(REFEREED RESEARCH)

RESPONSE SURFACE DESIGNS IN QUALITY CONTROL: YARN IRREGULARITY EXERCISE

KALİTE KONTROLDE YANIT YÜZEY DESENLERİ: İPLİK DÜZGÜNSÜZLÜĞÜ ÖRNEĞİ

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ABSTRACT

It is proposed that response surface designs with feasable region is an effective tool in prediction of a specific property of a product from the known properties of raw material, with a yarn irregularity exercise, for the first time in textile literature in this paper. The data used in this research is obtained from a cotton yarn spinning mill, being real production data. Response surface designs with feasible region are used to obtain the relationship between the response variable (yarn irregularity) and effecting factors (fiber properties) in 3D graphs and contour lines both for yarn in bobbin and cop form separately. It is concluded that this novel method of response surface designs with feasible region provides valuable results, is effective in prediction, is benificial in textile quality control, and can also be widely used in other industry branches when it is incorporated into a statistical quality control computer program.

Keywords: Design of Experiments, Response Surface Design, Feasible Region, Central Composite Design (CCD), Yarn Unevenness

ÖZET

Bu çalışmada, yanıt yüzey desenlerinin elverişli bölge ile beraber kullanılmasının, hammaddenin bilinen özelliklerinden ürünün belli bir özelliğinin tahminlenmesinde etkili bir araç olduğu, tekstil literatüründe bir ilk olarak bu çalışmada ortaya konulmuştur. Bu araştırmada, bir pamuk ipliği fabrikasının gerçek üretim verileri kullanılmıştır. Hem kops hem bobin halindeki iplik için, yanıt değişkeni (iplik düzgünsüzlüğü) ve etken faktörler (lif özellikleri) arasındaki ilişkinin elde edilmesi için 3-boyutlu grafik olan yanıt yüzey desenleri elverişli bölge ile beraber kullanılmıştır. Sonuç olarak, özgün bir metod olan yanıt yüzey desenlerinin elverişli bölge ile beraber kullanılmasının değerli sonuçlar verdiği, tahminlenme için etkili olduğu, tekstil kalite kontrolu için faydalı olduğu ve istatistiksel kalite kontrolu yapan bir bilgisayar programının içine eklendiği zaman endüstrinin diğer dallarında da yaygın olarak kullanılabileceği belirlenmiştir.

Anahtar Kelimeler: Deneme Desenleri, Yanıt Yüzey Deseni, Elverişli Bölge, Merkezi Bileşen Deseni (CCD), İplik Düzgünsüzlüğü

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INTRODUCTION

Quality control is an essential process in textile production as in many other industrial applications. Quality control increases the level of usage of a product, decreases the production costs, accomplishes new aspects in work, etc. Evaluative quality control tools are worked with many researches in various subjects in different textile fields. Quality control tools are used in the point of view of production, as well as predicting the properties of the final product from the known properties of raw material, which is an important subject of the era. Many work can be found in literature with the point of view of prediction and many graphical, statistical, mathematical, and simulation methods are used in predicting. Some of these methods are histograms, data charts, regression, analysis of variance, correlation, artificial neural networks, discriminant analysis, principal component analysis, varimax, design of experiments, etc. In this research, it is proposed for the first time in textile literature that response surface designs with feasable region is as effective as the methods listed above, with a yarn irregularity exercise given.

In literature, we can see prediction of yarn properties from fiber properties in many researches. In some of them, the predictors are yarn count [1-9], yarn twist [1-4,9], and roving parameters [1-4] besides fiber properties. The predicted yarn properties are yarn tenacity [1-3,5,7,9], yarn breaking elongation [1-3,8], yarn irregularity [1,2,4,5], hairiness [1,2,4,6], product of yarn count and tenacity multiplication (CSP) [5,10], constant of variation of count (CV_C%) [5], constant of variation of tenacity ($CV_{Tenacity}$%) [5], and imperfections (piece/km) [5]. In all these papers, regression analysis [2-4,6,8,11] and artificial neural networks [3-8, 10] are used. In one of them, Elman network which is a kind of artificial neural network is benefitted [9]. Comparisons of different methods are achieved successfully in some them [3,4,6,8]. It is also seen that both ring and rotor yarns are used and are searched for which one is predicted better than the other one [5,7]. In one paper, principal component analysis is used to determine which few fiber properties predict yarn properties the most [5]. The interactions between fiber properties and yarn properties are also studied [11,12] besides data charts of fiber properties to get through to yarn properties [13]. Intelligent control systems were also applied [14]. Predictors, properties and methods are briefly given here and will be focused on our novel method of response surface designs with feasible region for the rest of the paper.

Our research in general consists of predicting yarn properties from fiber properties by means of data charts, regression, principal component analysis including varimax, artificial neural networks, response surface designs with feasible region, and discrimimant analysis [15]. The response surface designs with feasible region in quality control is presented here only among the other research we did and is emphasized that response surface method is a quick, practical, and effective tool for predicting various properties of an end product, a yarn irregularity exercise is given in this paper. In literature, response surface designs with feasible region is not used in textile quality control and this research is important for being the first and contributes a lot to quality control by being easy and comprehensive. By the yarn irregularity exercise, it is understood that response surface designs with feasible region can be applied to the other properties of textile products, and even to the other branches of industry also.

THEORETICAL APPROACH

Design of experiments is a method where the value of a variable is effected by several factors while the factors take different combinations of data. The trend in effecting property is observed and this indicates the efficiency of these factors scientifically [16,17]. The purpose in using design of experiments is to determine the optimum factor values for the examined response variable. In order to solve a problem by design of experiments, the problem has to be understood very well, should be very cautious in choosing the factors, levels, and ranges; the most appropriate response variable and design of experiment should be chosen [18]. Design of experiments are expressed by particular subgroups like screening designs, response surface designs, full factorial designs, fractional factorial designs, optimal designs, latin hypercube designs, quasi-random designs, mixture designs, discrete choice designs, space-filling designs, nonlinear designs, Taguchi designs, and augmented designs [19-21]. Response surface design is applied in our research [15].

Response Surface Designs

Response surface design is an important subgroup in design of experiments. Response surface designs are used in modelling and optimization problems. In these problems, response variable is effected by several factors and the factor values which will give the optimum value for the response variable is searched for. Response surface designs are useful for modeling a curved quadratic surface to continuous factors. If the response variable is “y” and factors are “x_1”, “x_2”, … , “x_k” and deviation is “e”, then the response variable is generally expressed by Eq. 1 [22] :

$$y = f(x_1, x_2, \dots x_k) + e \quad (1)$$

Linear, quadratic and cubic models are given in Eq. 2 - 4 :

$$\text{Linear: } y = \beta_0+\beta_1x_1+\beta_2x_2+ \dots +\beta_kx_k+e \quad (2)$$

$$\text{Quadratic: } y = \text{Linear model} + \beta_3x_3 + \beta_{12}x_1x_2 + \beta_{13}x_1x_3 + \beta_{23}x_2x_3 + \beta_{k-1,k}x_{k-1}x_k + \beta_{11}x_1^2 + \beta_{22}x_2^2 + \beta_{33}x_2^3 + \beta_{kk}x_k^2 + e \quad (3)$$

$$\text{Cubic: } y = \text{Quadratic model} + \beta_{123}x_1x_2x_3 + \beta_{112}x_1^2x_2 + \beta_{113}x_1^2x_3 + \beta_{122}x_1x_2^2 + \beta_{133}x_1x_3^2 + \beta_{223}x_2^2x_3 + \beta_{233}x_2x_3^2 + \beta_{111}x_1^3 + \beta_{222}x_2^3 + \beta_{333}x_3^3 + \dots + e \quad (4)$$

If there are limitations for the design, the design obtained should be in accordance with these limitations. The first purpose in response surface method is to understand how the response variable changes by changing the factor values. To achieve this goal, response surface is visualized by a graphic (Fig. 1) and takes the name of response surface drawing. The second purpose in response surface method is to find the optimum response value. If there are more than one response variable, then the purpose is to determine the feasible region which optimizes both response variable’s values as seen in Fig. 2 [22-24].

Besides the response surface drawings, the contour lines help researchers to interpret the behavior of the response and notice the conditions around where the response is optimum. Contour lines show the similar heights of x_1-x_2 couples at the same response value. A sample of contour lines is given in Fig. 3. Both the response surface drawing and the contour lines are helpful tools to understand the trend of a response in different values of factors effecting it.

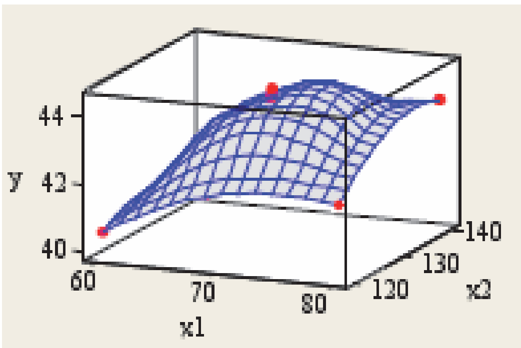


Figure 1. Response surface drawing

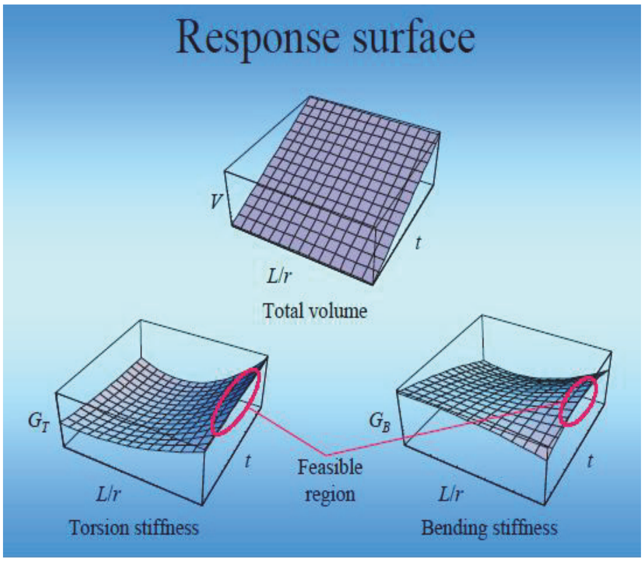


Figure 2. Feasible region

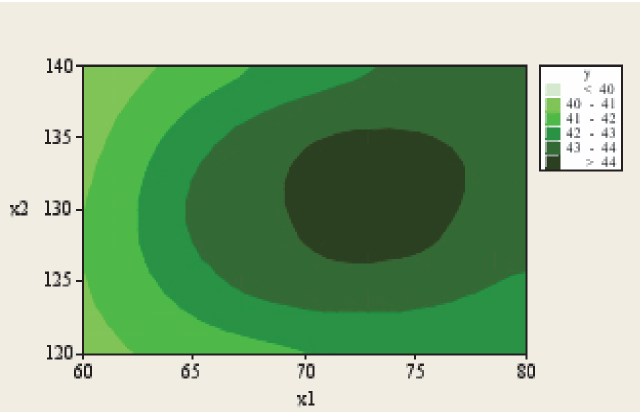


Figure 3. Example of contour lines

MATERIAL AND METHOD

The data used in this research is obtained from a company producing 100% cotton yarn in Uşak-Turkey, the company does these measurements regularly during their production, so the important point here is that real production data are used in this research, it is guaranteed that the results achieved from this research will be suitable for production [15].

The standard atmospheric conditions in the laboratory of the factory are 20±2^{0}C, 65±2%RH. Uster®HVI Spectrum apparatus is used in the regular measurements to obtain fiber properties which are fineness/ micronaire (Mic), maturity index (Mat), length (Len), fiber length uniformity index (Unf), short fiber index (SFI), fiber strength (Str), elongation (Elg), moisture content (Moist), reflectance (Rd), yellowness (b), trash count (Tr_Cnt) and trash % area (Tr_Area). Ring carded yarn Ne20-19.21T/inch yarn of which the data is used in this research is produced from this fiber lot and the production downstream is :

- Adana-Turkey region cotton fiber lots in blowroom;
- Carding machine (sliver count Ne0.12; machine speed 135 m/min);
- I.and II. drawing machines (sliver count Ne0.12; machine speed 1000 m/min; draft 8; doubling 8; enterance drafting zone distance 39±1-2 mm; main drafting zone distance 44±1-2 mm);
- Roving machine (roving count Ne0.6; machine speed 33 m/min; spindle speed 1250 revolutions/min; twist 0.94 T/inch; draft 4.96-5);
- Ring spinning machine (yarn count Ne20; machine speed 19.5-20 m/min; spindle speed 14000-15000 revolutions/ min; twist 19.21 T/inch; draft 33; clips white; traveller No ISO 63; enterance drafting zone distance 43.5±1-2 mm; main drafting zone distance 65±1-2 mm);
- Cop (yarn count Ne20; machine speed 1400-1500 m/min; knotter splicer; cop weight 2.5-3 kg).

Uster Tester 4-SX apparatus is used in the regular measurements of the factory to obtain yarn properties which are yarn irregularity (U%, CV_m%), hairiness, imperfections (thin -50%; thick +50%; neps +200%. Uster Tensorapid 3 apparatus is used in the regular measurements of the factory to obtain yarn properties which are maximum breaking strength, breaking strength in Rkm, breaking elongation, and breaking work. The regular measurements of the factory were written on papers, we entered them into the computer and studied for the response surface designs with feasible region and the other methods mentioned above in our research in general [15].

Fiber Data

Fiber data taken from the factory for the twelve different fiber properties mentioned above consists of 98 lots where each of them is the mean of 5 repeats. It is prefered to work with the means of them to get rid of the small differences which may decline the power of responce surface drawings. The means, standard deviations and constant of variations are given in Table 1.

Yarn Data

Yarn data taken from the factory for the ten different yarn properties mentioned above consists of 30 lots for yarn in bobbin form and 95 lots for yarn in cop form where each of them is the mean of 10 repeats. It is prefered to work with the means of them to get rid of the small differences which may decline the power of responce surface drawings. The means, standard deviations and constant of variations are given in Table 2. In the factory's manufacture, the yarn lots in Table 2 were produced from the same 98 fiber lots in Table 1.

Table 1. Means, SDs and CV% of the fiber properties

	Mic	Mat	Len	Unf	SFI	Str	Elg	Moist	Rd	b	Tr_Cnt	Tr_Area
Mean	4,9781	0,9203	29,4522	85,5337	7,0765	30,3041	9,6827	7,9306	67,3531	8,2459	54,2449	1,5232
SD	0,1377	0,0130	0,4465	0,7832	0,4681	1,0551	0,289	0,8858	1,7809	0,4424	12,4504	0,3567
%CV	2,766	1,417	1,516	0,916	6,615	3,482	2,984	11,169	2,644	5,365	22,952	23,42

Table 2. Means, SDs and CV% of the yarn properties

		%U	%CVm	H	Thin50	Thick50	Neps200	BForce	Elongation	Rkm	BWork
Bobbin	Mean	11,28400	14,46330	6,01670	1,75000	216,91700	285,16700	442,74700	5,25630	14,99270	626,86300
	SD	0,22695	0,34045	0,28067	1,87430	66,99100	150,88520	24,01450	0,46158	0,81246	79,31180
	%CV	2,011	2,354	4,665	107,103	30,883	52,911	5,424	8,781	5,419	12,652
Cop	Mean	12,02430	15,33550	7,23230	4,52600	239,10500	273,63200	436,61400	5,65650	14,78430	664,79200
	SD	0,55428	0,68230	0,32527	4,41070	53,91200	74,94130	24,23580	0,37958	0,82015	62,82460
	%CV	4,610	4,449	4,497	97,452	22,547	27,388	5,551	6,711	5,547	9,450

Method

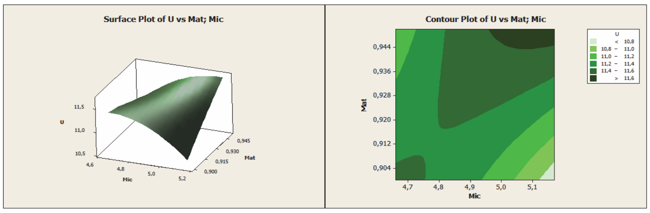
In order to show that response surface designs with feasible region are satisfactory tools for textile quality control, an exercise in yarn, both in bobbin and in cop form separately, is performed on irregularity property (U%) as response variable, and HVI results of fibers (Mic, Mat, Len, Unf, SFI, Str, Elg, Moist, Rd, b, Tr_Cnt, and Tr_Area) as effecting factors. Central composite design (CCD) method in MINITAB program is used to obtain the relationship between the response variable and effecting factors in 3D graphs as response surfaces. In each case, one response variable (U%) and two (Mic and one of the listed above) fiber properties are defined as effecting factors in the program. The occurring eleven combinations are examined for U%, and both the response surface drawings and contour lines are obtained. Further, the areas having low U% values are painted in lilac color on the contour drawings. These colored contour drawings are put on top of each other in the image processing program in MATLAB and their intersection gave the feasible region where we painted in red color. The feasible region is where the same lowest U% value area is found for the most number of combinations. By reading backwards from the feasible region to the response surface drawings, the value range of the fiber properties which give the lowest U% values are determined effectively [15]. If we are to study the breaking strength property of the yarn, then feasible region will then be where the same highest force area is found for the most number of combinations. When all this work will be incorporated into a statistical quality control computer program, evaluations will be more compelling before production.

RESULTS AND DISCUSSION

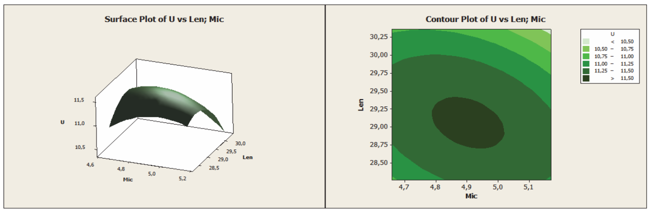
Yarn in bobbin form

The response surface drawings and contour lines for yarn in bobbin form are given in Fig. 4.

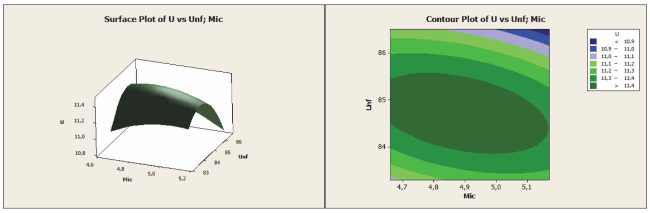
The different values of U% possess different shades of color in contour drawings (Fig. 4). The areas giving the lowest values of U% are painted in lilac (Fig. 5 and 7). The borders of the feasible region is acquired by intersecting the lilac colored areas. When doing the intersection, it is noticed that seven properties which are Mat, Len, Unf, SFI, Elg, Tr_Cnt and Tr_Area versus Mic intersect in the first feasible region colored in red in Fig. 6, the other four properties which are Str, Moist, Rd and b versus Mic intersect in the second feasible region colored in red in Fig. 8, both regions coinciding with U%<11.25%. Even the mean value for U% is 11.284% for yarn in bobbin form in Table 2, U%<11.25% condition is chosen because more than half percent of the data possessed a value less than 11.25% in a normal distribution curve. The difference between mean (11.284%) and condition (11.25%) is statistically insignificant (p=0.897), also proves that the data is distributing normal.



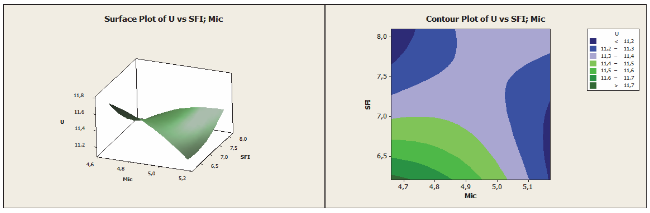
a) U% versus fiber fineness and maturity index



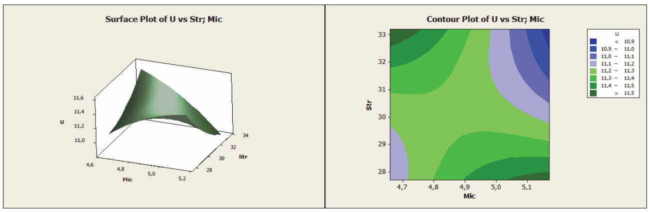
b) U% versus fiber fineness and length



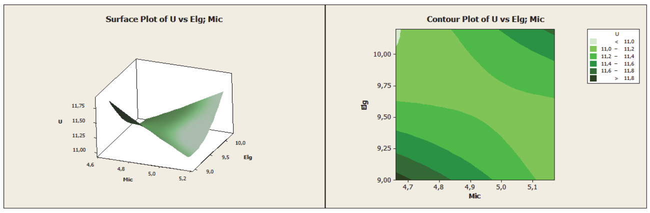
c) U% versus fiber fineness and fiber length uniformity index



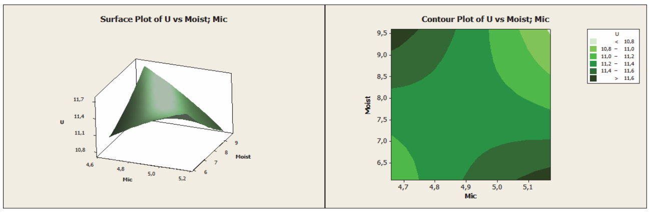
d) U% versus fiber fineness and short fiber index



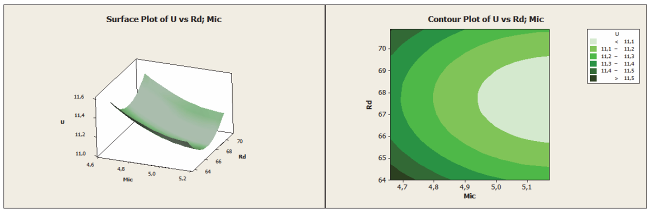
e) U% versus fiber fineness and fiber breaking strength



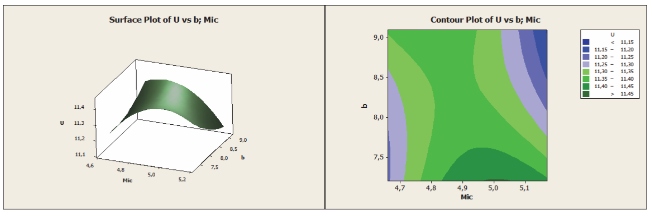
f) U% versus fiber fineness and fiber breaking elongation



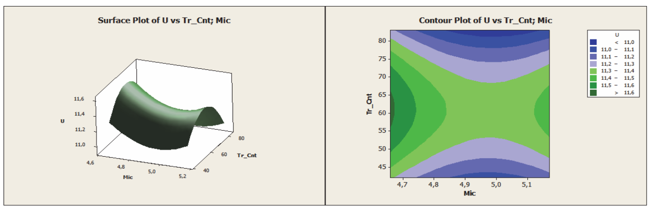
g) U% versus fiber fineness and moisture content



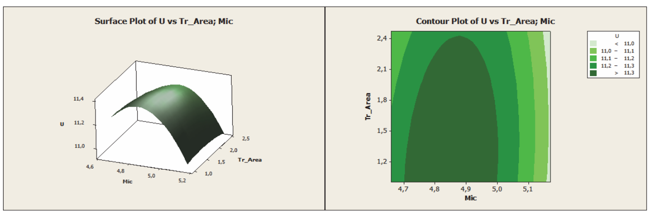
h) U% versus fiber fineness and reflectance



i) U% versus fiber fineness and yellowness



j) U% versus fiber fineness and trash count



k) U% versus fiber fineness and trash % area

Figure 4. Yarn in bobbin form, irregularity U% as response variable, versus various fiber properties, response surface drawing (left) and contour lines (right)

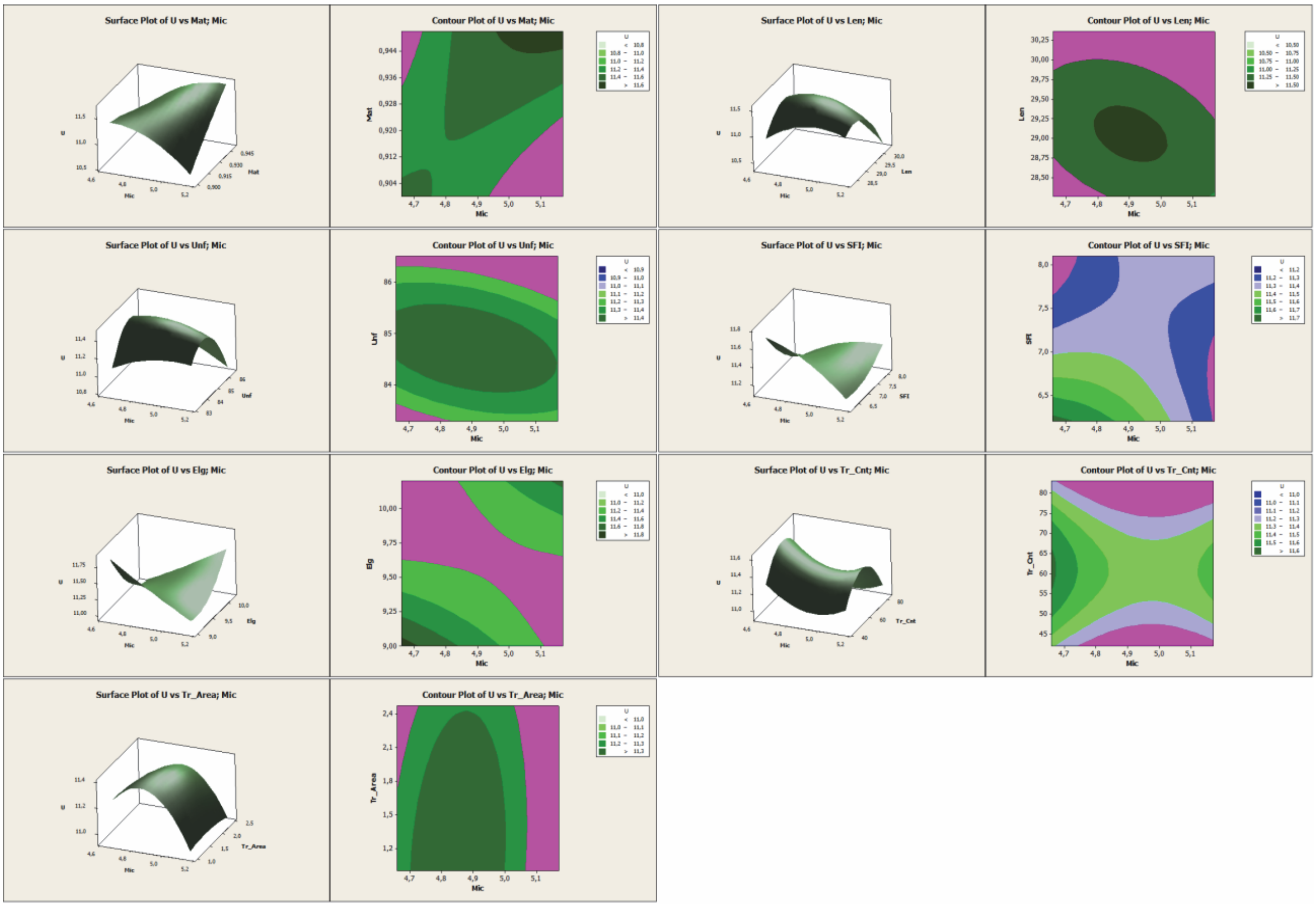


Figure 5. Lilac colors showing the places fulfilling the U%<11.25% condition for yarn in bobbin form for the first feasible region

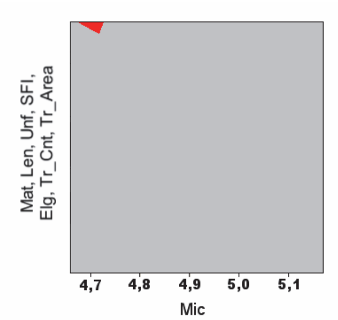


Figure 6. First feasible region which is constituted by intersecting lilac areas with U%<11.25 % condition for yarn in bobbin form in Fig. 5

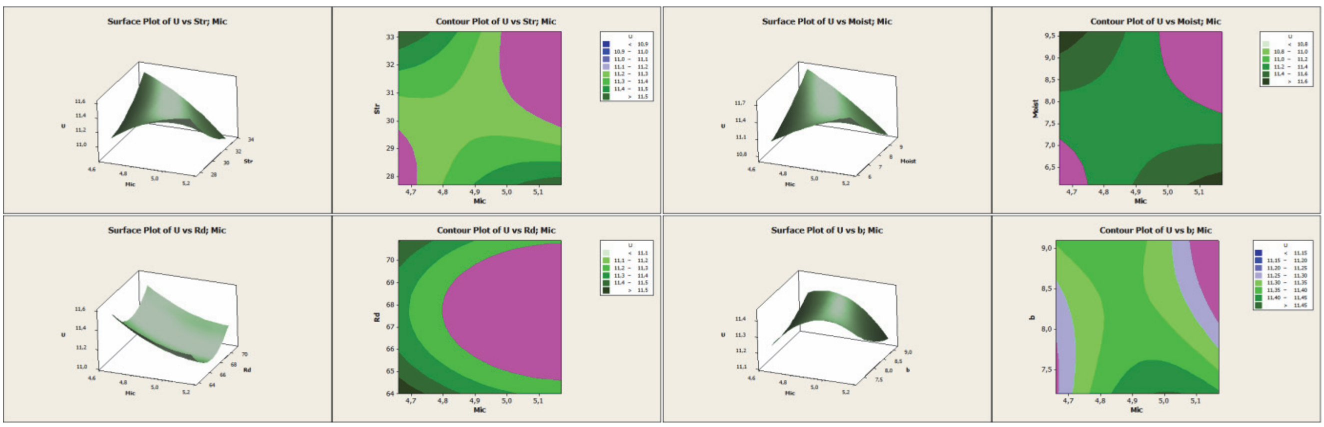


Figure 7. Lilac colors showing the places fulfilling the U%<11.25% condition for yarn in bobbin form for the second feasible region

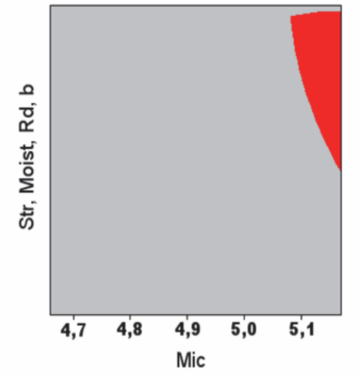


Figure 8. Second feasible region which is constituted by intersecting lilac areas with U%<11.25% condition for yarn in bobbin form in Fig. 7

By reading backwards from the first feasible region in Fig.6 to Fig.5, it is seen that the values for fiber properties giving the U%<11.25% condition are [15]:

Mic : 4.68 – 4.72	SFI : 8.01-8.10
Mat : 0.948-0.950	Elg : 10.14-10.20
Len : 30.26-30.36	Tr_Cnt : 81.00-83.00
Unf : 86.36-86.51	Tr_Area : 2.40-2.47

By reading backwards from the second feasible region in Fig.8 to Fig.7, it is recognized that the values for fiber properties giving the U%<11.25% condition are [15]:

Str : 30.29-33.08	Rd : 67.24-70.76
Moist : 7.74-9.52	b : 8.10-9.06

Yarn in cop form

The response surface drawings and contour lines for yarn in cop form are given in Fig. 9.

The same procedure is conducted for yarn in cop form as for yarn in bobbin form and Fig.10 is obtained. When the contour lines are intersected on top of each other, it is noticed that all properties which are Mat, Len, Unf, SFI, Elg, Tr_Cnt, Tr_Area, Str, Moist, Rd, and b versus Mic intersect in one feasible area colored in red in Fig. 11, coinciding with U%<12.2%. Even the mean value for U% is 12.0243% for yarn in cop form in Table 2, U%<12.2% condition is chosen because nearly half percent of the data possessed a value less than 12.2% in a normal distribution curve. The difference between mean (12.0243%) and condition (12.2%) is statistically insignificant (p=0.243), also proves that the data is distributing normal.

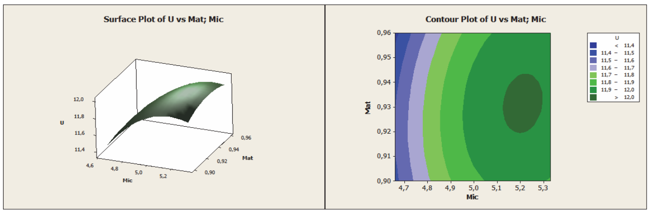
By reading backwards from the feasible region in Fig.11 to Fig.10, it is identified that the values for fiber properties giving the U%<12.2% condition are [15] :

Mic : 4.66-4.73	Elg : 9.83-10.08
Mat : 0.931-0.940	Moist : 8.33-9.00
Len : 29.35-29.68	Rd : 68.35-69.65
Unf : 85.27-85.90	b : 8.29-8.61
SFI : 7.34-7.68	Tr_Cnt : 65.00-75.00
Str : 30.56-31.40	Tr_Area : 1.57-1.86

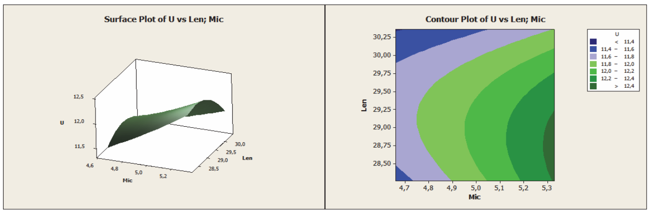
We can discuss these results in two ways :

- If a new cotton fiber lot arrives the ring yarn spinning factory and Ne20-19.21T/inch yarn will be produced from it, we can check the HVI results of that special lot one by one with the list above, and if the values of the new lot are between the limits given above for yarn in bobbin and cop form, we can say that the yarn produced will have U%<11.25% for bobbin and U%<12.2% for cop. If one or more property falls out of these limits, we can read backwards from Fig. 4 for bobbin and from Fig. 9 for cop and conclude what the U% will be in the new produced yarn;
- If a country has a system where every bale has its own HVI results tested and stuck on it in a central warehouse and we order bales from there, then we will order the bales with the limits given above, furthermore, we will order bales with such HVI values that we would achive an even better U%.

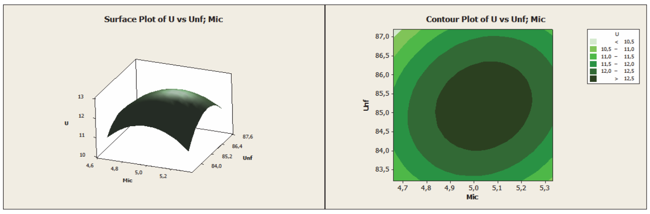
In this paper, only one yarn property (U%) is studied, but the same work can be done for different yarn properties such as yarn count, twist, tenacity, breaking elongation, yarn irregularity (CVm%), hairiness, product of yarn count and tenacity multiplication (CSP), constant of variation of count (CV_C%), constant of variation of twist (CV_{Twist}%) constant of variation of tenacity ($CV_{Tenacity}$%), and imperfections (piece/km), comparisons of these properties, ring and rotor yarns, fabric properties, different machine settings, etc. The effecting variables can be chosen from the point of view of the important properties, it can be worked with less or more effecting variables to perform feasible regions. In choosing the effecting variables, the opposite can be done, so that the yarn properties can be the effecting variables, a fiber property may be the response variable, and the feasible regions can be acccomplished vice versa, and the production can be started by knowning what will be reached at the end, therefore the advantages of this work is obvious. The originality of this concept is that if all this work will be incorporated into a comptuer program for statistical quality control, then the same research will be done for every different yarn property and for every fiber lot arriving the factory. New feasible regions will occur in due time, when the factory will make different settings in machines or renew machines in downstream they will compare the changes in the feasible regions and conclude if the new ones help for good or bad. The developed computer program can also be used in many different industrial applications. Other evaluative comments for the feasible region may come in due time.



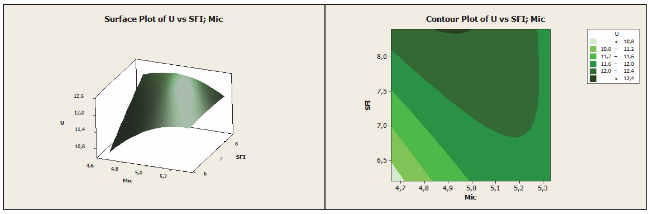
a) U% versus fiber fineness and maturity index



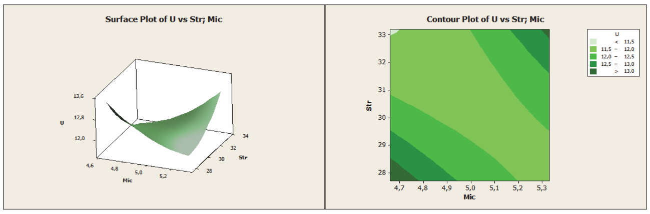
b) U% versus fiber fineness and length



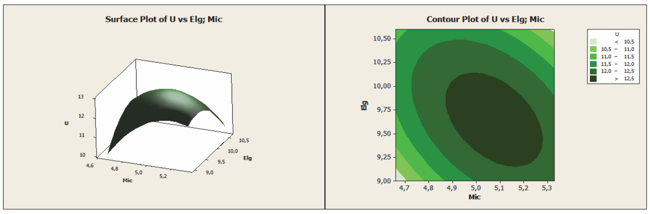
c) U% versus fiber fineness and fiber length uniformity index



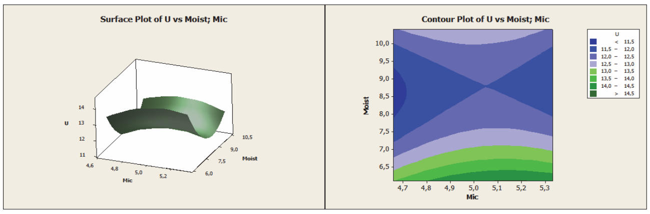
d) U% versus fiber fineness and short fiber index



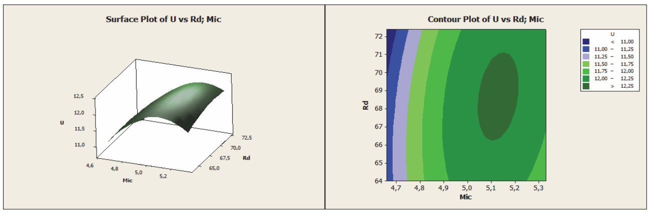
e) U% versus fiber fineness and fiber breaking strength



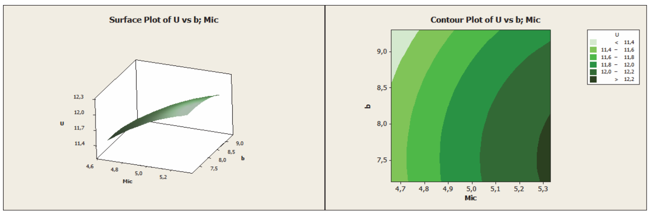
f) U% versus fiber fineness and fiber breaking elongation



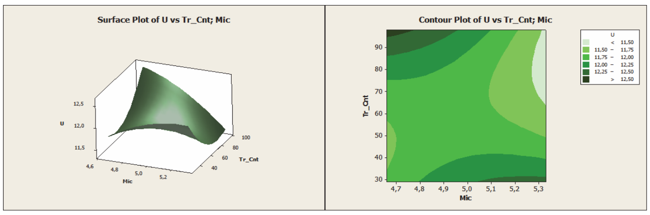
g) U% versus fiber fineness and moisture content



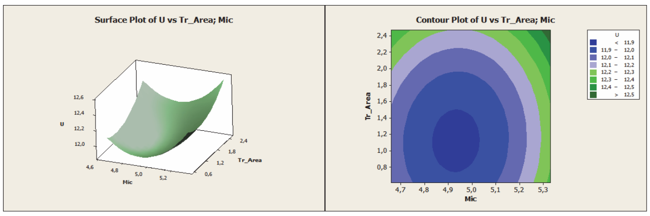
h) U% versus fiber fineness and reflectance



i) U% versus fiber fineness and yellowness



j) U% versus fiber fineness and trash count



k) U% versus fiber fineness and trash % area

Figure 9. Yarn in cop form, response variable irregularity in U%, versus various fiber properties, response surface drawing (left) and contour lines (right)

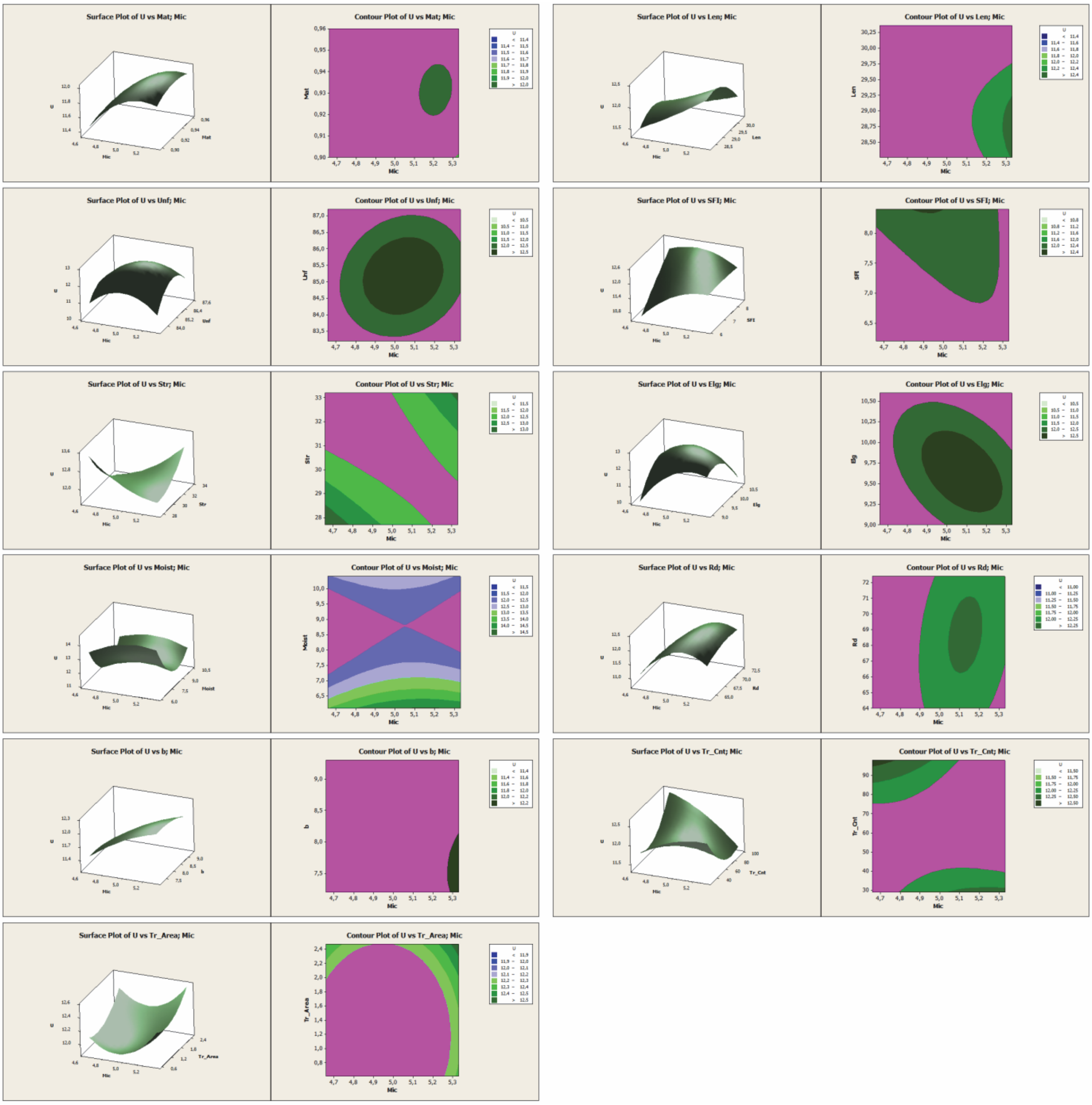


Figure 10. Lilac colors showing the places fulfilling the U%<12.2% condition for yarn in cop form

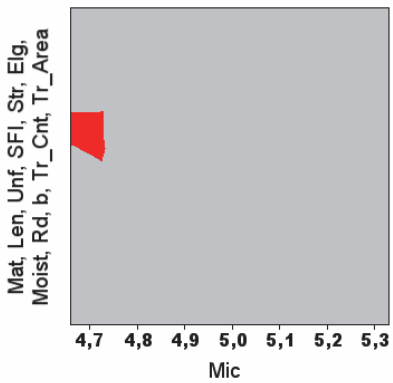


Figure 11. Feasible region which is constituted by intersecting lilac areas with U%<12.2% condition for yarn in cop form

CONCLUSION

It is proposed for the first time in textile literature that response surface designs with feasable region is an effective tool in prediction of a specific property of a product from the known properties of raw material, with a yarn irregularity exercise, in this paper. Our research mainly consisted of predicting yarn properties from fiber properties by means of data charts, regression, principal component analysis including varimax, artificial neural networks, response surface designs with feasible region, and discrimimant analysis [15]. All these methods except response surface designs with feasible region in quality control can be found in textile literature. It is presented here and is concluded that response surface method is important from the point that it contributes a quick, practical, and comprehensive tool for predicting properties of an end product.

The data used in this research is obtained from a company producing 100% cotton yarn in Uşak-Turkey, the company does these measurements regularly during their production, so the important point here is that real production data are used in this research, it is guaranteed that the results achieved from this research will be suitable for production.

Central composite design in MINITAB program is used to obtain the relationship between the response variable (U%) and effecting factors (fiber properties which are Mat, Len, Unf, SFI, Elg, Tr_Cnt, Tr_Area, Str, Moist, Rd, and b versus Mic) in 3D graphs as response surfaces both for yarn in bobbin and cop form. Our operation steps are :

- Obtaining the response surfaces and contour lines,
- Marking the places which have low U% value in lilac color,
- Putting the images on top of each other in the MATLAB image processing program,
- Intersecting the lilac colored areas,
- Achieving the red colored feasible regions.

We achieved feasible regions for U%<11.25% for yarn in bobbin form and U%<12.2% for yarn in cop form. When we read the borders of the feasible regions backwards, we reach the limits of the fiber properties for both the yarn in bobbin form at U%<11.25% and in cop form at U%<12.2%. The main logic here is the same as in other prediction methods where we have a set of known data and work to reach an unknown variable, here we do the same with response surface method and reach the unknown variable.

Feasible regions contribute information in two ways, first, comparing the new arrived HVI results of the fiber lot with the limits achieved with this work, or find the new U% value with the HVI results of the new fiber lot; second, if a country has a system where every bale has its own HVI results tested and stuck on it in a central warehouse and we order bales from there, then we would order the bales with the desired limits, furthermore, we would order bales with such HVI values that we would achive an even better U%.

In this paper, only one yarn property (U%) is exercised, but the same work can be done for different properties of textiles. The effecting variables can be chosen from the point of what is aimed at the end, it can be worked with less or more effecting variables to perform feasible regions. The production will be started by knowning what will be reached at the end. The originality of this concept is that if all this work will be incorporated into a comptuer program for statistical quality control, then the same research will be done for every different yarn property and for every fiber lot arriving the factory. New feasible regions will occur in due time and other evaluative comments for the feasible region may come in due time. That developed computer program can also be used in many different industry branches.

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