cutting Duration: Duration between the beginning and the end of the cutting process except stops and loading times.
- Loading Duration: Loading duration of cut fabrics to collection area and uncut fabrics into cutting area. The ratio of this period must be 2-3% of the total duration.
- Stop Duration: Represents total stop durations of cutter during the cutting process and interruption periods of cutting process. This period largely depends on the operator of machine. For example, if only one operator works for one cutter, it will be inevitable to stop the machine for collecting the pieces after cutting process. Increase in the number of pieces per unit area will also increase the collection time as well as stop durations. According to the performance and the number of operators, these durations may vary. It was revealed that the average of stop durations is 10% of total time according to the calculations on previous studies and data of this study.

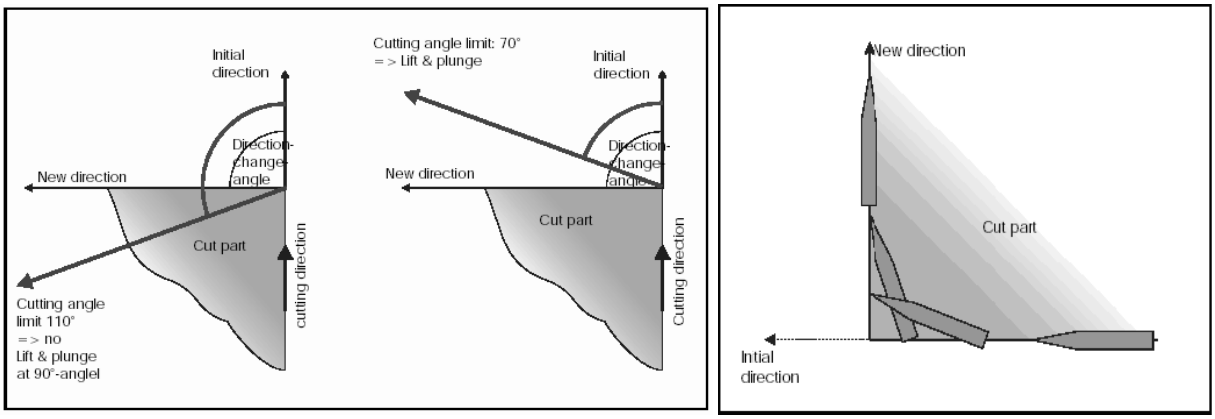

Figure 1. Cutting parameters for limiting angle in corners and corner cutting strategy (3)

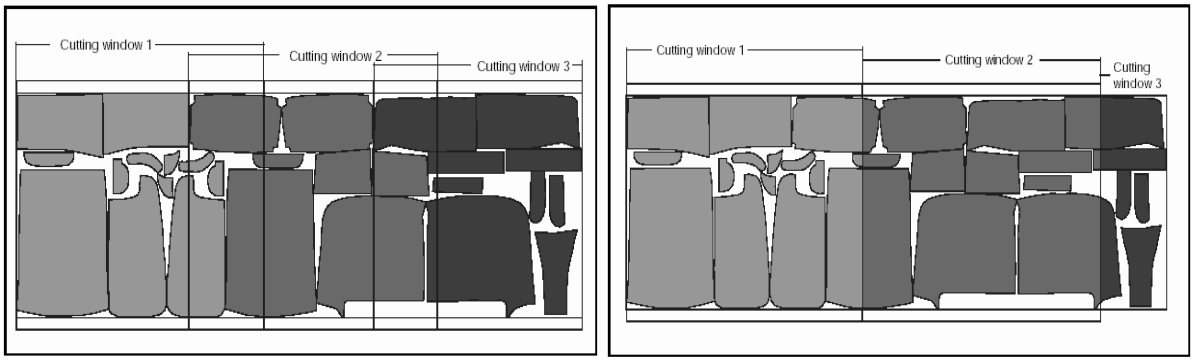

Figure 2. Transfer parameters for cutting window; cutting with stop, cutting without stop (3)

- Total time: Whole duration from the beginning of cutting process till the end.

  Total time = cutting durations + loading durations+ stop durations

- Cutting angle: It means the specified limit angle of the cutter head on the edges of cutting pieces. If the angle is under the limit, the cutter head goes out of fabric and down again after it changes the angle.
- Cutting distance: It means the length of the total surroundings of the pieces on marker plan. The cutter head performs the cutting along this distance. This distance has a direct impact on the cutting duration.
- Blank distance: The total movement distance of cutter head without cutting distance. The blank distance depends on cutting parameters and marker placement plans. These adjustments should be made so that the shortest blank distance will be achieved.
- Maximum speed: It refers to the reachable highest speed of the cutter head during the cutting process. Number of layers, fabric type and the height of vacuumed layers are effective to determine the limit of this speed.
- Average speed: The rate of the cutting path length to the cutting duration.
- Sharpening distance: The sharpening distance period of worn knife during cutting process.

2. MATERIAL AND METHOD

2.1. Materials

During this study four different denim fabrics and one velvet fabric were used for five different (marker) cutting processes. Cutting operations were performed in cutter Bullmer Procut XL 7501. Machinery has a cutting window in size 180 cm * 220 cm and suitable for mid-rise layers cutting. Except these materials, marker paper, perforated paper for moving marker, polyethylene cover were used to help cutting process for transferring fabrics and applying vacuum. Karl Schröder KG air permeability tester was used to determine and control vacuum parameter. 100 cm2 circle template and sensitive balance are used for measuring the weight of fabric to determine the cutting speed.

2.2. Method

The air permeability of fabrics was measured with the Karl Schröder KG air permeability tester in unit of "lt/dm^2.min", (4) and also weight of fabrics was measured with 100 cm^2 circle template and a sensitive balance, in unit of "g/m^2" (5) in order to identify and control parameters .

After this preliminary work, the cutting process took place. This study was performed in a cutting department of actively working mills which produce woven garments.

First, cutting principles and parameters of computer aided cutters have been examined in detail. As a result of the review, the parameters, which are appropriate to investigation, were determined. Some parameters were kept constant, the revealed results of changing parameters were examined.

In this study, 5 different markers belonging to different trousers models were used. 6 different cuttings were processed. The results and data of these cutting processes in accordance with the workflow above, were taken from the computer protocol of computer aided cutting system to evaluate. Data which affect the cutting efficiency were determined and compared.

3. RESULTS AND DISCUSSION

The application data and relationship between these values were investigated in this part.

Table 1. Application data

Marker Code	Marker 1	Marker 2	Marker 3	Marker 4	Marker 5	Marker 6
Fabric Type	Denim	Denim	Denim	Velvet	Denim	Denim
Fabric Weight (gr/m²)	457	428	378	277	422	378
Permeability (l/dm².dak)	55.9	61.5	108.5	56	257	108.5
Marker Length (m)	5.15	5.95	5.33	5.06	4.99	5.33
Marker Width (m)	1.46	1.5	1.58	1.44	1.58	1.58
Number of Layers	47	41	50	50	40	50
Number of Sizes	4	8	10	4	6	10
Cuttıng Distance (m)	103.04	128.22	132.45	90.29	103.21	131.93
Blank Distance (m)	61.8	35.2	74.93	25.74	70.06	73.91
Number of Cutting Windows	6	7	6	6	6	6
Max Speed (m/min)	10	8	15	15	10	20
Average Speed (m/min)	4.19	3.76	5.2	5.03	4.67	5.75
Number of Pieces	100	135	140	81	90	140
Number of Notches	216	288	330	200	216	330
Cutting Duration (h:min:sec)	00:24:37	00:34:04	00:25:28	00:17:57	00:22:06	00:22:56
Loading Duration (h:min:sec)	00:00:48	00:00:45	00:00:47	00:00:50	00:00:43	00:00:43
Stops (min)	4.17	5.28	2.7	5.82	3.2	2.1
Total Time (dak)	29.6	40.12	28.95	24.6	26.05	25.83
Cutting Angle	60	60	90	60	89	110
Sharpening Distance (mm)	1800	1800	2500	1800	2000	2500
Vacuum Power (%)	100	100	90	100	90	90
Vacuumed Height (cm)	3.5	3.4	3.8	3.9	3.5	3.8

Data were taken from cutting department of an active woven garment factory and obtained from cutting processes belonging to 5 different trousers models. The effect of these data to cutting efficiency and cutting quality were investigated.

Maximum speed and average speed varies in direct proportion (Figure 3). However, other factors that affect the average speed such as notching, blank distance prevent the exchange rate remains constant. In addition, rates of the curved pieces and the speed of cutter head in these curves are also important factors for speed changes.

Maximum cutting speed has an inverse relationship with cutting duration (Figure 4). However the maximum speed is not the only reason for this decrease in cutting duration.

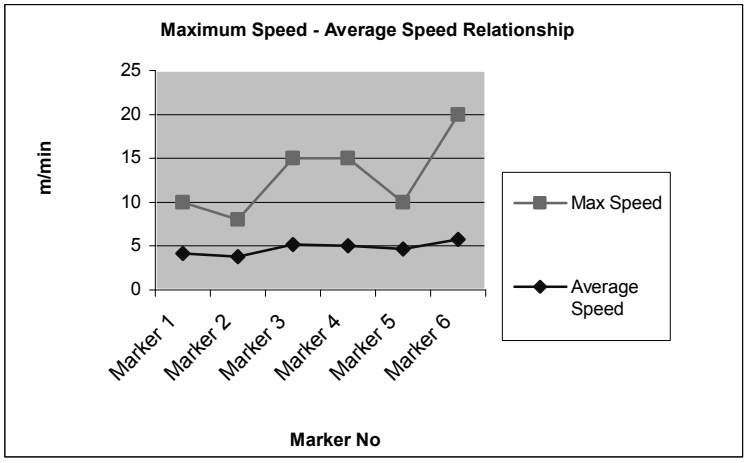

Figure 3. Maximum speed - Average speed relationship

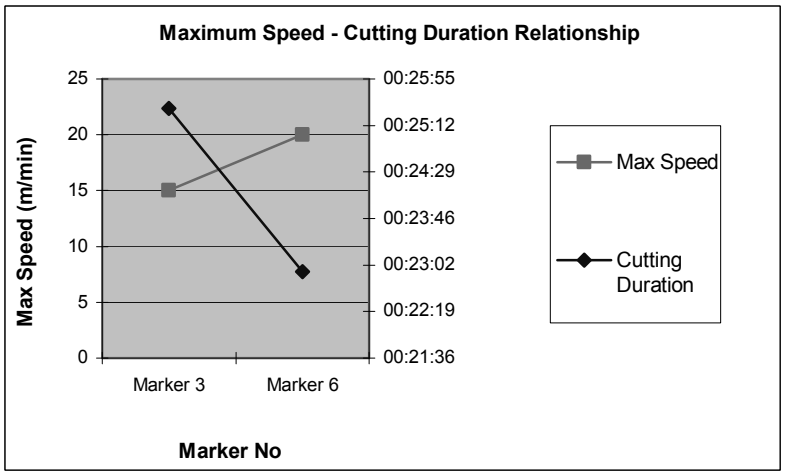

Figure 4. Maximum speed - Cutting duration relationship

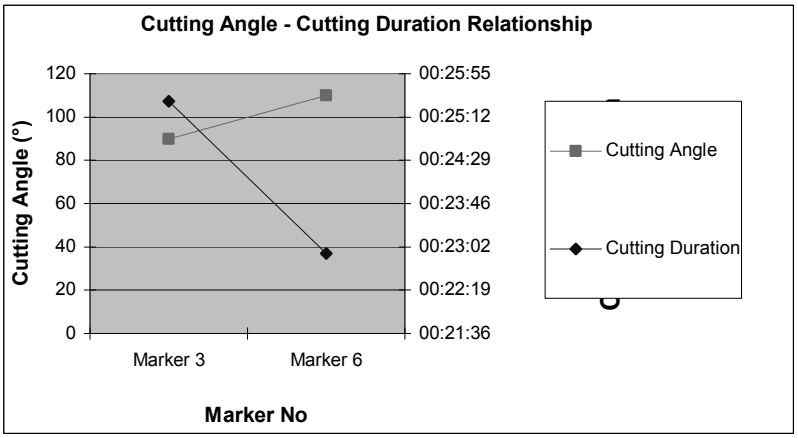

Figure 5. Cutting angle - Cutting duration relationship

One of the factors affecting the cutting duration is the cutting angle. There is an inverse relationship between the cutting angle and cutting duration. Marker 3 and Marker 6 are the different cutting applications with the same trousers model (Figure 5).

Increase in the cutting distance parallels the increase in the cutting duration. However, the maximum speed increase in Marker 3 is more attracted than increase in the cutting distance. Thus cutting duration is decreased. This case has led to an imbalance in the graph (Figure 6).

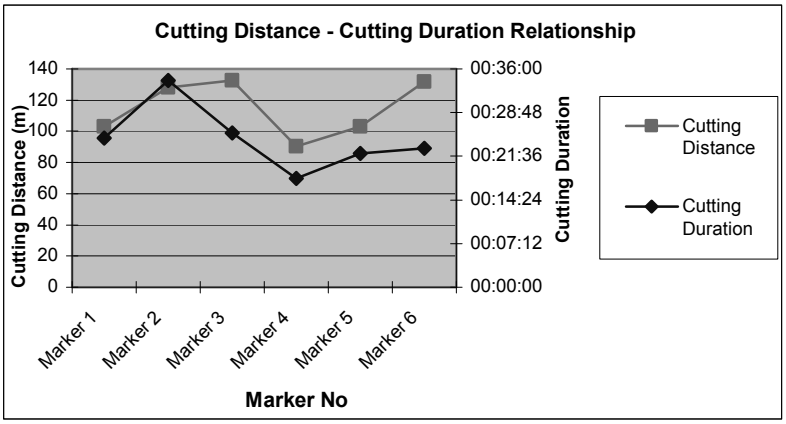

Figure 6. Cutting distance - Cutting duration relationship

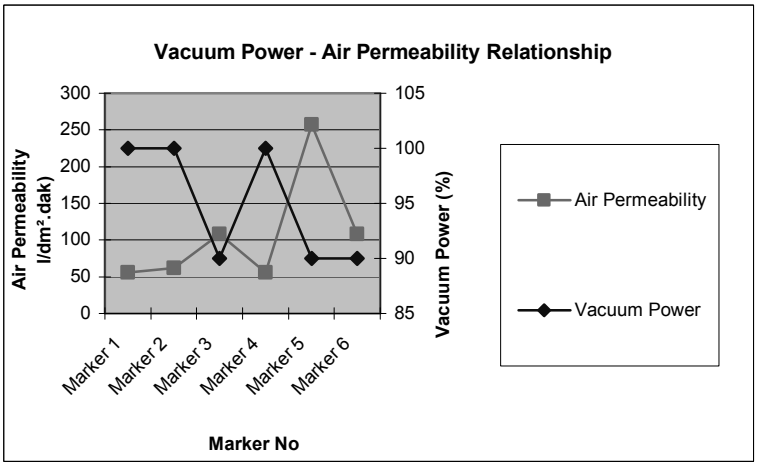

Figure 7. Vacuum power – Air permeability relationship

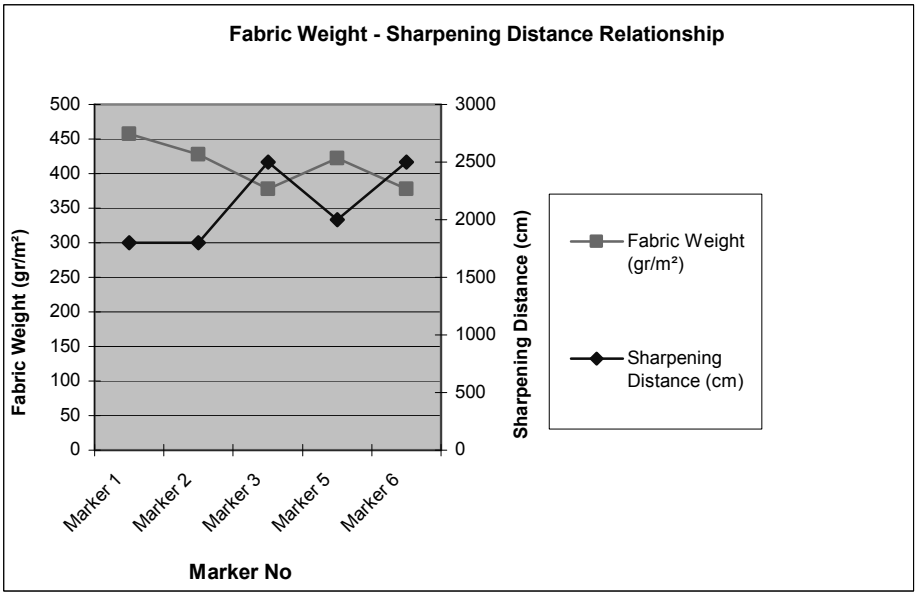

Figure 8. Fabric weight – Sharpening distance relationship

Figure 7 shows an inverse relationship between the vacuum power and the air permeability. Air permeability values have been obtained as a result of the measurements and require a constancy of these measurement values. Therefore, the imbalance in Marker 5 exemplifies an error in the factory environment.

Balanced exchange of curves of fabric weight and sharpening distance shows a direct correlation between these two elements (Figure 8).

4. CONCLUSION

Data, obtained from this research, were compared. According to these comparisons, there are lots of parameters affecting the cutting efficiency and cutting quality in cutting process with computer aided cutters. These parameters can be grouped under 4 headings written below:

- Fabric properties
- Model and marker features
- Machine settings
- Operator performance

Fabric Properties:

The cutting quality of garment pieces in marker is related with the force applied by the cutter's knife and the resistance of fabrics in terms of physical and mechanical fabric properties (6). The arrangement according to some fabric properties such as fabric structure, fabric weight and air permeability etc. affects the quality and efficiency of cutting.

The fabrics used in the study have different air permeabilities owing to different fabric structures. The vacuum power should be arranged according to these air permeability values. Fabrics with low air permeability values must be pressed under high vacuum power, fabrics with high air permeability values must be pressed under low vacuum power.

Fabrics with similar structures were used in this study. Changes in fabric weight change the density and thereby hardness of fabric. This result leads to rustiness of the cutter knife. The cutter knife must be sharpened often while working with heavier weights and rare while working with lower weights.

Model and marker properties:

The number of pieces in the model, the cutting distance, the blank distance, the number and type of notches, curvilinearity rates of patterns and marker length affect the quality and efficiency of the cutting.

Number of pieces is related directly with cutting distance. Thus number of pieces is the decisive factor for the cutting duration. The blank distance of cutter head between pieces increases the cutting duration as well. The blanks between pieces are also effective for blank distance. Another factor which is effective in this matter, is the choice of pieces' cutting sequence.

Number of notches on pieces increases the cutting duration directly. Applied notch type affect the duration of the notching. Therefore this situation should not be overlooked while preparation of marker.

Cutter head reduces the speed to increase cutting quality while cutting curved pieces. This has an increasing effect on the cutting duration as well.

Machine Settings:

Cutting parameters are set as desired according to the cutting features for different fabrics and different markers.

Cutting speed and vertical knife frequency must be set in as high as possible without disrupting the cutting quality.

Cutting angle is a determining factor for sharp corners. If sharp corners are needed this angle must be kept less. This acute angle will play an important role in increasing the cutting quality. In the meantime, increase in lost time would be a negligible level in terms of cutting quality.

Vacuum power provides the fixing of fabric layers. Tightly fixed layers have a direct effect on the cutting quality.

Sharpening distance depends on the fabric properties and the number of layers. The frequency of sharpening affects the knife lifetime and the cutting quality directly.

Notching can be done in different ways by machine settings. Notches can be cut before or during the cutting processes of pieces. In terms of cutting quality, notching before cutting process would be the right decision. Because during cutting process, the holes between cut pieces decrease the desired vacuum power while notching. Insufficient vacuum can cause deviations of notches which are the important signs for sewing process.

It is possible to cut common lines at once. If this parameter is chosen, it is not necessary to cut same line again. It can be performed with a single cutting movement. In addition, if the distance between two parallel lines is under the defined value, the cutting operation can be performed in their mid-points by the system. Thus, cutting distance is decreased. In this way, the cutting time can be shortened.

Operator Performance:

It was determined that; technical education and personal skills of the operator are very important factors for a continuous cutting process. The operator must be able to change the settings of computer aided cutting system, when faced with different cutting conditions. For this reason, the training and technical knowledge of the operator are the most important factors. In addition, the operator's dexterity in collecting cut pieces has a major effect on the stop durations.

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REFERENCES

1. Hands C., Hergeth H.A., Hudson P., 1997, "Marker Making in Small Clothing Companies: Part 1", *International Journal of Clothing Science and Technology*, 9, pp: 154-165.
2. Erdoğan M Ç., 1998, "Modern Kesim Sistemleri", *Tekstil ve Konfeksiyon*, 8(1), pp: 74-77.
3. Assyst-Bullmer, 2003, "Bullmer Procut Cutter User's Manual", Part: 5, pp: 1-30.
4. TSE, "TS 397 EN ISO 9237 Textiles - Determination of the permeability of fabrics to air".
5. TSE, "TS 251 Textiles - Woven fabrics - Determination of mass per unit length and mass per unit area".
6. Blekac R., Gersak J., 1998, "Influence of Mechanichal and Physical Properties of Fabrics on Cutting Process", *International Journal of Clothing Science and Technology*, 10(3/4), pp: 293-304.