DEVELOPMENT of a MULTI-PURPOSE SOFTWARE for the DESIGN of FIGURED WOVEN FABRICS

A Thesis Submitted to the
Graduate School of Natural and Applied Sciences of
Dokuz Eylül University
in Partial Fulfillment of the Requirements for
the Degree of Master of Science in Computer Engineering

by
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February, 1999
İZMİR

M.Sc. THESIS EXAMINATION RESULT FORM

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ACKNOWLEDGEMENTS

My biggest thanks go to Prof. Dr. Güngör BAŞER and Assoc. Prof. Dr. Alp KUT, who are the advisers of this thesis. They provided feedback in all phases of this study. They listened and helped me with great patience. I would like to thank for their help, great effort and unlimited tolerance.

My greatest thanks to all my friends who helped me with this study.

At last but not least thanks to my family.

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ABSTRACT

The automation and the need of being a learned society as the result of latest developments in technology at this time when we are entering the years of two thousands have already changed the sight of textile industry appreciably. This development has not yet been completed and gives the signals that it will gradually increase. Weaving industry which is one of the most important areas in textiles, takes its place also in this change.

Another important sector of the years 2000s is the computer sector. This sector which is only 55 years old has already put its signature on the second half of the 20^{th} century and has got its just share in the textile industry.

The computer that is the most powerful apparatus of modern technology is increasing its influence today in the design field, too. Multi sided benefits can be gained by the computer in the physical and aesthetic design of fabrics. The structural design of a fabric can be realized by assigning numerical values to basic fabric parameters defining the structure. The computer through a suitable algorithm may do the selection of the values to be assigned to the design variables that satisfy the objectives related to the function of the fabric. The appearance of the fabric whose structural design has been achieved may also be obtained successfully on the screen.

In this study the program developed to make the computer do the fabric design work with all its technical and aesthetic aspects leaving the user as little work as possible presents him a number of choices and makes him arrive at the best result with clear instructions at all steps. The choices are related to basic aesthetic and

physical fabric parameters such as fabric dimensions, fabric weight, type of weave, colour plans, type and count of yarns.

On the other hand, the designer has been given the opportunity of using the unlimited colour scale which the computer has. As a result of this the colouring problem in woven fabrics has somewhat been solved to a certain degree.

Lastly, to make fabrics with the aimed qualifications, cost calculation is also made according to the values which have been obtained by the technical design work carried out on the computer.

ÖZET

İkibinli yıllara gireceğimiz şu sıralarda teknolojideki son gelişmelerin sonucu olan otomasyon ve bilgi toplumu olma gereksinimi tekstil endüstrisinin görünümünü oldukça değiştirmiştir. Bu değişim henüz tamamlanmış değildir ve giderek artabiliceğinin işaretlerini vermektedir. Tekstilin en önemli alanlarından biri olan dokuma endüstrisi de bu değişim içinde yerini almaktadır.

İkibinli yılların bir başka önemli sektörü ise bilgisayar sektörüdür. Henüz 55 yılını doldurmuş olan bu sektör yirminci yüzyılın ikinci yarısına imzasını çoktan atmış ve elbetteki tekstil endüstrisinde hakettiği yeri çoktan almıştır.

Çağdaş teknolojinin en güçlü aracı bilgisayar bugün tasarım sürecinde de etkinliğini gittikçe arttırmaktadır. Kumaşların estetik ve fiziksel tasarımında bilgisayardan çok yönlü olarak yararlanılabilir. Kumaşın yapısal tasarımı, yapıyı belirleyen temel kumaş parametrelerine sayısal değer vererek gerçekleşir. Kumaşın işlevine bağlı amaçları sağlayan tasarım değişkenlerine verilecek değerlerin seçimi uygun bir algoritma ile bilgisayara yaptırılabilir. Yapısal tasarımı gerçekleştirilmiş kumaşın görünümü de bilgisayar ekranında başarılı bir biçimde elde edilebilir.

Bu çalışmada kumaş tasarımının tüm teknik ve estetik yönleriyle bilgisayara yaptırılması için oluşturulan program, kullanıcıya olanak ölçüsünde az iş bırakarak çok sayıda seçenek sunmakta ve her aşamada açıklayıcı bilgiler ile en uygun sonuçları en kısa zamanda elde etmesini sağlamaktadır. Bu seçenekler kumaş boyutları, kumaş ağırlığı, örgü tipi, renk planları, iplik tip ve numarası gibi kumaşın temel estetik ve fiziksel parametreleri ile ilgilidirler.

Diğer taraftan, bu çalışma ile tasarımcıya, bilgisayarın sahip olduğu sonsuz renk skalasından yararlanma olanağı yaratılmıştır. Bunun sonucu olarak da dokuma kumaşlarda renklendirme sorununa bir ölçüde cevap verilebilmiştir.

Son olarak, istenen özelliklerde kumaş yapabilmek için bilgisayarda uygulanan teknik tasarım çalışmasıyla elde edilen değerlere göre kumaş için bir maliyet hesabı da yapılmaktadır.

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To The Memory of My Grandfather,

Osman GÖKÇE

CHAPTER ONE
INTRODUCTION

1.1. General structure and basic production methods of woven fabrics

Fabrics can be defined as all kinds of products, which are made by putting the textile fibres together to make a tissue with a smooth surface and uniform thickness, which is elastic and strong. Basic properties such as smooth surface, small thickness, elasticity, strength and covering properties show great variation depending on the fabric structure. Basic properties of woven fabrics can be understood better if three basic methods of fabric production - weaving, knitting and non-woven methods – are considered together, because they make different kinds of fabric.

Weaving is an ancient technique to make up a fabric by the intersection of two sets of yarns at right angles to each other. These sets of yarns, namely the warp and weft are interlaced with each other in a certain manner to form a structure which must be stable and uniform. The manner in which warp and weft yarns are interlaced together by passing over and under each other is called the **weave**. Such a structure is known as a **woven fabric**, but there are other ways of obtaining a fabric. A **textile fabric** may, essentially, be considered as a sheet of fibrous material with a uniform surface and a rather soft and flexible structure. Therefore it is possible to form fabrics directly by fibres having the above mentioned properties. Such fabrics are called **non-woven** fabrics. The method of knitting, however, achieves the formation of a fabric structure by joining sets of yarn loops by passing each newly formed loop over a previous one. Whatever method has been used to form a fabric, a certain degree of

cover must be provided on the fabric surface, because a textile fabric has the primary function to cover surfaces such as of a human body, furniture, floor etc. The structures like fishnets with insufficient cover and like a wire mesh with no flexibility will not conform with the definition of a textile fabric.

In woven and knitted fabrics the cover is obtained by the yarns lying on the surface of the fabric. Stability, on the other hand, is obtained by the structural character of the weave plus the **density** or **sett** of the yarns on the fabric surface. Uniformity is, however, obtained, by the orderly arrangement of interlacings of the yarns in the weave and by the perfection of the actual weaving process.

A final requirement for a fabric, especially for those that are woven, is the **strength** and **elasticity**. A fabric must stand up to various strains during use and should also recover from deformations after the deforming effects are removed.

Weaving is also an art, and a very ancient art too. The way the warp and weft yarns interlace form certain patterns on the fabric surface. These weave effects impart the fabric different appearances and will also be the source of a certain texture on the fabric surface. Surface texture will affect the handle and certain physical properties of the fabric, such as moisture absorption, warmth, air permeability etc., as well as fabric appearance. Thus, surface texture is also considered as an aesthetic property.

The basic principles of weaving can be explained in the following way:

In order to form a woven fabric structure one set of yarns, namely the warp, must be prepared and placed on the weaving machine, called the **loom,** as a sheet of parallel yarns under some tension. The weft yarn is, then, to be inserted in between the warp yarns at right angles in a way to make the required interlacing. To achieve this, warp yarns have to be separated into two groups, one group being above the other, thus forming a gap in between through which the weft yarn can be placed by a certain means. This gap is called the **warp shed** and the means used to insert weft may be a **shuttle** or some other instrument. The formation of the fabric is achieved by the loom with the application of the following five basic motions:

1. *Shedding*: Separation of the warp yarns into two sheets.

2. *Weft insertion (picking)*: Insertion of the weft between the warp yarns.

3. *Beating up*: Pushing the weft in between the warp threads to be entrapped in the cloth structure.

4. *Warp let off*: Feeding in of the warp by letting off the warp beam.

5. *Cloth take up*: Drawing of the fabric to be wound on the cloth beam.

The first three of these motions are the main motions for the fabric formation and the last two are complementary motions to ensure the continuation of the weaving process under stable conditions. Beating up motion is affected by the forward movement of the reed through, which the warp yarns have previously been passed. It is so synchronised that the beating up action takes place when the shed just starts to change and thus at the completion of this motion the weft is entrapped between the warp yarns in the cloth structure. Let off motion is a feeding action whereas cloth take up means the production of the cloth.

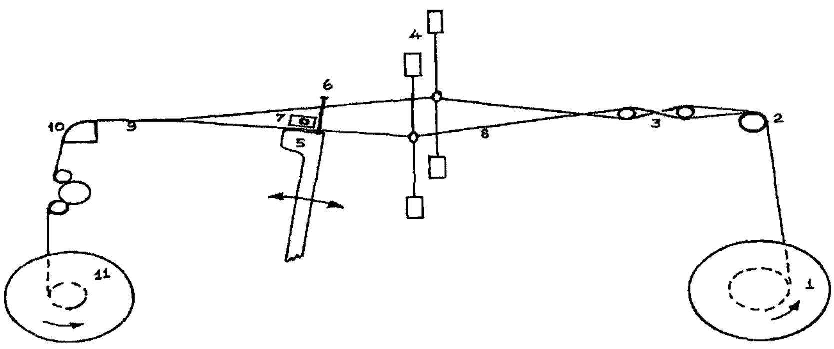


Figure 1.1. Loom Schema (1.Beam 2. Loom back rest 3. Crossed heald 4. Heald shaft 5. Loom sley 6. Reed 7. Shuttle 8. Warp 9. Fabric 10. Loom front rest 11. Cloth beam)

1.2. Theory of design

In design of woven fabric, as it is in many industrial products, there should be a harmonious relationship between the physical structure and the aesthetic aspect. The design achieved should be technically producible, in other words the technical possibilities should be adequate for the production of the designed fabric. It is especially so for a figured fabric in that the figure characteristics and the design capacity of the weaving loom should be matching. In the light of the above statements, a **design** can be described as a selection from a series of choices for the determination of physical and aesthetic properties of the finished product. The design work should, also, include the preparation of the production data. In order to attain the correct or suitable choice, the relationship between the fabric properties and the production data should be fitting at an adequate level. More important than this, however, is the condition that the structural fabric properties defined by assigning them selected values should give the required fabric performance properties such as strength, weight, aesthetic appearance etc. Moreover, the selected values defining the fabric structural properties should also fit the following criteria:

1. The set of data selected should be limited.

2. The values representing the design should be in harmony with each other.

3. The choice should fulfil the basic aims of the design.

1.2. Kinds of design

1.3.1. Technical design

Technical design is the determination of the technical properties of a fabric, which would give the required quality or performance properties in usage fitting the aim of the design. This can be stated as raw material properties, dimensional, and structural properties.

1.3.2. Aesthetic design

The surface appearance and other visual properties, which have an influence on human brain, are important in addition to the physical properties of the fabric. These properties appear as the results of colour, form and texture. Consequently, we can define the aesthetic design of a fabric as the determination of visual properties such as colour, form and texture effects [Başer 1979].

There are three parameters affecting the aesthetic design:

1. Raw material

2. Fabric weave structure

3. Colour plans applied on yarns

As a first step to an aesthetic design a coloured design or a simulation of surface appearance of the fabric is prepared. This will determine the surface design of the fabric in terms of colour form. The structural properties of the fabric will, then, be determined so as to produce these effects. The design work will also include the finishing methods to impart properties such as brilliance, hairiness and the clarity of design on the fabric surface.

1.4. Fabric analysis

The analysis of a sample fabric is widely used in industry as an approach to fabric design. As a result fabrics are generally produced according to a given sample as a reproduction of it. A fabric is either made as an exact reproduction of the sample fabric or as a resemblant of it. In both situation a correct and successful analysis of the fabric is needed. The following are the steps in fabric analysis:

- *Fabric Weave:* The way the warp and weft yarns are interlaced to build the fabric structure is called the weave. The sort of weave affects the sett, which is thread density, the thickness and the weight of the fabric. The weave type is, on the other hand, a parameter which affects the mechanical properties and the inner and surface structure of the fabric.

- *Warp sett on the loom:* The warp sett is the warp density on the reed.

- *Weft sett on the loom:* Weft sett is the pick density between the temples in front of the reed on the fabric surface which is in a tight state on the loom.

- *Length of warp:* It is the total length of warp which is necessary to produce a definite number of cloth rolls that make a production lot.

- *Number of ends:* It is the total number of warp ends which take place within the fabric width.

- *Warp plan:* It is a plan which displays the order of warp yarns along the width of the fabric when yarns of different raw material, count, colour and effect are used.

- *Weft plan:* As the warp plan, it is a plan showing the order of weft yarns along the length of the fabric.

- *Colour plan for warp and weft:* These are the plans showing the order in which yarns of different colours are used. If the yarns are also of different type as regards to kind, count etc., the warp and weft plans are arranged as colour plans as well.

- *Denting:* It is a plan showing the way warp yarns are passed through the dents of the reed. For example it will show how many warps are passed through each dent.

- *Reed width:* This is the width of the warp sheet on the loom which is equal to the length of the pick inserted into the shed.

- *Drafting plan:* It is a plan showing the order in which the warp yarn are passed through the heald eyes on the heald shafts.

- *Pegging plan:* It is a plan showing the movements of the heald shafts in the shed through successive pickings.

- *Fibre type: Fibre m*aterial such as cotton, wool, silk, polyester etc.

- *Fabric unit weight:* It is the weight of unit area of the fabric like g/m^2.

1.5. Surface design in woven fabric

Fabric is a product, which is presented to individuals and societies as clothing or household goods such as table covers, carpets and curtains. Weaving gives the fabric surface a special property called **surface texture**. In woven fabrics different kinds of weaves give different surface textures. These surface textures reflect the light to different directions creating various appearances or effects. The bright or mat appearance of colours on surface depends on the surface structure created by the weave and also on the raw material used.

Fabric drape, which is the bending property of the fabric surface or **pile** on carpets and velvets give special texture effects that change the appearance. These properties named **texture** effects add aesthetic qualities to a fabric.

1.6. Structure of woven fabrics

The weave structure of the woven fabrics come into being by the interlacings made by the warp and weft yarns being perpendicular to each other in the fabric plane. Thus at any point in the fabric plane where a warp yarn intersects with the weft yarn one of them is over the other. The weave structure thus formed repeats itself in both warp and weft directions after a certain number of picks and ends respectively. These repeating parts of the fabric structure which is called the weave unit or the unit weave can be shown diagrammatically on point paper. Each row of squares of the unit weave shown on point paper represents weft yarns and each column a warp yarn. Every square on the weave unit is a point of intersection of a warp with a weft and if the warp is up on that point a cross sign is put in the square or the square is filled in, otherwise it is left blank which shows that the weft is up. Therefore it can be said that in mathematical terms a weave unit is a matrix with elements taking the values of either 1 or 0,1 showing that the warp is up. This makes the weave structures to be generated and manipulated quite easily in the computer space.

1.6.1. Plain weave:

The simplest weave is the plain weave in which the warp and weft yarns are over and under on successive squares in either way. It is a structure being formed by maximum number of interlacings in a given area. Plain weave is widely used in cotton fabrics as sheetings and print cloth and in lightweight wool fabrics used as summer suitings. It gives the strongest and thinness structure because of maximum number of interlacings provided which allows low sets to be applied without weakining the structure.

1.6.2. Twill weaves:

In twill weaves warp or weft yarns pass over more than one yarn making floats of two or more which run across a diagonal line on the fabric surface. This diagonal line may make angles different from 45 degrees according to the type. These twill lines also give rise to ridges on fabric surface. In simple twills given in Figure 1.1 each float is displaced in the adjoining float by one square on the point paper design and this is called a step of one. If the adjoining float is displaced by more than one square up or down then steep twills will be obtained and this will be called a step of two or more. Figure 1.2. shows steep and flat twills.

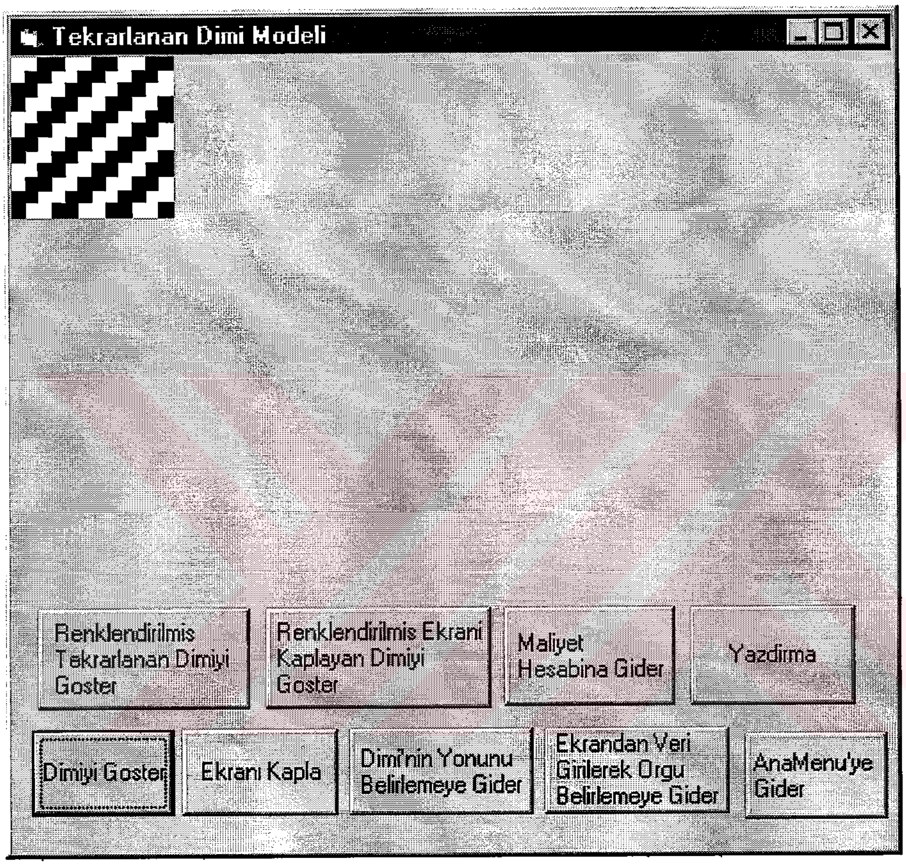


Figure 1.2: 2/2 Right Twill Weave with step 1.

The twill weave gives an elastic fabric structure and because of fewer interlacings in a given fabric area the fabric may be woven with a higher sett and thus a heavier and thicker fabric will be obtained. When a higher sett than normal is applied in the weave this will push the yarns out of fabric surface by jamming the adjacent yarns and thus fabric thickness will increase. The elastic structure of twill fabrics makes them resistant against sudden stretches. Because of this structure twill weaves are widely used in suitings and in particular in fabrics used in trousers.

Steps of two or more can be applied in both warp and weft directions. Flat twills are obtained when stepping is applied in the weft direction. On the other hand when the normal step of one or higher steps of two or more are applied downwards in developing the weave on point paper the twill lines running from right to left upwards will be obtained. Such twills are named as left twill while the normal twills are named right twill Figure 1.3 shows some examples of these.

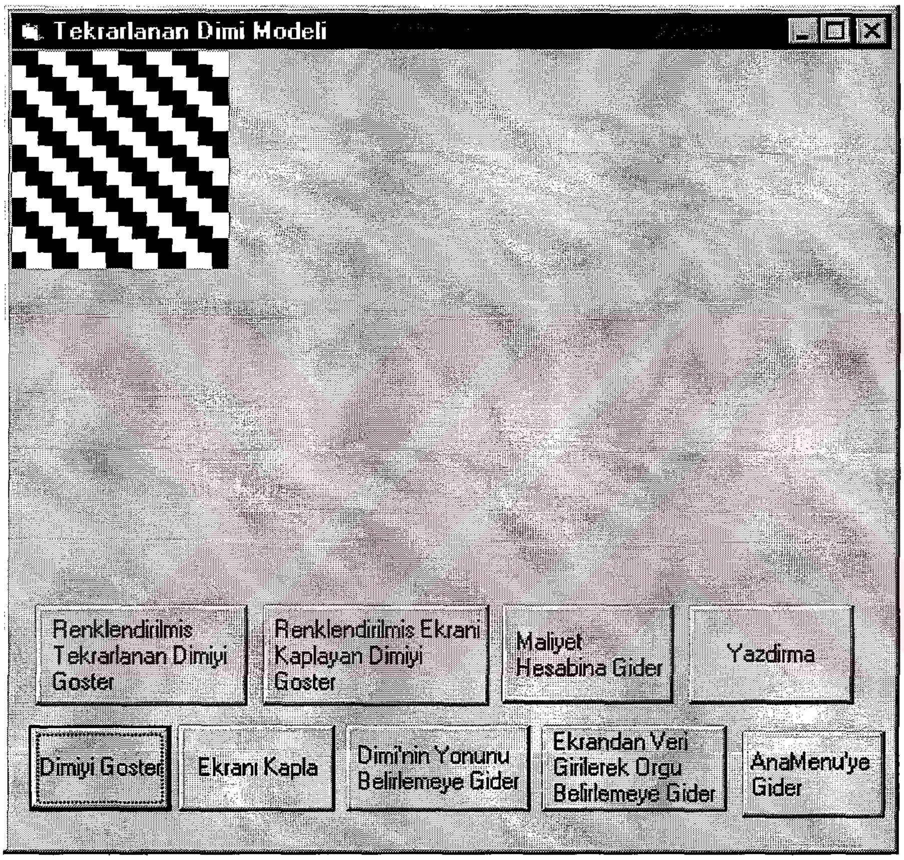


Figure 1.3: *2/2 Left Twill Weave with step 1.*

If instead of the interlacings used such as 2/1, 2/2, 3/1, 3/2, 3/3, ½, 1/3, 2/3 etc. used in simple weaves, interlacings or intersections consisting of varying floats of 1, 2, 3 etc. in both warp and weft are used in combination, then fancy twill are obtained. These intersections called fancy intersections can be expressed in the manner as 3-2-1-2 etc. In the first, third, ... floats in the series show the warp floats and the second, forth, ... the weft floats. Figure 1.4a and Figure 1.4.b show some examples of fancy twills.

	X	X
X	X	
X		X

2/2

		X
	X	
X		

½

	X	X	X
X	X	X	
X	X		X
X		X	X

3/1

Figure 1.4a: Fancy Twills

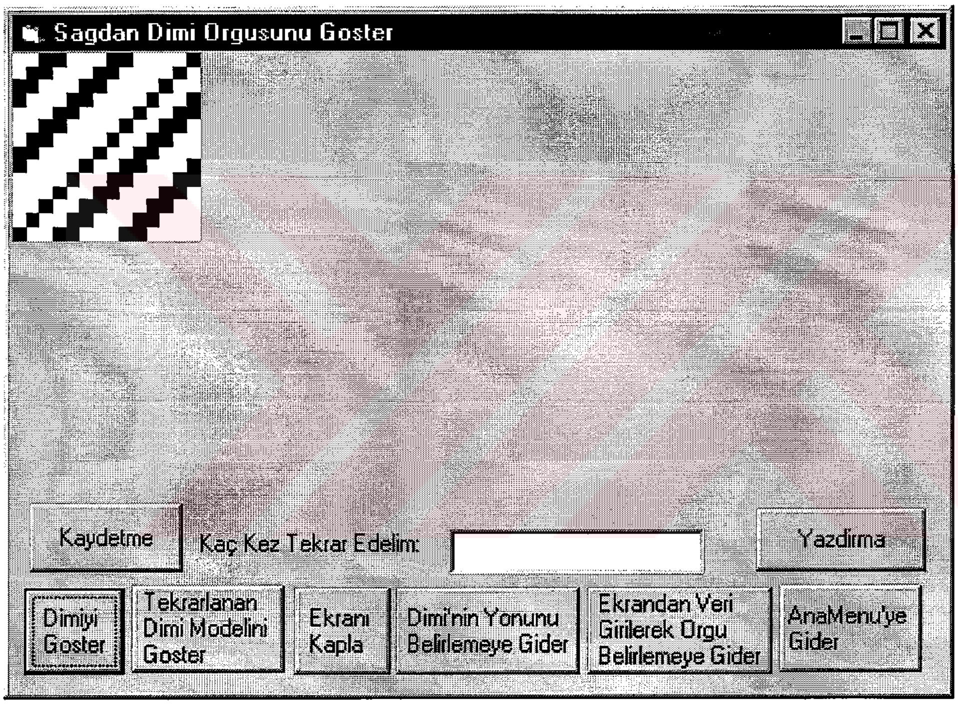


Figure 1.4b: 1-4-2-3-2-2 Fancy Twill

Another type of twill weaves is the herring bone which is formed as a combination weave by using a left and right twill weave unit of the same warp weaves dimension side by side. There can be simple and fancy varieties of the herring bone weaves as shown in Figure 1.5a. and 1.5b. The herring bone arrangement is used widely in striped fabrics. In this case the floats of the left and right twill along the line joining the two weave sections are arranged so that the warp floats of one will be against the weft float of the other which gives what is called as a clean cut effect. Thus the adjoining line of the two weave sections becomes more distinct.

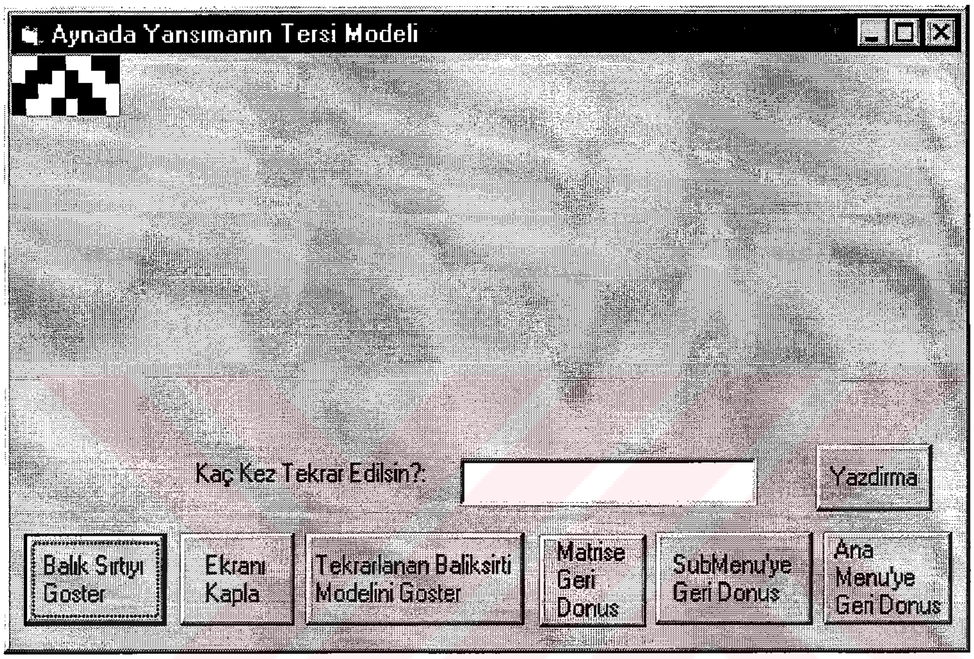


Figure 1.5a: Clean cut effect

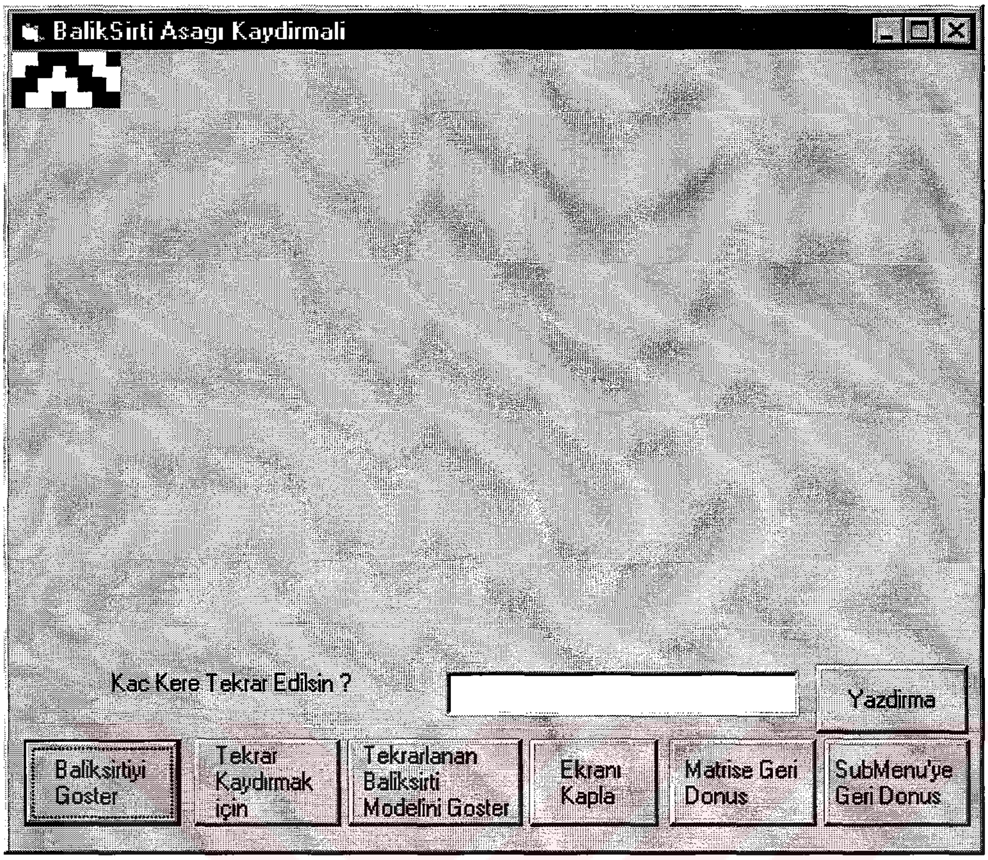


Figure 1.5b: Zigzag effect

1.6.3. Satin and sateen weaves:

They are weaves in which every warp or weft yarn in the weave repeat interlace at one point only. If the weave has warp face with long warp floats it is called a satin if it has weft face with long weft floats a sateen weave. The points of interlacings will be arranged by applying steps of two or more as in twill weaves but the step applied should not be a factor of the weave size. Figure 1.6 shows example.

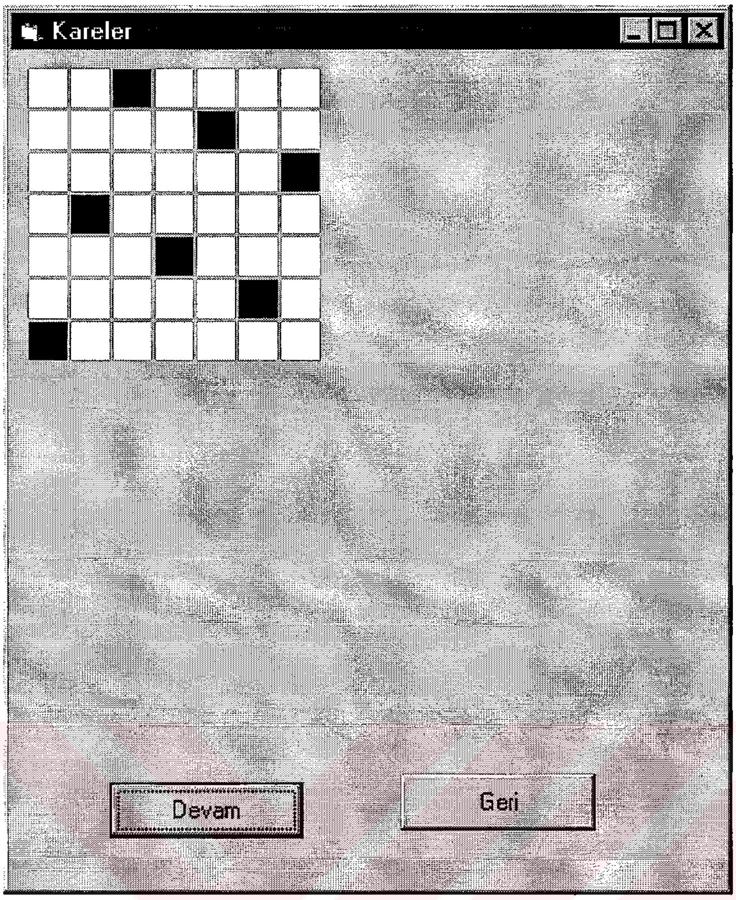


Figure 1.6: Sateen Weave which contains seven things

1.6.4. Basket or matt weaves:

These are plain weave derivatives in which the groups of warp and weft floats form square areas and are arranged as in a checker board. Here also simple and fancy interlacings are used to give various matt weaves as shown in Figure 1.7.

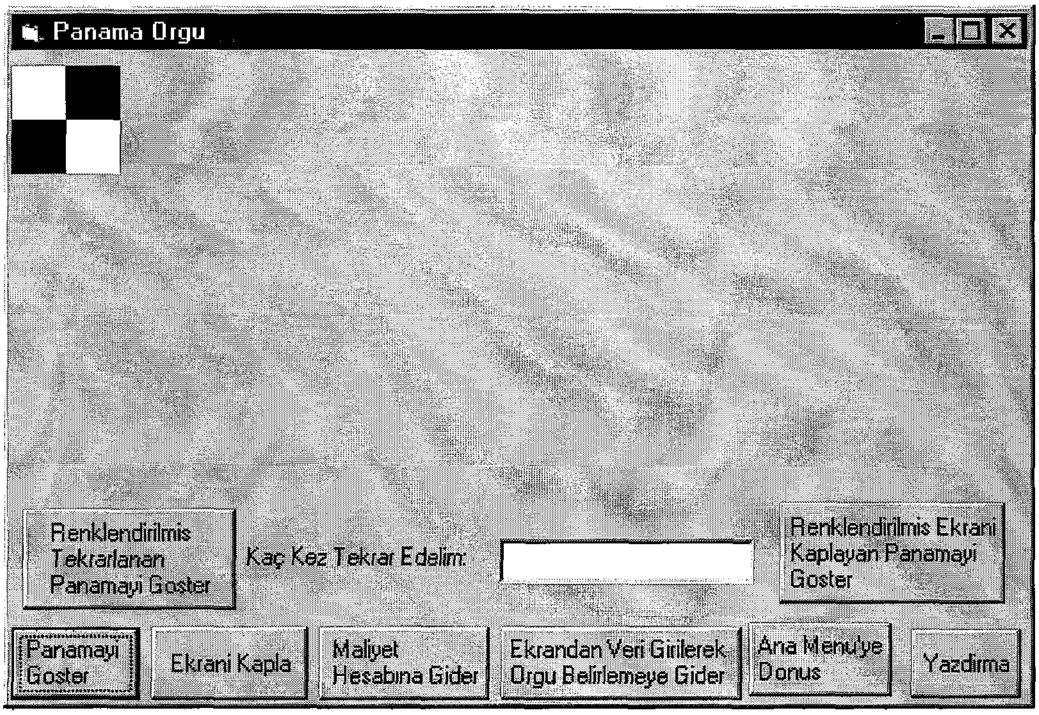


Figure 1.7: 4/4 Basket Weave.

1.6.5. Check weaves:

When four weave units are arranged as in a checker board then we obtain a check weave. If a weave A and a weave B are used to obtain a simple check weave the possible arrangements are show in Figure 1.8. More than two weaves and more complex arrangements may be used to obtain fancy checks.

1.6.6. Diced weaves:

These group of weaves are like small size check weaves where the adjacent sections are the mirror images of each other, that is the marks in one change to blanks in the other and the first intersection in one becomes the last in the other. Some well known examples are shown in Figure 1.9: these weaves give soft, porous, slack structures to obtain fancy fabrics with good permeability properties without endengering fabric stability.

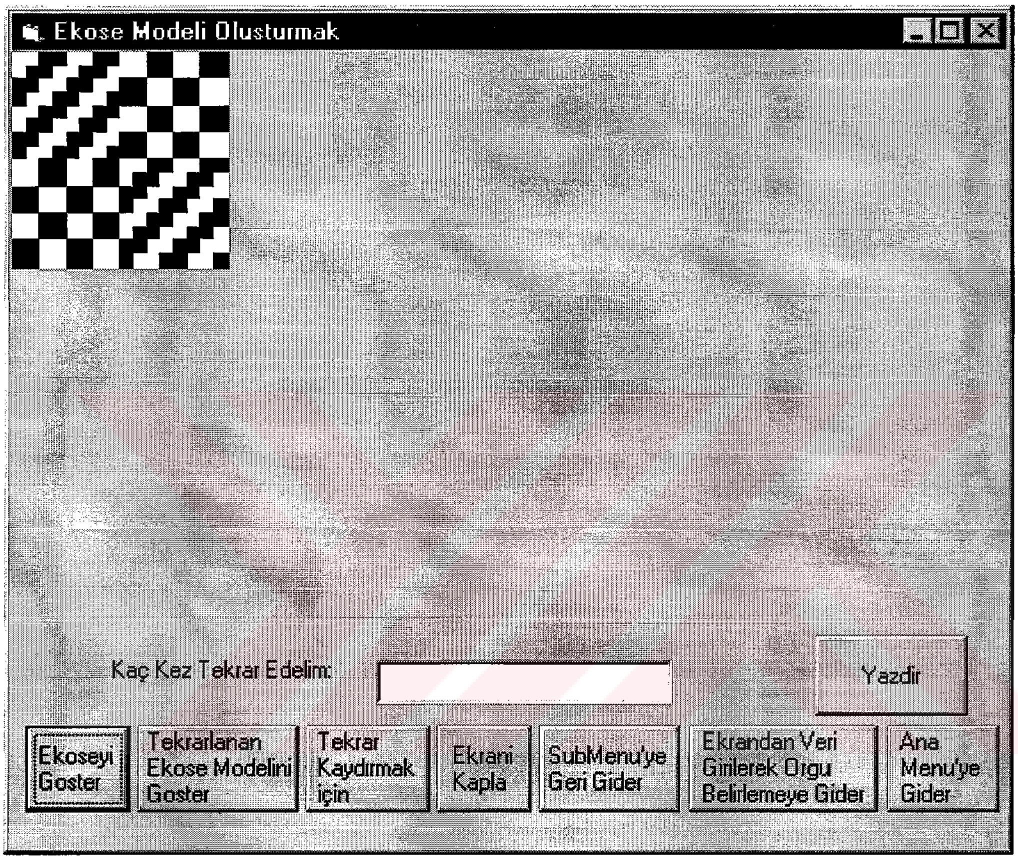


Figure 1.8: Check Weave (2/2 Basket and 2/2 Twill)

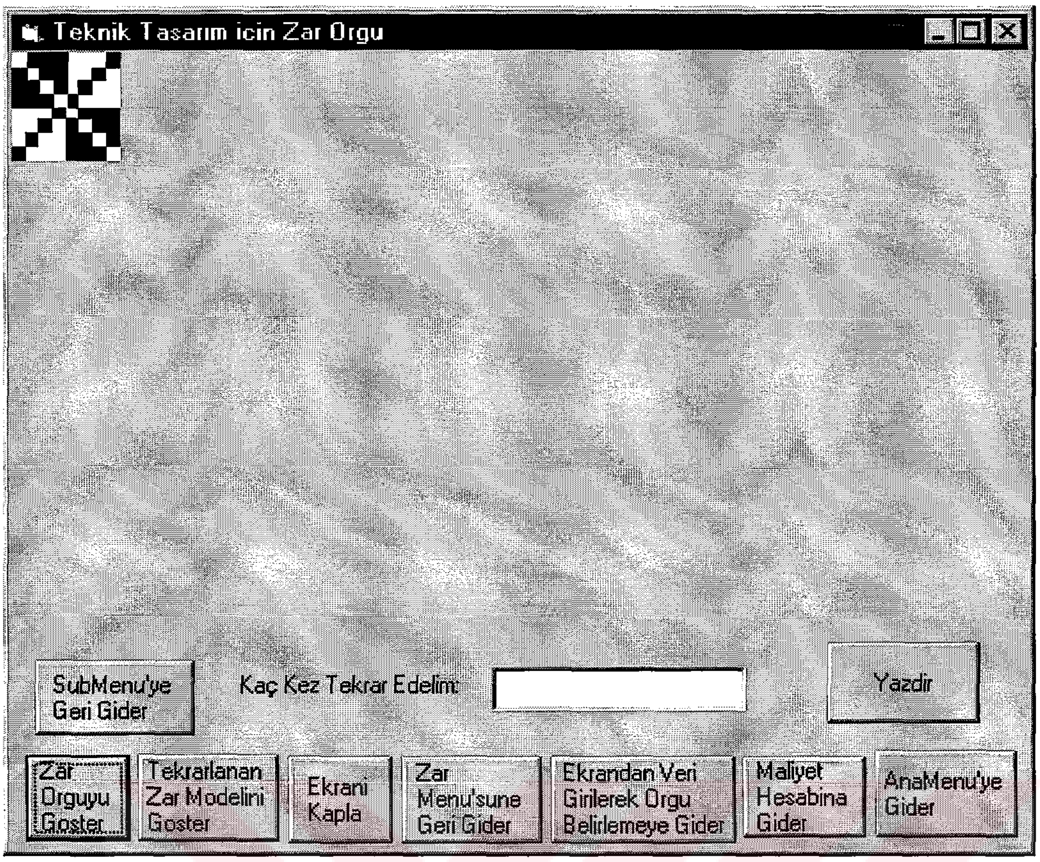


Figure 1.9: Crow Diced Weaves

1.7. Aim of this study

We are about to enter the 21st century and all industrial sectors make use of computers and their conveniences. The textile sector also has given great importance to computer applications in recent years.

Nowadays there is much activity in computer applications showing itself in design areas. The appearance of a fabric whose design has been done can be seen on a screen immediately and successfully. But as mentioned before aesthetic and structural design should be carried out together in harmony. The surface appearance of a designed fabric on the screen does not have much use except for marketing purposes. It does neither mean that a fabric is producible when its aesthetic design is obtained on a computer screen. In figured fabrics in particular, because of some technical reasons that will be explained later, the relationship between the aesthetic design and the structural design of a fabric is complicated and obtaining a harmony brings some problems too. One of these problems is the sufficiency of quality properties and the other is the cost.

The aim of this study is to design single fabrics with colour and figure effects having the required agreement between its aesthetic and technical properties by means of computer and to translate the design into the weaving language and to see the prime cost as well.

In this study a program has been developed to make the computer do the fabric design work with all its technical and aesthetic sides and to make the user do little work by presenting him a number of choices to make him arrive at the best result as soon as possible with clear instructions at all steps. The choices are related to basic aesthetic and physical fabric parameters such as fabric dimensions, fabric weight, type of weave, colour plans, type and count of yarns.

The aim of this study is to develop software which also enables the design of a single figured fabric as good as possible, both aesthetically and physically, in spite of certain restrictions.

In designing the fabric the solution is reached by trying the alternatives until the requirements are fulfilled. Naturally these experiments need the precious time of the designers and the fabric producers if actual fabrics are to be produced. The first advantage of computers can be seen at this stage. The alternatives may be created and tested without doing an actual production. Another advantage is to see the harmony of colours of yarns on the screen – as a computer has unlimited colour capacities and to apply them at once. Besides a computer has the advantage at reaching the most suitable solution by making iterations at a great speed.

Very different kinds of fabric can be designed by means of a computer. Another advantage of this is to see the best appearances of fabric although it may not be the most proper one. In this way the aesthetic appearance of the fabric can thus be decided on. It will then be possible to start the production immediately using the computer. Great speed can be attained with figured fabrics and also the designer can make the necessary changes with the figures when he sees them on the screen and he is so free that he can use his artistic talents unlimitedly.

1.8 Previous studies

♦ In 1992 design of a single woven figured fabric was performed aesthetically by means of a computer as a diploma dissertation work by Volkan ÇİTİMOĞLU who was a student of Textile Engineering in E.Ü. In this programme, three methods – extra warp, extra weft and weave combination methods – were employed. Keeping the figure in the recording medium, preparing the figure on the screen, enlargement and moving were nested in the program. With the help of the program pegging and drafting plans could be obtained, estimating production parameters and obtaining the approximate visual appearance of the fabric on the screen could be achieved. Furthermore the following advantages can be obtained with the help of this program:

1. The design procedures are accelerated and loss of time is reduced.

2. Figures with large dimensions can be prepared easily and quickly by means of the program.

3. It is possible for the designer to see the alternatives on the screen and to decide for a better fabric appearance.

4. Production parameters can be calculated quicker and more precisely by the iterative nature of calculations at computer speed.

But when the program is studied thoroughly some week points and drawbacks can be observed such as:

1. Return functions are not included between procedures, which is important in using the programme with flexibility.

2. Colour palette is limited and it is impossible to see the colour on the screen before use, because the colours are entered by their names.

♦ Another study was a diploma dissertation work done in 1996 by Umut ÇIMRIN who was a student of Textile Engineering in E.Ü. In this study values are obtained, firstly, by technical design method to produce a fabric with the aimed specifications, and then the cost of this fabric is calculated according to these values. This program has some drawbacks, too,since.

1. The production parameters which should be made changeable are fixed in the program and it is impossible to update them later.

2. The visual effect of the aesthetic design cannot be seen on the screen.

♦ In the doctorate thesis that belongs to Levent HEKİMOĞLU (1984), the physical design of woven fabric has been studied and in the former parts of the study, mathematical approach for solutions of both physical and aesthetic design has been put forward.

♦ Apart from these theoretical studies, design improvising and visual software are being used widely in Türkiye and all over the word.

♦ One of this software is ‘ 4D-BOX ’ design programme that has been improvised by JUN CO LTD. PXE PROJECT and it is very easy to perform. In this program, designer transfers the design from the paper or something to the screen by using the electronic pen. Designer may want to turn or to change or to shrink the design. This program provides possibilities in these events.

CHAPTER TWO

METHODS AND MATERIALS

2.1. Physical properties of fabrics

We can examine these properties in four groups:

1. Structural properties
2. Mechanical properties
3. Sensory properties
4. Permeability and conductivity properties

2.1.1. Structural properties

Cloth width, cloth length, weave, cloth thickness and cloth sett are the basic structural properties of a fabric. The fabric weight can also be mentioned as a structural parameter as it is widely used instead of thickness, which is a very important dimensional property. These parameters that are called the technical properties in industry affect the other physical parameters which show the performance of fabric in use. These are mostly the mechanical properties of fabrics.

2.1.2. Mechanical properties

Breaking strength, breaking extension, tearing strength, bending resistance, bursting strength, resistance to rubbing, crease resistance, resistance to wrinkling, bending rigidity, wear resistance are the mechanical properties which are related to the performance of fabric in use and which also specify its quality.

Mechanical properties of a fabric are properties that can be measured by various testing methods and thus can be expressed by numbers. They are the result of elastic properties of fibres and are affected also by structural properties of yarn and fabric such as yarn count, weave type and the fabric sett. Since a thick yarn will be strong, the fabric made of such a yarn will also be strong. Since the fabric strength is the resultant of yarn strengths the higher the sett (warp and weft) the higher the fabric strength will be. Although the relationships between the fibre properties and mechanical properties of fabrics are rather complex, they can approximately be expressed in mathematical terms.

2.1.3. Sensory properties

These are the properties such as softness, fabric drape and handle. They are the result of complex combinations of bending and frictional properties. They are usually judged subjectively by handling, touching and visual observation but these are also methods proposed to make objective measurements of them by testing. These properties also are related to the fibre properties as well as the structural properties of both yarn and fabric.

2.1.4. Permeability and conductivity properties

There are two kinds of permeability, namely water and air permeability. Although these properties are directly related to the fabric thickness, water permeability depends greatly on surface structure as well. The air permeability, on the other hand, is related to the amount and distribution of spaces within the fabric. Thus the weave structure has great influence upon them. Equally important are the fabric sett and yarn structure.

Thermal conductivity depends on the thermal properties of fibre and the fabric thickness. The amount of still air within the fabric volume is important because stagnant air transfers heat rather badly. Absorption of body sweat by the fabric also depends on the same factors and is very important for bodily comfort.

The electrical properties of a fabric such as electrical conductivity and chargeability with static electricity are important and depend mostly on fibre properties.

2.2. Chemical properties of fabrics

These are properties which are direct results of fibre properties. These are properties such as dyebility, washability, resistance to air, water, light, acids, bases and to solvents, soiling, staining etc.. These properties make the selection of raw material in the design work important.

2.3. Aesthetic properties of fabrics

There are also visual properties of fabrics, which affect its surface appearance and also the impressions that they create in human brain, apart from the technical properties defining fabric behaviour in usage. The visual properties of a fabric are important properties that should be taken into account in textile design work, from the point of view of their usage both in the interior of buildings and also as suitings because they have an effect on the person and on the surroundings that the person live in.

Visual characteristics show up themselves as aesthetic values which are formed by the components of colour, form and texture together. From this angle the artistic and technical works which create the colour, form and texture values of a fabric can be defined as the aesthetic design of fabric [Başer 1979].

2.3.1. Aesthetic design parameter

The yarn and fabric properties, which affect the colour, form and texture values that create the surface appearance of a fabric, can be termed as design parameters. The first of these is the raw material and it affects the basic properties of the colours obtained on the surface of the fabrics such as hue, tone, brightness and purity. On the other hand, the yarn type will influence the state of fibrous layer on the fabric surface and the measure of light reflecting power of the fabric.

The two most important parameters which affect aesthetic properties in woven fabrics are the weave and the colour plan. The weave is the most important factor in the formation of the surface structure as well as in forming the basic fabric structure and texture. In woven fabrics a smooth and slippery surface can be obtained as well as surfaces, which have indentations, cells, pores, roughness and puckers by using different weave structures. Moreover in obtaining figure and effect designs, use is made of weave arrangements and use can also be made of the "Colour and Weave Effects" by the application of colour plans.

2.3.2. Surface Planning

Surface planning and colour design work is a first step in aesthetic design, which defines the surface appearance of a fabric from only the point of view of colour and form. As a second step, the finishing properties of the fabric will be determined also from an aesthetic point of view. These are the characteristics such as hairiness, brightness and the clarity of design that have to be a achieved on fabric surface which will be defined by the finishing routine that shows the order and duration of finishing processes to be applied.

2.4. Coloured and figured fabrics

2.4.1. Basic structure of coloured and figured fabrics

Fabric weave is the basic structure of woven fabrics. In order to obtain an aesthetic surface appearance on woven fabrics use is made of various colour and figure effects. The methods of obtaining these are generally based on three basic ideas. These are:

To obtain figure effects by using different weaves in the design unit according to a certain plan, which involves making use of different tone effects provided by different weaves.

To obtain colour effects by using warp and weft yarns of different colour to obtain an effect, which is a combination of the weave and yarn colour called as "Colour and Weave Effect" or is a combination of various classical colour and weave effects in accordance to a certain colour plan.

To obtain figure effects created by the floats of extra yarns by using these extra yarns in warp and weft directions.

The method employed in this work to obtain figure effect is the method of using weave combinations. In this both in ground and figure areas the same warp and weft yarns are used but the weaves used in these areas are different. By the contrast that this creates the figure contour is obtained. For example a right twill weave of same type may be used in the figure whereas a left twill weave may be used in the ground.

2.5. Woven fabric structure and physical design relations

The parameters defining the relationship between the structural properties and design of woven fabrics are as follow:

1. Yarn diameters

2. Yarn densities

3. The weave

These may be called structural parameters. Besides these, the properties such as yarn twist, bulkiness, hairiness and softness are other structural parameters, which influence the inner and surface structure of a fabric in various degrees. The ways of influencing design by these basic structural parameters are the main problems of physical design work.

2.5.1. The effect of yarn diameter

The yarn diameter influences the yarn densities to be used with a given weave with the condition that a balanced and stable fabric structure is obtained; and it is also the most important factor in determining the fabric thickness and unit weight in relation to the yarn densities employed. As the yarn diameter decreases (as the yarn becomes finer) a denser fabric can be woven, but as the yarn diameter increases the fabric thickness and unit weight will also increase.

Since the yarns in the woven fabric structure are in a compressed state, it will be necessary to use the coefficient K which defines the effective yarn diameter in the formula $d=1/K\sqrt{N}$ where d is the diameter and N is the yarn count. According to Ashenhurst this coefficients is 7,9 for worsted yarns, 7,3 for woollen yarn, 8,3 for cotton and like yarn in the metric count system [Başer, 1998].

2.5.2. The effect of yarn setts

The yarn setts influence the cover which the yarns provide on the fabric surface as well as they affect the fabric thickness and unit weight. The cover obtained on fabric surface is important because of the fact that it affects fabric properties such as heat transfer, air and water permeability and handle. On the other hand, depending on yarn diameter and fabric weave the structure of fabric which has not been woven at adequate setts will not be stable. The fabric will contract from both length and weight in use or some surface defects will develop.

The crimp factors which are determined by the weaving and finishing contractions have great role in fabric design work. This should been determined on the bases of experience or certain methods of calculation [Başer 1983].

As the setts increase the fabric weight will also increase proportionally. Moreover, with increasing setts fabric becomes harder both as inner structure and also as surface property; the yarns go out of fabric plane of symmetry and the fabric becomes thicker by the overlapping of the yarns. These phenomena are also closely related with the weave structure of the fabric.

2.5.3. The effects of fabric weave

The weave type affects the setts and the fabric thickness as well as fabric unit weight. The weave type is also a parameter which, by determining the inner and surface structure of the fabric, affects fabric mechanical properties. As the sett increases the fabric unit weight will also increase. As the number of floats in the weave increases the possibility of weaving a tighter fabric increases because of the number of threads coming side by side.

2.6. Relationship between fabric structure and aesthetic design

It had already been stated that the aesthetic value of a woven fabric was created by the elements of colour, form and surface texture. Let us now, examine how the structural properties influence these factors and also the interactions between these three factors as influenced by structural parameters.

2.6.1. The creation of colour value in woven fabrics

The application of colour in woven fabrics is done in two different ways, namely as single colour or more than one colour. There are great differences between two applications because the colour effects obtained by employing more than one colour create form effects as well in certain cases.

Colour is applied to make fabrics more attractive and this is usually more effective than form. Very interesting colour effects can be obtained by the application of a suitable colour plan to a simple weave. On the other hand, if colours and colour plans are not well selected, the form elements may lose their effects completely [Watson 1954].

The effect of weave is limited in affecting the brightness in single colour applications. Nevertheless, in multi colour applications the weave takes up a greater aesthetic function. Some of the colour and weave effects are shown in Figure 2.1 obtained by the application of weave and colour plans together. These are the colour and weave effects obtained with plain and twill weaves which give form effects of hairlines, step, star, square and spot effect.

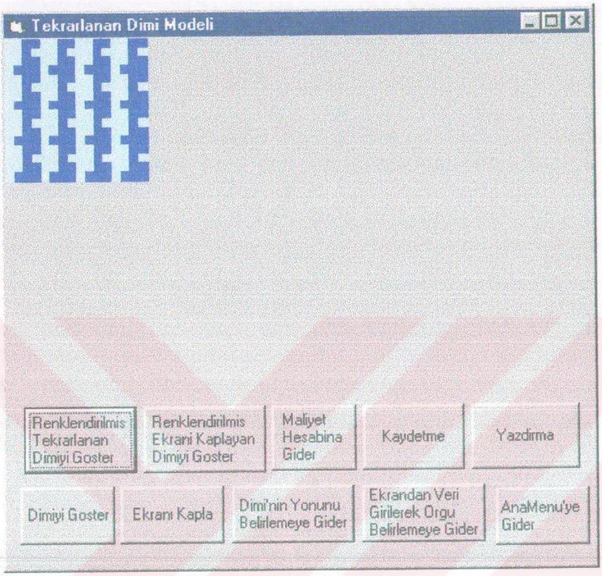


Figure 2.1a: Warp Hairlines Effect with 2/2 Twill Weave.

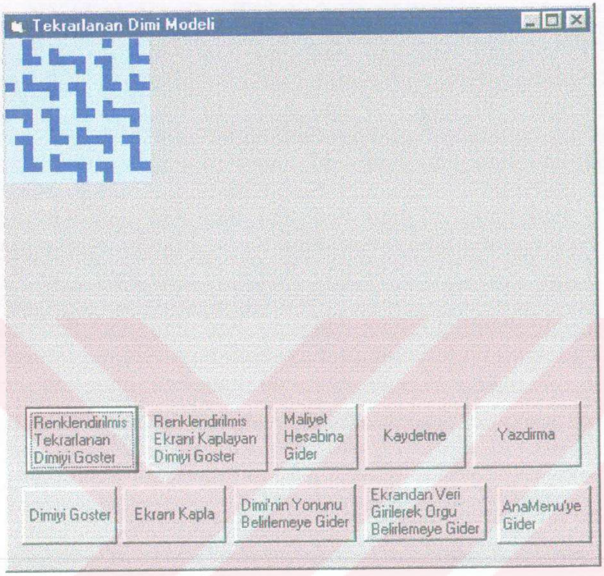


Figure 2.1b: Step Effect with 2/2 Twill Weave.

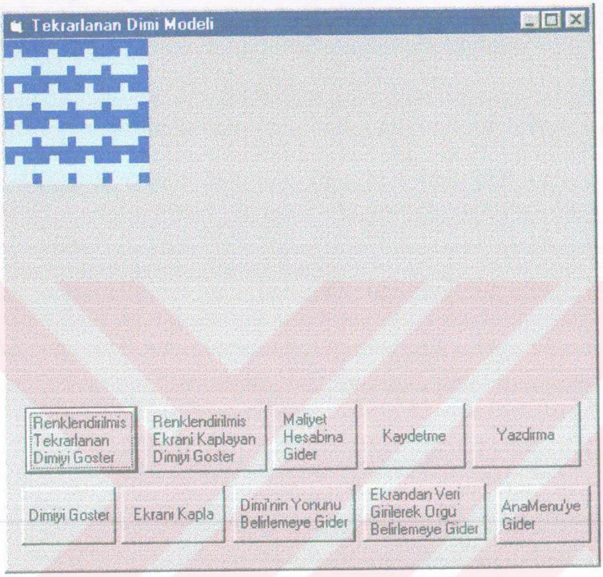


Figure 2.1c: Weft Hairlines Effect with 2/2 Twill Weave.

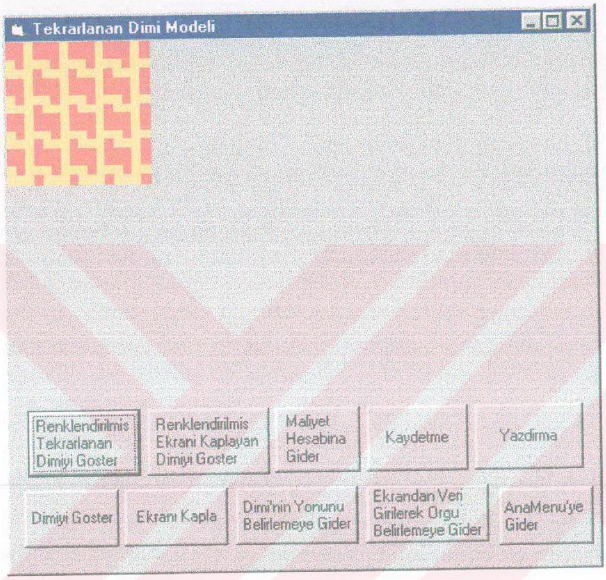


Figure 2.1d: Spot effect with 2/2 Twill Weave.

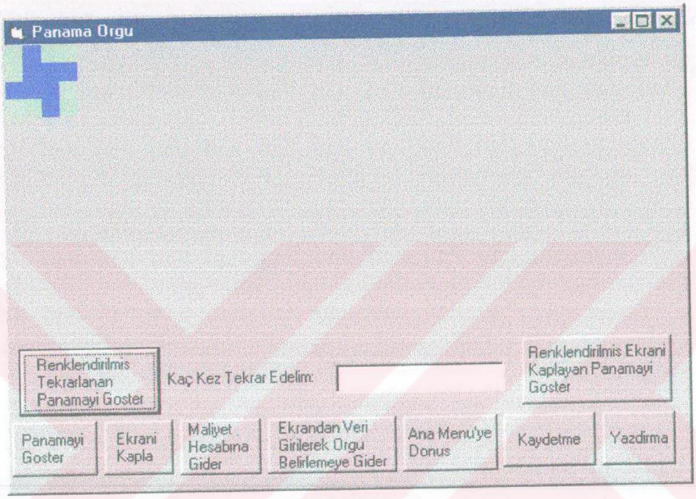


Figure 2.1e: Star Effect with 2/2 Basket Weave.

Figure 2.1a ,2.1b,2.1c,2.1d,2.1e: Coloured Weave Effect

2.6.2. Development of form values in woven fabrics

The form element in woven fabrics shows itself in various arrangements starting from the simplest visual effects up to complex compositions consisting of figure in varying colours.

In principle the areas defined by different weaves on a fabric surface will define a figure area having a contour. The more the weaves in combination are different from each other, the more distinct will the effect be, but as the weave factors of different weaves are different it will became difficult for them to make a balanced fabric structure. From these points of view, weaves which are similar in structure but opposite in the effects they create may be selected.

2.6.3. Development of texture values in woven fabrics

Surface structure is a design factor determined by the yarn type, weave, yarn setts and finishing processes applied after weaving. The increase in sett is a factor which accentuates the characteristic surface structure created by the weave.

Both in coloured design and also in figured fabrics the surface structure produces a structural value or texture, which is specific for the woven fabrics when combined with colour and form factors. We may call this as imparting depth to fabric, a third dimension to design [Başer 1984] .

2.7. Design problems in figured fabrics

Although the appropriate weave type can easily be decided on for simple fabrics taking into account the required mechanical properties and surface structure in the light of the explanations made up to now, in figured fabric certain design problems will come out. These are:

1. Providing figure size

2. Providing a clear contour to the figure

3. Providing surface smoothness

4. Providing stability of the figure

2.7.1. Factors determining figure size

In woven fabrics the two important factors limiting the figure size are the design capacity of the loom and the warp sett applied. The yarn diameter and weave type is other limiting factors for the figure size as they affect the sett.

To create the figure both the warp and weft yarn will make certain movements. The movements will be repeated after a certain number of yarns have been used in both directions. In a certain drafting system the pegging plan which determines the movement of the heald shafts may be developed freely and thus a figure of the required size is obtained in the warp direction. The width of the figure in weft direction, on the other hand, depends on the number of the warp movements provided by the loom according also to the method of developing the figure. In extra warp structures by using one extra warp for two ground warps and also by selecting the extra warp yarns coarser it is possible two enlarge the figure in the weft direction. This may be applied with the extra weft structure to enlarge the figure in the warp direction.

2.7.2. Factors effecting contour clarity

The contour clarity of the figure depends upon the number of yarns used in the figure area and the fabric sett. As the number of yarn used and the sett are increased the figure becomes clear. Especially the cross and curved lines on the figure contour will became neater as the number of yarns is increased, but this will necessitate more warp yarn movements meaning a greater design capacity of the loom.

2.7.3. Factors determining the surface smoothness of the figure

To obtain a figure with smooth surface a weave which is either warp dominant or weft dominant is used in the figure or a weave which has increased sett in one direction to enable the warp or weft to be seen more on the surface may also be used.

This is especially the case in coloured figures which are obtained by the warp and weft effect. The surface smoothness in fabrics on which the figures are obtained by extra yarns may involve the following problems to be solved:

If the floats of the extra yarns are too long there will be puckering in the figure because of tension differences between the ground and extra yarns. This is more so with course extra yarns. A second problem will be that when the extra yarn floats are long the figure surface will not have adequate stability in use. In this case the long floats are broken at suitable points by interlacing them to the ground weave. But this will give rise to the ground colour to become visible in figured area. By selection of suitable yarn counts for the extra yarn and using the interlacing as a factor of ornamentation suitable solutions are obtained [Başer, 1979].

2.7.4. Factors determining figure stability

As mentioned above long floats used in figured sections of the fabric and inadequate sett decreases the fabric stability and wear. Long floats of yarns have small resistance to rubbining and they may also come out of the fabric structure when they are caught by human or metal nail and by similar objects. This will cause destruction and wear of the fabric. The same happens when figured fabrics are woven with a low sett.

Consequently, whatever is the method the design work is a work of synthesis. It involves multi solutions by making selections from many more alternatives. Thus the success of the design work will be evaluated by a comparison of the solution with the aim of the design. From this angle, design works must be carried out as a work to find many alternatives instead of one solution which requires continuous research and experience [Başer 1984]

2.8. Computer approach in solving design problems

As the aim of a design work is to make a choice of the suitable alternatives worked out that will form an aimed product, it is necessary to see if the assigned values to structural parameters are suitable for product performance properties or design aims. If not, it will be necessary to make new assignments until a suitable solution is reached. If this process is formulated as an optimisation problem, a computer can find solution to this problem by suitable algorithms in a reasonable time. The iteration can be continued by giving new values to reach a suitable solution. The algorithm may be based on mathematical optimization or a simulation approach. So a computer will help a designer, by making the iteratif calculation, to choose the most suitable one from amongst a series of fabrics in a short time. It usually will take a very long time for a designer to reach a satisfactory solution by conventional methods without using a computer. A computer provides a designer with great possibilities about the aesthetic design of a fabric. By obtaining fabric appearance for different weaves and colour plans on the computer screen, a choice can be made without weaving a patterned fabric [Başer, 1994].

Whatever the designing method is, the basic problem in designing of a fabric is to decide on the design parameters – which are the finished properties of the fabric with characteristics suited to the aim. But because of the variety of these parameters and complex relationships between them care should be taken to select an appropriate set of design parameters that are compatible with each other as well. In other words, the validity of the solution should be studied thoroughly. On the other hand, as in all designing problems, the solution will be numerous. So an approach to find the most suitable solution will only be possible by an effective method or by studying the first solution and doing the necessary changes on it. The advantage of computers for such calculations, which are done again and again, is clear.

In textile factories, fabric designs are generally prepared by artists or planners. In some situations, technical problems are overlooked and technical men remove the difficulties which occur during the actual production, by taking some practical precautions. But sometimes these precautions do not work because of wrong designing and inadequate performance qualifications and they may cause unnecessary costs and faulty products.

Computer programs may enable a routine calculating method to reach at a suitable solution by making the necessary corrections at all levels. On the other hand various alternatives can be tried by using these computer programs and control mechanisms can be built in the programme to ensure the validity of the solution, that is to guarantee that the fabric specified by that solution will provide the required quality level, performance characteristics and producibility.

2.9. Technical design approach

2.9.1. Relations between fabric weight, yarn counts and yarn setts

In technical design approach it is usually required to design a fabric to give a certain unit weight which often governs the use of the fabric.

Considering that yarn counts and sett are kept the same, W (weight per square metre) in terms of N (metric count) and S (sett) is:

$$W = (2 * k * S) \div N \quad g/m^2, \; k = \text{constant} \qquad (1)$$

Here weft sett, warp sett and counts are assumed to be equal. Also, k is a coefficient about the crimps of yarns, which is above and around 100.

However, the sett value is important from the point of maintaining fabric strength and use of mechanised weaving. Therefore, the relation between yarn count and weave is stated by setting theories, in general, as

$$S = F_w * K * \sqrt{N} \qquad (2)$$

Here;

F_w = The effect of weave to sett, a value smaller than 1.

K = A coefficient specifying the effect of yarn type to yarn diameter.

N = Yarn count

Using the equalities (1) and (2), yarn count can be found by the formula:

$$N = (2 * k * K * Fw \div W)^2 \qquad (3)$$

2.9.2. Weaving calculation

The numerical values required for weaving a fabric should be calculated from values specifying the fabric design. The calculations done for this purpose are called weaving calculations.

The abbreviations used in weaving calculations are given as follows:

ET = Reed width in cm.

EK = Fabric width in cm.

A1, A2 = Width contractions in weaving and finishing respective by as percentages.

CTS = Total number of warp ends

COZSIK = Warp sett in ends per cm.

ATSIK = Weft sett in picks per cm.

BDGTS = The number of warp yarns passing from a single dent

LC = Warp length in m.

LK = Fabric length in m.

B1, B2 =Length contractions in weaving and finishing as percentages.

WA = Weft weight in g.

WC = Warp weight in g.

C1, C2 = Percentage weight losses

GRM = Weight per unit area in g per meter square.

NA, NC = Weft and warp counts as metric counts.

Weaving calculations using this data are shown below.

2.9.2.1. Reed width

$$ET = (EK * 10000) \div [(100 - A1) * (100 - A2)] \qquad (4)$$

2.9.2.2. Total Number of ends

$$CTS = COZSIK * EK \qquad (5)$$

2.9.2.3. Reed number

$$TN = (CTS * 10) \div (ET * BDGTS) \quad (6)$$

2.9.2.4. Warp length

$$LC = (LK * 10000) \div [(100 - B1) * (100 - B2)] \quad (7)$$

2.9.2.5. Weft weight

$$WA (gr) = ((100 - C1) * ET * LK * ATSIK) \div (100 * NA) \quad (8)$$

2.9.2.6. Warp weight

$$WC (gr) = ((100 - C2) * LC * EK * COZSIK) \div (100 * NC) \quad (9)$$

2.9.2.7. Weight per unit area

$$GRM (gr / m^2) = (WA + WC) \div (EK * LK) \quad (10)$$

2.9.3. Verification of the appropriate yarn count for a given weight

Let us remember the formula (3) calculated before:

$$N = (2 * k * K * F_w \div GRM)^2 \quad (11)$$

In this formula, k is a coefficient e.g. k=115. In this case,

$$2 * k = 230$$

If we put this value in the above formula, yarn counts for weft and warp yarn will be:

$$NA = (K * 230 * F_w \div GRM)^2 \qquad (12)$$

$$NC = (K * 230 * F_w \div GRM)^2 \qquad (13)$$

2.10. Developing a computer program to accomplish the technical design and to calculate fabric cost

2.10.1. The algorithm of technical design

The following values are fed in to the program.

F_w = The weave factor

K = A coefficient varying according to yarn type

VA, VC = Tightness factors for weft and warp

EK = Fabric width

GR = Required weight per unit area

LK = Required fabric length

A1, A2 = Width contractions in weaving and finishing

B1, B2 = Length contractions in weaving and finishing

C1, C2 = Weight losses

This program aims at evaluating the necessary information for the fabric to be woven using this data. Meantime, fabric specifications are obtained, which would provide a fabric to resemble the required fabric through the use of the available technology as much as possible. The values determined as target functions and specifying the properties of the planned fabric are as follows:

TN = Reed Number as number of dents per 10 cm.

WA = Weft weight

WC = Warp weight

NA = Weft count

NC = Warp count

CTS = Total number of warp ends

ATS = Total number of weft ends

COZSIK = Sett of warp

ATSIK = Sett of weft

GRM = Weight per unit area

ET = Reed width

LC = Warp length

YEK = Fabric width

BDGTS = The number of warp yarn passing from a single dent

In this program, the design value tolerance for weight is ±5%, and tolerance for fabric width is ±1 cm. as accepted (Başer 1984).

In cases when the deviation exceeds 5%, the following procedure is followed according to whether the weight is greater or smaller.

GRM 5% Less	GRM 5% More
1. NC = NC – 1	1. NC = NC + 1
2. NA = NA – 1	2. NA = NA + 1
3. ATSIK = ATSIK + 0,5	3. ATSIK = ATSIK – 0,05
4. NC = NC – 1	4. NC = NC +1
5. NA = NA – 1	5. NA = NA +1
6. ATSIK = ATSIK + 0,5	6. ATSIK = ATSIK – 0,5
7. Y = Y + 1	7. Y = Y + 1

The operation done in step 7 is to acquire a more flexible approach increasing the 5% weight tolerance to 6%. If this does not work, the procedure is repeated from step 1.

As the double-fold yarn counts do not vary one by one, a change of 1 unit in yarn count is applied as a change of 2 units.

If the difference between the required fabric width and the produced fabric width is greater than 1 cm., it is tried to decrease this difference to below 1 cm. by increasing or reducing by FARK * COZSIK the total number of warp ends.

If the reed number is above 150, appropriate values of reed numbers are searched by increasing the number of warp ends through the dents by one.

2.10.2. Cost calculation algorithm

In the program, costs are classified as follows:

1) Weft material cost (TL / Kg) = ATMAL

2) Warp material cost (TL / Kg) = COZMAL

3) Cost of winding the weft (TL / Kg) =ATBOBMAL

4) Warp preparation cost (TL / m) = COZHAZMAL

5) Drafting cost (TL / 1000Ends) = THM

6) Weaving cost (TL / 1000Picks) = DOKMAL

7) Finishing cost (TL / m) = APREMAL

2.10.2.1. Weft and warp material cost

Before cost calculation, the material losses in preparation operations are added to weft and warp weights. The new weight values can be calculated by the formulas:

$$KWA = WA / (0{,}997) \qquad (14)$$

$$KWC = WC / (0{,}99) \qquad (15)$$

Here, KWA and KWC stand for the thus calculated weft and warp weights.

In the program, there are four separate subprograms as wool, cotton, single-fold and double-fold. By the input values at the beginning of the program, the suitable program from among these four is automatically selected. The yarn count obtained from the design calculations carried out by the computer is automatically selected from the price list, and weft and warp cost are displayed along with the price list.

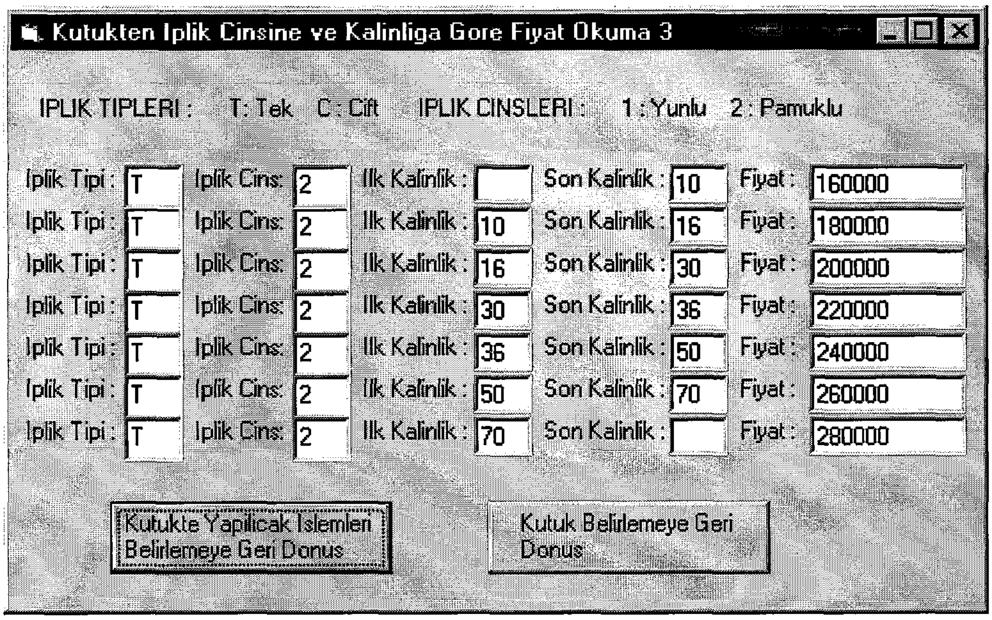


Table 2.1: Tables of the yarn cost for the type and thickness

Costs are then calculated as follows:

ATMAL = KWA * ATKIFIYATI (16)

COZMAL = KWC * COZGUFIYATI (17)

But costs are calculated for dyed (coloured) cotton as follows:

ATMAL = KWA * (ATKIFIYATI * 200000) (16)

COZMAL = KWC * (COZGUFIYATI * 200000) (17)

- In labour costs piece rate wage systems have been accepted and the unit prices been calculated accordingly as follows:

The minimum monthly payment of a worker is taken as 120000000 T.L.

The monthly working period is 25 days. There are 8 hours of work daily.

In a month, there are 25 * 8 = 200 hours of work.

(The weekly total working hour is 48 hours.)

The payment of a worker per hour is 120000000 ÷ 200 = 600000 T.L.

The monthly payment of a qualified worker is 150000000 T.L.

The hourly payment of a qualified worker is 150000000 ÷ 200 = 750000 T.L.

2.10.2.2. Cost of warp operation

2 normal workers are needed for warp preparation operation. Thus, the values found per man are doubled as two workers are involved.

Machinery speed = 800 m/min

Efficiency = 80% (Plain)

40% (Designed)

1000m. warp labour cost

For medium type CTS = 3000

(Designed) 800 * 60 * 0,40 * 3000 km/hour = 57600 km/hour

(Plain) 800 * 60 * 0,80 * 3000 km/hour = 115200 km/hour

Designed fabric unit price = 600000 ÷ 576000 = 10,4 T.L./km

Plain fabric unit price = 600000 ÷ 115200 = 5,20 T.L./km

For two workers⇒ Designed fabric unit price = 10,4 * 2 = 20,8

For two workers⇒ Plain fabric unit price = 5,20 * 2 = 10,4

TARC = Unit warp price

Warp Type	Section Number	T.L./1000m.
Direct	X	10,4
Sectioned (Cotton)	< = 5	20,8
Sectioned (Cotton)	> 5	22,9
Sectioned (Wool)	< = 5	22,0
Sectioned (Wool)	6 – 10	23,1
Sectioned (Wool)	> 10	24,2

Table 2.2. Warp cost table

Calculation = Total warp length (m/1000) * Unit price

Calculation = Total number of warp ends * Warp length * Unit price

<u>Warp preparation cost</u> = CTS * LC * TARC ÷ 1000 (18)

2.10.2.3. *Cost of drafting operation*

Warp Type	Total Number of Warp Ends	T.L.
Plain	< 3000	1080000
Plain	3000 – 5000	1200000
Plain	> 5000	1220000
Design	< 3000	1440000
Design	3000 – 6000	1600000
Design	> 6000	1760000

Table 2.3. Drafting cost table

2 workers are needed for this operation. Daily average is 8 drafting operations.

As one drafting will be done for each fabric produced, unit price is directly added to cost. (If fabric amount is too high, for example higher than 2000m., then this unit price value is repeated for every standard warp length.)

For example: If the standard warp length is 2000m. and fabric length is 8000m., then drafting cost is 8000 ÷ 200 = 4 times folded. (The results of division are to 1,2,3…)

2.10.2.4. *Cost of sizing operation*

Two workers are involved.

Speed = 500 m./min.

Efficiency = 90%

Hourly production = 500 * 60 * 0,90 = 27000 m.

Hourly cost = 600000 * 2 = 1200000 T.L.

Unit price = 1200000 ÷ ((27000 * 4000) ÷ 1000) = 11,11 T.L./km.

1km. = 1000m.

Sizing process cost = Warp length * Unit cost * Total number of cost ÷ 1000

<u>Sizing process cost</u> = (LC * TARC * CTS) ÷ 1000 (19)

Cost of starch = Warp weight * Sizing amount moved * Sizing material cost for kg.

<u>Cost of starch</u> = WC * 0,08 * 450000 (20)

Cost of sizing operation = Sizing process cost + Cost of starch

<u>Cost of sizing operation</u> = ((LC * TARC * CTS) ÷ 1000) + (WC * 0,08 * 450000) (21)

2.10.2.5. Cost of weft winding operation

Yarn Type	**Count**	**R%**
Cotton	<= 16	75
Cotton	> 16	85
Synthetic	—	90
Wool (Wlln.)	<= 8	65
Wool (Wlln.)	> 8	70
Wool (Wd.)	<= 30	75
Wool (Wd.)	> 30	80

Table 2.4. Efficiency table for weft winding

One worker serves 10 spindles.

Winding speed = 1500 m./min.

Hourly production = 10 * 1500 * 60 * R = 900R km.

900R km. of yarn winding with 600000 T.L.

Cost of weft winding = (Total number of picks * Reed width * 600000) ÷ (100000 * 900R) (T.L.)

Cost of weft winding = (ATS * ET * 600000) ÷ (100 * 1000 * 900R) (T.L.) (22)

2.10.2.6. Cost of weft pirn winding

It is done using the weft-winding table and it is used in the case of shuttle weaving.

One worker serves 10 spindles.

Production speed = 800 m./min.

Hourly production = 10 * 800 * 60 * R = 480R km.

Cost of weft pirn winding = (Total number of picks * Reed width * 600000) ÷ (100 * 1000 * 480R) (T.L.)

Cost of weft pirn winding = (ATS * ET * 600000) ÷ (100 * 1000 *480R) (T.L.) (23)

2.10.2.7. Cost of weaving

The number of looms one worker serves (Tsay)

Loom speed = (Thız) d/dak

Loom efficiency = (Rtez)

Hourly production = Thız * 60 * Rtez * Tsay ÷ 1000 (1000wefts/hour)

750000 T.L./hour = Labour payment

Cost of weaving = (Total number of picks * Labour payment * Unit price) ÷ Hourly production (T.L.)

Cost of weaving = (ATS * 750000 * TARD) ÷ (Thız * Rtez * Tsay * 60) (24)

For example: Tsay = 6

Thız= 340 d/min

Rtez = 0,85

Fabric type		**Unit Price Coefficient**
Plain	Fine	1,05
	Coarse	1,00
Design	Basic, Fine	1,15
	Complex, Fine	1,20
	Basic, Coarse	1,10
	Complex, Coarse	1,15

Table 2.5. Weaving cost table

- This programme is prepared for a weaving factory where yarn is assumed to be supplied from outside.

2.10.2.8. Cost of raw material

1. Warp material cost
2. Weft material cost
3. Cost of starch

Cost of raw material = Warp material cost + Weft material cost + Cost of starch (25)

2.10.2.9. Weaving labour cost

1. Cost of warping operation
2. Cost of drafting operation
3. Sizing process cost
4. Cost of weft winding operation
5. Cost of weft pirn winding
6. Cost of weaving

Weaving labour cost = Cost of warp operation + Cost of drafting_operation + Sizing process cost + Cost of weft winding operation + Cost of weft pirn winding + Cost of weaving (26)

2.10.2.10. Finishing cost

Finishing is assumed to be done.

Fabric Type	**Cost**		
	Pre Finishing	Color	Finishing
Worsted, Light weight	0	0	300
Worsted, Medium	0	0	350
Worsted, Heavy	0	0	400
Woollen, Light weight	0	0	350
Woollen, Heavy	0	0	400
Worsted (Top dyed)	0	200	350
Sheeting (White)	200	0	100
Sheeting (Dyed)	200	200	100
Shirting (White)	250	0	150
Shirting (Coloured)	250	200	150
Print cloth	200	250	150
Cotton, Straight dyed (Light weight)	200	200	150
Cotton, Straight dyed (Heavy weight)	200	280	200

Table 2. 6. Finishing cost table

- Indirect labour cost = Weaving labour cost (27)
- Depreciation cost = (Weaving labour cost + Indirect labour cost + Raw material cost) * 0,04 (28)
- Energy cost = (Weaving labour cost + Indirect labour cost + Raw material cost) * 0,02 (29)
- General cost = (Weaving labour cost + Indirect labour cost + Raw material cost + Finishing cost) * 0,15 (30)

- Finance cost = (Weaving labour cost + Indirect labour cost + Raw material cost + Finishing cost + Energy cost + Depreciation cost + General cost) * 0,16 (31)

- Total cost = (Weaving labour cost + Indirect labour cost + Raw material cost + Finishing cost + Energy cost + Depreciation cost + General cost + Finance cost) (32)

- Total unit cost = Total cost ÷ Fabric length(LK) (T.L./m.) (33)

CHAPTER THREE

STRUCTURE of the COMPUTER PROGRAMME

3.1. Figured Fabric Design Tool (FFDT) Algorithm schemas

The tool has been developed in a structure as given in Figures 3.1 to 3.7.

Main Algorithm of Program

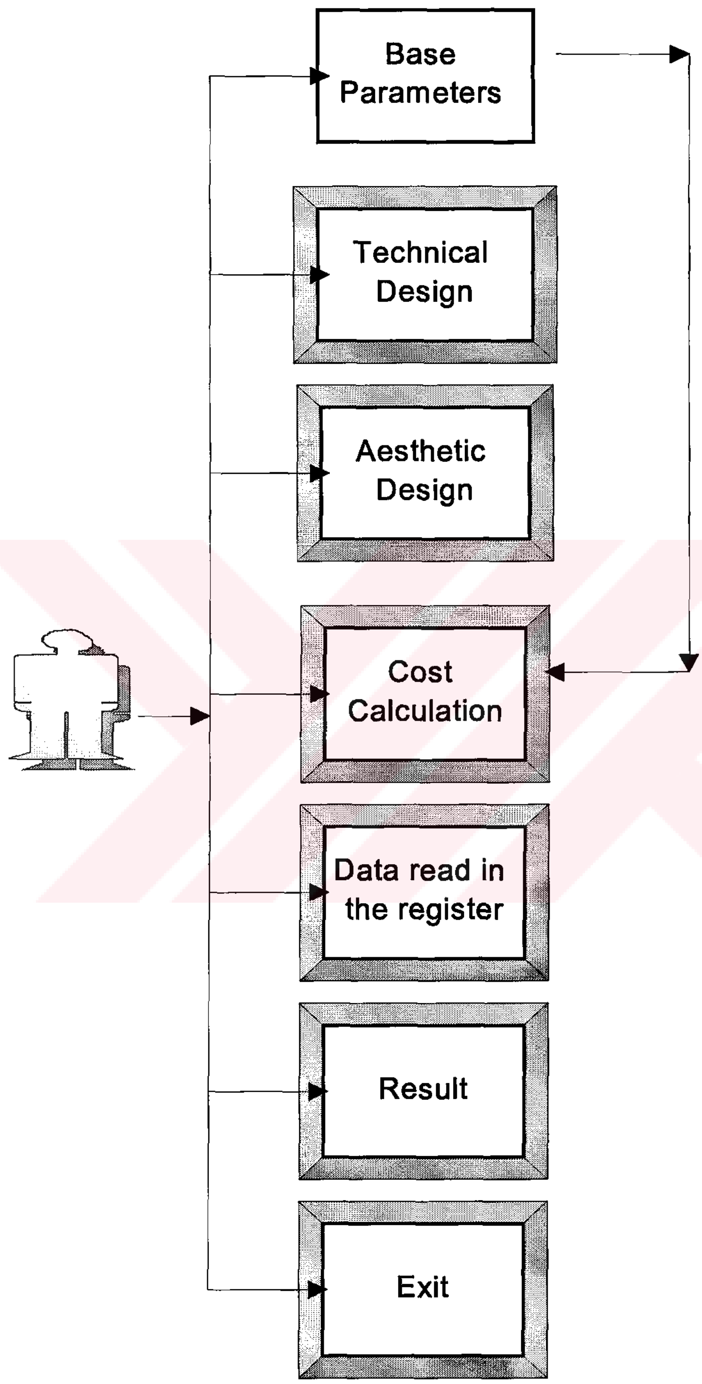


Figure 3.1: Main Algorithm Schema.

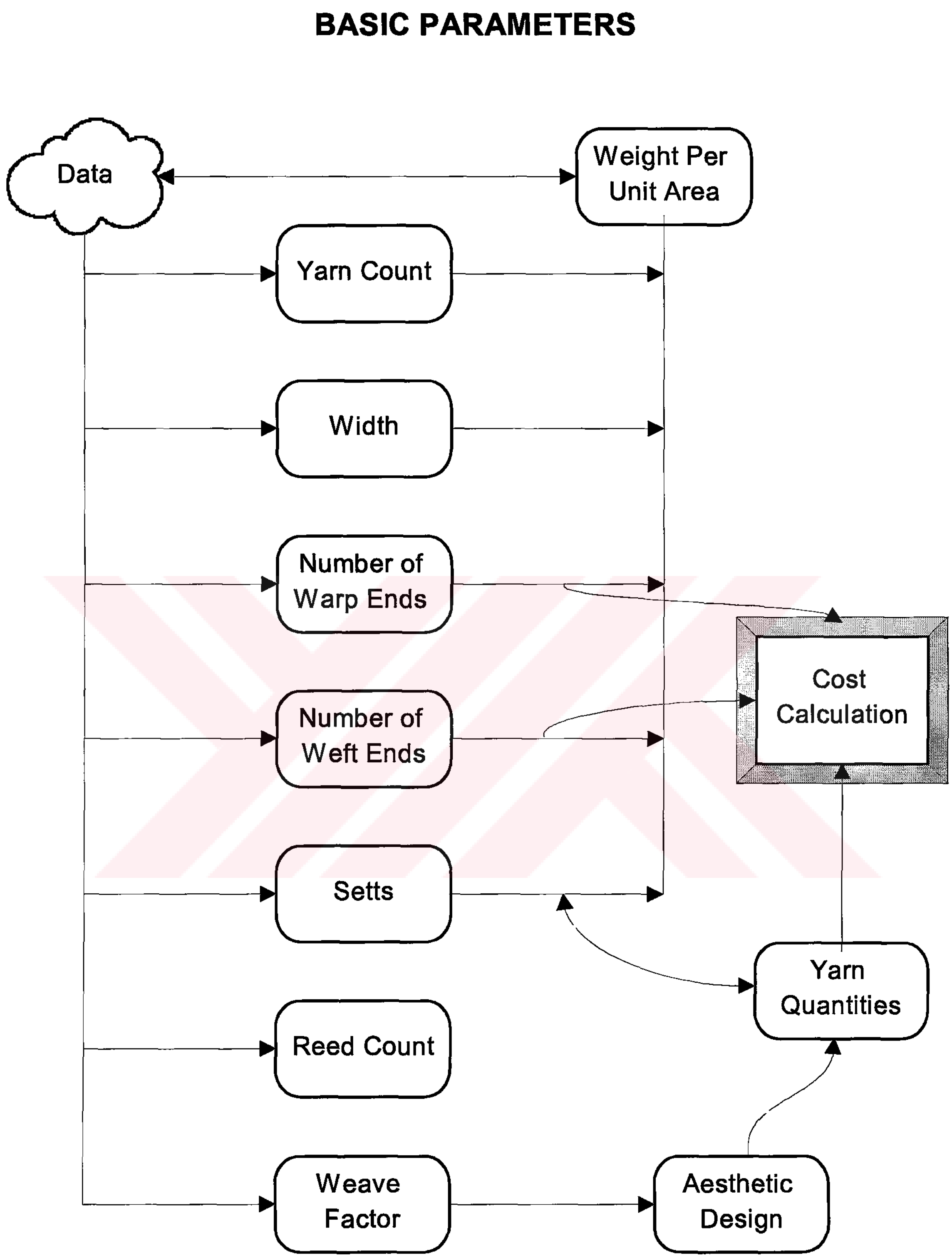


Figure 3.2: Basic Parameter Algorithm Schema.

TECHNICAL DESIGN

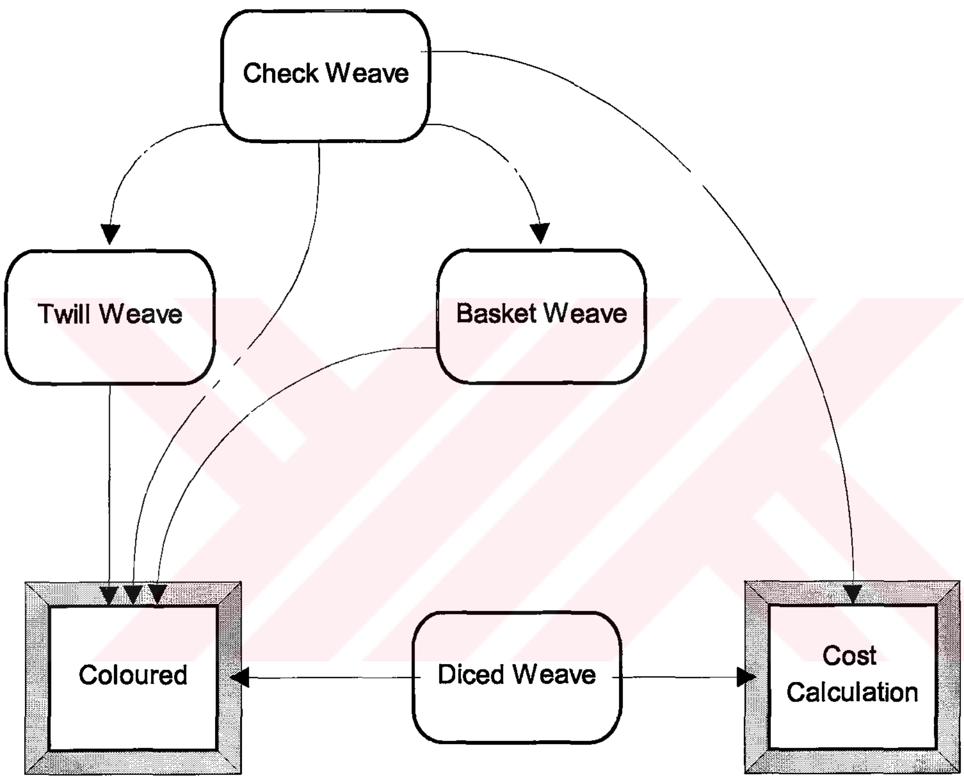


Figure 3.3: Technical Design Algorithm Schema.

AESTHETIC DESIGN

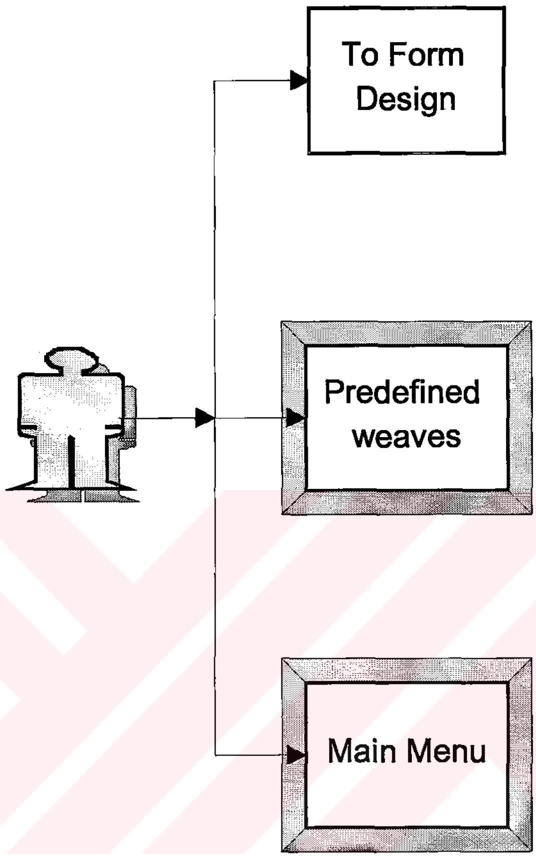


Figure 3.4: Aesthetic Design Algorithm Schema.

PREDEFINED WEAVES

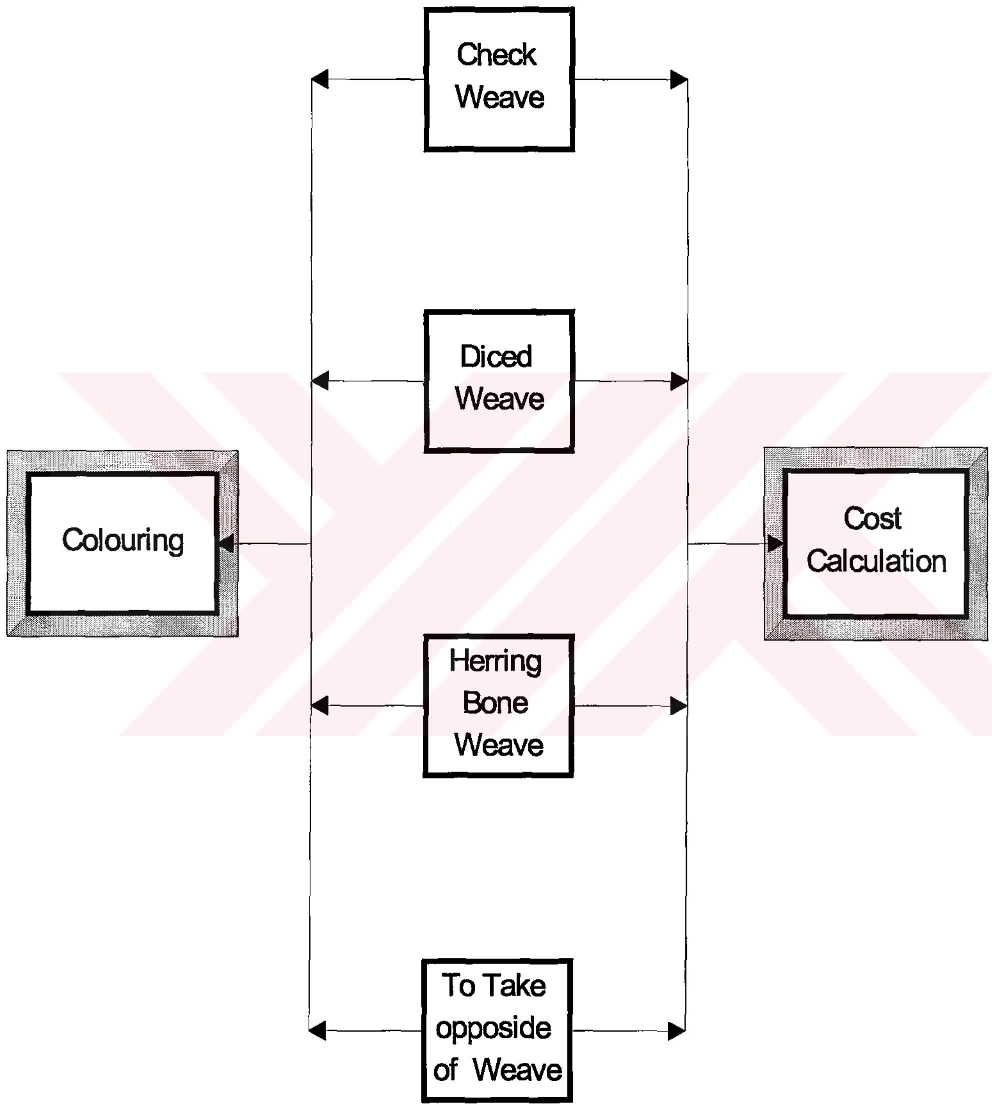


Figure 3.5: Predefined Weave Algorithm Schema.

COST CALCULATION

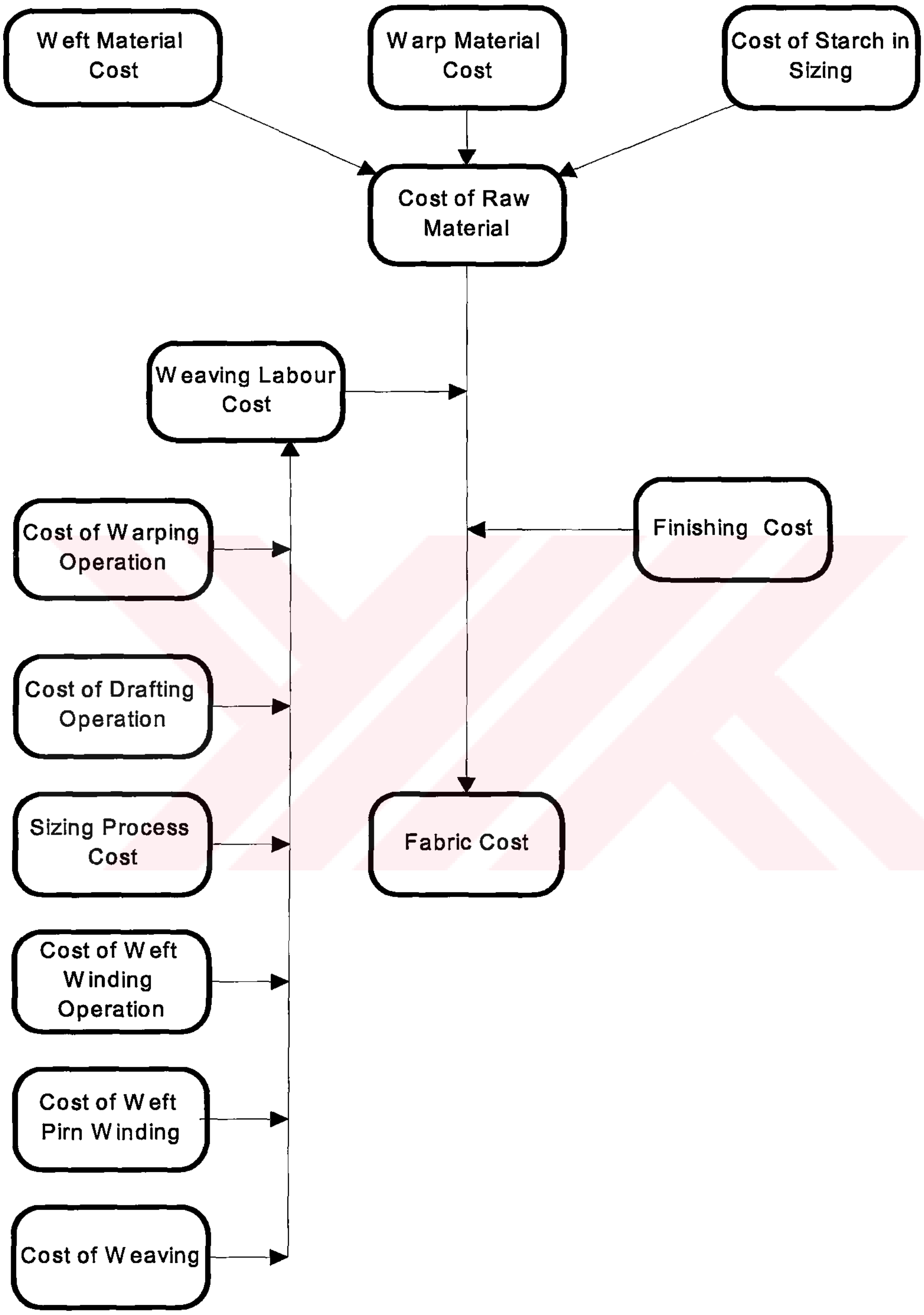


Figure 3.6: Cost Calculation Algorithm Schema.

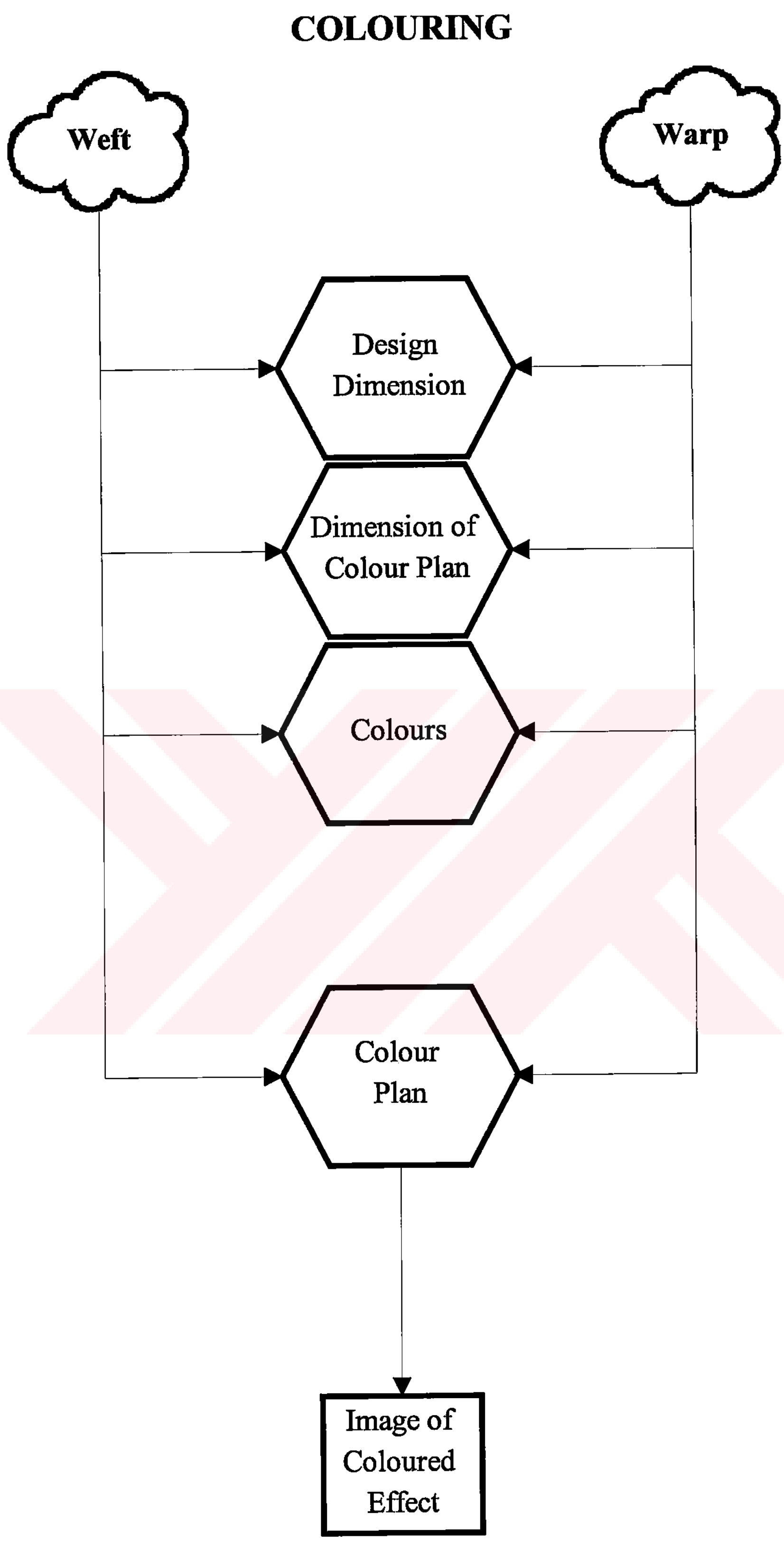


Figure 3.7: Colouring Algorithm Schema.

3.2. Structure of the Figured Fabric Design Tool (FFDT)

The Figured Fabric Design Tool has been created in the compiler called "Visual Basic 4.0". The tool is in a form where sub menus are reached after selections are made from a main menu. The sub menus consist of auxiliary menus within themselves.

Let us consider all these menus and the functions they perform:

3.2.1. Main Menu of FFDT:

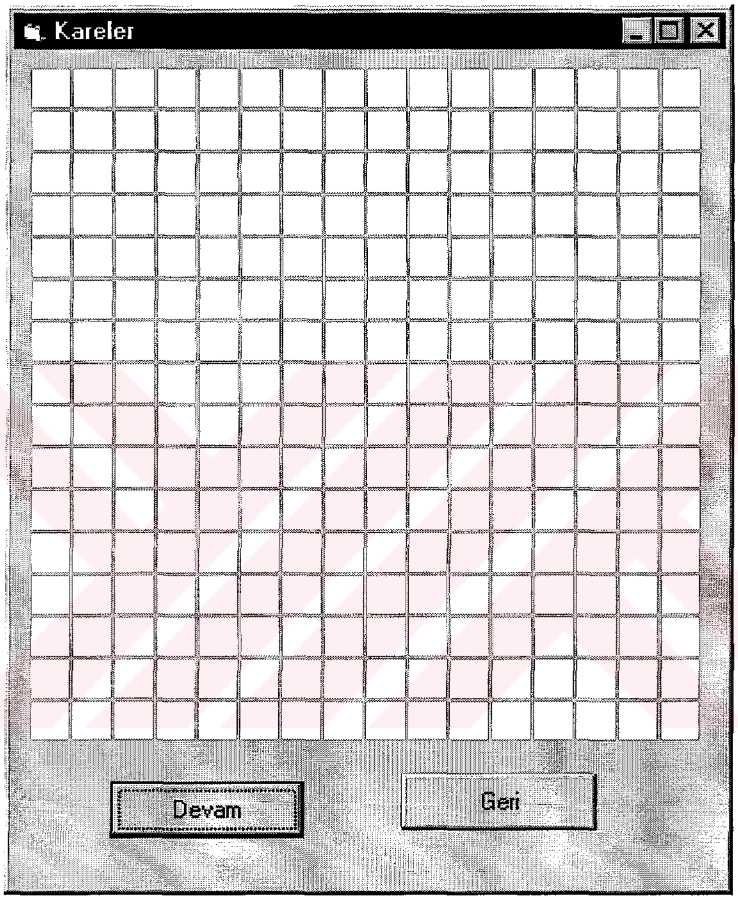
It provides passage to the other menus and the functions to be performed. (Figure 3.8)

3.2.1.1. *Basic parameters:* Here the data necessary for the cost calculations are entered. If these data are not entered here, these data are requested again at the outset of the cost calculations. If they have already been entered, then those values entered at the outset of the cost calculations come up on screen; if desired changes can be made on these values. (Figure 3.9)

3.2.1.2. Technical design: Another menu is called here. There are three choices available here. The first is the same as the basic parameters as mentioned above. In the second it is entered into a menu where the names of the weave types obtained by certain algorithms are included. The desired weave is obtained or derived here. In the third it is returned to the main menu mentioned above.

3.2.1.3. Aesthetic design: Another menu is called here. There are three choices in this. The first choose is to create a figure. Here squared areas called by specifying the dimensions from a set of given dimensions and the required figure is created on them. This is done by clinking the mouse on the selected small square or by moving the mouse over these squares at will. The second, on the other hand, serves to create a new weave without following any algorithm. For this, the required number of warp end weft are asked first and then a form is opened where would be the squares upon which the weave will be developed.

For example:



Warp number is 5 and weft number is 5 too.

By clicking over these squares with the mouse the required design is obtained by painting in these squares to black or white.

3.2.1.4. Cost: From here it is gone to the form where the data for the basic parameters are entered. If these data have been entered beforehand as mentioned before, then these values come up on screen. It is allowed to make any changes here if they are required to be altered. In both cases the values entered are treated and the values necessary and those required are obtained. In the rest of this section any kind of calculation for cost estimation is achieved. For instance, warp and weft preparation costs, warp and weft processing cost etc. are calculated. As a result, the total cost taking account all the aspects is calculated.

3.2.1.5. Read data from file or make changes: From here it is entered into a sub menu where files are sorted according to their contents. From there on the content of any file desired is looked over or updating is carried out on that file.

3.2.1.6. Result: It is gone to the form, from here, where a general result is given of the operations performed in cost calculations.

3.2.1.7. Exit: it helps us to exit from the programme.

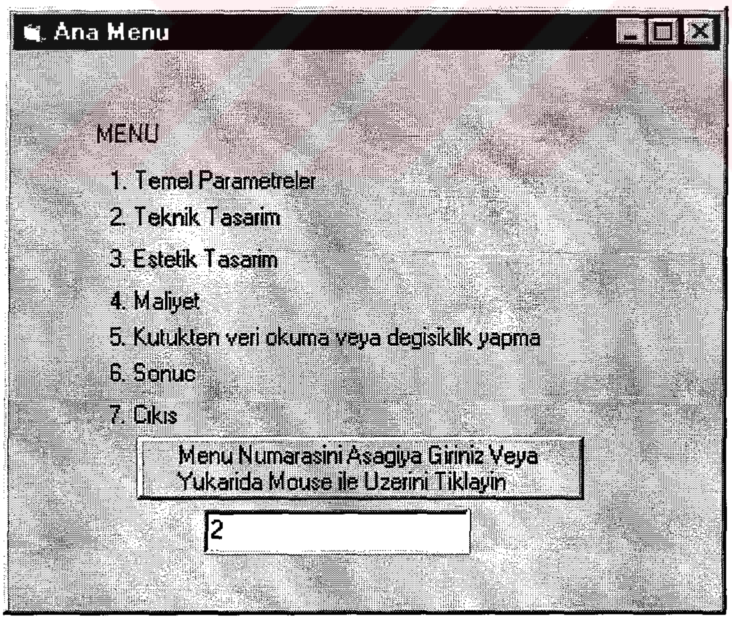


Figure 3.8: Main Menu of FFDT

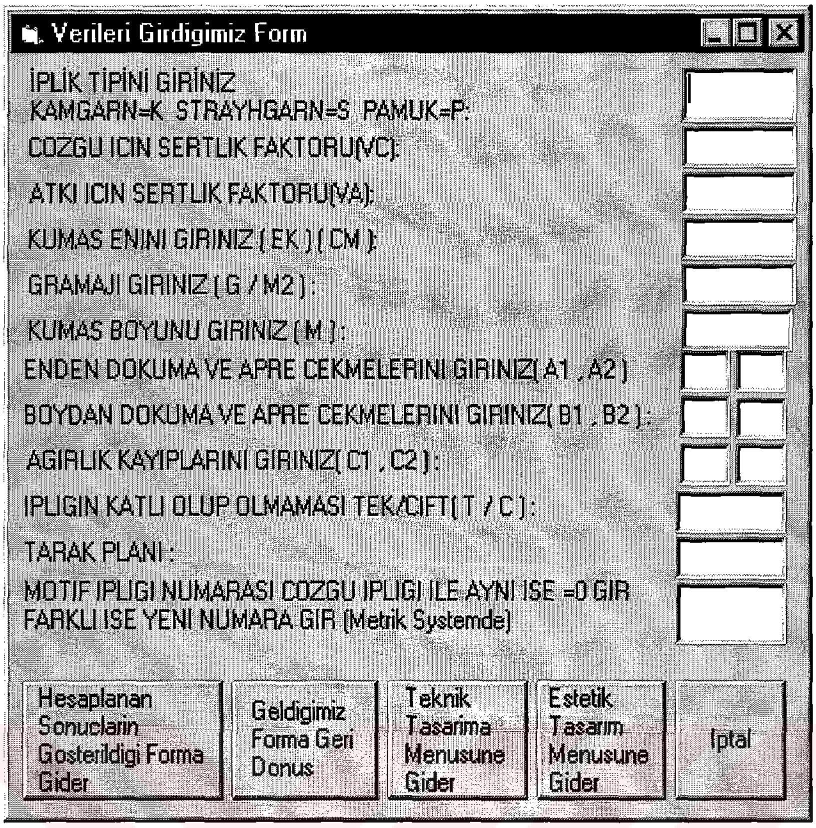


Figure 3.9: The form the user enters the data for the cost calculation.

3.2.1.2. Technical design:

Technical design submenu is as follows:

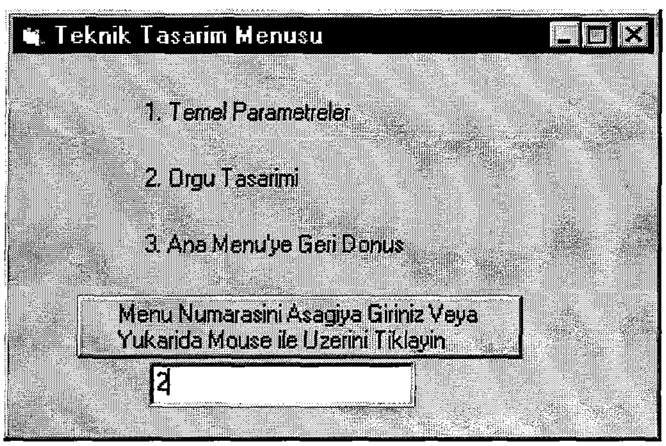


Figure 3.10: Technical design submenu

If user chooses weave types Figure 3.11 appears. User can choose one of the predefined weaves such as twill weave, check weave, basket weave, diced weave.

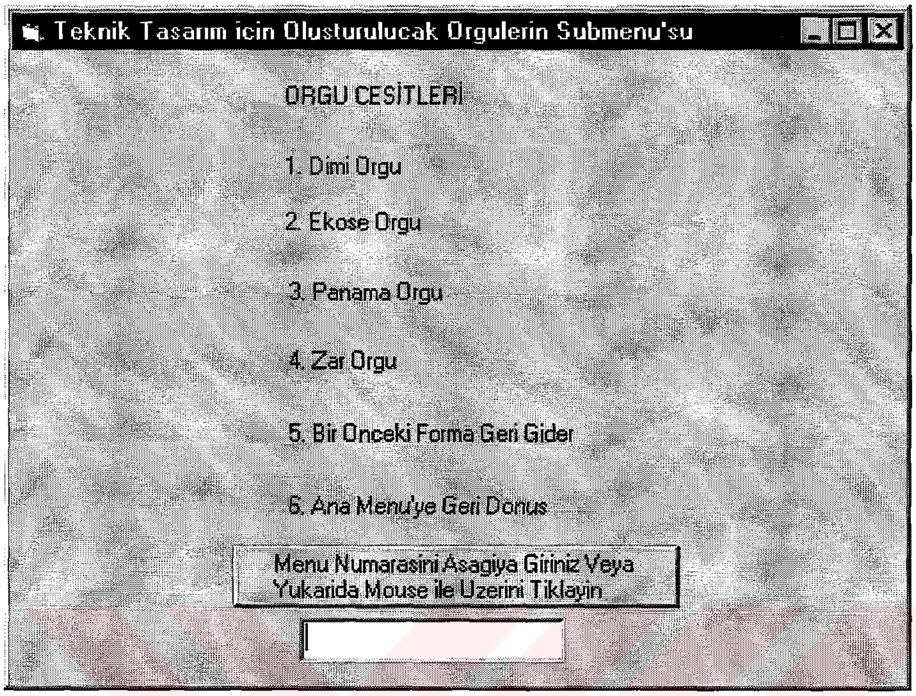


Figure 3.11: Submenu which includes weave types of technical design

- *In twill weave:*

User enters the number of interlacings and step number in the Figure 3.12.

Figure 3.12: The form which the user enters parameters of twill weave.

Later, if he presses the continue button, he has to choose left twill or right twill in Figure 3.13.

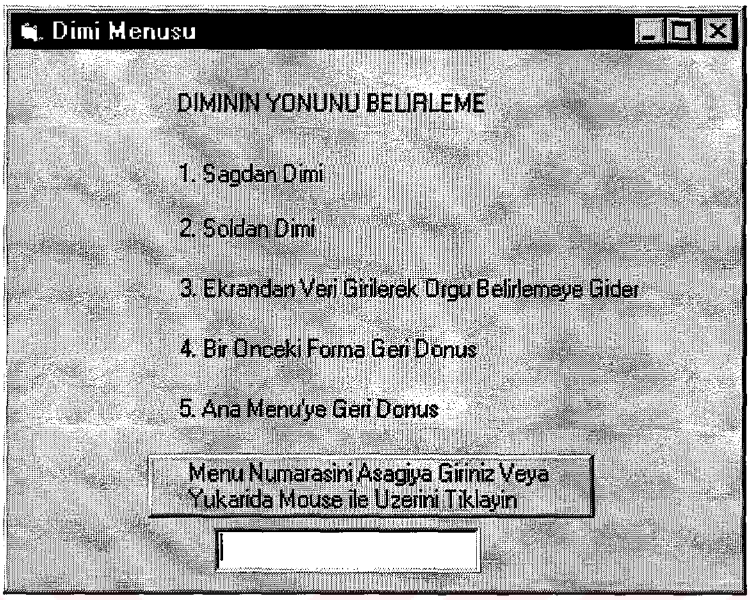


Figure 3.13: Menu for twill

And then, if the user chooses left or right twill, the twill weave appears as depicted in Figure 3.14.

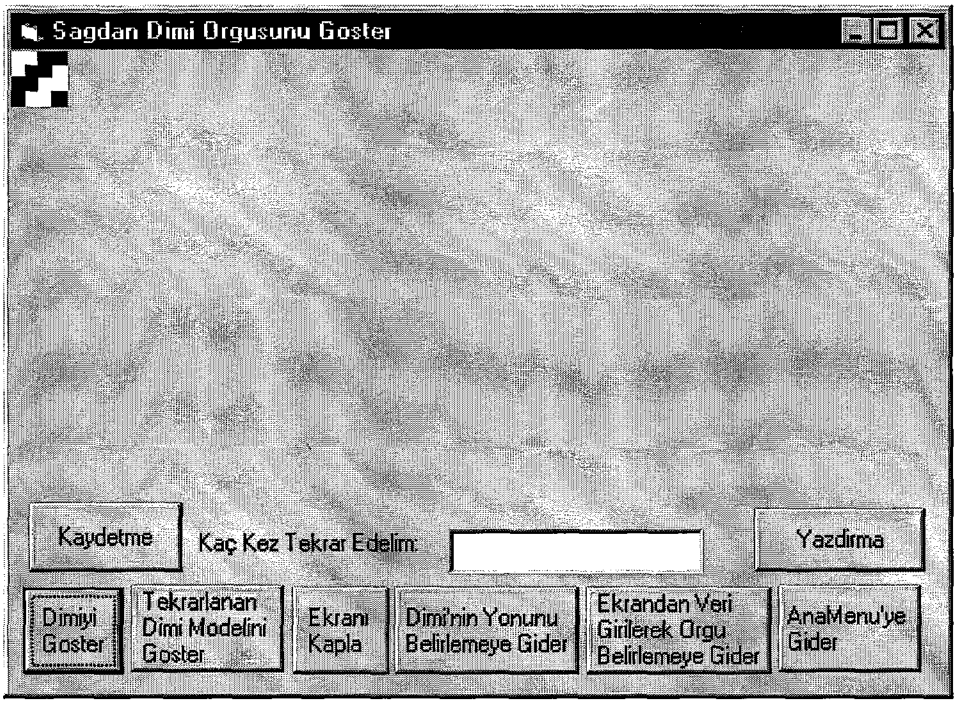


Figure 3.14: The form with appearances 2/2 Right Twill Weave with step 1.

In order to make the twill as coloured, the user has to enter the number of repeats needed as in the textbox. As default, this value of the number of repeats is constantly 2 so twill is repeated two times or value times. Figure 3.15.

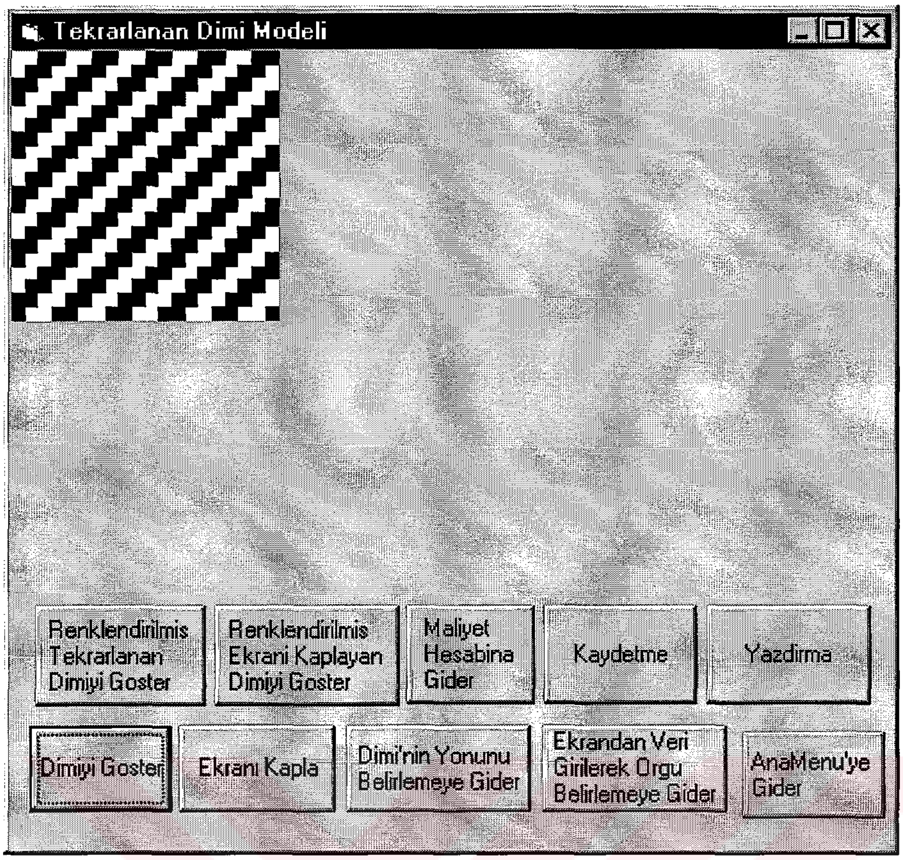


Figure 3.15: The form with appearances repeated 2/2 Right Twill Weave with step 1.

This form has a lot of facilities such as cost calculation button, colouring button etc. These facilities will be explained in the next section.

- *Diced weave:*

The user first defines which type of diced weave he will choose. These types are Bird's Eye Weave, Crow, Granit, Basket, Barley Cord, Mock Gauze. Figure 3.16.

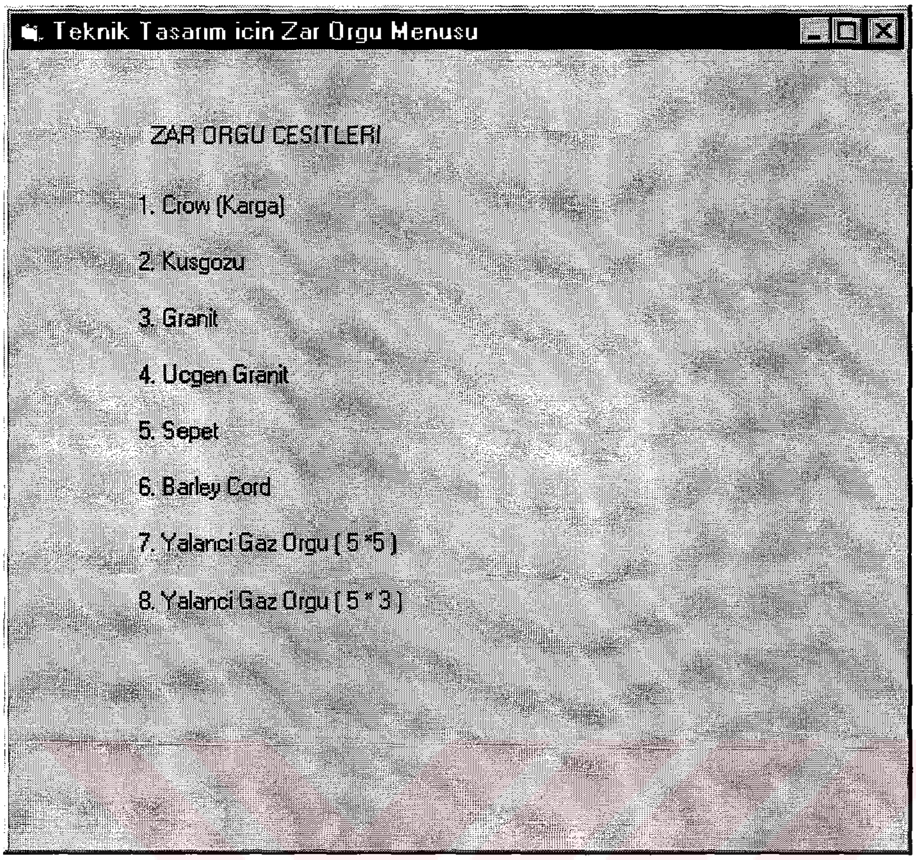


Figure 3.16: Types of Diced Weave Menu.

The user chooses one of the diced weave types appearing on the form shown in Figure 3.17. If the user is wants to obtain a coloured effect he or she has to insert a value for the number of repeats in the textbox shown in figure 3.18.

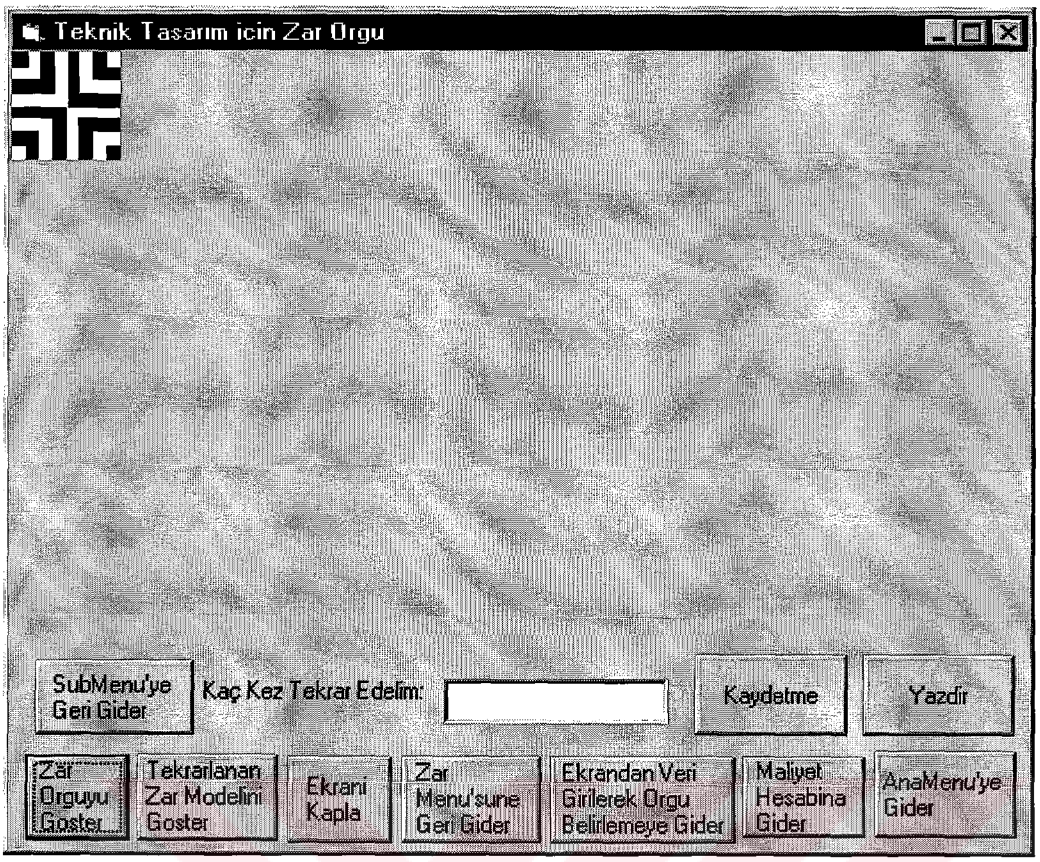


Figure 3.17: Basket Diced Weave.

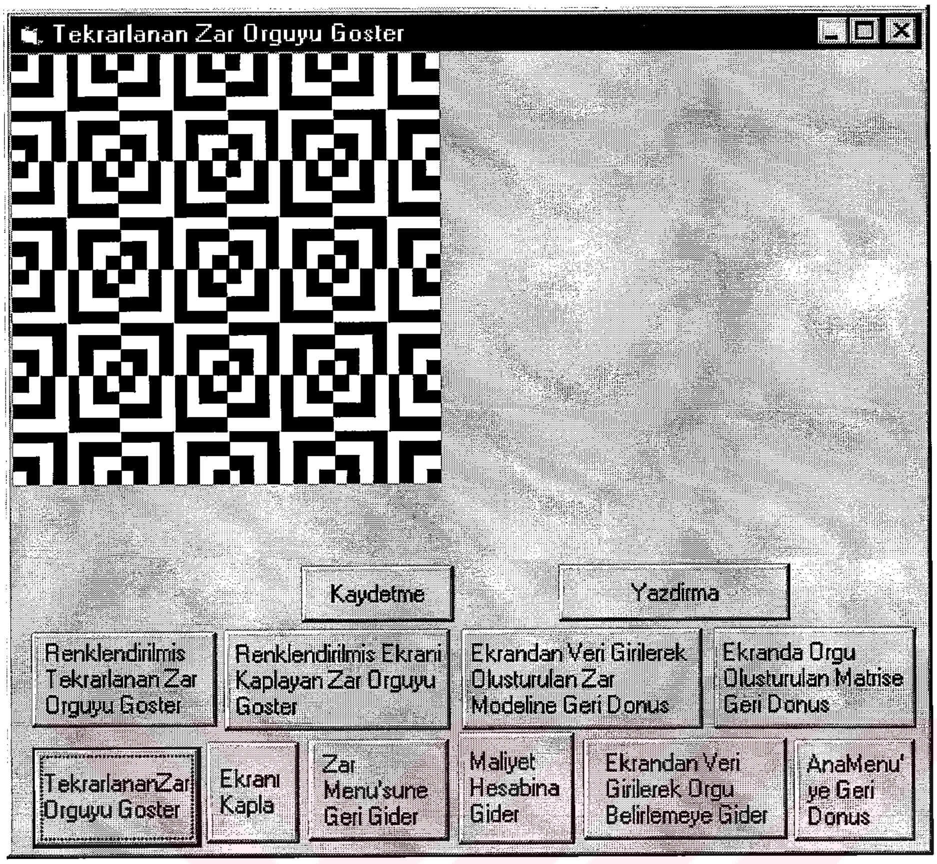


Figure 3.18: Basket Diced Weave for four repeats.

- *Basket weave:*

If basket weave in Figure 3.11 is chosen, Figure 3.19 appears. When the show button is clicked, the user is required to enter the number of interlacings and later the interlacing values.

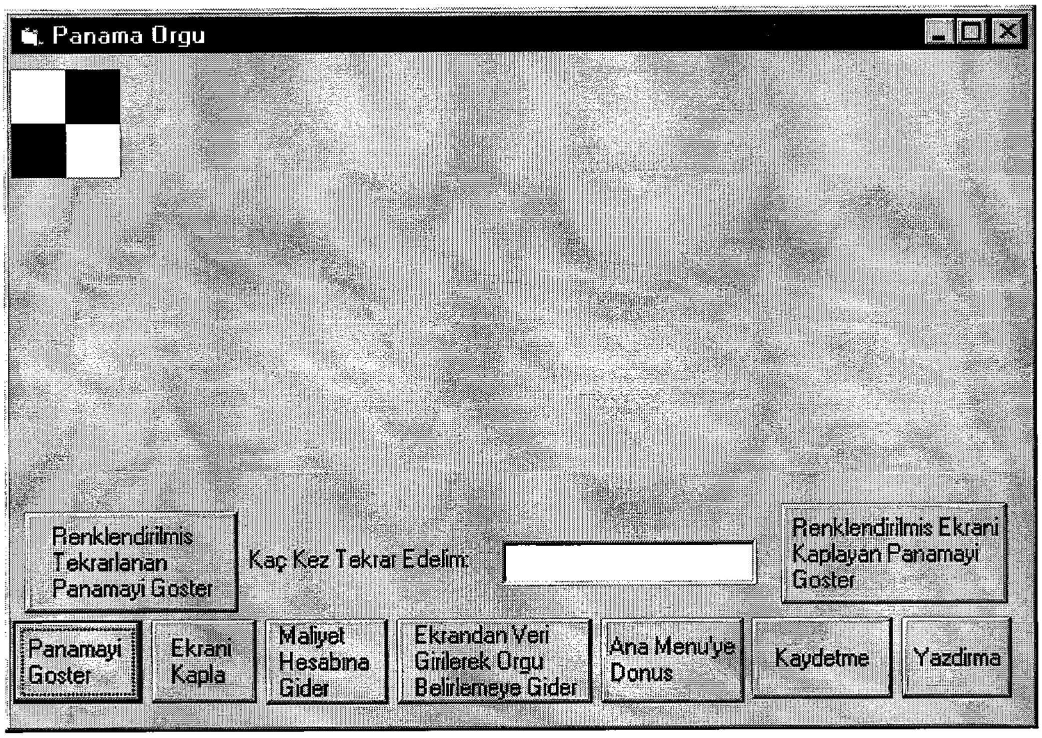


Figure 3.19: 4/4 Basket Weave

- *Check Weave:*

Check weave needs two weaves because check weave is created the combination of two weaves. Thus, the user has to choose the first weave, which is twill or basket weave in Figure 3.20.

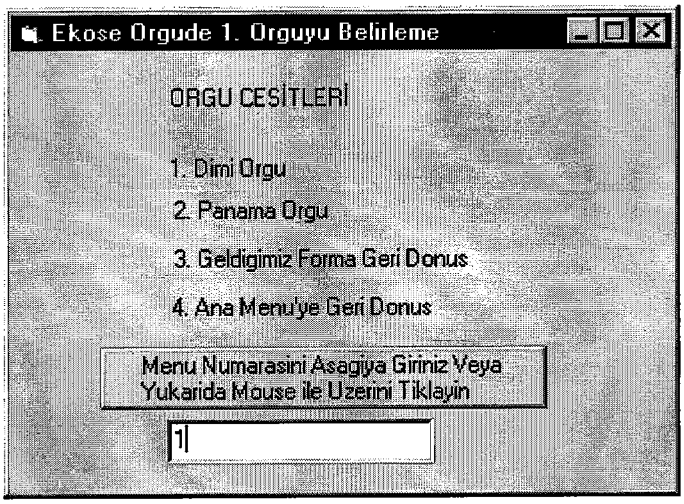


Figure 3.20: Check Weave Menu for first weave.

If the user chooses twill weave in the Figure 3.20, procedure is started work in the previous section. So user enters interlacing value and step number in Figure 3.21.

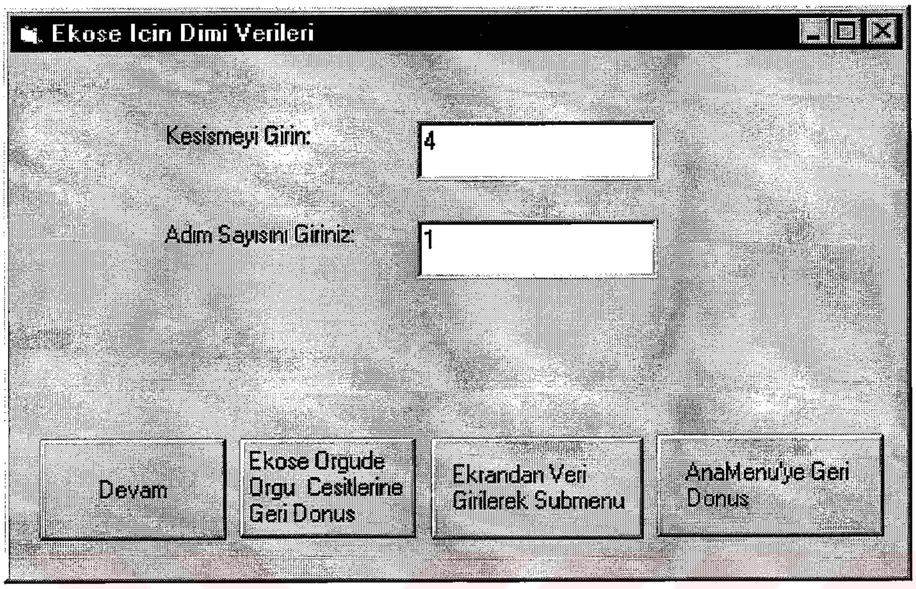
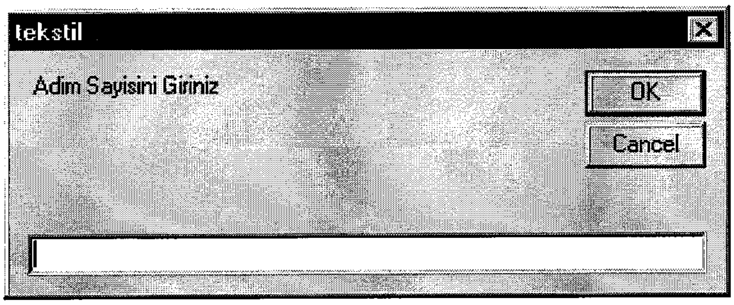


Figure 3.21: Twill Parameters for first check weave.

User chooses continue button. The twill weave appears as shown in Figure 3.22. But the tool asks the user if he wants to change the step number.

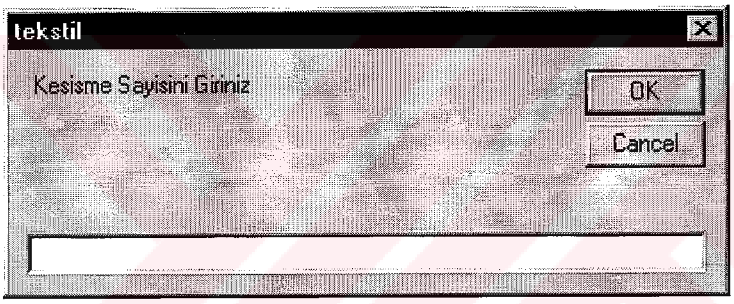
If the user changes the step number he presses the button whose name is Yes button which brings to the screen the textbox as follows:



The user presses the button whose name is No. The program is takes on the last step number entered.

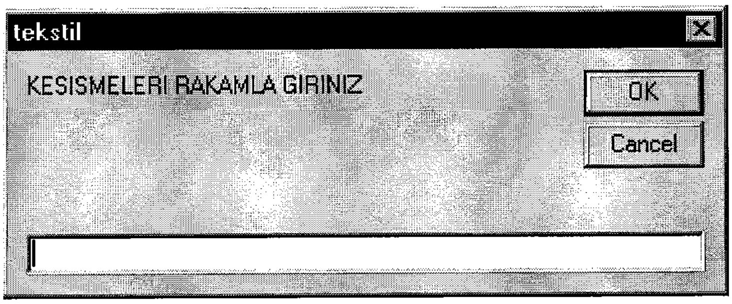
FFDT asks the user if he wants to change the interlacing value.

If the user changes the interlacing value, the user presses the button whose name is Yes as follows:



The user presses the button whose name is No. The program takes on entering the last interlacing value entered.

At last, interlacing numbers are entered, which are related to the number at interlacings previously entered as follows:



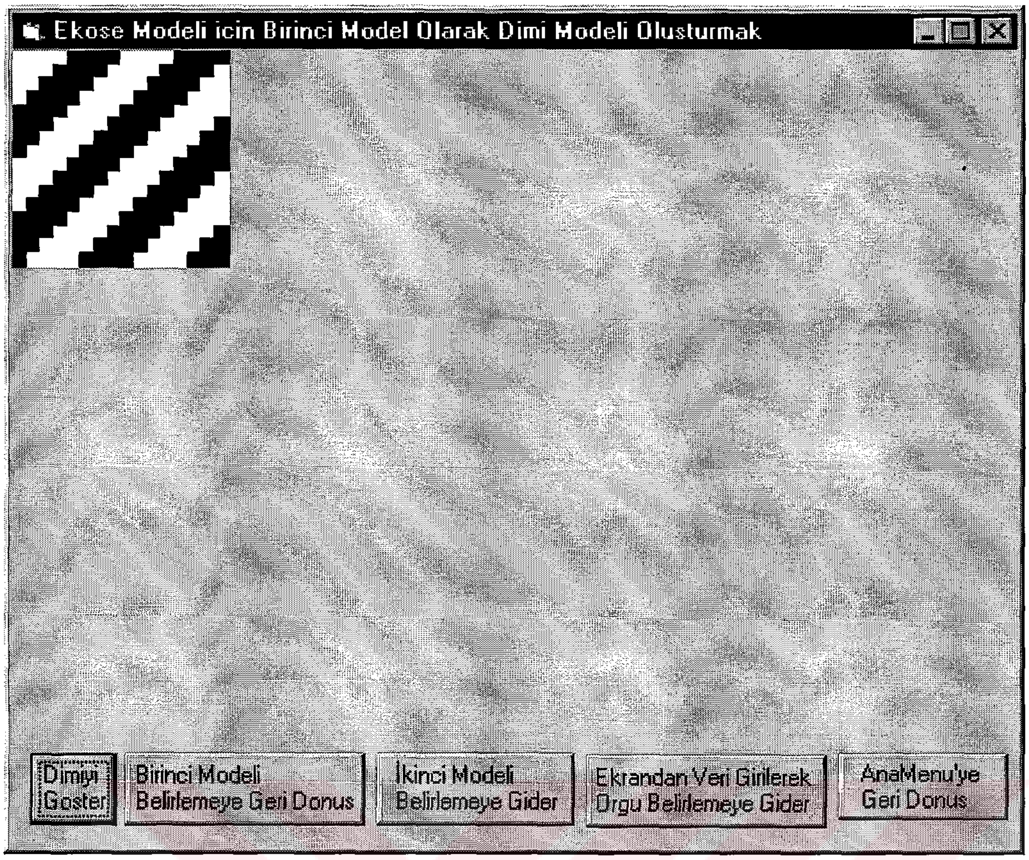


Figure 3.22: The Form which shows The Twill Weave for the First Unit of Check Weave.

If the user chooses basket weave in the Figure 3.20, procedure starts to work as explained in the previous section. This is shown in Figure 3.23. So the user has to enter interlacing value and interlacing numbers like the previous section.

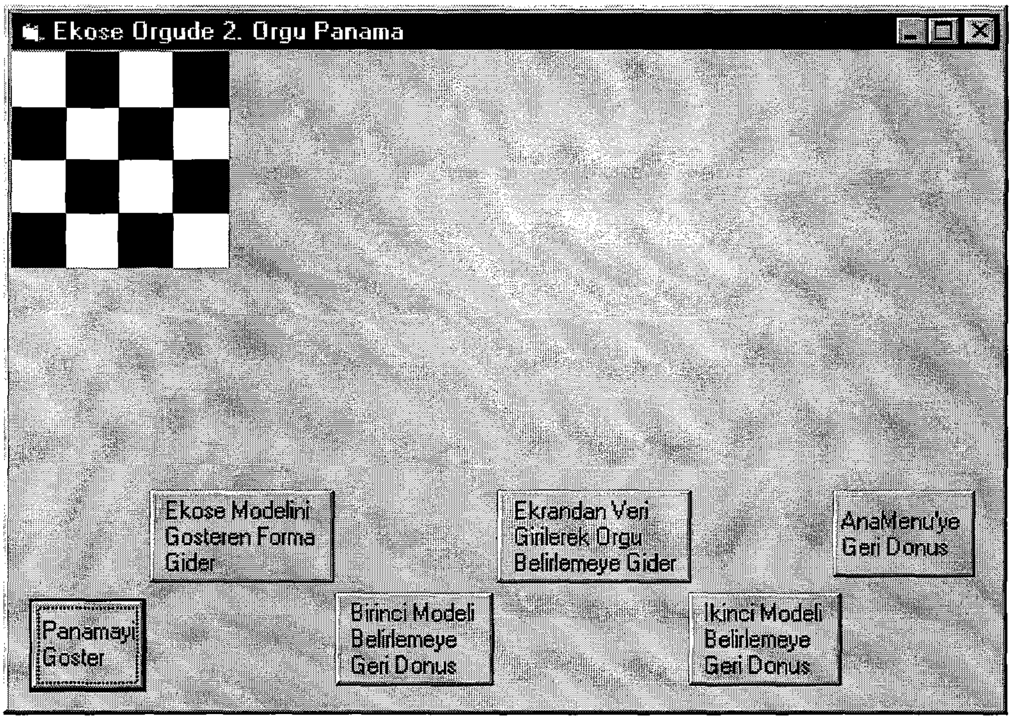


Figure 3.23: The Form which shows The Basket Weave for the First Unit of Check Weave.

In Figure 3.22 and Figure 3.23, the user chooses the button whose name is going to determine the second weave. FFDT shows the second weave menu which looks like the first one as in Figure 3.24:

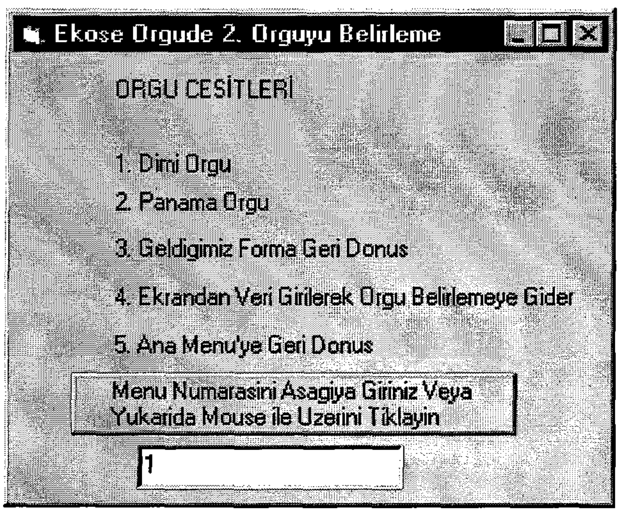


Figure 3.24: Check Weave Menu for second weave.

The user chooses one of the weaves and the procedure works as previously. And then, FFDT shows the second weave form as Figure in 3.25.

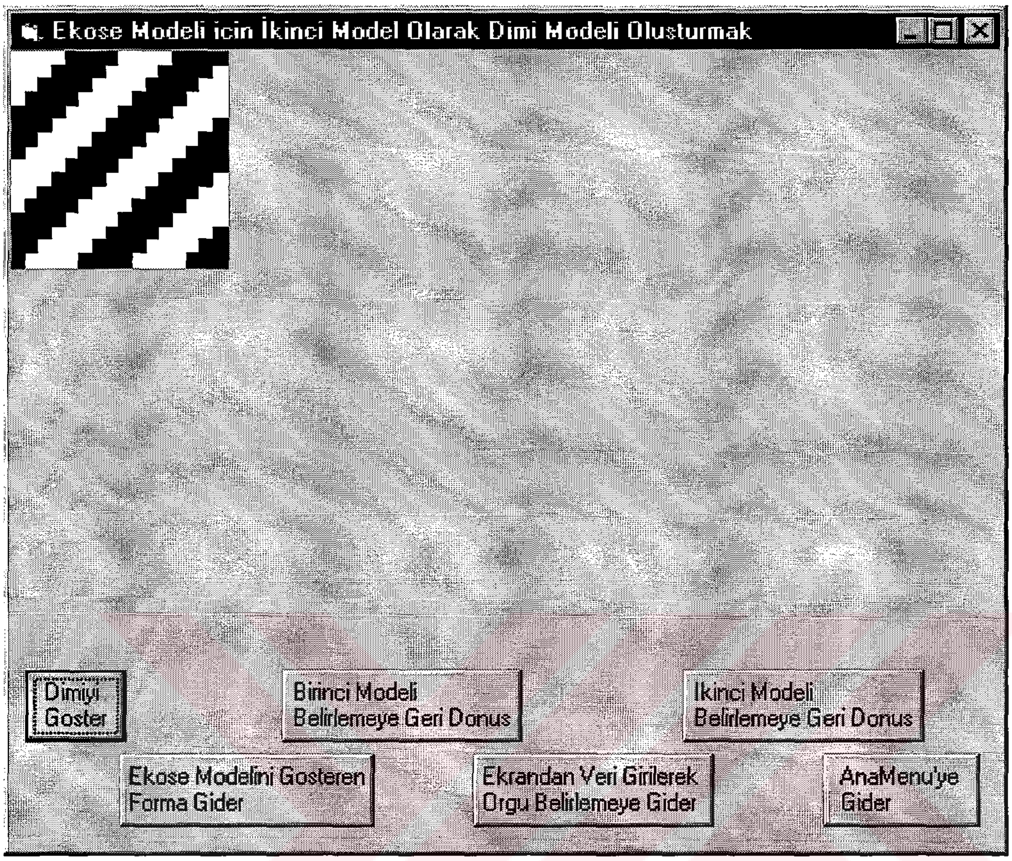


Figure 3.25: The form which shows twill weave for the second unit of check weave.

The user presses the button whose name is "going to the form showing the check weave. FFDT asks the user where the weave is slid with Figure 3.26.

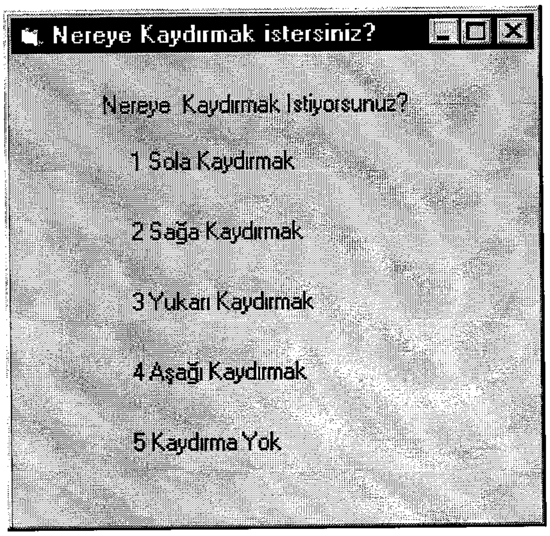


Figure 3.26: Menu which shows the manner the check weave is slid.

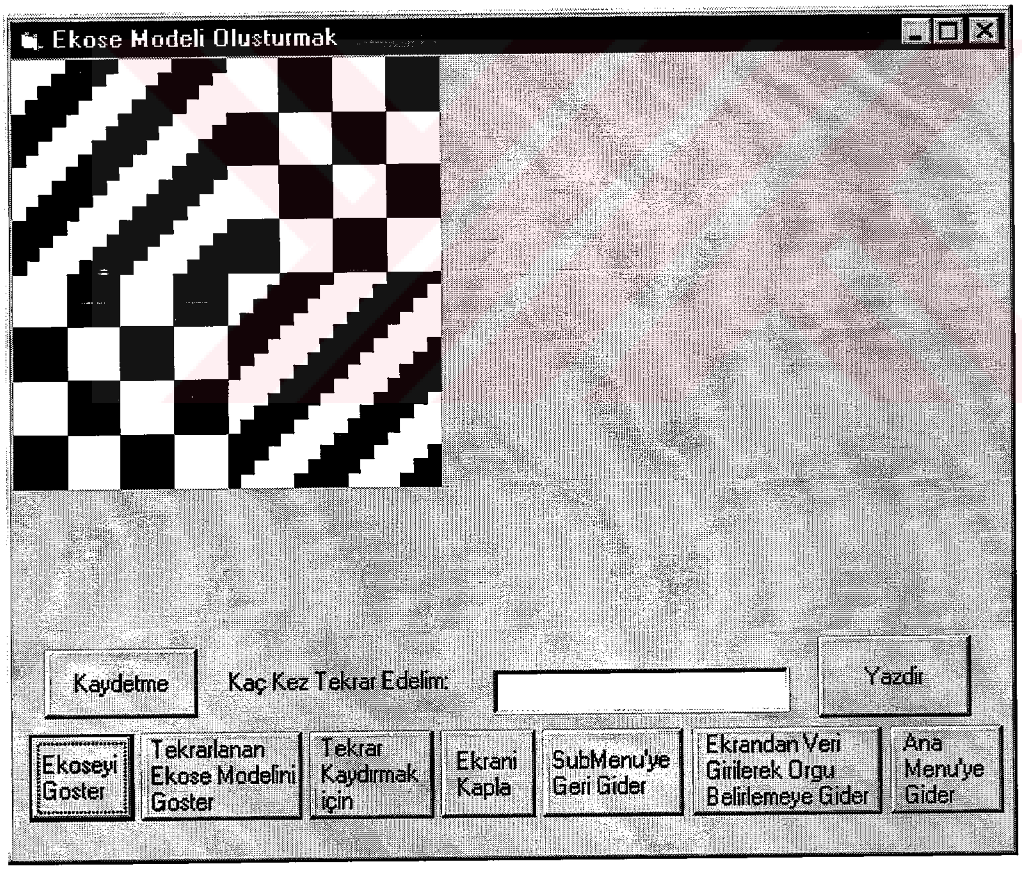


Figure 3.27: Check weave with no slide.

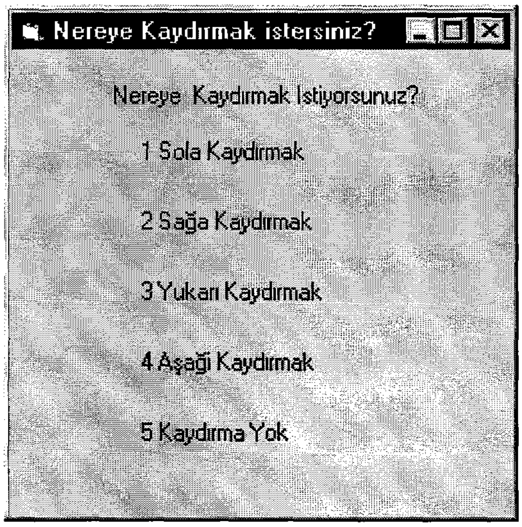


Figure 3.28: Menu which shows the manner the check weave is slid.

If he chooses left slide, FFDT shows it as in Figure 3.29.

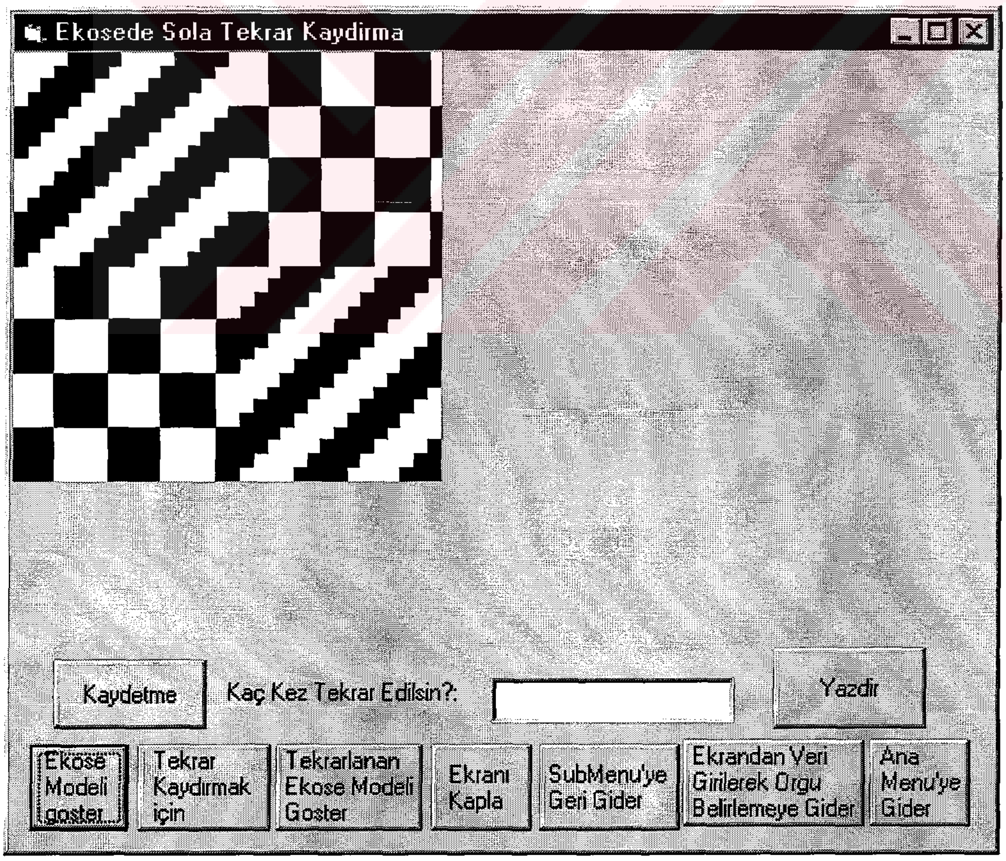


Figure 3.29: Check Weave with one left slide.

If user chooses “shows the Repeated Check Weave” button he has to enter the repeated value in the textbox. So FFDT appears in the following form.

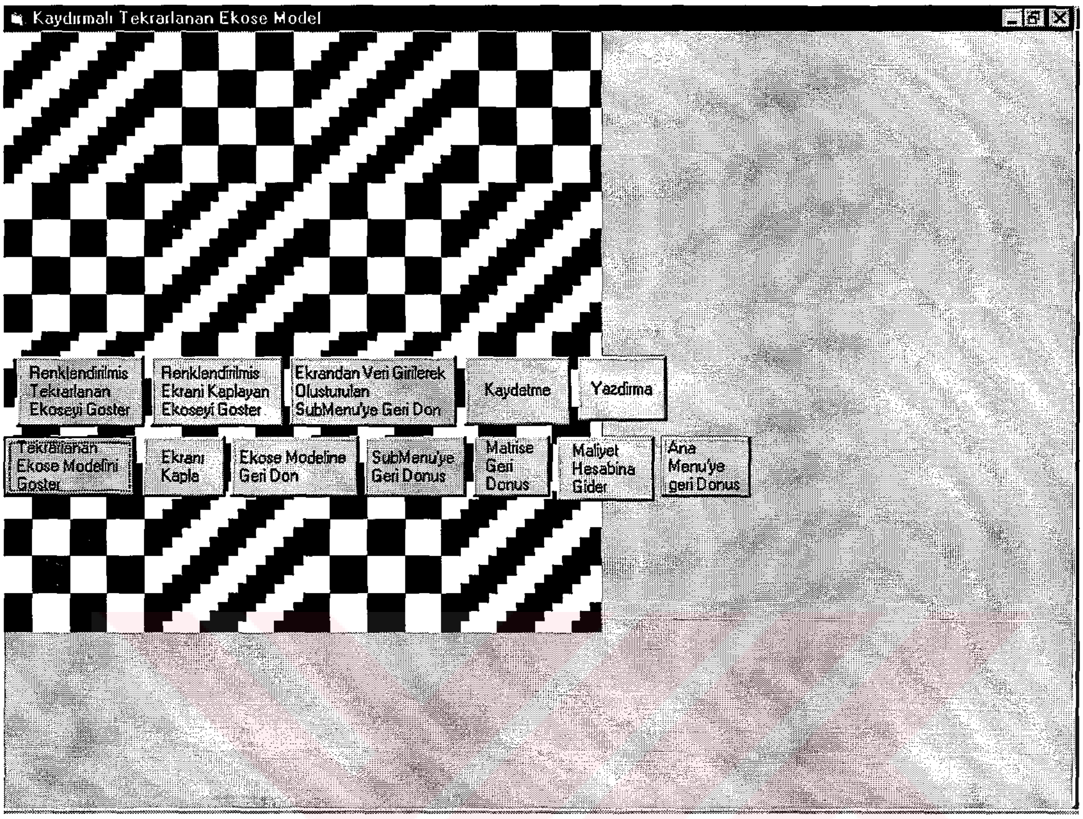


Figure 3.30: Appearance of check weave which is repeated twice.

3.2.1.3. Aesthetic design:

If aesthetic design is chosen as in Figure 3.8, The following menu appears.

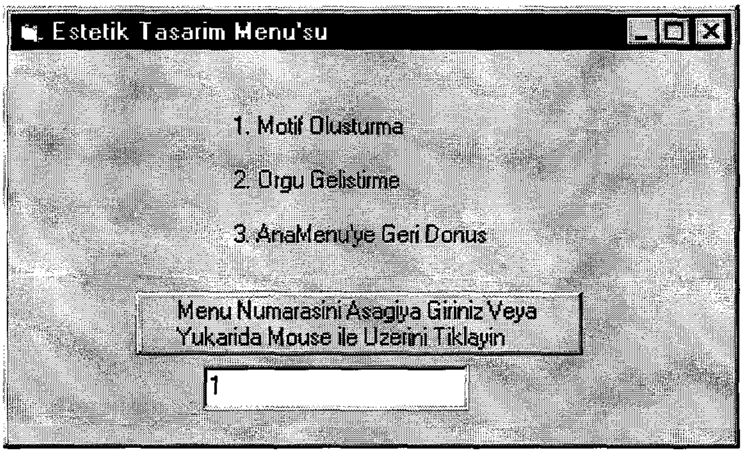


Figure 3.31: Aesthetic Design Menu.

If figure formation is chosen, the forms which shows how the figure is determined. Figure 3.32.

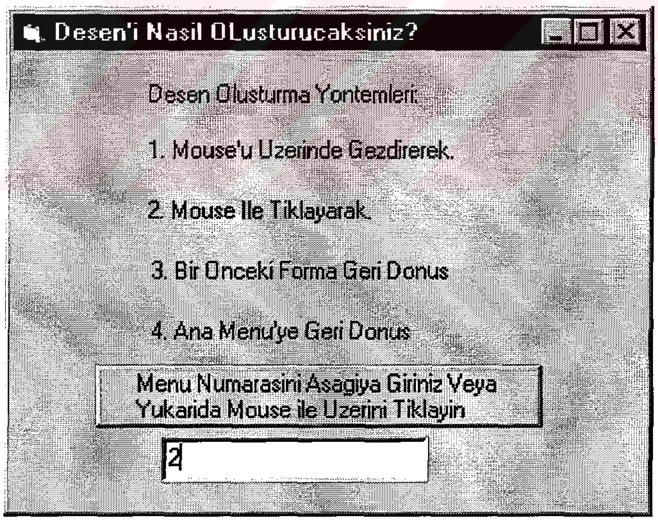


Figure 3.32: The form which asks the size of the figure appearance.

If the user chooses 1 or 2 in Figure 3.32, then it is returned to the form which asks the size of the figure in Figure 3.32.

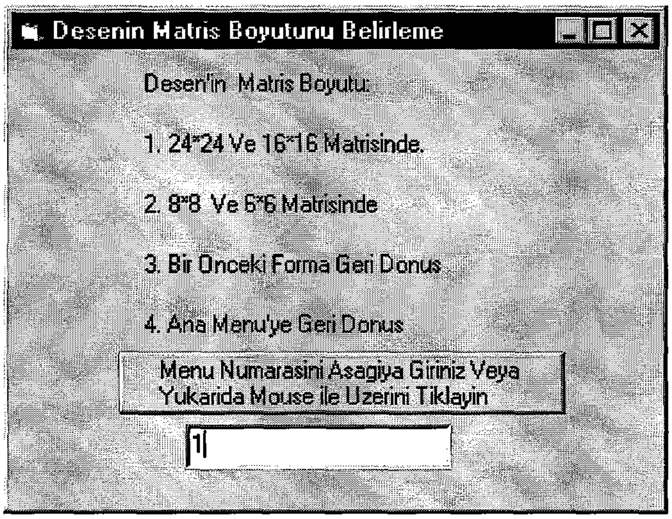


Figure 3.33: The form which asks the size of the figure.

If the user chooses "24x24 and 16x16 Matrix" and "Click with Mouse", FFDT shows the Figure 3.34.

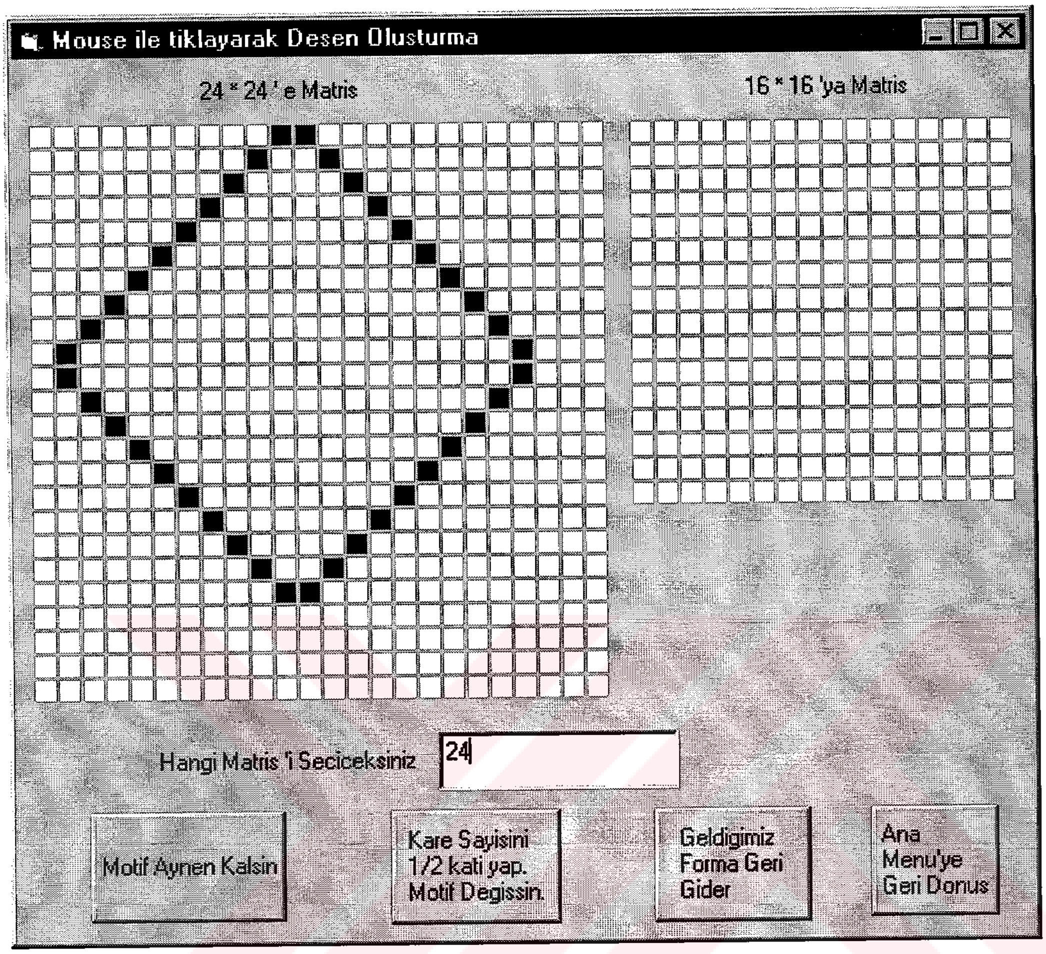


Figure 3.34: Appearance of 24x24 matrix whose figure is created by clicking with the mouse.

If the user chooses “8x8 and 6x6 Matrix” and “Click with Mouse”, FFDT shows the Figure 3.35.

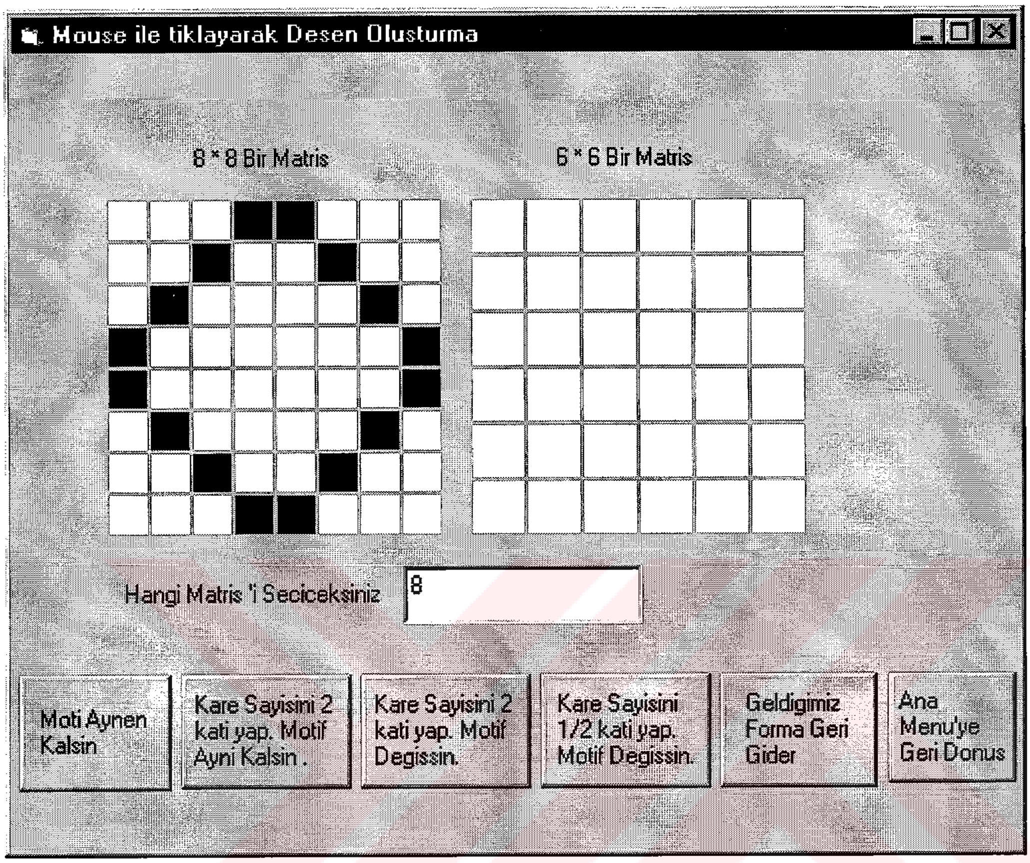


Figure 3.35: Appearance of 8x8 matrix whose figure is created by clicking with the mouse.

If the button whose name is "Double the square number and let the figure same" is clicked in Figure 3.35, FFDT shows the Figure as in Figure 3.36.

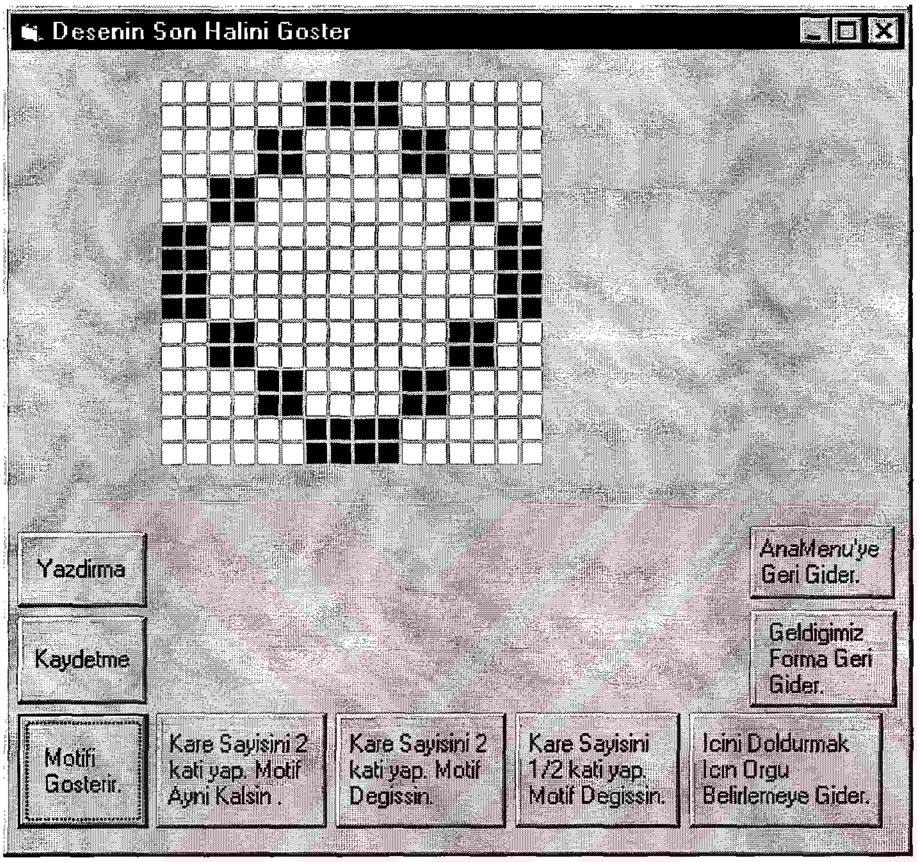


Figure 3.36: Appearance of unchanging Figure.

If the button whose name is "Double the square number and change the figure" is clicked in Figure 3.35, FFDT shows the Figure as in Figure 3.37.

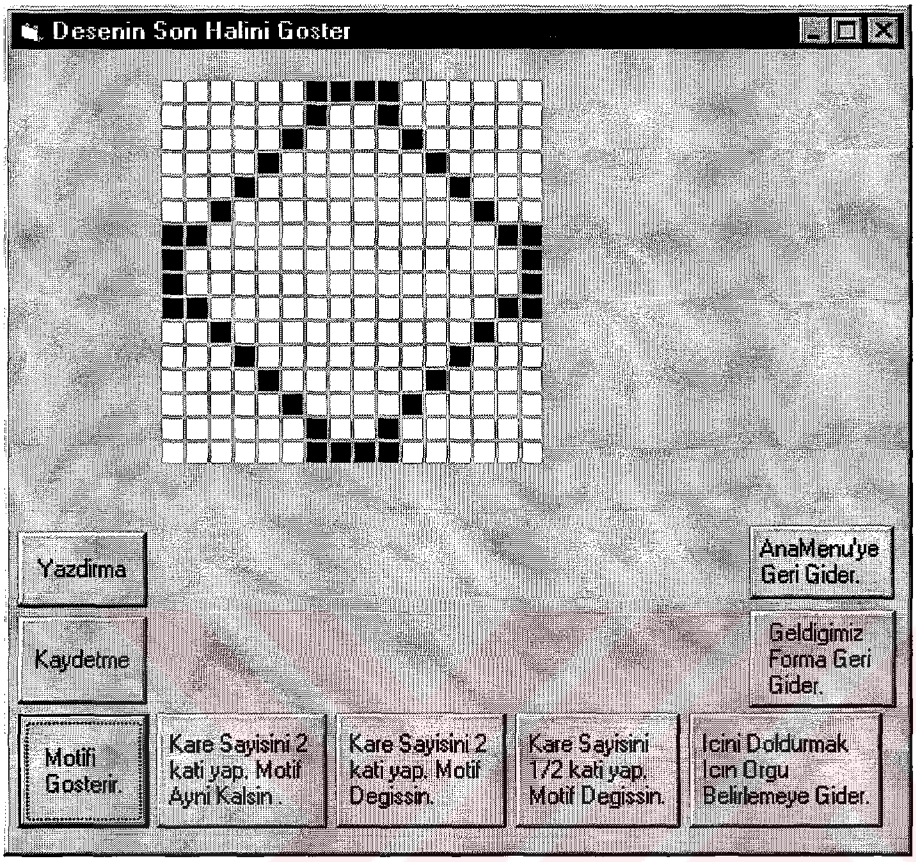


Figure 3.37: Appearance of changing Figure.

If the button whose name is "Divide the square number by 2 and change the figure" is clicked in Figure 3.35, FFDT shows the Figure as in Figure 3.38.

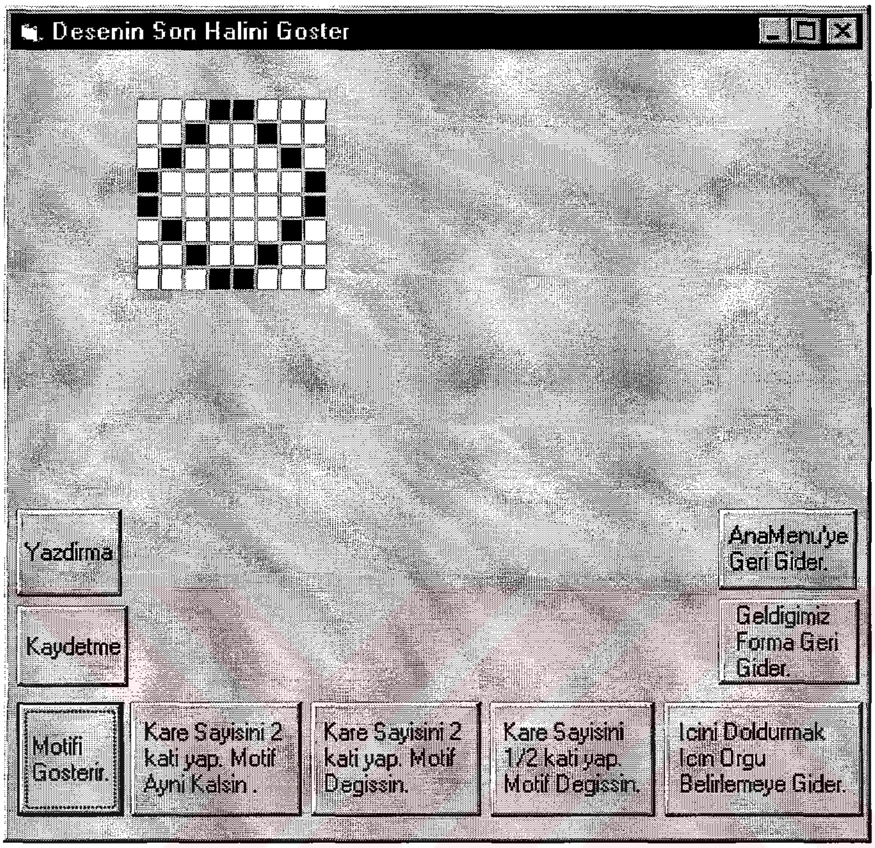
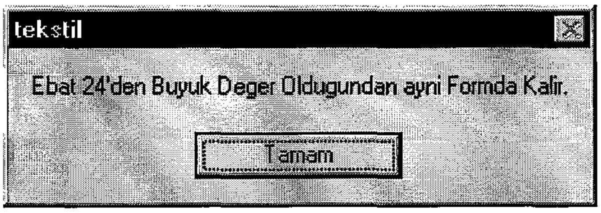


Figure 3.38: Appearance of Figure which is reduced.

If double the square number and do not change the figure or double it but change the figure is chosen in Figure 3.37, a message as follows appears.



When the message comes, "Okay" is clicked and it is returned back to 3.37. If "fill inside" button is clicked, Figure 3.39 appears

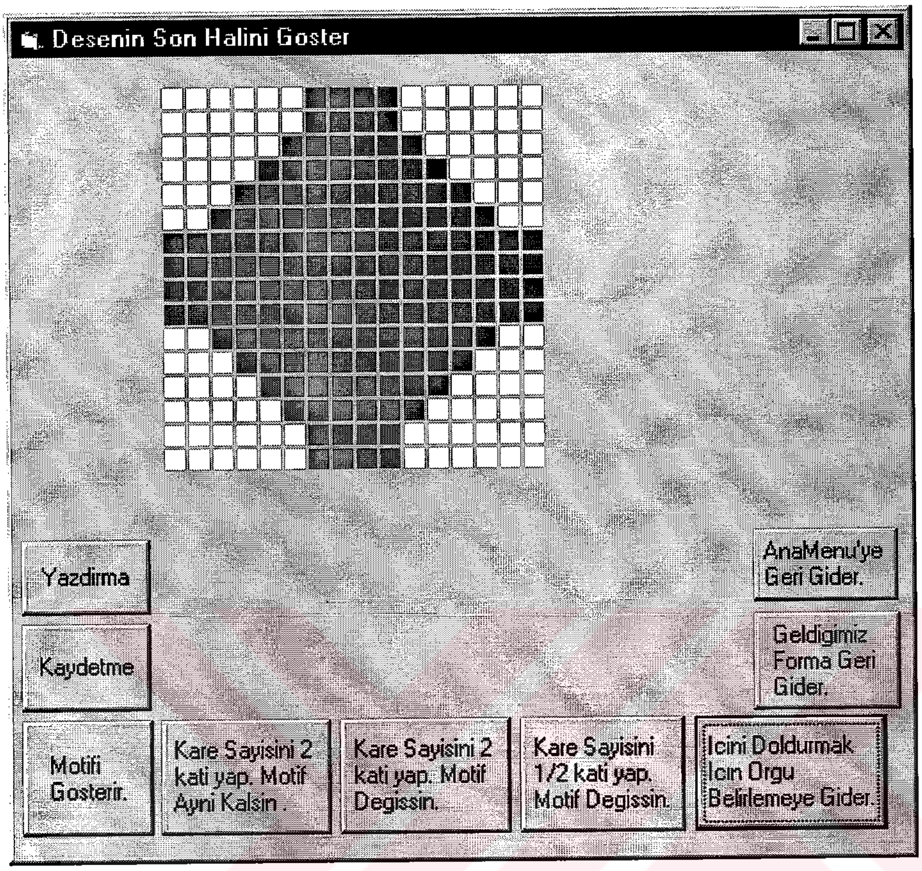
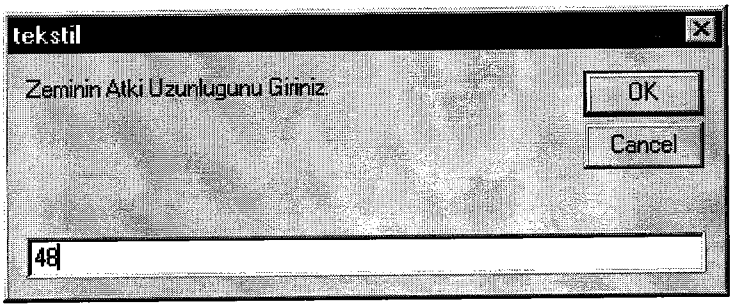


Figure 3.39: Appearance of figure which is filled.

The warp and weft lengths of the background are wanted.



After all, FFDT shows the form which helps to determine the background weave.

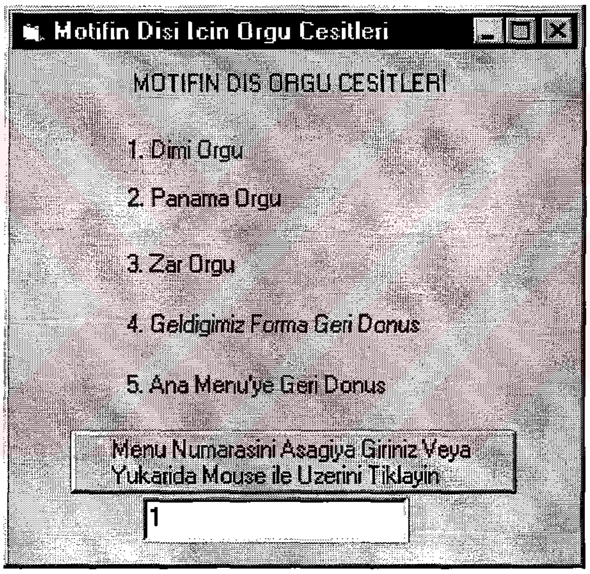


Figure 3.40: Types of weave for background.

When the twill is chosen, interlacing value and step numbers and direction of twill is determined in Figure 3.41.

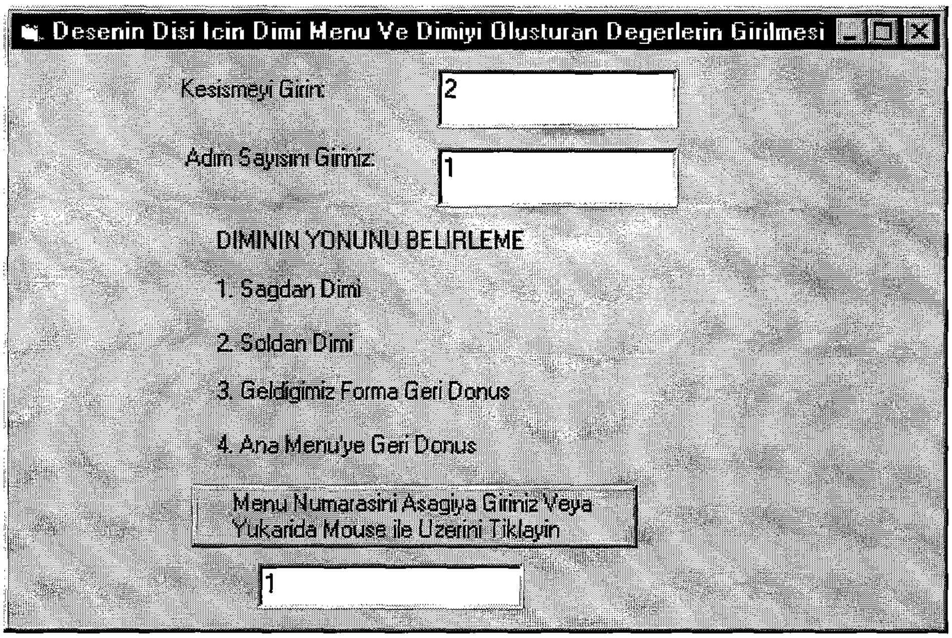
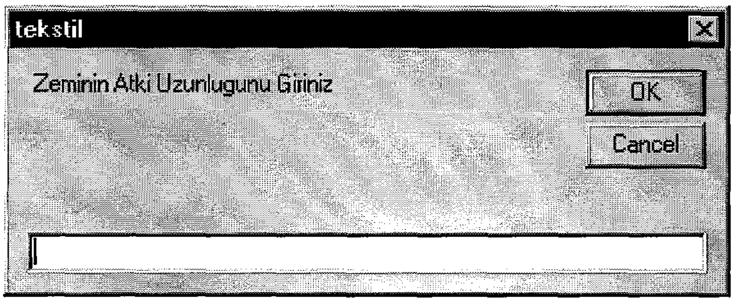


Figure 3.41: Appearance of the twill types.

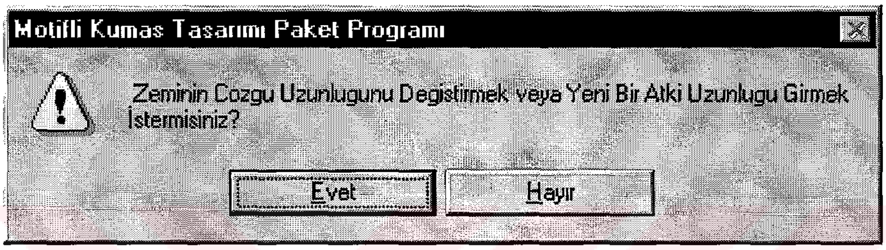
When the direction of twill is decided the following messages appear.

The first message asks if the weft length of the ground is wanted to be changed or a new weft length is wanted to be entered as follows:

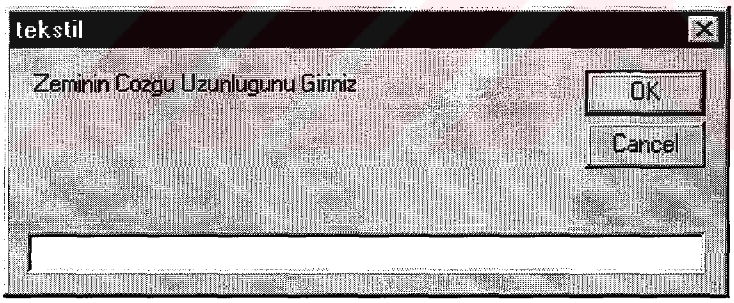
If "Yes" is entered in first message the weft length of the ground is wanted as follows.



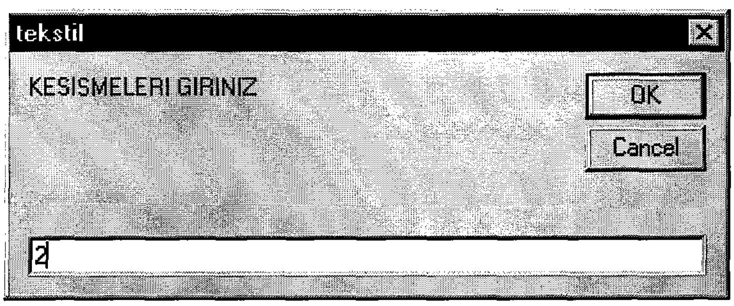
The first message asks if the weft length of the ground is wanted to be changed or a new weft length is wanted to be entered as follows:



If "Yes" is entered in second message the weft length of the ground is wanted as follows:



After all, numbers are wanted to be entered relating to the interlacing values.



FFDT shows the figure given in the Figure 3.39 whose background is 2/2 twill weave as shown in Figure 3.42.

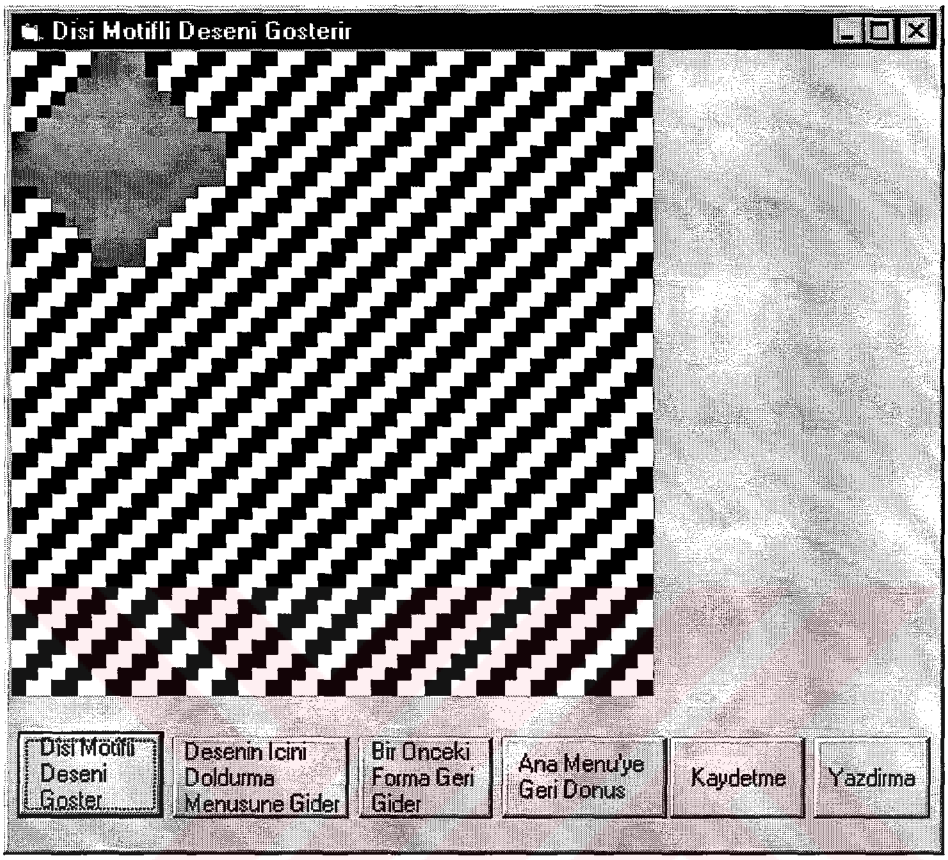


Figure 3.42: Weave whose background is 2/2 twill weave.

If the inside of the figure is wanted to be filled, the following forms asks the weave type to be chosen.

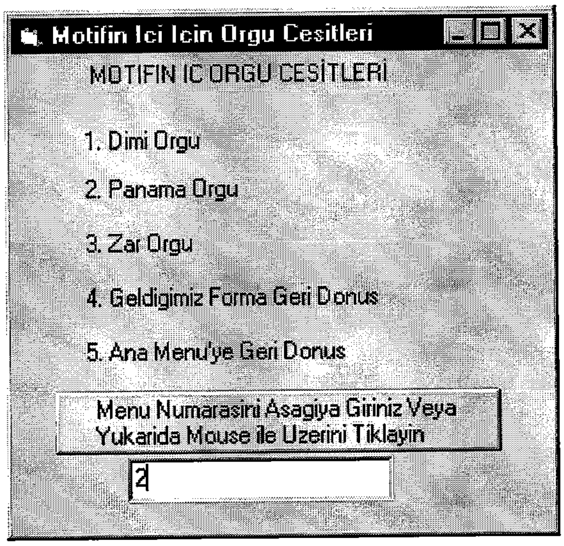


Figure 3.43: Form in which the inner weaves of figure are shown.

FFDT appears the figure twill in the background and basket weave inside.

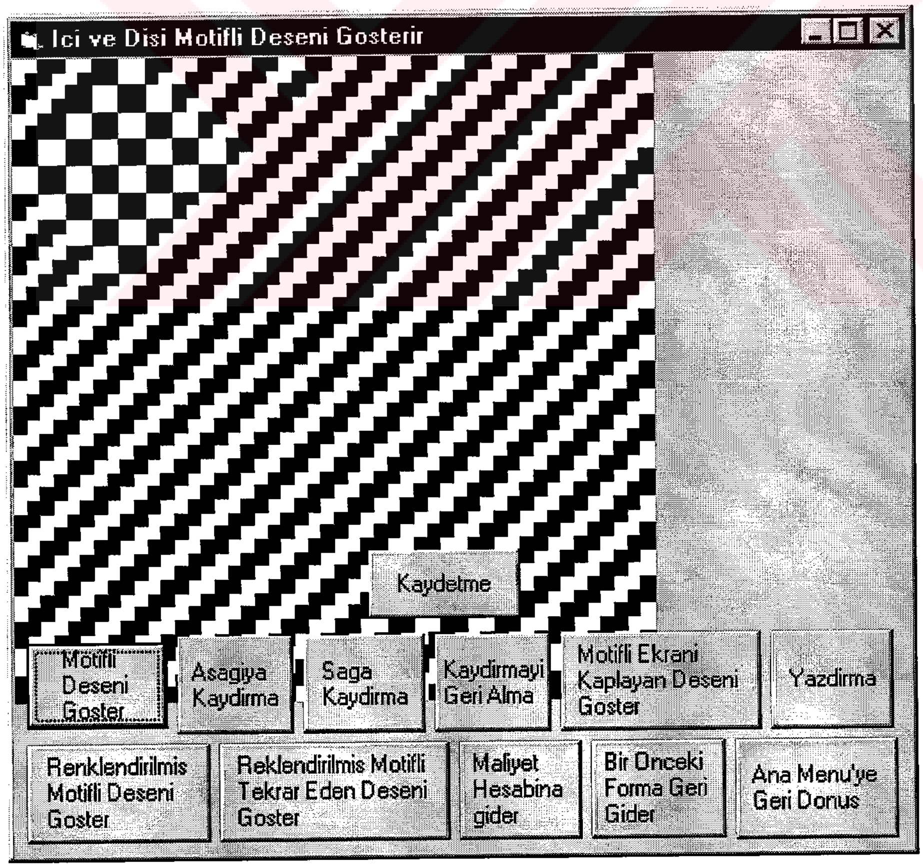


Figure 3.44: Figure with twill in the background and basket weave inside.

When the Figure 3.44 is slid down once the appearans we shall obtained is as follows:

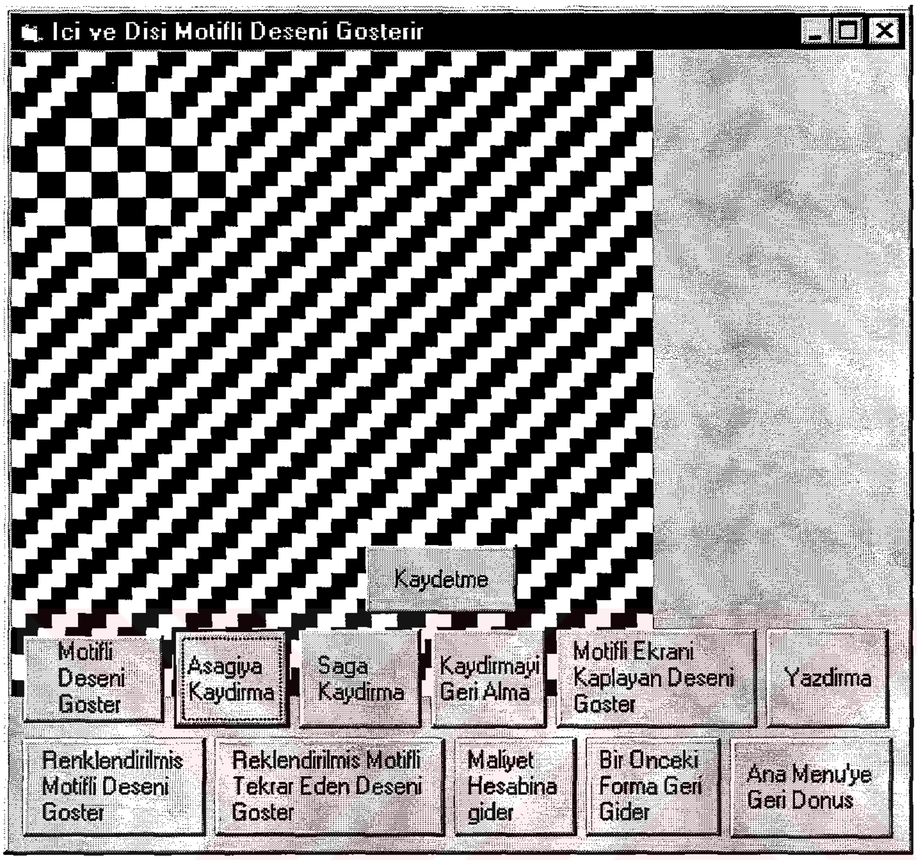
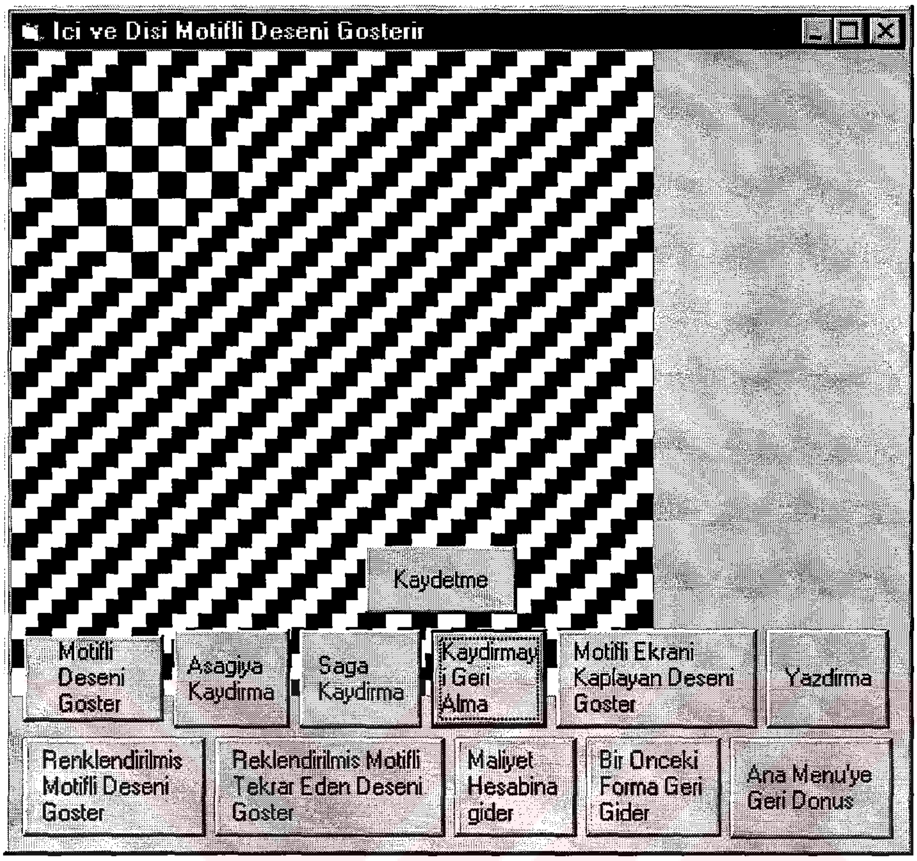


Figure 3.45: Figure which shows the result of downward sliding.

Forms of Figure 3.45 when it is slid right once as follows:



If "developing the weave" is chosen from aesthetic menu, the form that asks the weft and warp numbers come up. Figure 3.46.

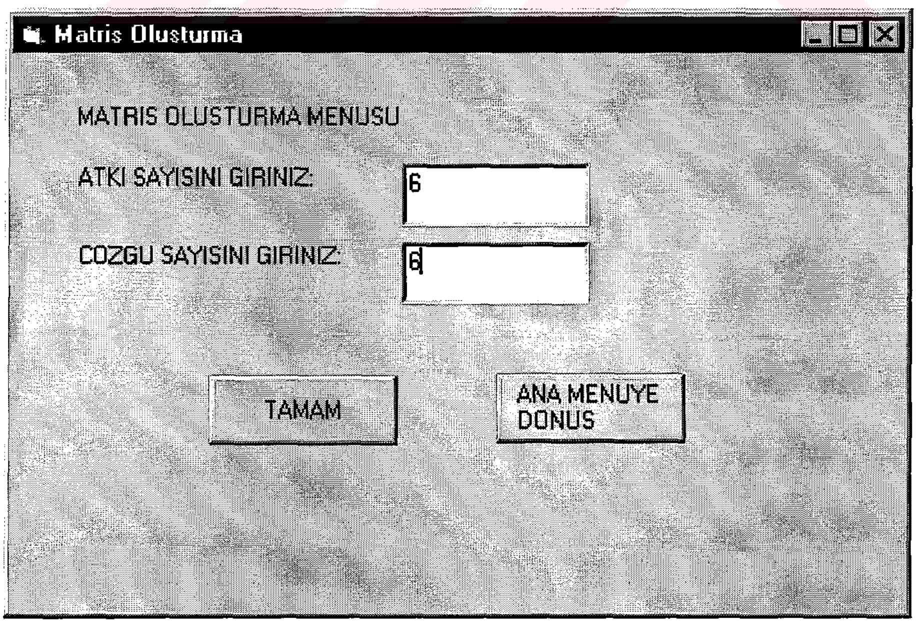


Figure 3.46: The form that asks the weft and warp numbers

According to the weft and warp numbers given in 3.46, we reach the squares above and the weave is made by clicking the mouse. Figure 3.47.

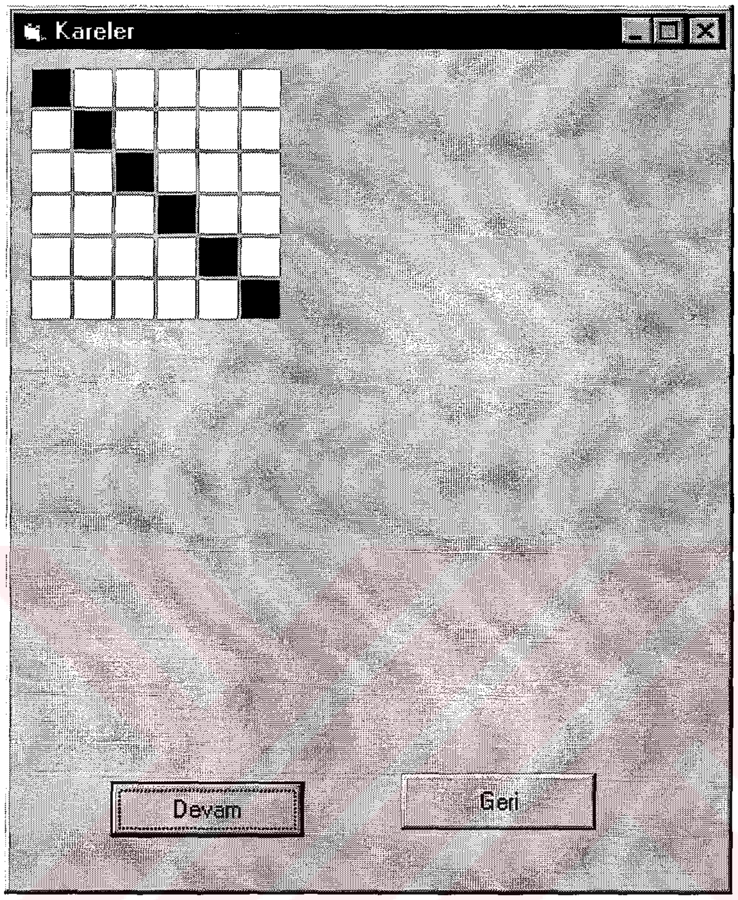


Figure 3.47: The form at which the weave is made.

When the "Go on" is clicked, the form which gives the choice for the type of the weave. Figure 3.48.

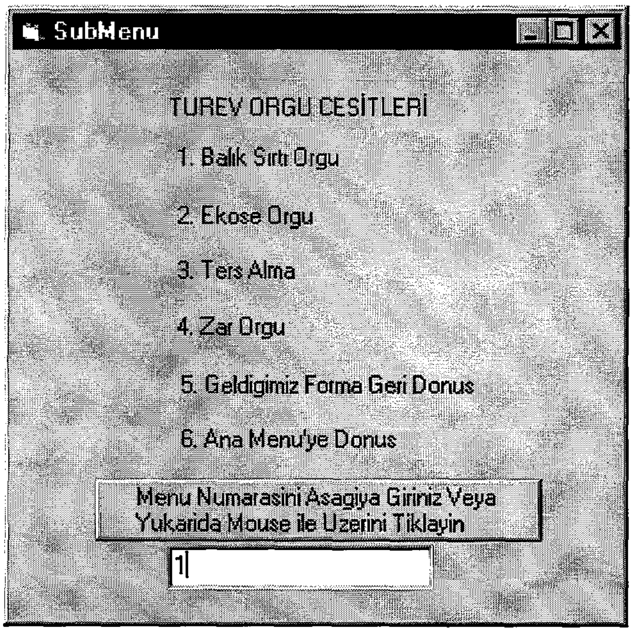


Figure 3.48: Menu of type of weave.

♦ If herring bone is chosen as in Figure 3.48 the form which wants the type at Herring Bone to be chosen is shown in Figure 3.49

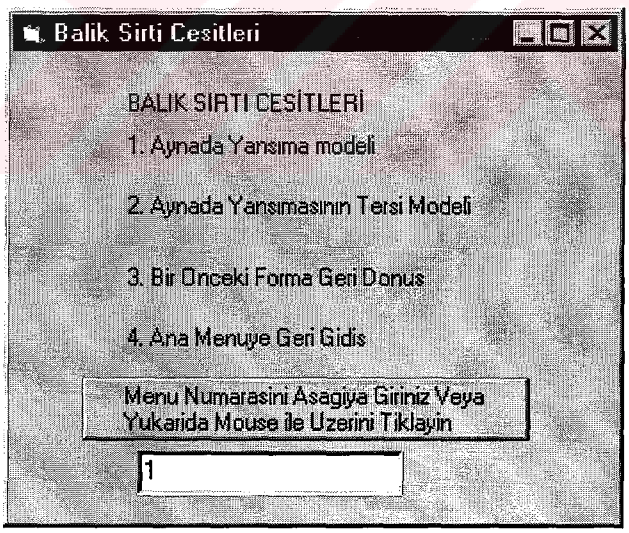


Figure 3.49: Menu of type of herring bone.

If "Reflection in the mirror" in Figure 3.49 is chosen, the user is wanted to choose how to slide the herring bone as in Figure 3.50.

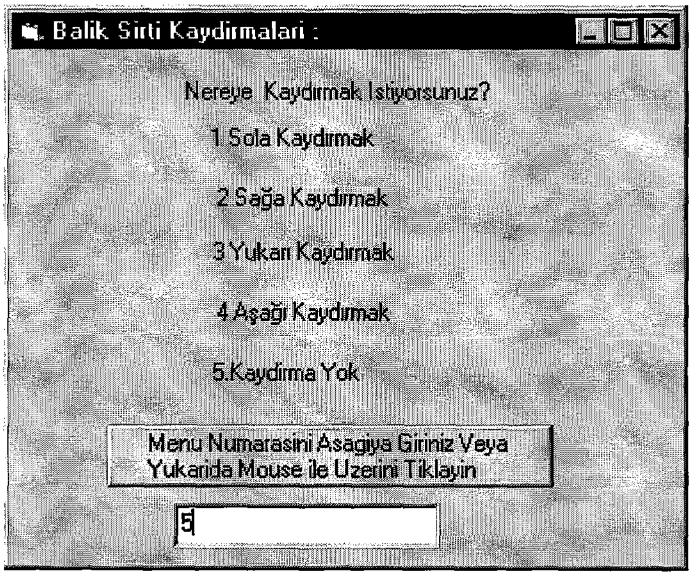


Figure 3.50: Slide of herring bone.

If the user has chosen "there is no slide" the following figure is obtained as shown in Figure 3.51.

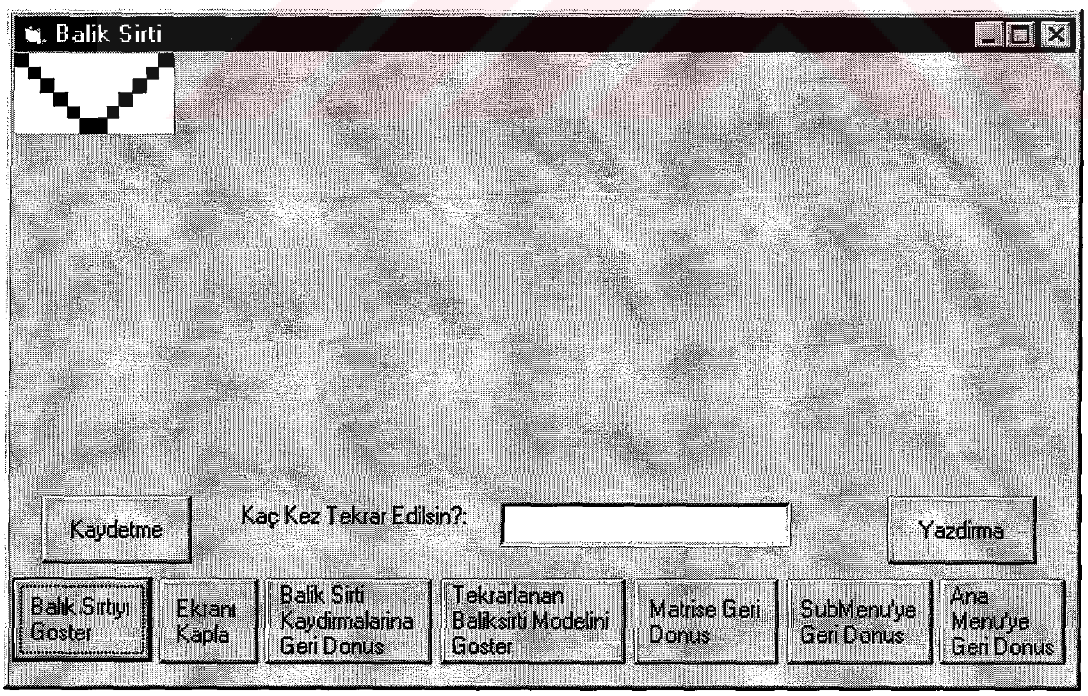


Figure 3.51: When there is no slide.

If Figure 3.51 and the choice not liked, the user can chose a slide by "Return back to herring bone slide" button.

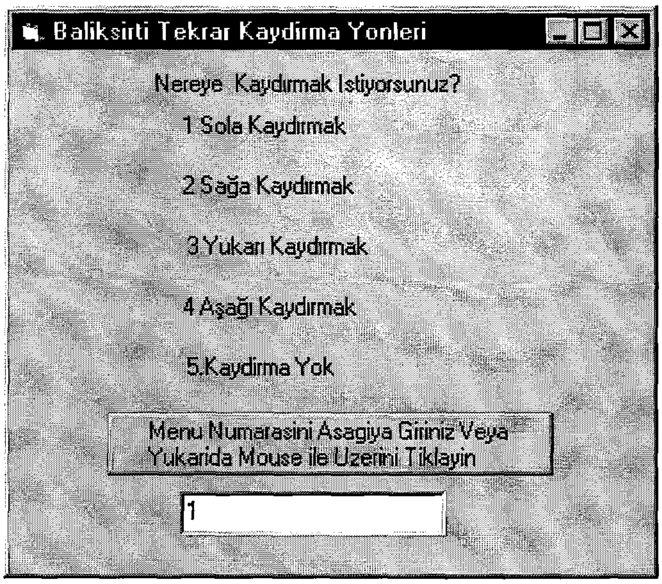


Figure 3.52: Repeated slide menu.

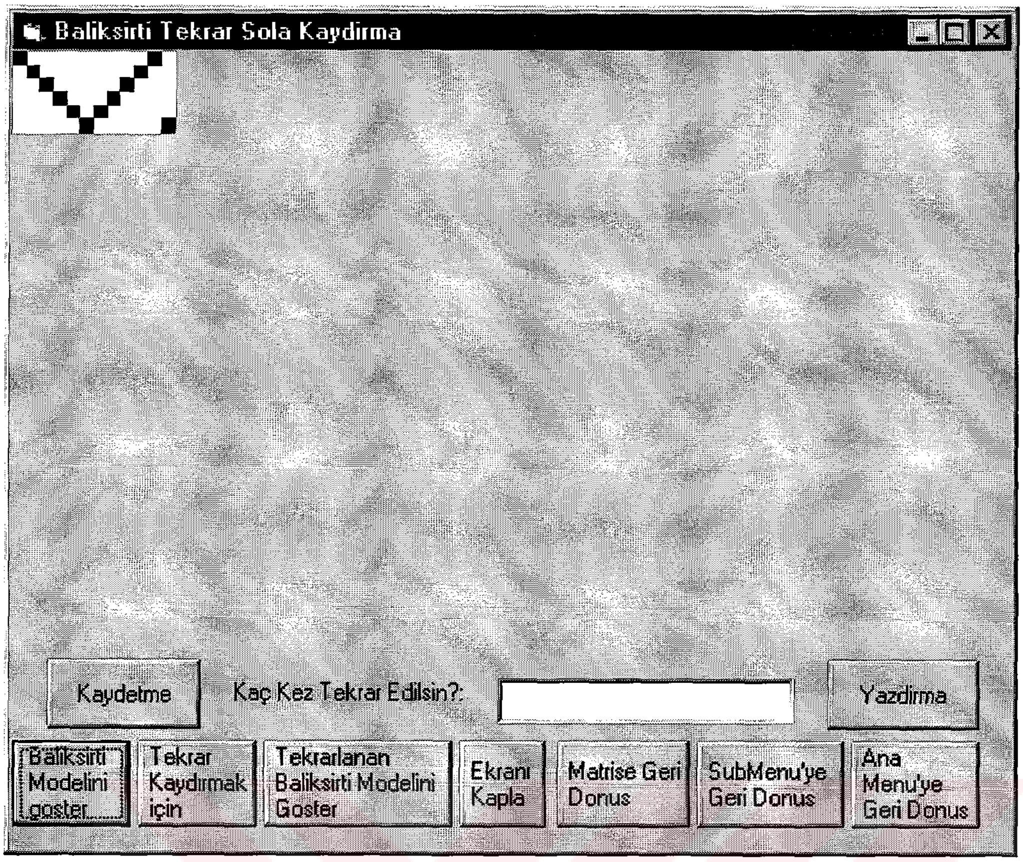


Figure 3.53: Slide left once when Figure 3.51 is not liked.

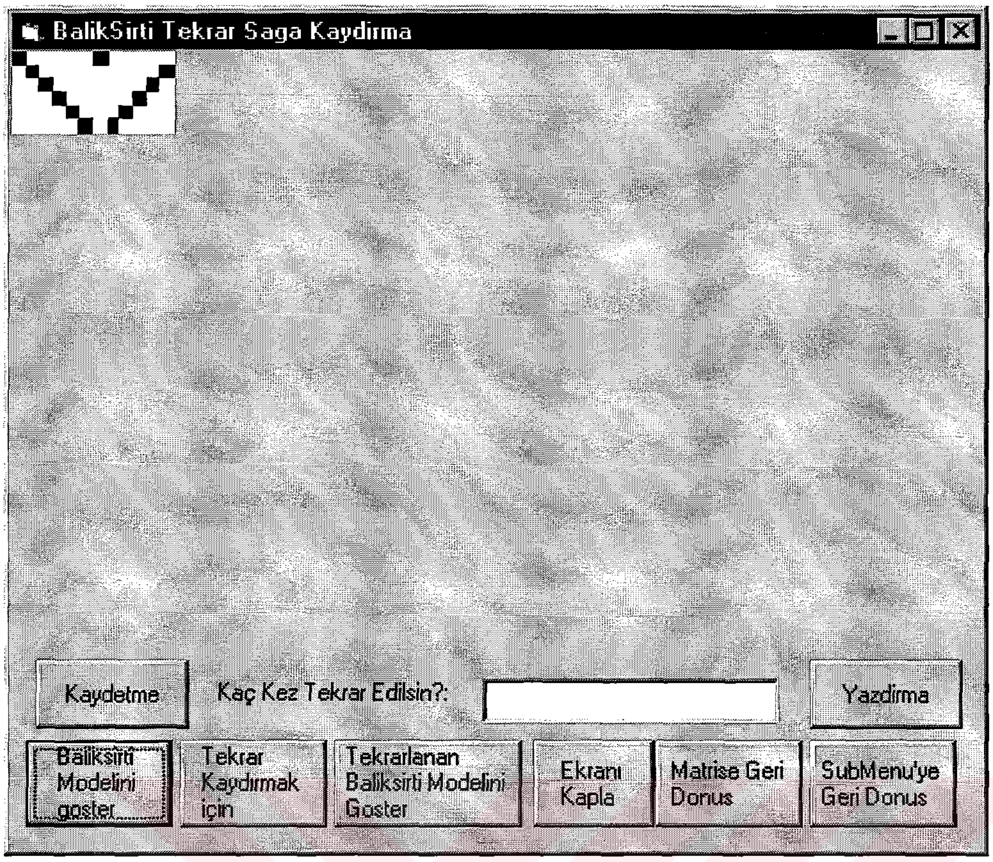


Figure 3.54: Slide right once when Figure 3.51 is not liked.

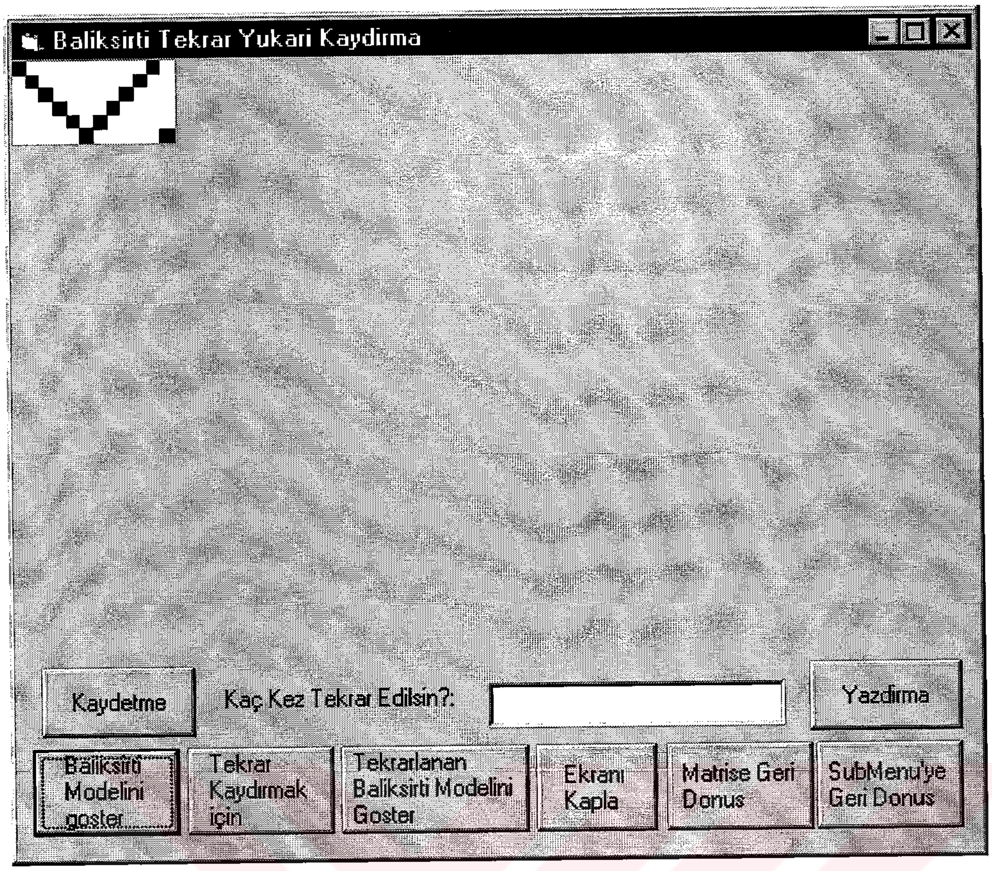


Figure 3.55: Slide upwards once when Figure 3.51 is not liked.

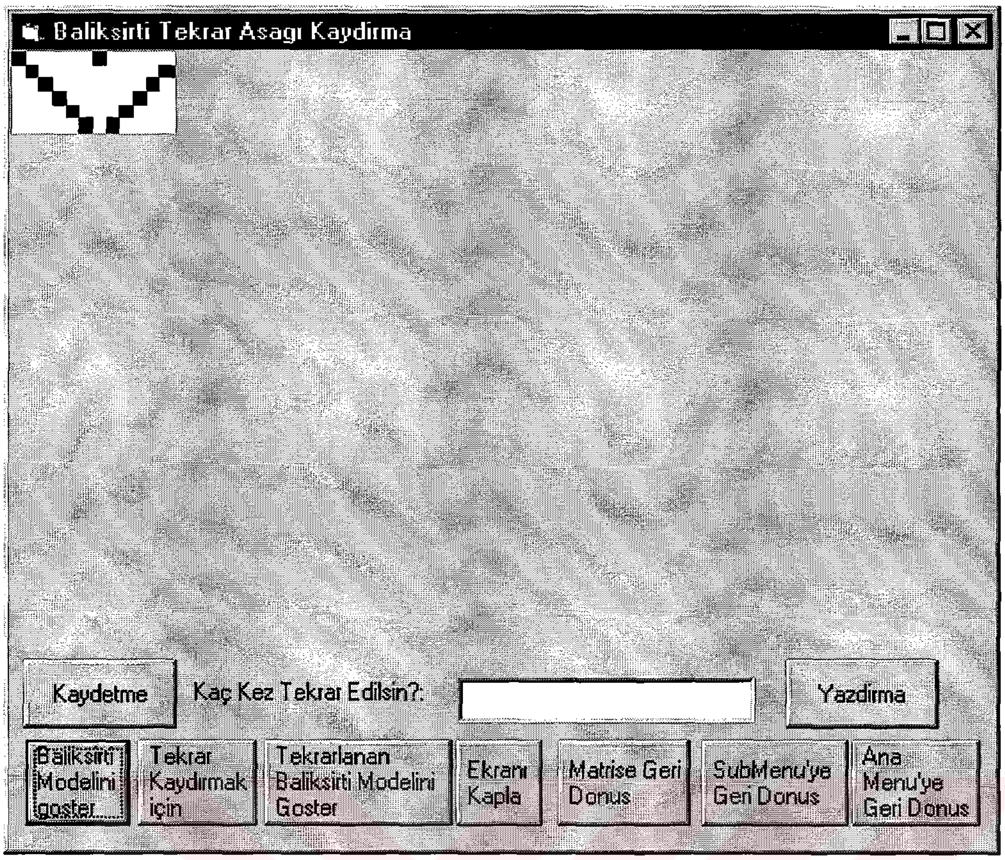


Figure 3.56: Slide down once when Figure 3.51 is not liked.

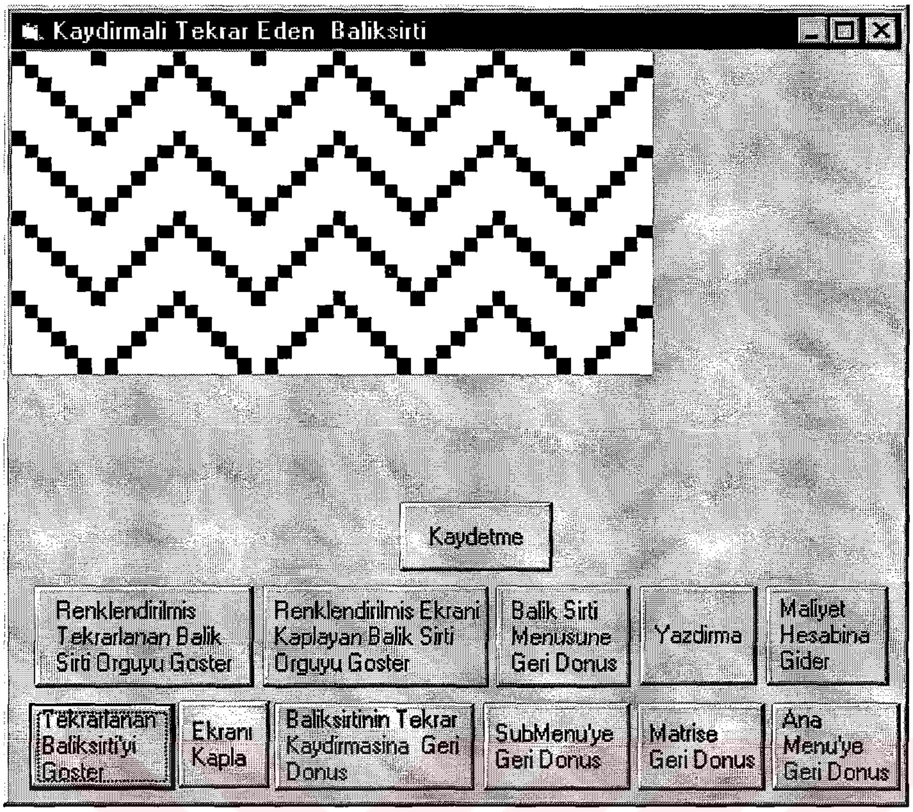


Figure 3.57: Slide down Repeated four times.

If opposite of "Reflection in the mirror" is chosen , the form that shows this appears. All the selections on the screen can be done.

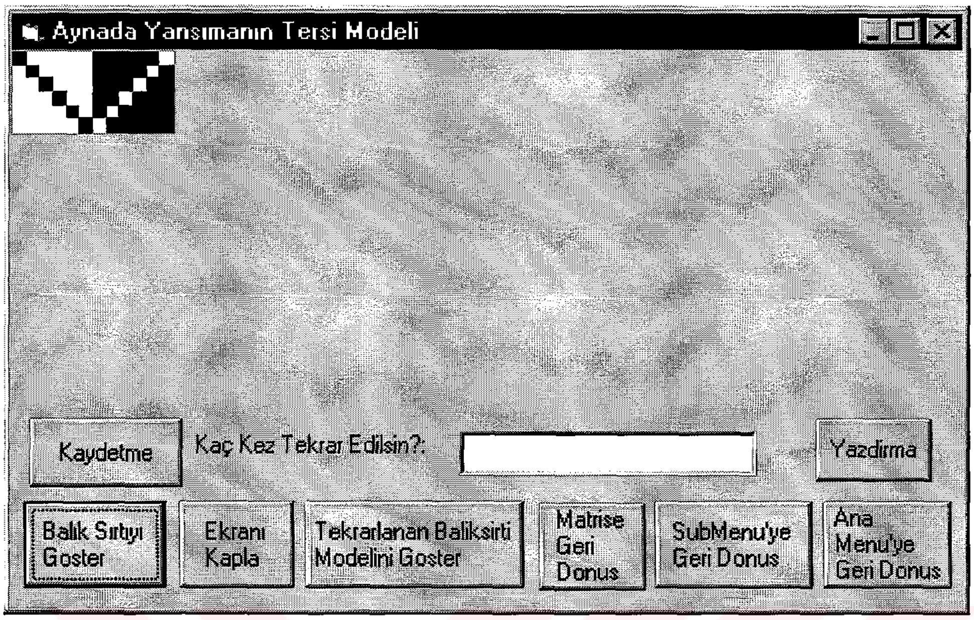


*Figure 3.58: O*pposite of reflection in the mirror.

♦ If check weave in 3.48 is chosen, a form in which check weave types are chosen comes.

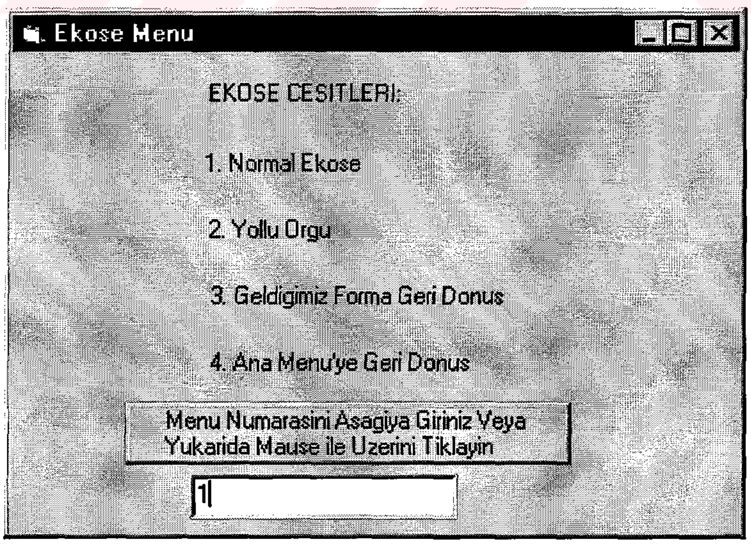


Figure 3.59: Menu of types of check weave.

If “Simple check weave” is chosen from Figure 3.59, the user is wanted to enter a second weave.

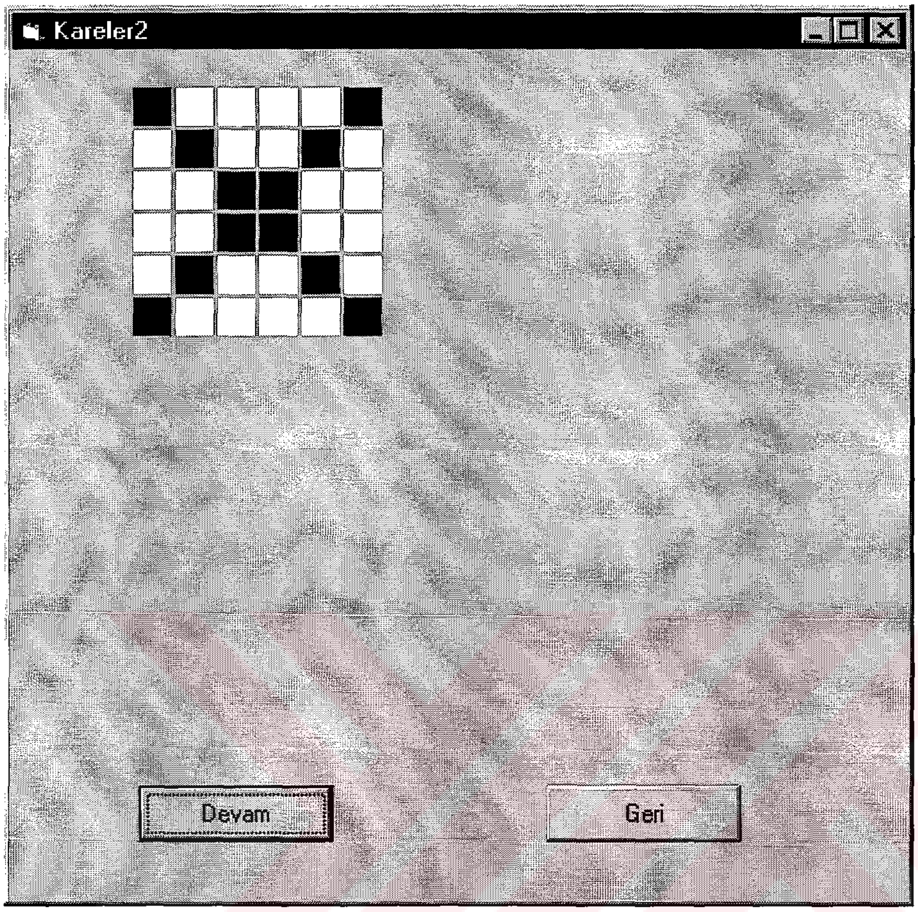


Figure 3.60: The form which the user enters the second check weave

Later the procedure between Figure 3.26-3.29 can be carried out as in check weave by technical design.

If “Stripe pattern” is chosen from Figure 3.58, the user is asked how many types of weaves will be combined in Figure 3.61 and the form, which looks like Figure5.60, related to the answer comes.

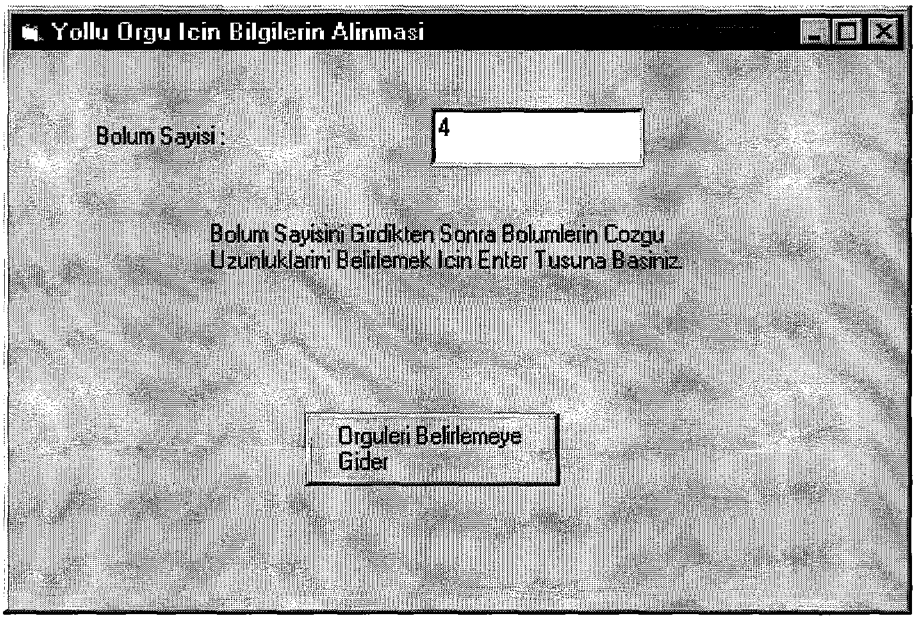
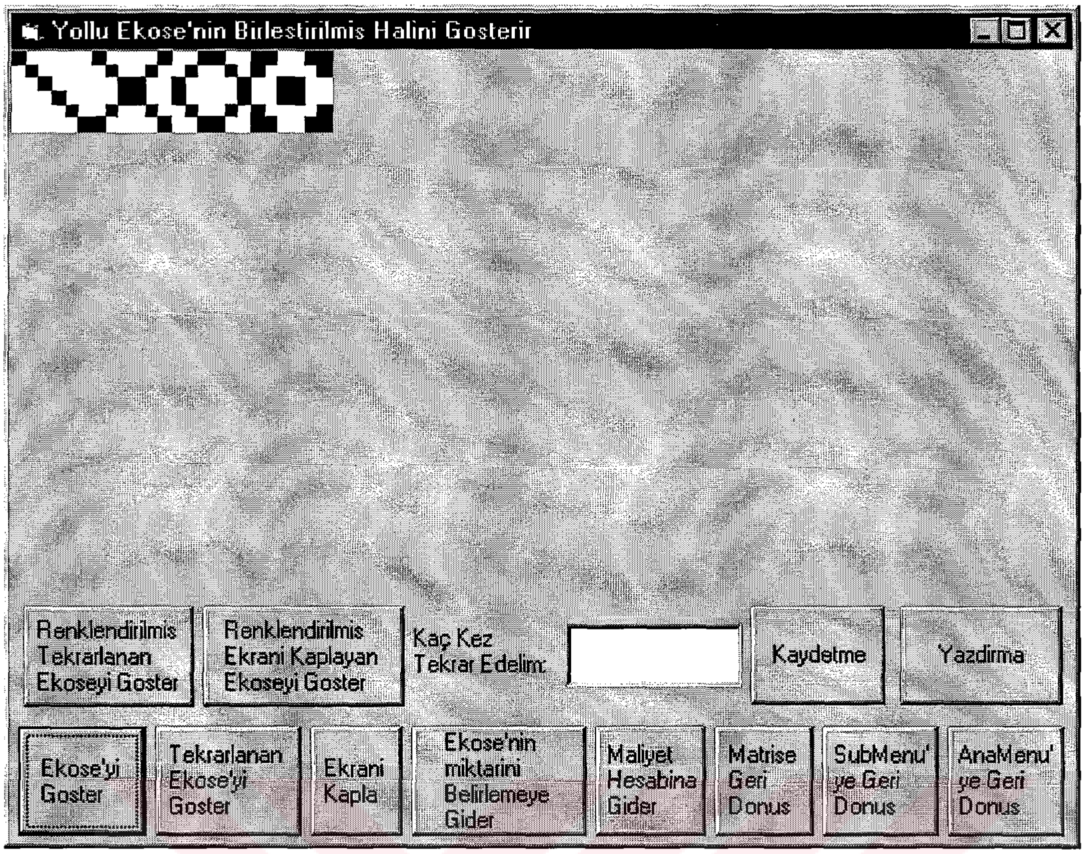


Figure 3.61: How many types of weave will be connected for the stripe pattern

At last forms in which all these weaves come together appear.



♦ If number 3 in Figure 3.48 is chosen, a form which connects the entered weave and its opposite appears. Figure 3.62.

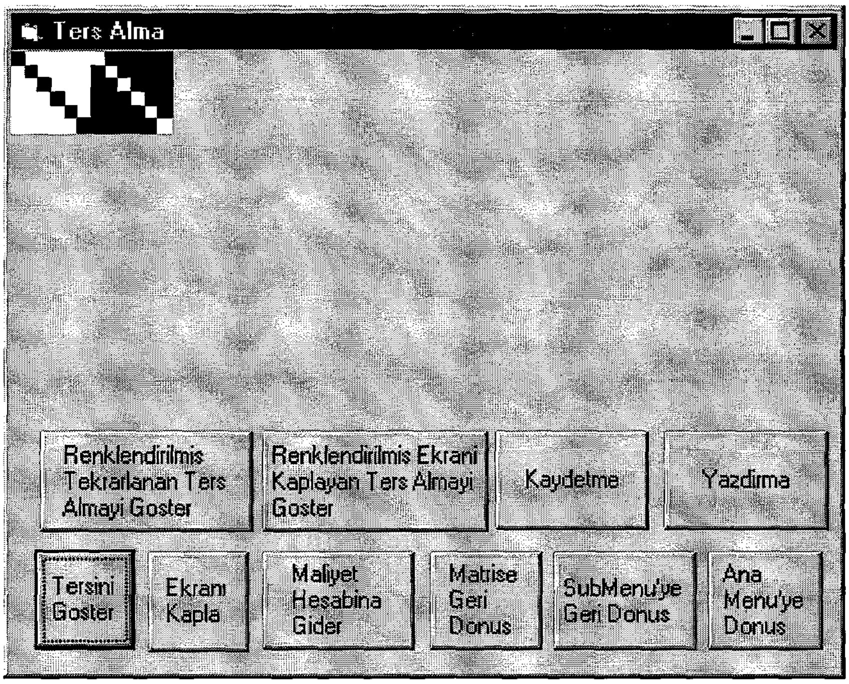
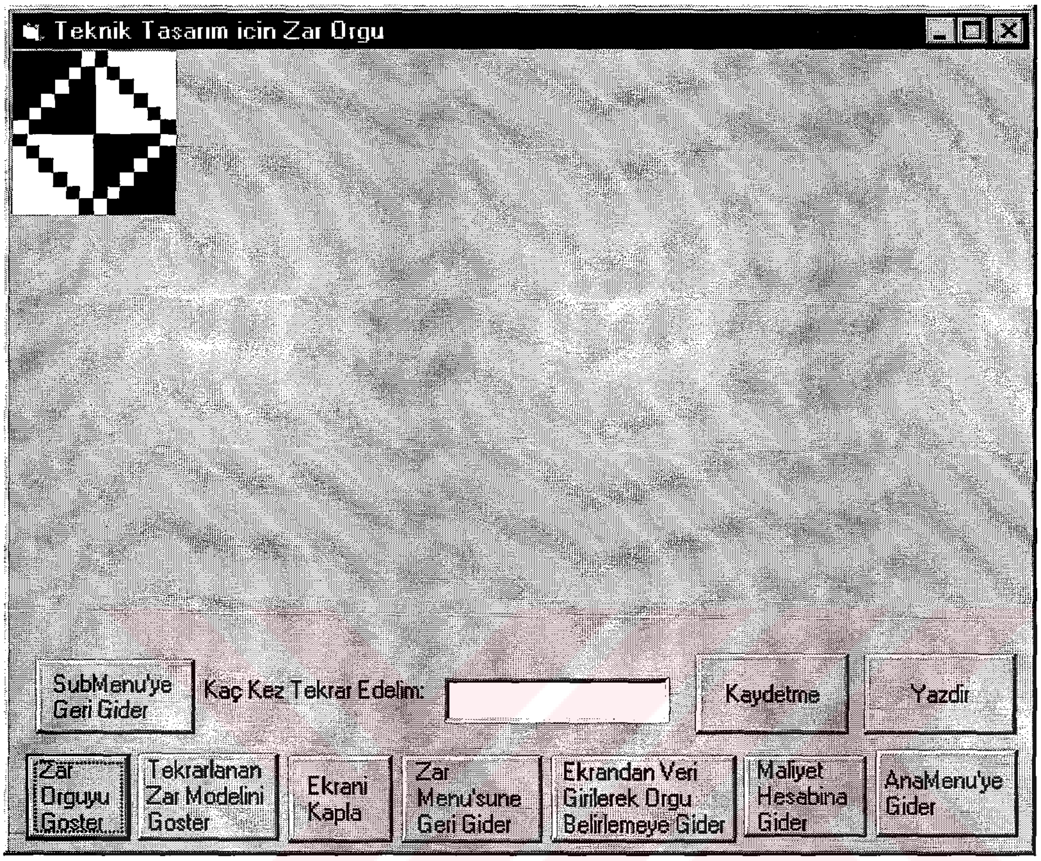


Figure 3.62: The form which shows the combination of the weave and its opposite.

♦ If "Diced weave" in aesthetic design menu (Figure 3.48) is chosen, diced weave is created by the entered weave.



3.4.1.4. Cost: Using the data in Figure 3.9, and taken from the file, the cost calculation which has been explained previously (Section 2.9-2.10) is done in the given order and the results can be seen on the screen in the same order. These examples are shown in appendix.

♦ *Colouring:*

The user must enter weft and warp colour number. Then he can choose the colours which are related to their colour number. And then, the user determines in what order the chosen colours will be used by entering values in the grid forms. Thus, the weave or the figure is coloured to the determined colours.

CONCLUSIONS

Design of woven fabrics is studied and performed as an artistic study for the surface design and as a technical study for the preparation for weaving prior to the actual production. This approach as two different approaches carried out separately disturbs the entirety of the design process and makes the solution of technical problems. With the tool which is the software developed in this work, the problems are decreased to the least and the most suitable solutions can be obtained quickly on the computer screen.

In designing a fabric, the solution is reached by trying alternative solutions that suit the aims of design by trying, evaluating and making decisions on them. Doing all these tests causes a great loss of precious time both for designers and for fabric producers. The first advantage of computers in fabric design is obvious at this very point. Another advantage is to see the harmony of colour of yarns on the screen and to make choices immediately before production, because the colour capacity of computer screen is unlimited. Computers will also have great role at finding the suitable technical parameters about the fabric.

In this study, a computer programme which combines the aesthetic and technical design methods and which applies them interactively is also linked with a programme for calculation of unit cost. Thus comprehensive software has been obtained which achieves figured fabric design with all its aspects including the production data and expected cost.

SUGGESTIONS

To increase the usage capacity of this tool at all levels of fabric production the following additions are suggested to be made:

1. Figured fabric design can be extended for double fabrics.

2. A fabric design programme can be added for figuring with extra yarns.

3. The drafting and pegging plans can be obtained.

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Cimrin, U. (1996). Bir Dokuma Kumaşın Teknik Tasarımına Dayalı Maliyet Hesapları Yapan Bir Bilgisayar Programının Geliştirilmesi. İzmir.

Çitimoğlu, V. (1992). Tek Katlı Motifli Kumaşların Bilgisayar ile Tasarlanması.İzmir.

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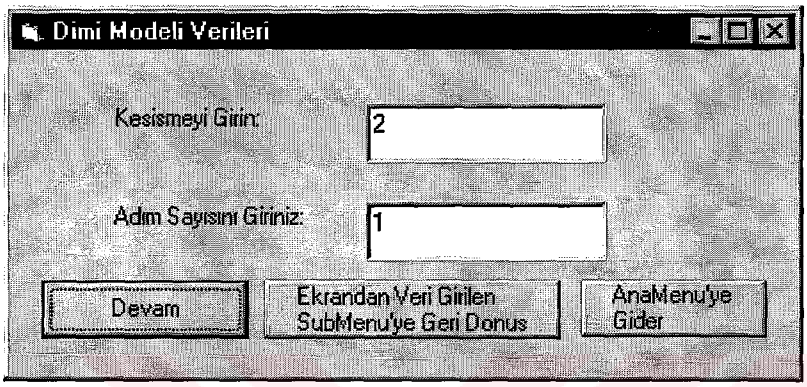
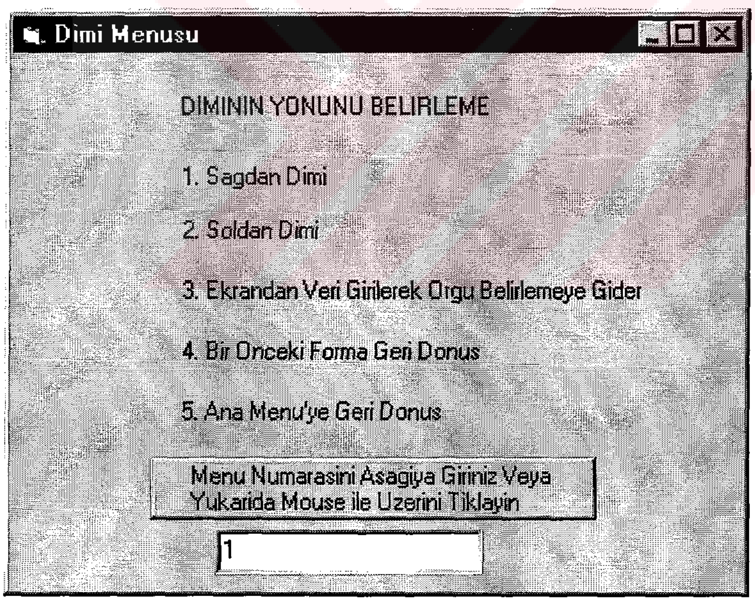
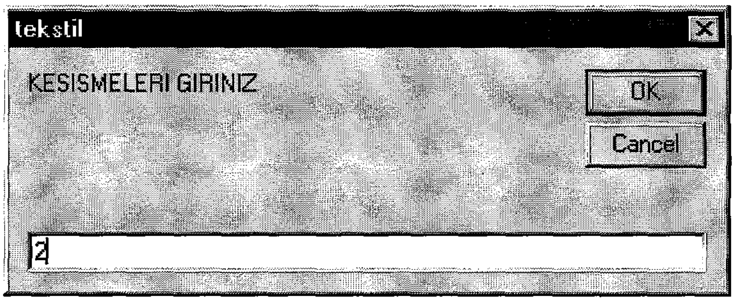
Watson, W. (1956). Textile Design and Colour, Revised by E. G. Taylor, J. Bunchan. Longsman, Green and Co. London, New York, Toronto.

APPENDIX A

TWILL WEAVE



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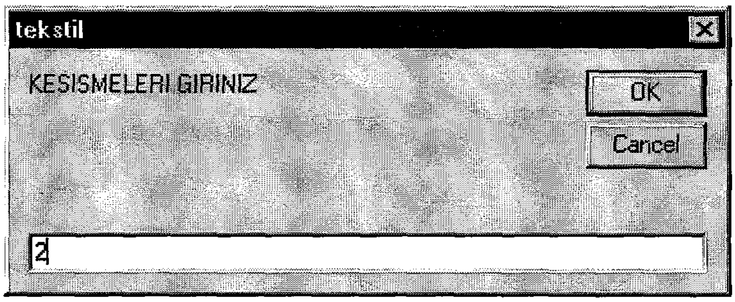
Cancel
2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OK
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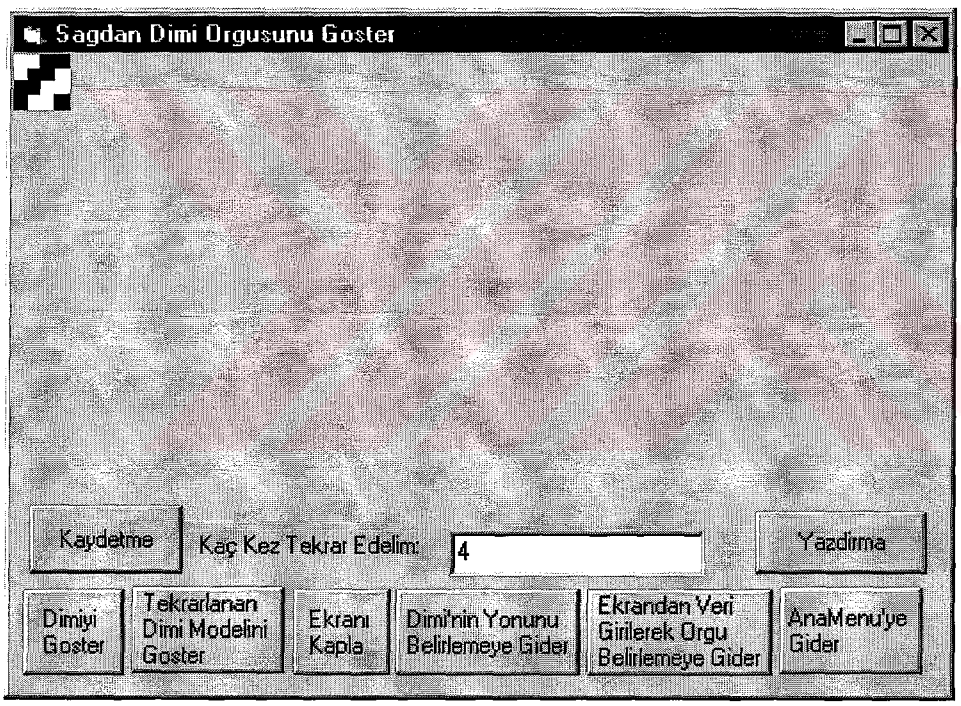
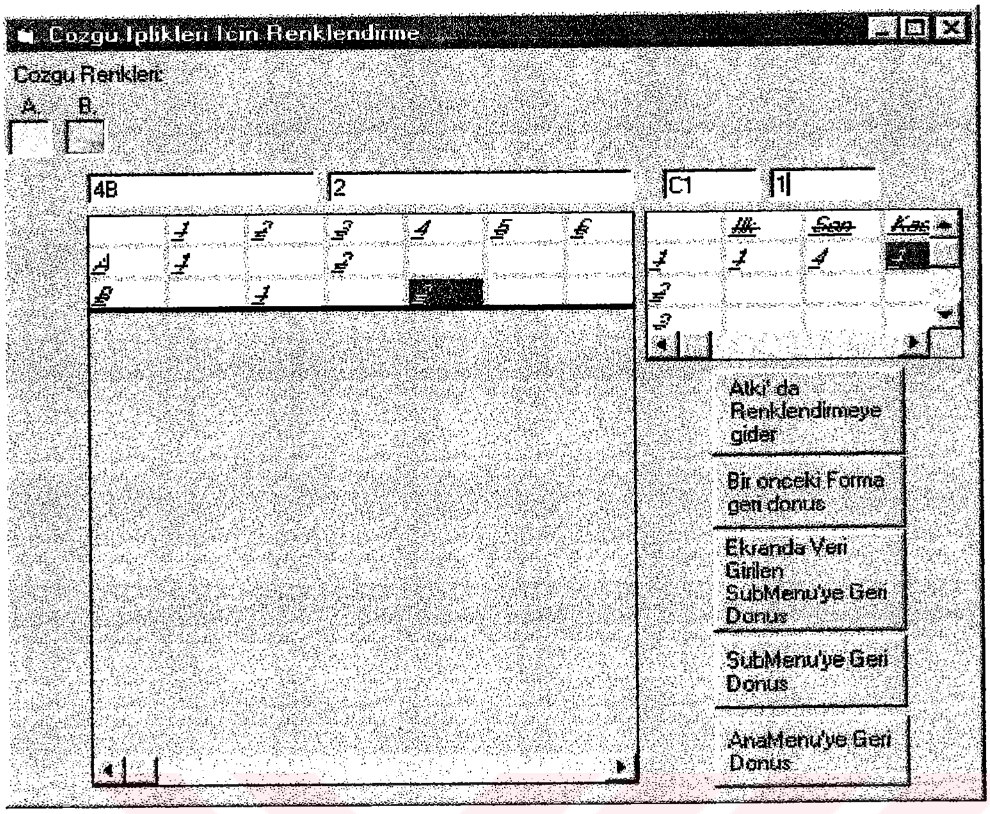
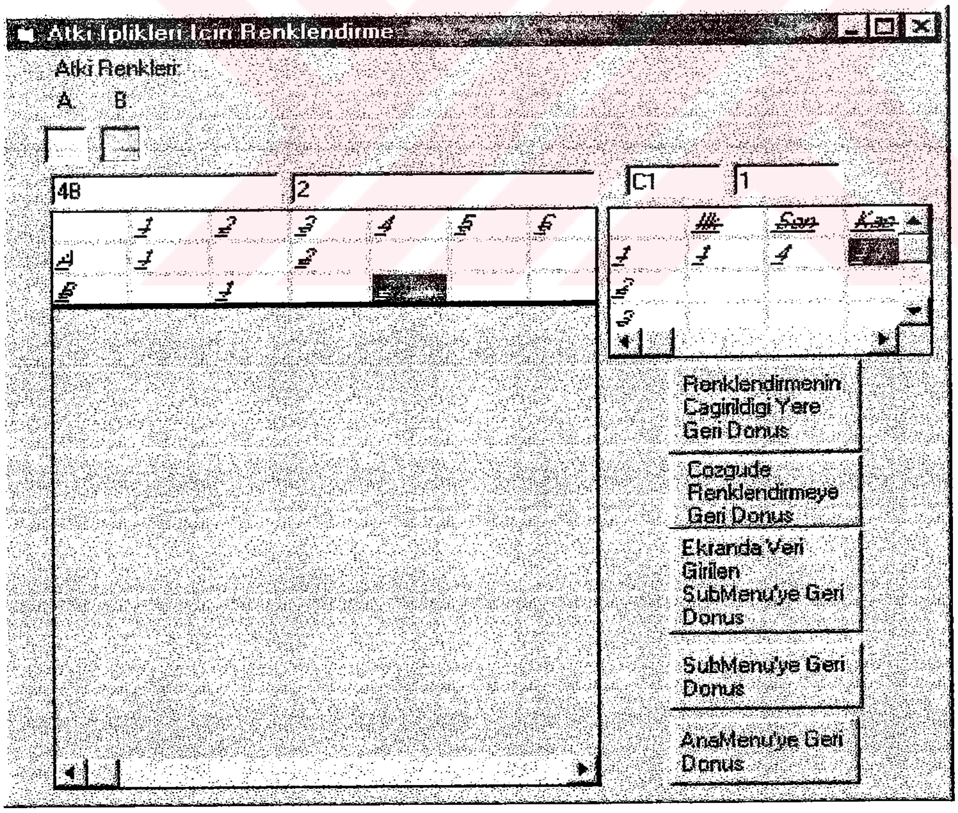
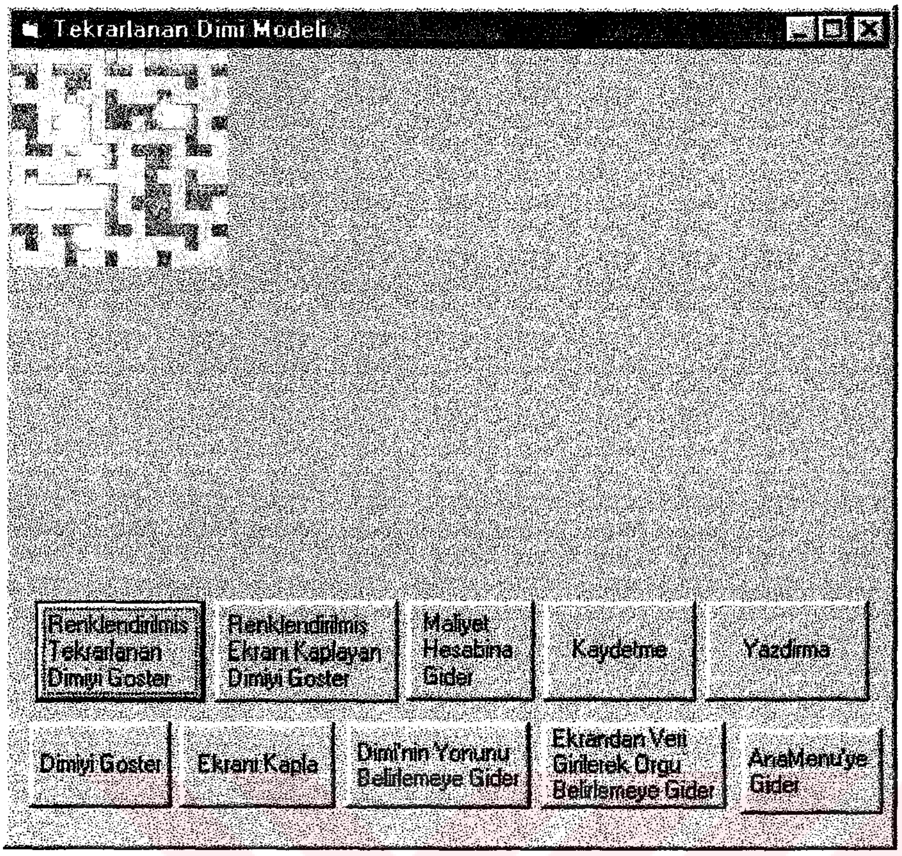
2


Sagdan Dimi Orgusunu Goster
Kaydetme
Kaç Kez Tekrar Edelim:
4
Yazdirma
Dimiyi Goster
Tekrarlanan Dimi Modelini Goster
Ekrani Kapla
Dimi'nin Yonunu Belirlemeye Gider
Ekrandan Veri Girilerek Orgu Belirlemeye Gider
AnaMenu'ye Gider


Cozgu Iplikleri Icin Renklendirme
Cozgu Renkleri:
A
B
4B
2
C1
1
Atki' da Renklendirmeye gider
Bir onceki Forma geri donus
Ekranda Veri Girilen SubMenu'ye Geri Donus
SubMenu'ye Geri Donus
AnaMenu'ye Geri Donus


Atki Iplikleri Icin Renklendirme
Atki Renkleri:
A
B
4B
2
C1
1
Renklendirmenin Cagirildigi Yere Geri Donus
Cozgude Renklendirmeye Geri Donus
Ekranda Veri Girilen SubMenu'ye Geri Donus
SubMenu'ye Geri Donus
AnaMenu'ye Geri Donus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Renklendirilmis Tekrarlanan Dimiyi Goster
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Maliyet Hesabina Gider
Kaydetme
Yazdirma
Dimiyi Goster
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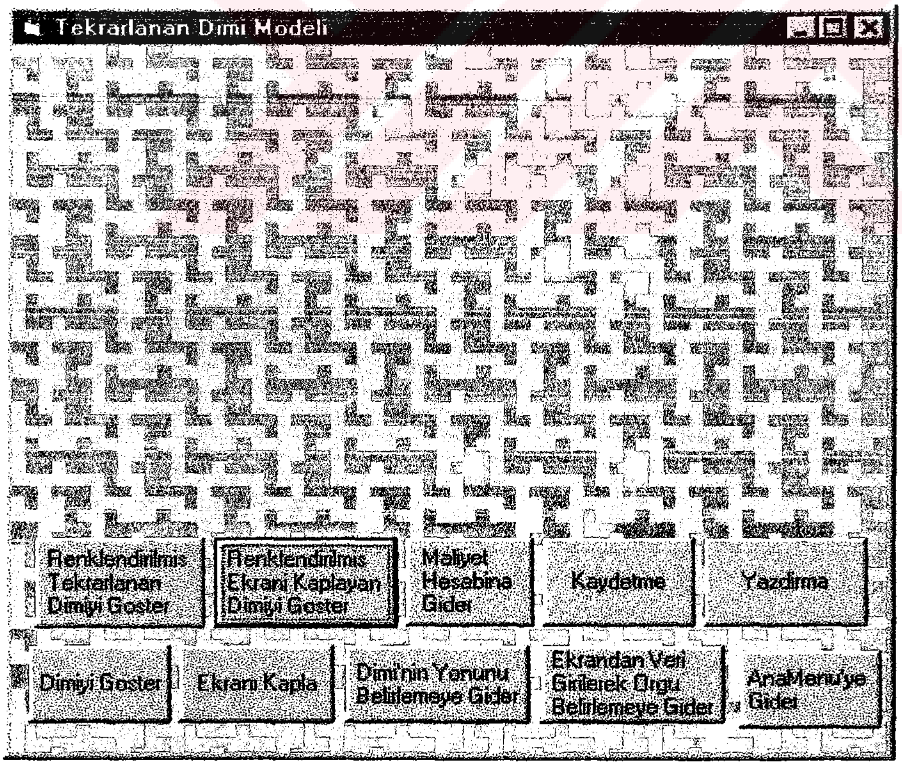
AnaMenu'ye Gider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Yazdirma
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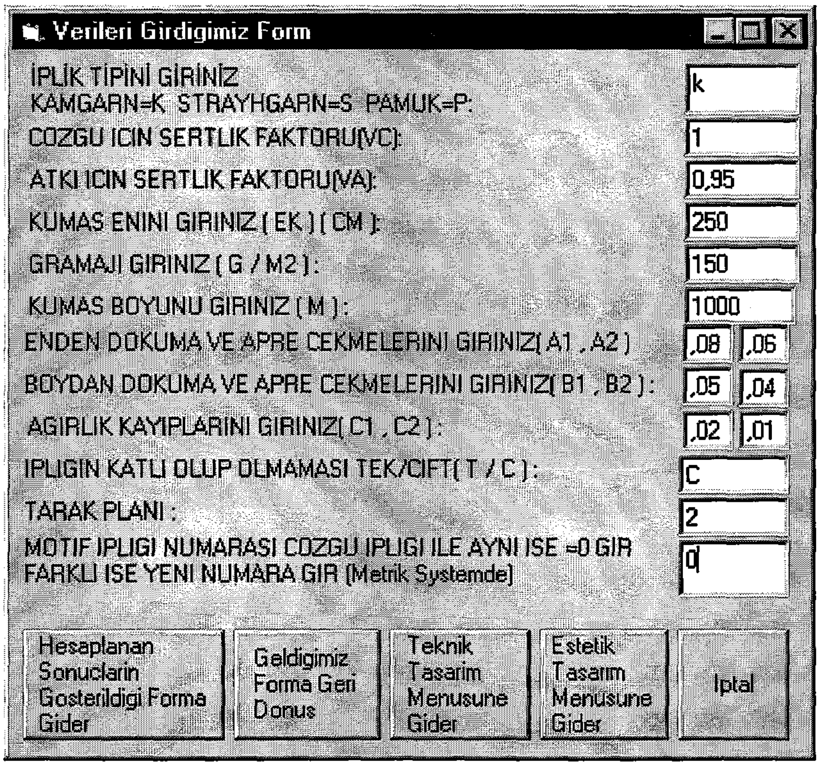
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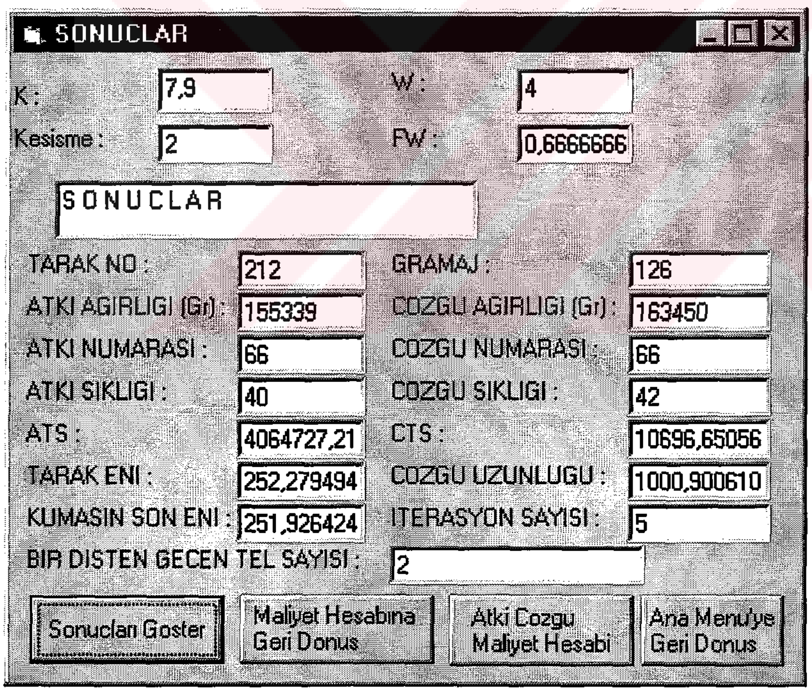
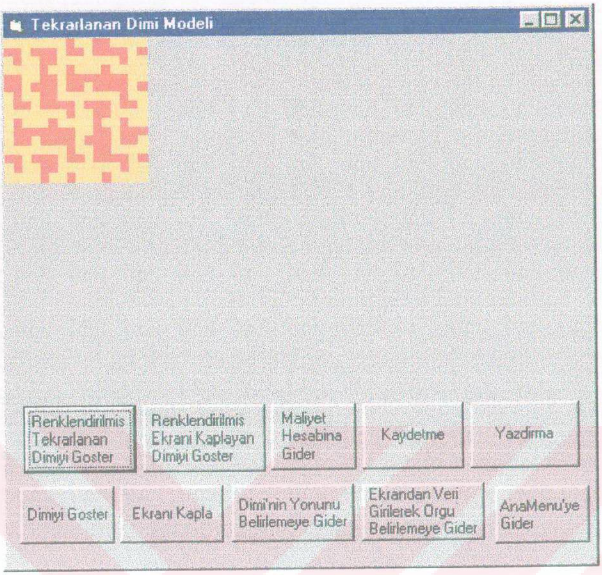
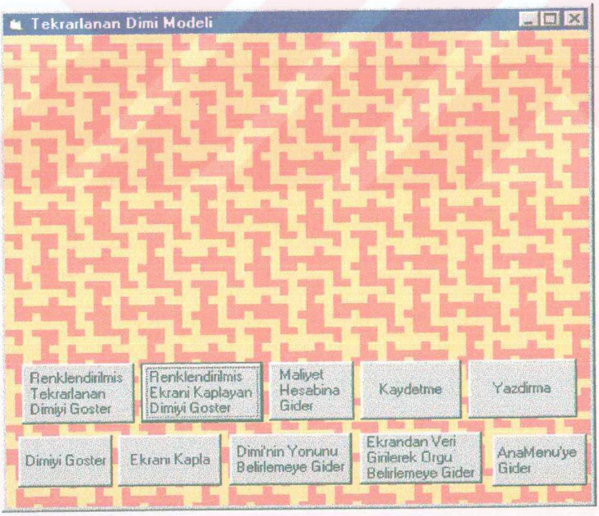
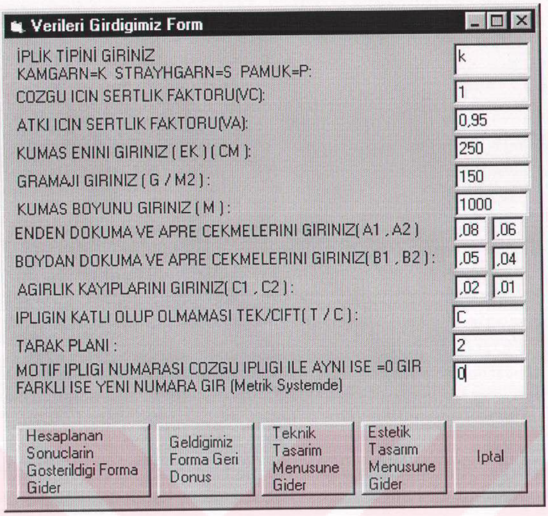
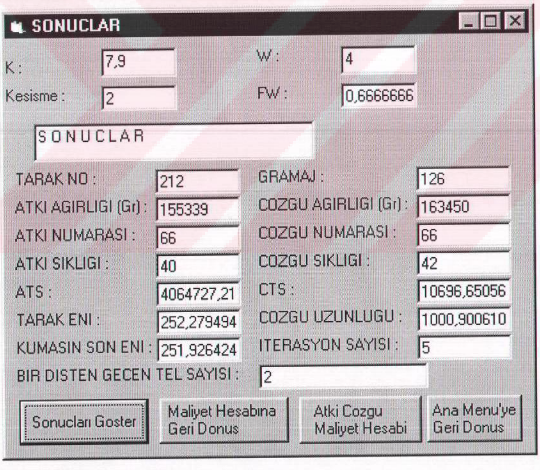
k
COZGU ICIN SERTLIK FAKTORU(VC):
1
ATKI ICIN SERTLIK FAKTORU(VA):
0,95
KUMAS ENINI GIRINIZ (EK) (CM):
250
GRAMAJI GIRINIZ (G / M2):
150
KUMAS BOYUNU GIRINIZ (M):
1000
ENDEN DOKUMA VE APRE CEKMELERINI GIRINIZ(A1 , A2)
,08
,06
BOYDAN DOKUMA VE APRE CEKMELERINI GIRINIZ(B1 , B2):
,05
,04
AGIRLIK KAYIPLARINI GIRINIZ(C1 , C2):
,02
,01
IPLIGIN KATLI OLUP OLMAMASI TEK/CIFT(T / C):
C
TARAK PLANI :
2
MOTIF IPLIGI NUMARASI COZGU IPLIGI ILE AYNI ISE =0 GIR
FARKLI ISE YENI NUMARA GIR (Metrik Systemde)
0
Hesaplanan Sonuclarin Gosterildigi Forma Gider
Geldigimiz Forma Geri Donus
Teknik Tasarim Menusune Gider
Estetik Tasarım Menusune Gider
Iptal

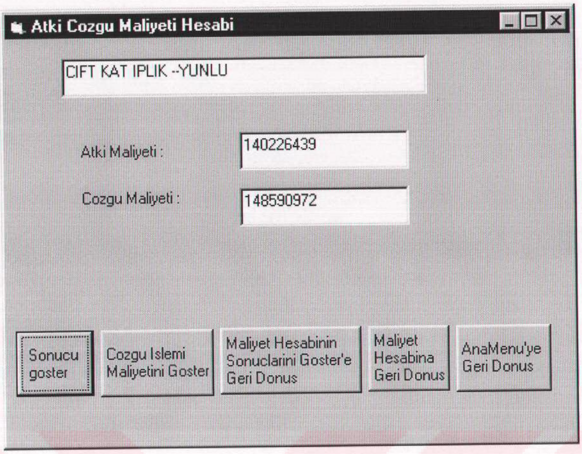

SONUCLAR
K :
7,9
W :
4
Kesisme :
2
FW :
0,6666666
SONUCLAR
TARAK NO :
212
GRAMAJ :
126
ATKI AGIRLIGI (Gr) :
155339
COZGU AGIRLIGI (Gr) :
163450
ATKI NUMARASI :
66
COZGU NUMARASI :
66
ATKI SIKLIGI :
40
COZGU SIKLIGI :
42
ATS :
4064727,21
CTS :
10696,65056
TARAK ENI :
252,279494
COZGU UZUNLUGU :
1000,900610
KUMASIN SON ENI :
251,926424
ITERASYON SAYISI :
5
BIR DISTEN GECEN TEL SAYISI :
2
Sonuclari Goster
Maliyet Hesabina Geri Donus
Atki Cozgu Maliyet Hesabi
Ana Menu'ye Geri Donus

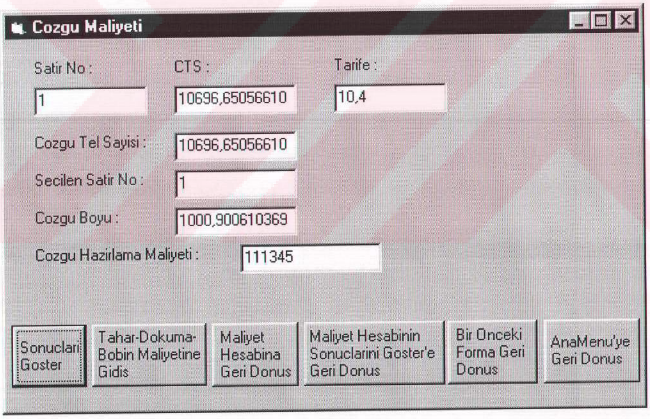

Tekrarlanan Dimi Modeli
Renklendirilmis Tekrarlanan Dimiyi Goster
Renklendirilmis Ekrani Kaplayan Dimiyi Goster
Maliyet Hesabina Gider
Kaydetme
Yazdirma
Dimiyi Goster
Ekranı Kapla
Dimi'nin Yonunu Belirlemeye Gider
Ekrandan Veri Girilerek Orgu Belirlemeye Gider
AnaMenu'ye Gider

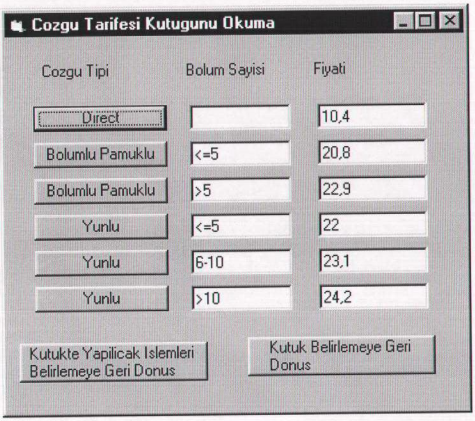

Tekrarlanan Dimi Modeli
Renklendirilmis Tekrarlanan Dimiyi Goster
Renklendirilmis Ekrani Kaplayan Dimiyi Goster
Maliyet Hesabina Gider
Kaydetme
Yazdirma
Dimiyi Goster
Ekranı Kapla
Dimi'nin Yonunu Belirlemeye Gider
Ekrandan Veri Girilerek Orgu Belirlemeye Gider
AnaMenu'ye Gider

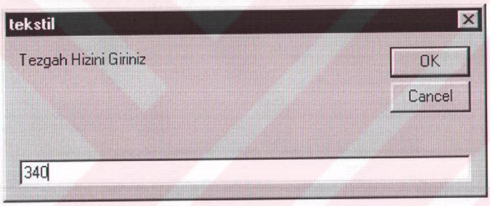

Verileri Girdigimiz Form
İPLİK TİPİNİ GİRİNİZ
KAMGARN=K STRAYHGARN=S PAMUK=P:
k
COZGU ICIN SERTLIK FAKTORU(VC):
1
ATKI ICIN SERTLIK FAKTORU(VA):
0,95
KUMAS ENINI GIRINIZ (EK) (CM):
250
GRAMAJI GIRINIZ (G / M2) :
150
KUMAS BOYUNU GIRINIZ (M) :
1000
ENDEN DOKUMA VE APRE CEKMELERINI GIRINIZ(A1 , A2)
,08
,06
BOYDAN DOKUMA VE APRE CEKMELERINI GIRINIZ(B1 , B2) :
,05
,04
AGIRLIK KAYIPLARINI GIRINIZ(C1 , C2) :
,02
,01
IPLIGIN KATLI OLUP OLMAMASI TEK/CIFT(T / C) :
C
TARAK PLANI :
2
MOTIF IPLIGI NUMARASI COZGU IPLIGI ILE AYNI ISE =0 GIR
FARKLI ISE YENI NUMARA GIR (Metrik Systemde)
0
Hesaplanan Sonuclarin Gosterildigi Forma Gider
Geldigimiz Forma Geri Donus
Teknik Tasarim Menusune Gider
Estetik Tasarım Menusune Gider
Iptal

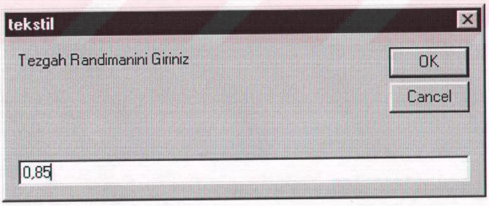

SONUCLAR
K :
7,9
W :
4
Kesisme :
2
FW :
0,6666666
S O N U C L A R
TARAK NO :
212
GRAMAJ :
126
ATKI AGIRLIGI (Gr) :
155339
COZGU AGIRLIGI (Gr) :
163450
ATKI NUMARASI :
66
COZGU NUMARASI :
66
ATKI SIKLIGI :
40
COZGU SIKLIGI :
42
ATS :
4064727,21
CTS :
10696,65056
TARAK ENI :
252,279494
COZGU UZUNLUGU :
1000,900610
KUMASIN SON ENI :
251,926424
ITERASYON SAYISI :
5
BIR DISTEN GECEN TEL SAYISI :
2
Sonucları Goster
Maliyet Hesabına Geri Donus
Atki Cozgu Maliyet Hesabi
Ana Menu'ye Geri Donus

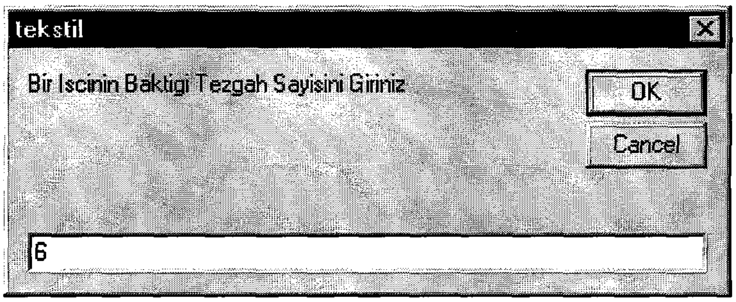

Atki Cozgu Maliyeti Hesabi
CIFT KAT IPLIK --YUNLU
Atki Maliyeti :
140226439
Cozgu Maliyeti :
148590972
Sonucu goster
Cozgu Islemi Maliyetini Goster
Maliyet Hesabinin Sonuclarini Goster'e Geri Donus
Maliyet Hesabina Geri Donus
AnaMenu'ye Geri Donus

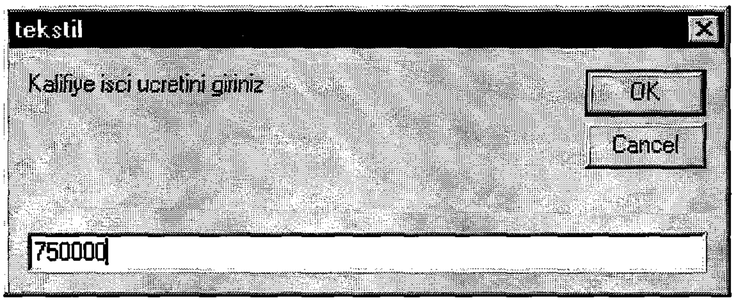

Cozgu Maliyeti
Satir No :
1
CTS :
10696,65056610
Tarife :
10,4
Cozgu Tel Sayisi :
10696,65056610
Secilen Satir No :
1
Cozgu Boyu :
1000,900610369
Cozgu Hazirlama Maliyeti :
111345
Sonuclari Goster
Tahar-Dokuma-Bobin Maliyetine Gidis
Maliyet Hesabina Geri Donus
Maliyet Hesabinin Sonuclarini Goster'e Geri Donus
Bir Onceki Forma Geri Donus
AnaMenu'ye Geri Donus

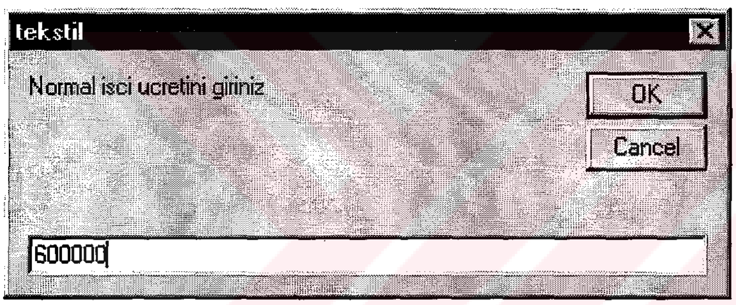

Cozgu Tarifesi Kutugunu Okuma
Cozgu Tipi
Bolum Sayisi
Fiyati
Direct
10,4
Bolumlu Pamuklu
<=5
20,8
Bolumlu Pamuklu
>5
22,9
Yunlu
<=5
22
Yunlu
6-10
23,1
Yunlu
>10
24,2
Kutukte Yapilicak Islemleri Belirlemeye Geri Donus
Kutuk Belirlemeye Geri Donus

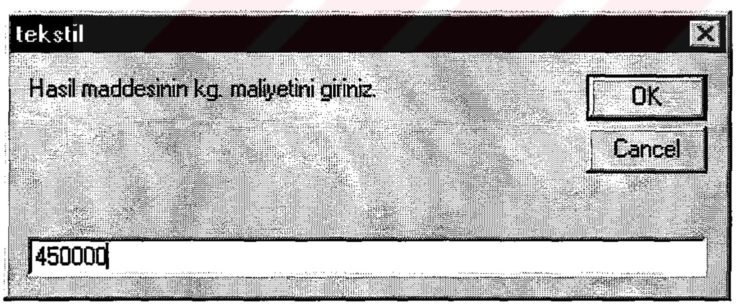

tekstil
Tezgah Hizini Giriniz
OK
Cancel
340

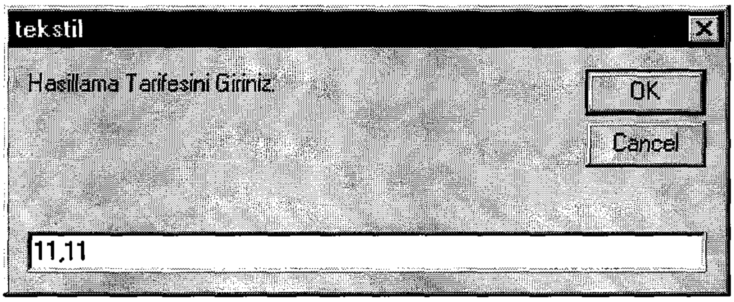

tekstil
Tezgah Randimanini Giriniz
OK
Cancel
0,85

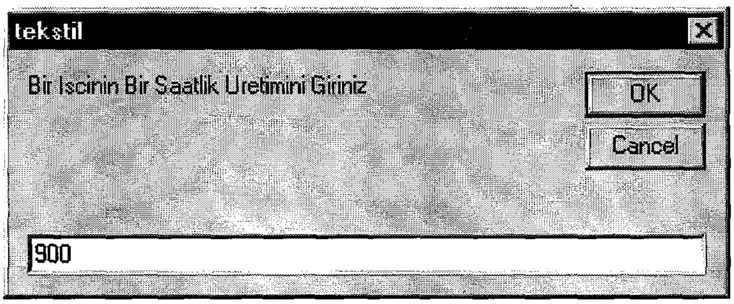

tekstil
Bir Iscinin Baktigi Tezgah Sayisini Giriniz
OK
Cancel
6

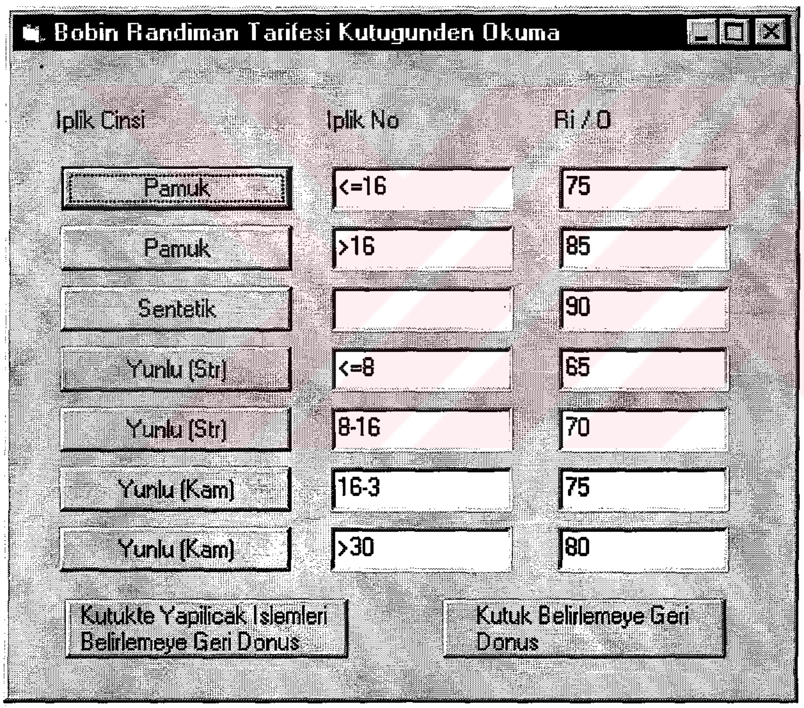

tekstil
Kalifiye isci ucretini giriniz
OK
Cancel
750000

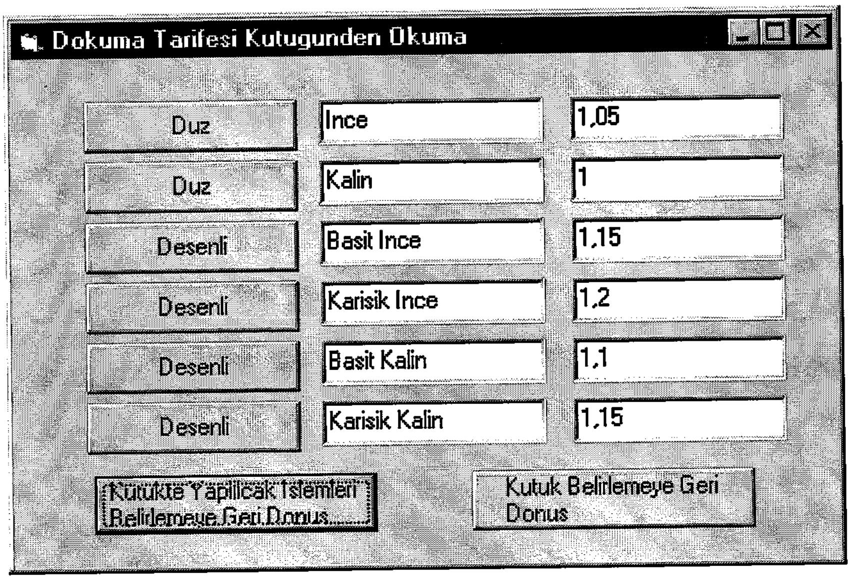

tekstil
Normal isci ucretini giriniz
OK
Cancel
600000

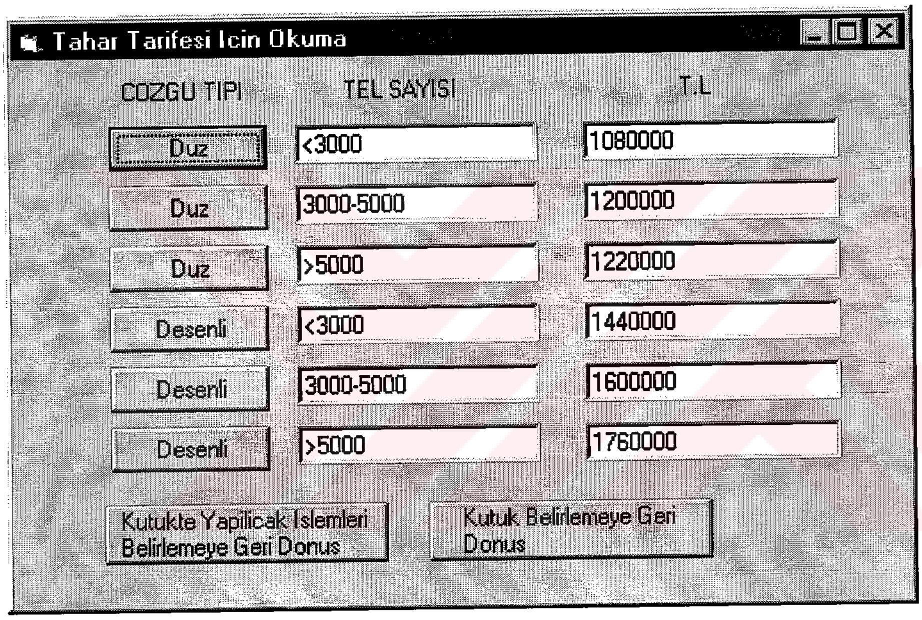

tekstil
Hasil maddesinin kg. maliyetini giriniz.
OK
Cancel
450000

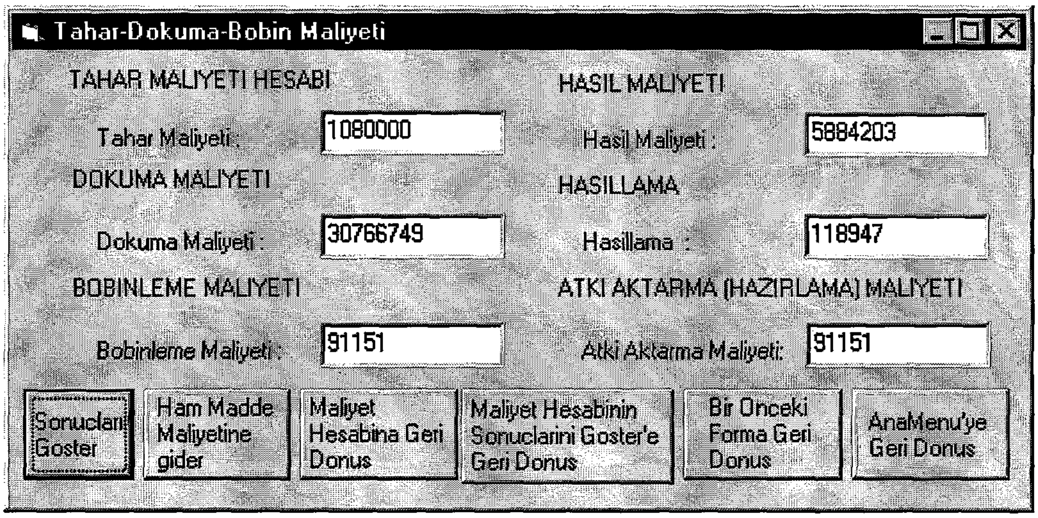

tekstil
Hasillama Tarifesini Giriniz
OK
Cancel
11,11

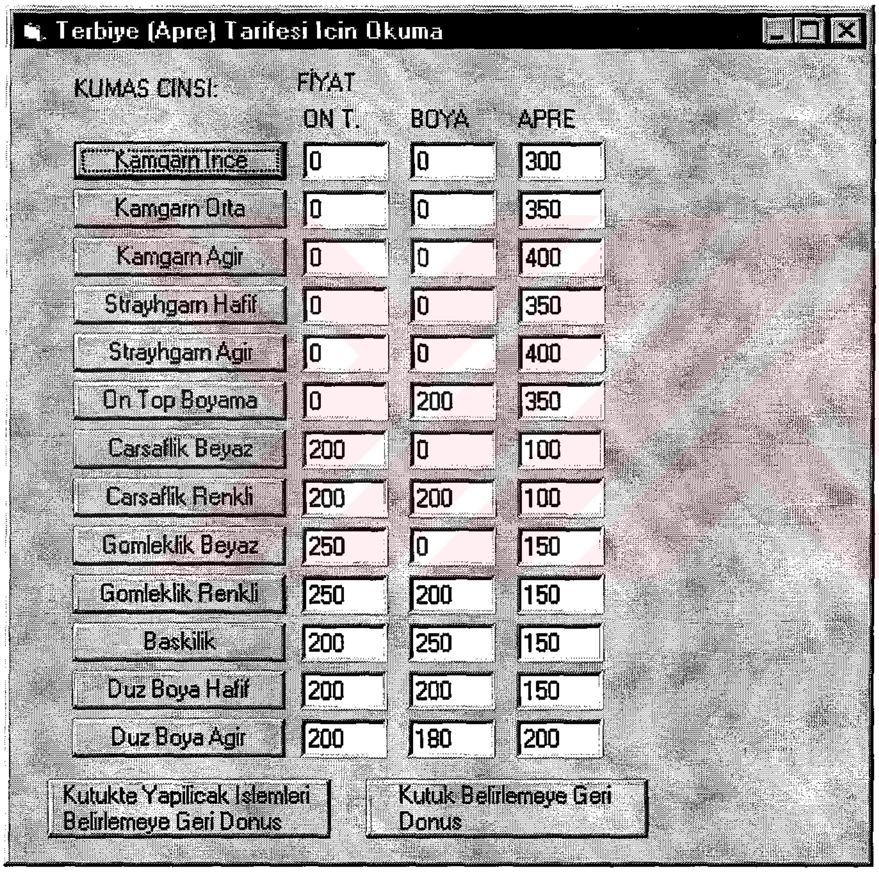

tekstil
Bir Iscinin Bir Saatlik Uretimini Giriniz
OK
Cancel
900

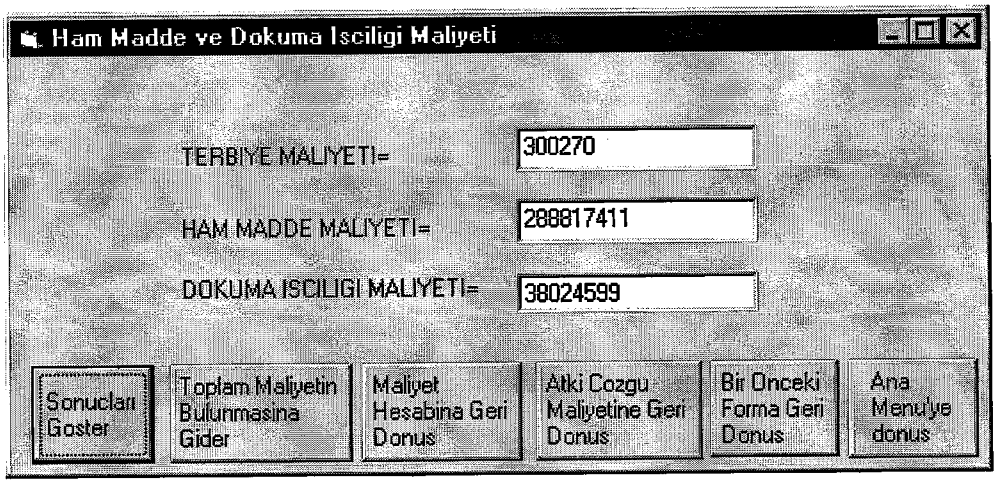

Bobin Randiman Tarifesi Kutugunden Okuma
Iplik Cinsi
Iplik No
Ri / O
Pamuk
<=16
75
Pamuk
>16
85
Sentetik
90
Yunlu (Str)
<=8
65
Yunlu (Str)
8-16
70
Yunlu (Kam)
16-3
75
Yunlu (Kam)
>30
80
Kutukte Yapilcak Islemleri Belirlemeye Geri Donus
Kutuk Belirlemeye Geri Donus

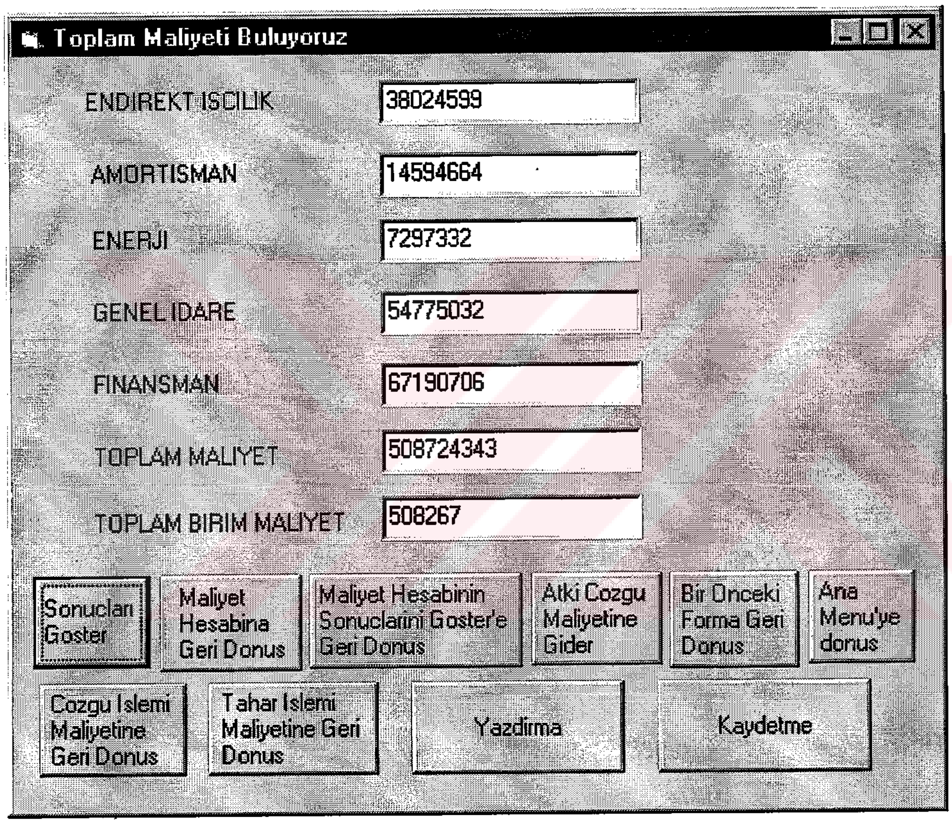

Dokuma Tarifesi Kutugunden Okuma
Duz
Ince
1,05
Duz
Kalin
1
Desenli
Basit Ince
1,15
Desenli
Karisik Ince
1,2
Desenli
Basit Kalin
1,1
Desenli
Karisik Kalin
1,15
Kutukte Yapilicak Islemleri Belirlemeye Geri Donus
Kutuk Belirlemeye Geri Donus


Tahar Tarifesi Icin Okuma
COZGU TIPI
TEL SAYISI
T.L
Duz
<3000
1080000
Duz
3000-5000
1200000
Duz
>5000
1220000
Desenli
<3000
1440000
Desenli
3000-5000
1600000
Desenli
>5000
1760000
Kutukte Yapilicak Islemleri Belirlemeye Geri Donus
Kutuk Belirlemeye Geri Donus

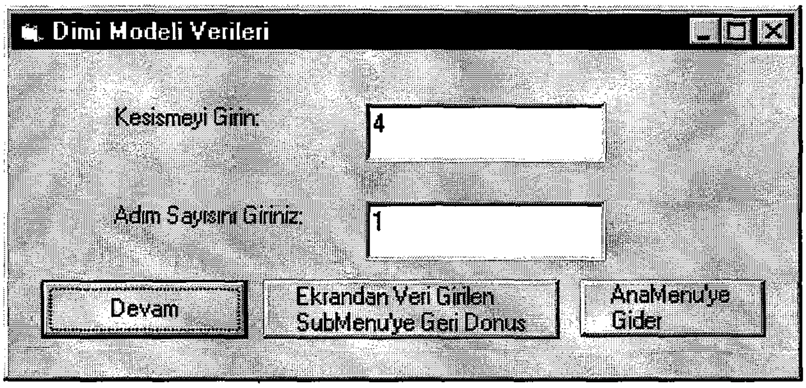

Tahar-Dokuma-Bobin Maliyeti
TAHAR MALIYETI HESABI
Tahar Maliyeti :
1080000
HASIL MALIYETI
Hasil Maliyeti :
5884203
DOKUMA MALIYETI
Dokuma Maliyeti :
30766749
HASILLAMA
Hasillama :
118947
BOBINLEME MALIYETI
Bobinleme Maliyeti :
91151
ATKI AKTARMA (HAZIRLAMA) MALIYETI
Atki Aktarma Maliyeti:
91151
Sonuclari Goster
Ham Madde Maliyetine gider
Maliyet Hesabina Geri Donus
Maliyet Hesabinin Sonuclarini Goster'e Geri Donus
Bir Onceki Forma Geri Donus
AnaMenu'ye Geri Donus

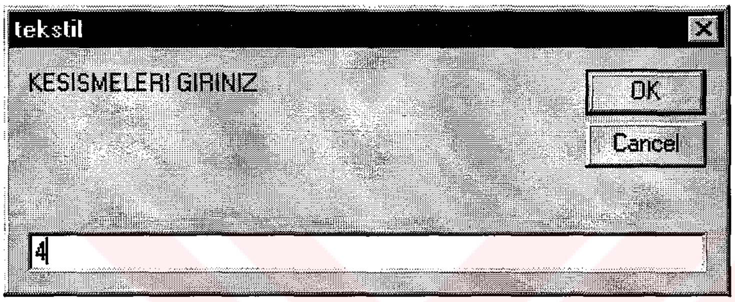

Terbiye (Apre) Tarifesi Icin Okuma
KUMAS CINSI:
FİYAT
ON T.
BOYA
APRE
Kamgarn Ince 0 0 300
Kamgarn Orta 0 0 350
Kamgarn Agir 0 0 400
Strayhgarn Hafif 0 0 350
Strayhgarn Agir 0 0 400
On Top Boyama 0 200 350
Carsaflik Beyaz 200 0 100
Carsaflik Renkli 200 200 100
Gomleklik Beyaz 250 0 150
Gomleklik Renkli 250 200 150
Baskilik 200 250 150
Duz Boya Hafif 200 200 150
Duz Boya Agir 200 180 200
Kutukte Yapilicak Islemleri Belirlemeye Geri Donus
Kutuk Belirlemeye Geri Donus

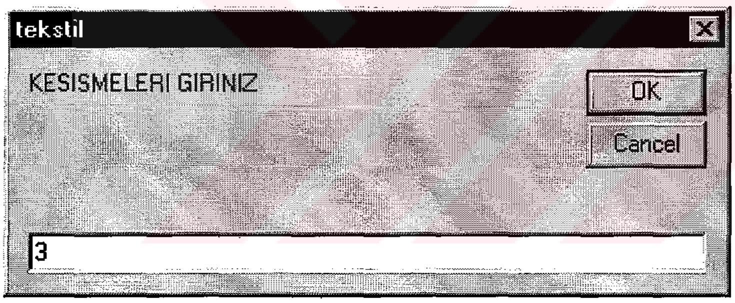

Ham Madde ve Dokuma Isciligi Maliyeti
TERBIYE MALIYETI=
300270
HAM MADDE MALIYETI=
288817411
DOKUMA ISCILIGI MALIYETI=
38024599
Sonuclari Goster
Toplam Maliyetin Bulunmasina Gider
Maliyet Hesabina Geri Donus
Atki Cozgu Maliyetine Geri Donus
Bir Onceki Forma Geri Donus
Ana Menu'ye donus

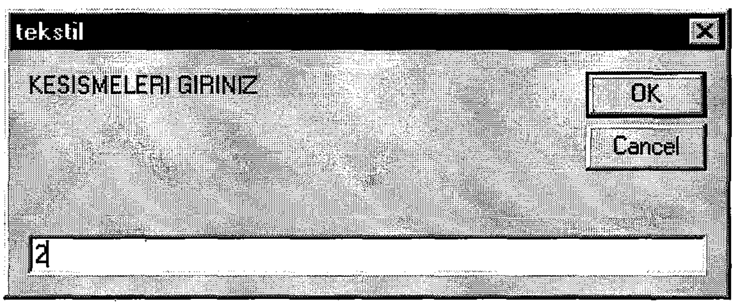

Toplam Maliyeti Buluyoruz
ENDIREKT ISCILIK
38024599
AMORTISMAN
14594664
ENERJI
7297332
GENEL IDARE
54775032
FINANSMAN
67190706
TOPLAM MALIYET
508724343
TOPLAM BIRIM MALIYET
508267
Sonuclari Goster
Maliyet Hesabina Geri Donus
Maliyet Hesabinin Sonuclarini Goster'e Geri Donus
Atki Cozgu Maliyetine Gider
Bir Onceki Forma Geri Donus
Ana Menu'ye donus
Cozgu Islemi Maliyetine Geri Donus
Tahar Islemi Maliyetine Geri Donus
Yazdirma
Kaydetme

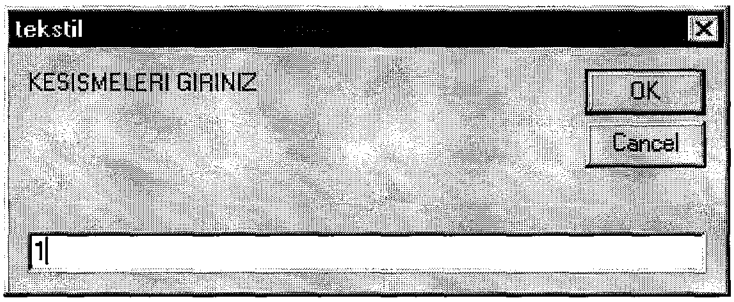
Example 2:

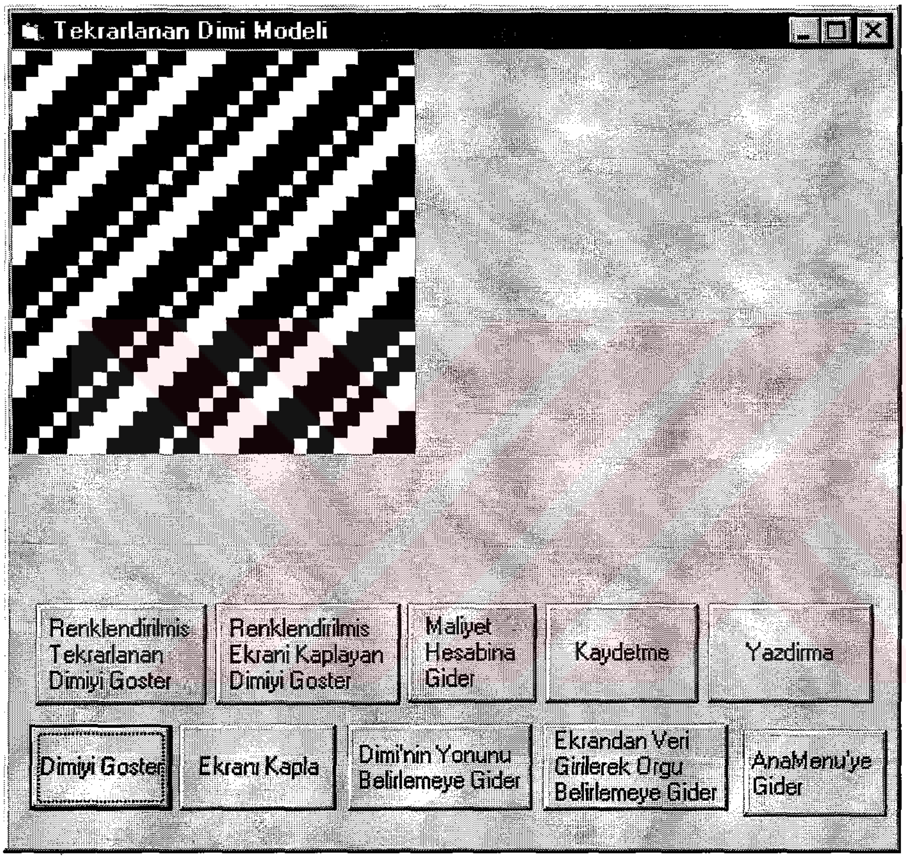

Dimi Modeli Verileri
Kesismeyi Girin:
4
Adim Sayisini Giriniz:
1
Devam
Ekrandan Veri Girilen SubMenu'ye Geri Donus
AnaMenu'ye Gider

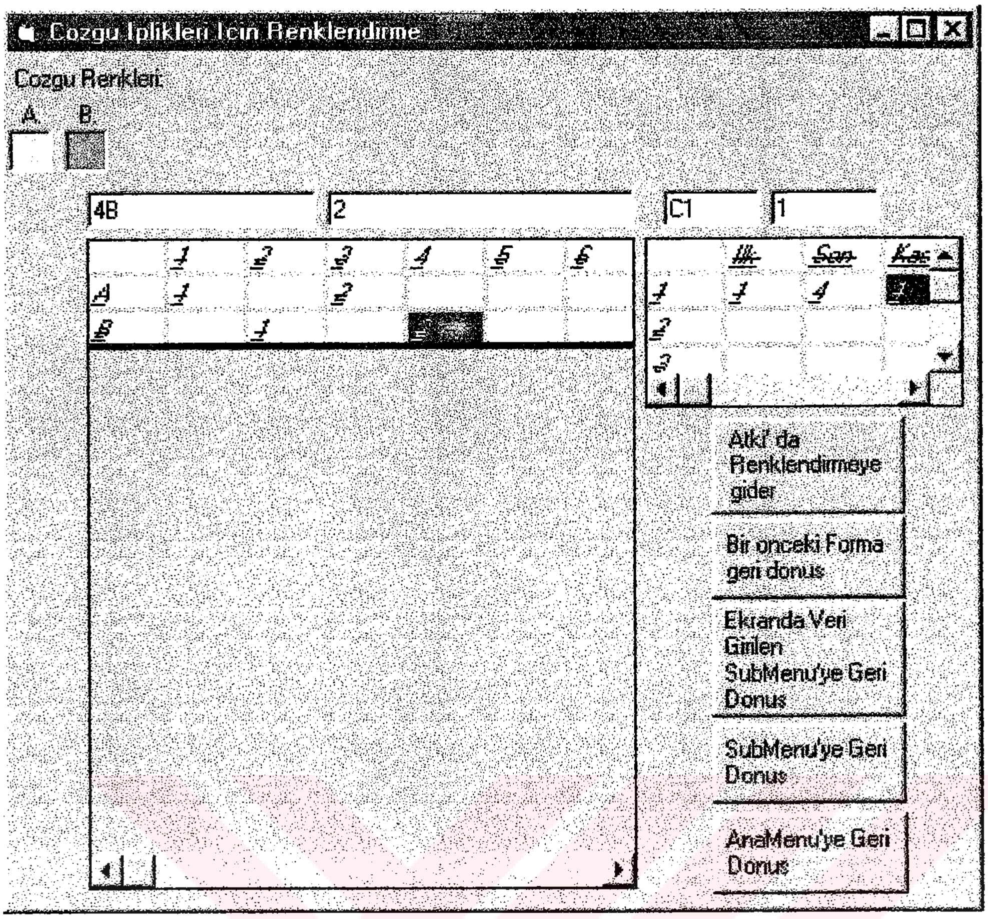

tekstil
KESISMELERI GIRINIZ
OK
Cancel
4

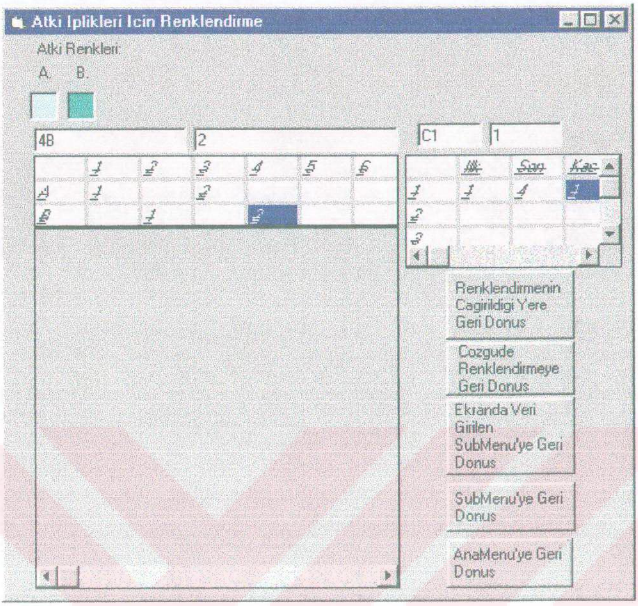

tekstil
KESISMELERI GIRINIZ
OK
Cancel
3

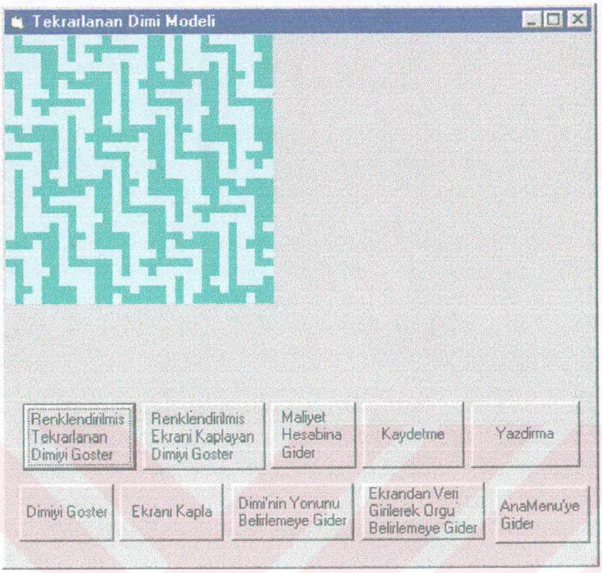

tekstil
KESISMELERI GIRINIZ
OK
Cancel
2

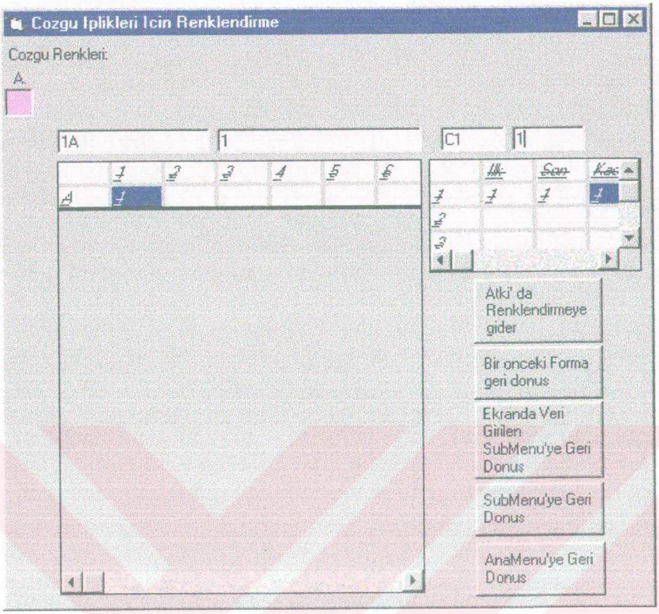

tekstil
KESISMELERI GIRINIZ
OK
Cancel
1


Tekrarlanan Dimi Modeli
Renklendirilmis Tekrarlanan Dimiyi Goster
Renklendirilmis Ekrani Kaplayan Dimiyi Goster
Maliyet Hesabina Gider
Kaydetme
Yazdirma
Dimiyi Goster
Ekrani Kapla
Dimi'nin Yonunu Belirlemeye Gider
Ekrandan Veri Girilerek Orgu Belirlemeye Gider
AnaMenu'ye Gider

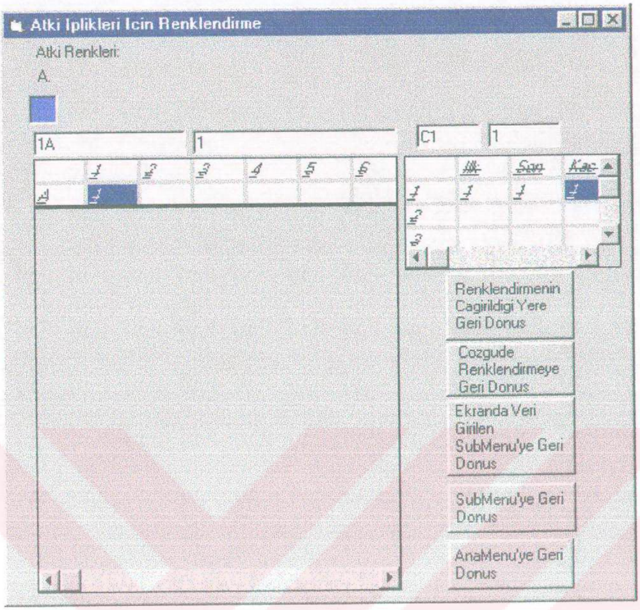

Cozgu Iplikleri Icin Renklendirme
Cozgu Renkleri:
A
B
4B
2
C1
1
Atki' da Renklendirmeye gider
Bir onceki Forma geri donus
Ekranda Veri Girilen SubMenu'ye Geri Donus
SubMenu'ye Geri Donus
AnaMenu'ye Geri Donus

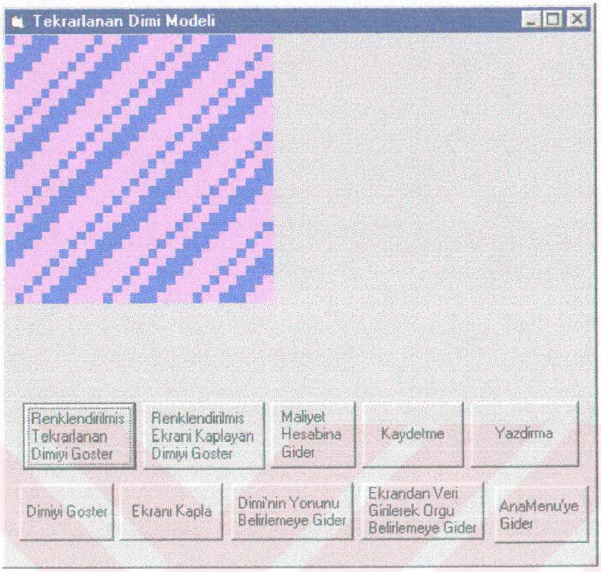

Atki Iplikleri Icin Renklendirme
Atki Renkleri:
A.
B.
4B
2
C1
1
Renklendirmenin Cagirildigi Yere Geri Donus
Cozgude Renklendirmeye Geri Donus
Ekranda Veri Girilen SubMenu'ye Geri Donus
SubMenu'ye Geri Donus
AnaMenu'ye Geri Donus

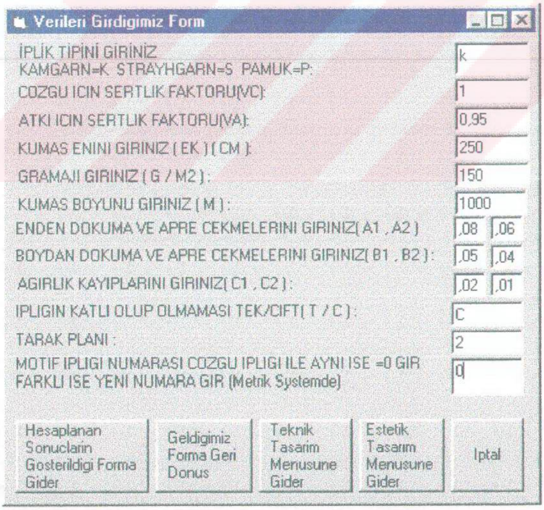

Tekrarlanan Dimi Modeli
Renklendirilmis Tekrarlanan Dimiyi Goster
Renklendirilmis Ekrani Kaplayan Dimiyi Goster
Maliyet Hesabina Gider
Kaydetme
Yazdirma
Dimiyi Goster
Ekranı Kapla
Dimi'nin Yonunu Belirlemeye Gider
Ekrandan Veri Girilerek Orgu Belirlemeye Gider
AnaMenu'ye Gider

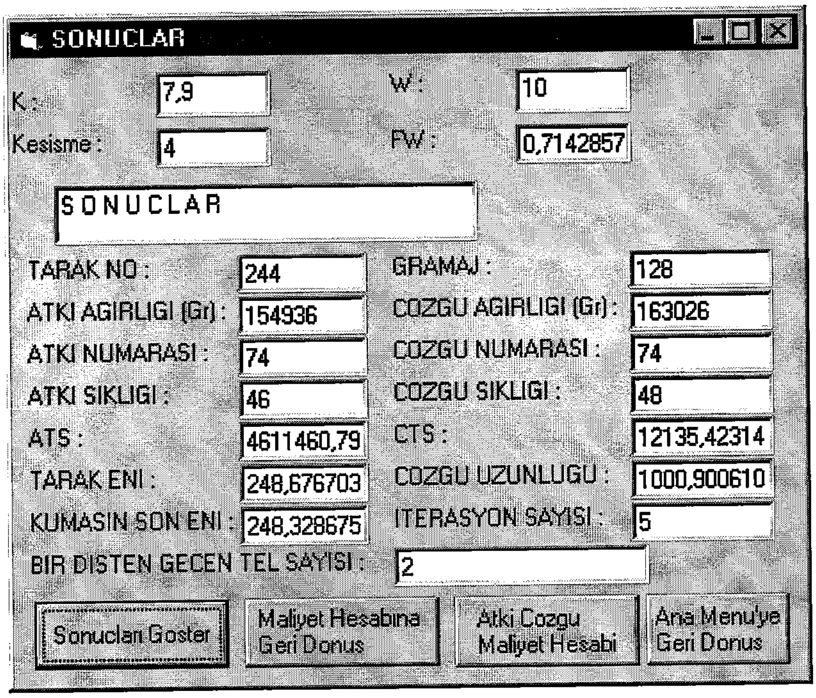


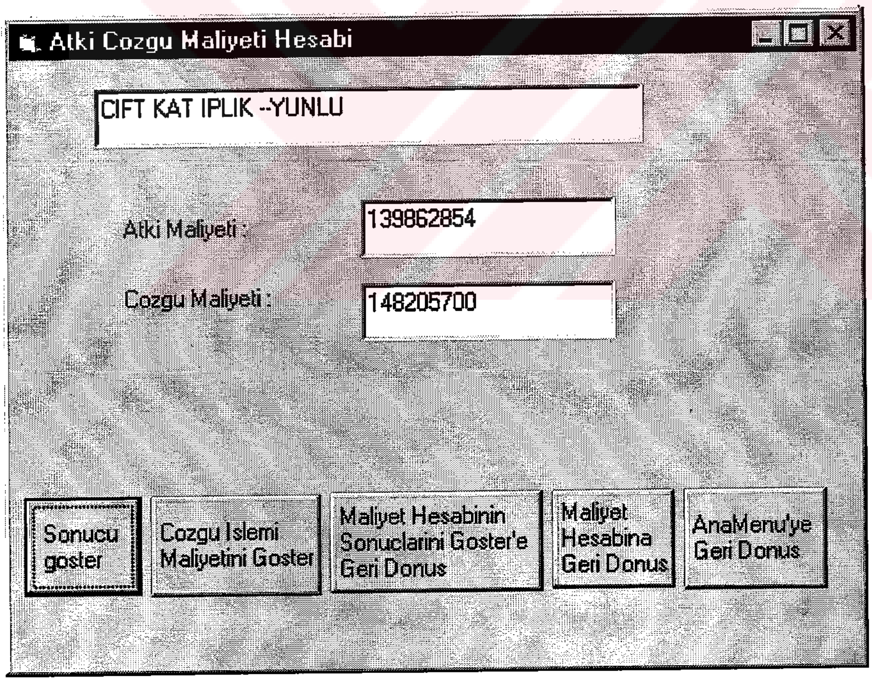
Cozgu Iplikleri Icin Renklendirme
Cozgu Renkleri:
A
1A
1
C1
1
Atki' da Renklendirmeye gider
Bir onceki Forma geri donus
Ekranda Veri Girilen SubMenu'ye Geri Donus
SubMenu'ye Geri Donus
AnaMenu'ye Geri Donus


Atki Iplikleri Icin Renklendirme
Atki Renkleri:
A.
1A
1
C1
1
Renklendirmenin Cagirildigi Yere Geri Donus
Cozgude Renklendirmeye Geri Donus
Ekranda Veri Girilen SubMenu'ye Geri Donus
SubMenu'ye Geri Donus
AnaMenu'ye Geri Donus

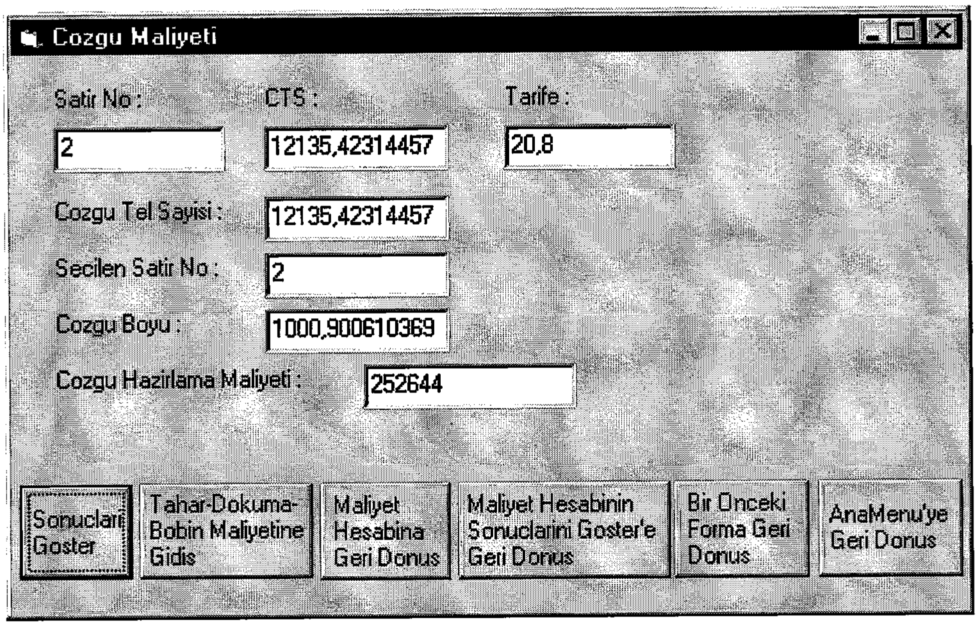

Tekrarlanan Dimi Modeli
Renklendirilmis Tekrarlanan Dimiyi Goster
Renklendirilmis Ekrani Kaplayan Dimiyi Goster
Maliyet Hesabina Gider
Kaydetme
Yazdirma
Dimiyi Goster
Ekranı Kapla
Dimi'nin Yonunu Belirlemeye Gider
Ekrandan Veri Girilerek Orgu Belirlemeye Gider
AnaMenu'ye Gider

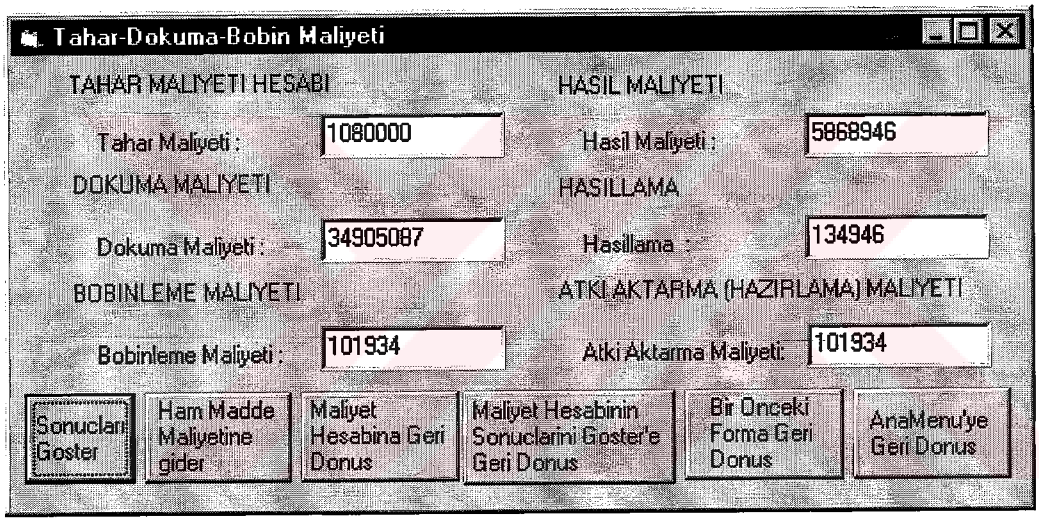

Verileri Girdigimiz Form
İPLİK TİPİNİ GİRİNİZ KAMGARN=K STRAYHGARN=S PAMUK=P:
k
COZGU ICIN SERTLIK FAKTORU(VC):
1
ATKI ICIN SERTLIK FAKTORU(VA):
0,95
KUMAS ENINI GIRINIZ (EK) (CM):
250
GRAMAJI GIRINIZ (G / M2):
150
KUMAS BOYUNU GIRINIZ (M):
1000
ENDEN DOKUMA VE APRE CEKMELERINI GIRINIZ(A1 , A2)
,08
,06
BOYDAN DOKUMA VE APRE CEKMELERINI GIRINIZ(B1 , B2):
,05
,04
AGIRLIK KAYIPLARINI GIRINIZ(C1 , C2):
,02
,01
IPLIGIN KATLI OLUP OLMAMASI TEK/CIFT(T / C):
C
TARAK PLANI :
2
MOTIF IPLIGI NUMARASI COZGU IPLIGI ILE AYNI ISE =0 GIR FARKLI ISE YENI NUMARA GIR (Metrik Systemde)
0
Hesaplanan Sonuclarin Gosterildigi Forma Gider
Geldigimiz Forma Geri Donus
Teknik Tasarim Menusune Gider
Estetik Tasarim Menusune Gider
Iptal

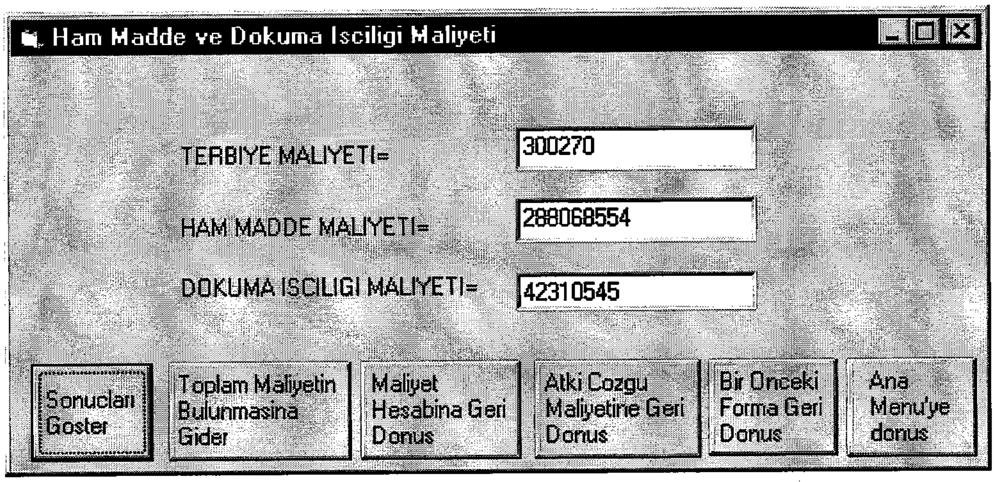


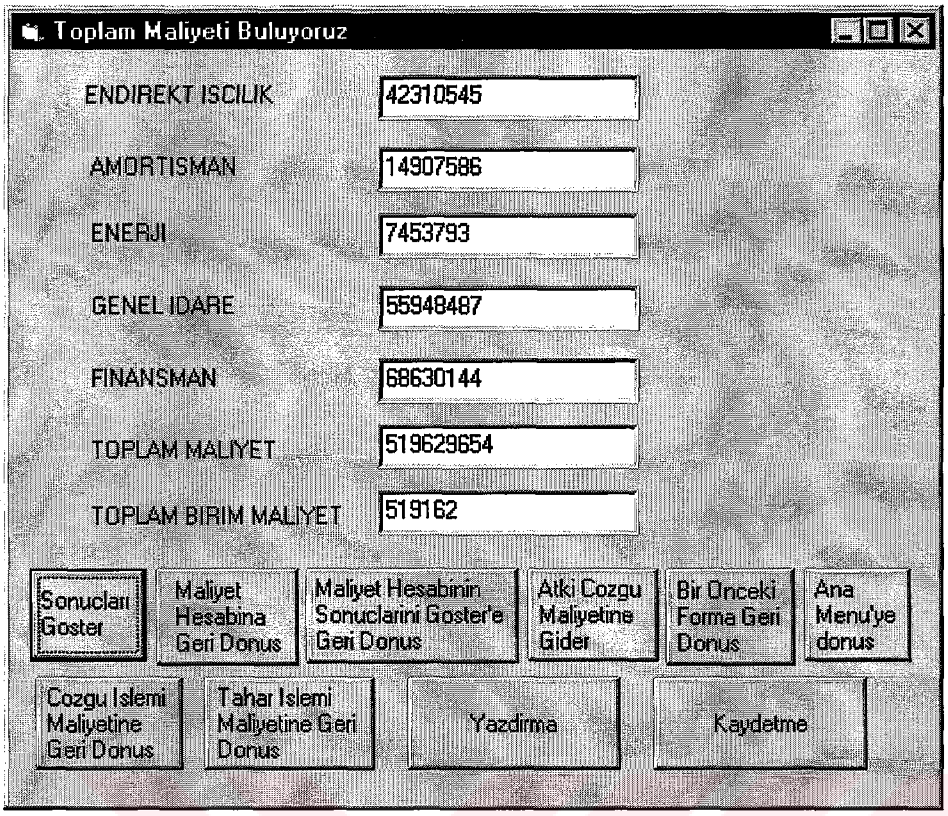


If the user can not change the previously value FFDT is used them for the calculation. But these result not same because their interlacing value is deferent.


Cozgu Maliyeti
Satir No :
CTS :
Tarife :
2
12135,42314457
20,8
Cozgu Tel Sayisi :
12135,42314457
Secilen Satir No :
2
Cozgu Boyu :
1000,900610369
Cozgu Hazirlama Maliyeti :
252644
Sonuclari Goster
Tahar-Dokuma-Bobin Maliyetine Gidis
Maliyet Hesabina Geri Donus
Maliyet Hesabinin Sonuclarini Goster'e Geri Donus
Bir Onceki Forma Geri Donus
AnaMenu'ye Geri Donus


Tahar-Dokuma-Bobin Maliyeti
TAHAR MALIYETI HESABI
Tahar Maliyeti :
1080000
HASIL MALIYETI
Hasil Maliyeti :
5868946
DOKUMA MALIYETI
Dokuma Maliyeti :
34905087
HASILLAMA
Hasillama :
134946
BOBINLEME MALIYETI
Bobinleme Maliyeti :
101934
ATKI AKTARMA (HAZIRLAMA) MALIYETI
Atki Aktarma Maliyeti:
101934
Sonuclari Goster
Ham Madde Maliyetine gider
Maliyet Hesabina Geri Donus
Maliyet Hesabinin Sonuclarini Goster'e Geri Donus
Bir Onceki Forma Geri Donus
AnaMenu'ye Geri Donus


Ham Madde ve Dokuma Isciligi Maliyeti
TERBIYE MALIYETI=
300270
HAM MADDE MALIYETI=
288068554
DOKUMA ISCILIGI MALIYETI=
42310545
Sonuclari Goster
Toplam Maliyetin Bulunmasina Gider
Maliyet Hesabina Geri Donus
Atki Cozgu Maliyetine Geri Donus
Bir Onceki Forma Geri Donus
Ana Menu'ye donus

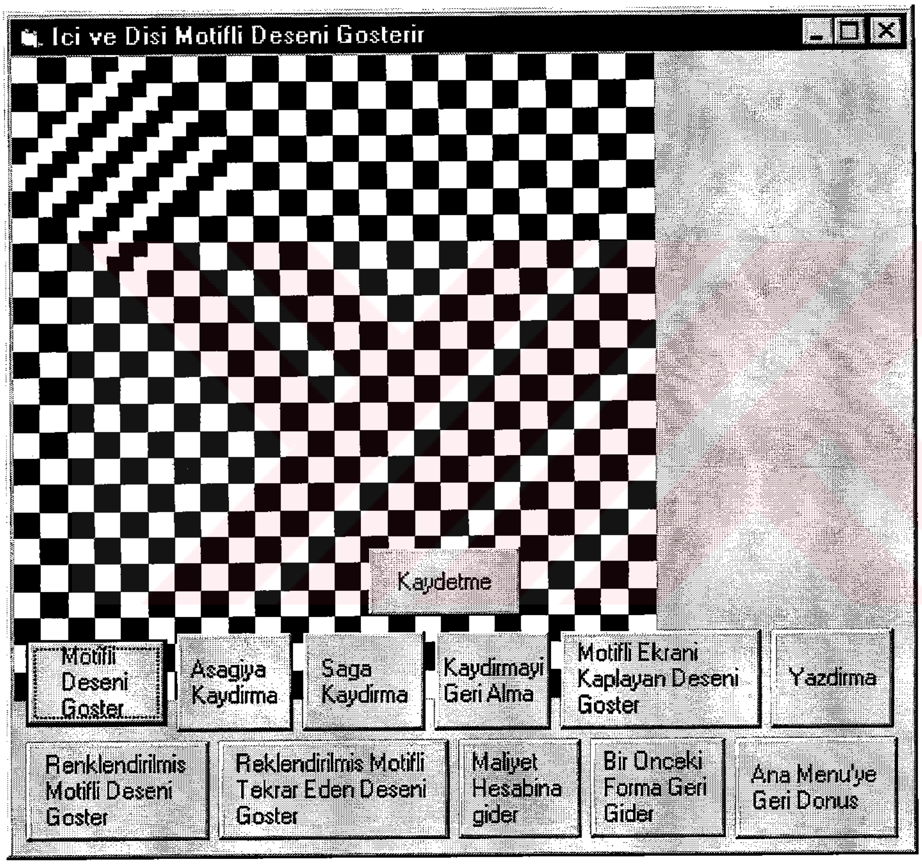


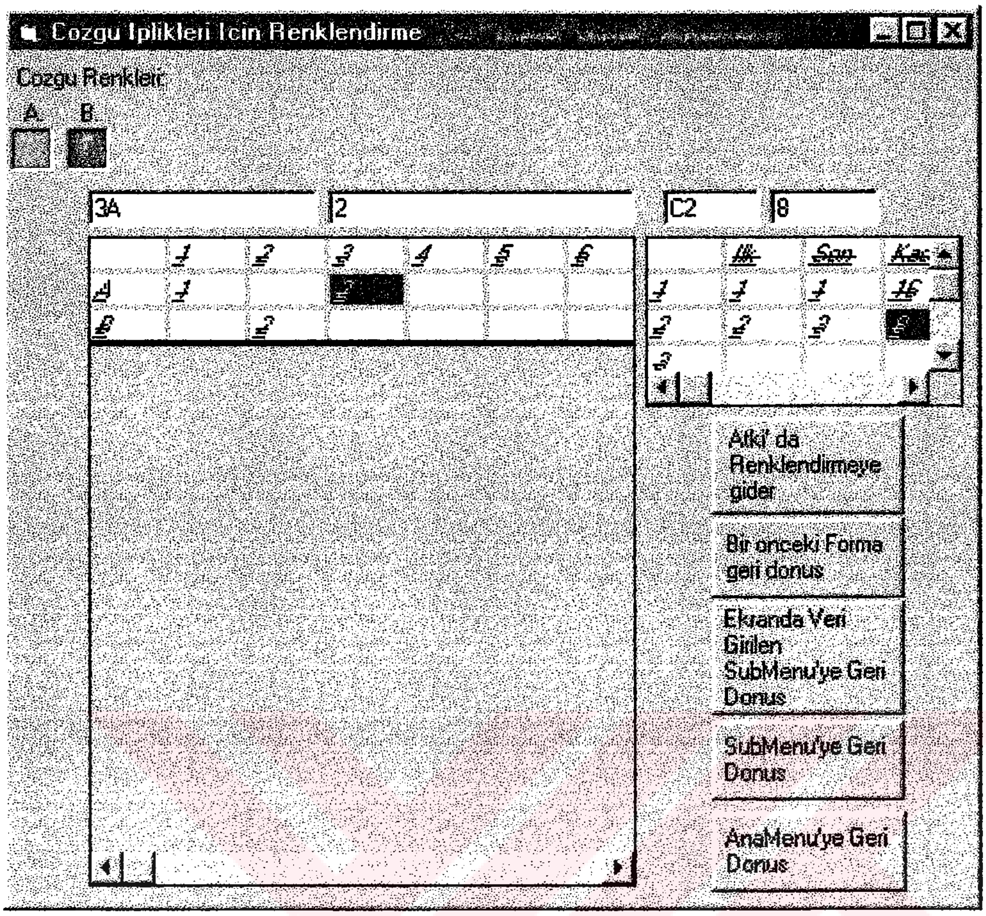
Toplam Maliyeti Buluyoruz
ENDIREKT ISCILIK
42310545
AMORTISMAN
14907586
ENERJI
7453793
GENEL IDARE
55948487
FINANSMAN
68630144
TOPLAM MALIYET
519629654
TOPLAM BIRIM MALIYET
519162
Sonucları Goster
Maliyet Hesabina Geri Donus
Maliyet Hesabinin Sonuclarini Goster'e Geri Donus
Atki Cozgu Maliyetine Gider
Bir Onceki Forma Geri Donus
Ana Menu'ye donus
Cozgu Islemi Maliyetine Geri Donus
Tahar Islemi Maliyetine Geri Donus
Yazdirma
Kaydetme

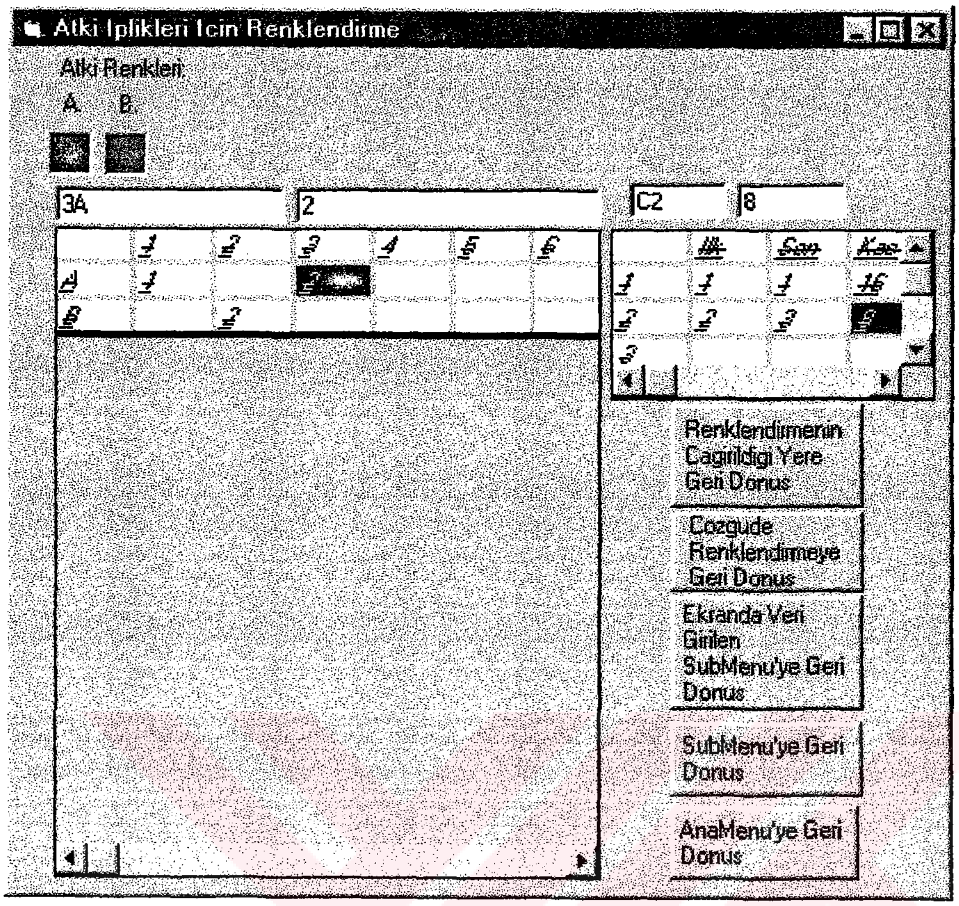
APPENDIX B

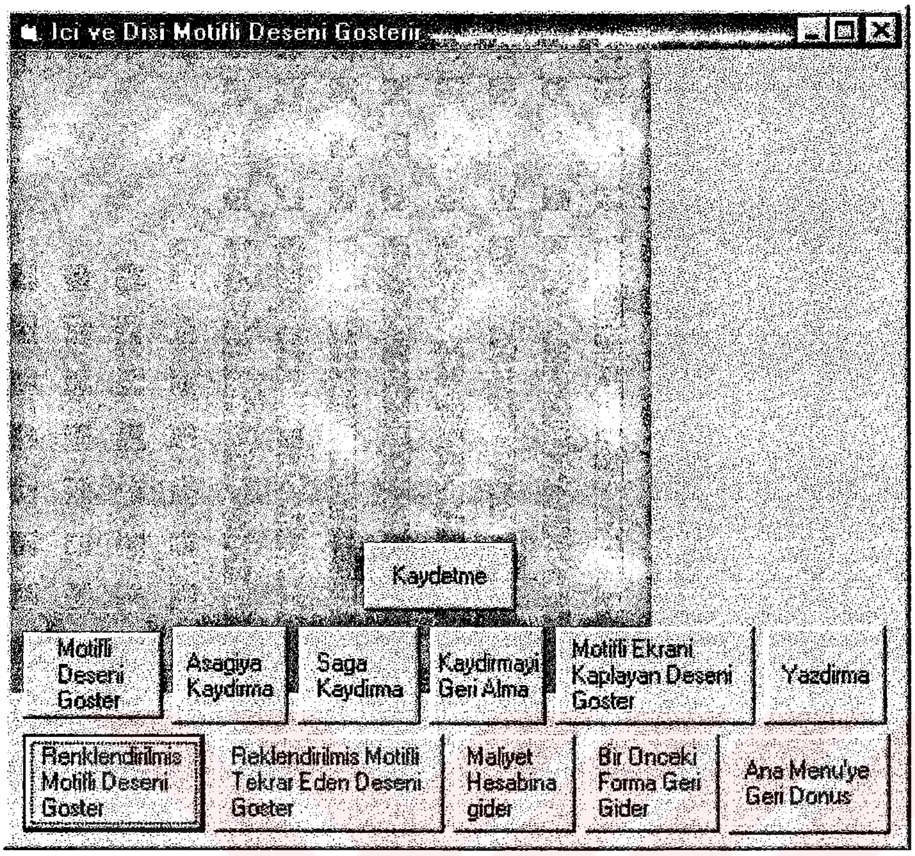
FIGURE EFFECT

Figure inside is 2-2 Right Twill weave, figure outside is 2-2 Basket weave.




Cozgu Iplikleri Icin Renklendirme
Cozgu Renkleri:
A
B
3A
2
C2
8
Atki' da Renklendirmeye gider
Bir onceki Forma geri donus
Ekranda Veri Girilen SubMenu'ye Geri Donus
SubMenu'ye Geri Donus
AnaMenu'ye Geri Donus


Atki Iplikleri Icin Renklendirme
Atki Renkleri:
A. B.
3A
2
C2
8
Renklendirmenin Cagirildigi Yere Geri Donus
Cozgude Renklendirmeye Geri Donus
Ekranda Veri Girilen SubMenu'ye Geri Donus
SubMenu'ye Geri Donus
AnaMenu'ye Geri Donus


Ici ve Disi Motifli Deseni Gosterir
Kaydetme
Motifli Deseni Goster
Asagiya Kaydirma
Saga Kaydirma
Kaydirmayi Geri Alma
Motifli Ekrani Kaplayan Deseni Goster
Yazdirma
Renklendirilmis Motifli Deseni Goster
Reklendirilmis Motifli Tekrar Eden Deseni Goster
Maliyet Hesabina gider
Bir Onceki Forma Geri Gider
Ana Menu'ye Geri Donus