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Research on Green Process Design for Special Knitting of Computerized Flat Knitting Machine Based on Green Ecological Concept

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Abstract

In recent years, the continuous increase of labor costs has restricted the development of labor-intensive enterprises. At the same time, people have higher and higher requirements for the comfort and fashion of clothing. Foreign countries have established a relatively mature knitting technology system for the research of full-form knitting technology of computerized flat knitting machines. Although it has not been widely marketed, the operation is relatively simple and the equipment is stable. Green manufacturing is a large system involving all aspects of the product life cycle and even the product life cycle process. It reflects people's serious reflection on the environmental and ecological damage caused by modern science and technology culture, and also reflects the designer's moral and social responsibility. Return. Compared with traditional product design, the green design capability of an enterprise relies more on the management and application ability of green design knowledge. Today, when the environmental protection situation is quite severe, green design is by no means just a slogan. Based on the green ecological concept, this paper analyzes the green process design of computerized flat knitting machine.

Keywords:*Flat knitting machine, Weaving, Technology, Green design*

1.INTRODUCTION

In recent years, the continuous increase of labor costs has restricted the development of labor-intensive enterprises. At the same time, people have higher and higher requirements for the comfort and fashion of clothing. Therefore, the traditional production mode of knitted clothing can no longer meet people's wearing needs [1]. Electronic program control is an important aspect of the application of electronic technology in flat knitting machines. It focuses on the control of various actions in the knitting process of fully formed products, which is a prerequisite for the production of whole fabrics by computerized flat knitting machines [2]. Full-forming knitting technology is also called seamless knitting technology or wearable knitting technology, which refers to the one-time knitting of the whole garment on a computerized flat knitting machine, and the garment can be worn without sewing or only with a little sewing after getting off the machine [3]. Full-formed clothing is formed at one time without cutting and sewing, so it has good wearing comfort and aesthetic feeling, is popular and fashionable, and is deeply loved by consumers [4]. The full-form weaving method effectively changes the traditional production mode and improves the comfort of the garment. This is a breakthrough in the knitting industry, providing unlimited business opportunities for manufacturers. The precision and stability of domestic computerized flat knitting machines are still insufficient compared with Japanese and German computerized flat knitting machines, and there are also differences in the design of process programming [5]. Green manufacturing is the embodiment of the sustainable development strategy of human society in modern manufacturing. It is imperative to implement green manufacturing. For this reason, research on green manufacturing is rapidly emerging around the world.

Since the full-form production method can respond quickly to the market, only the required number of parts can be produced when needed, and the loss in circulation is reduced [6]. Therefore, full-form knitted products can be a knit product that is beneficial to the development of the earth's ecology. Foreign research on the full-forming weaving process of computerized flat knitting machines has established a relatively mature weaving process system. Although it has not been widely marketed, the operation is relatively simple and the equipment is stable [7]. Full-form knitted products are superior to ordinary knitted products in terms of softness, comfort and lightness, and are one of the development trends of computerized flat knitting machine products [8]. The electronic needle selection technology can realize single needle selection, and it is convenient and flexible to change the knitting motion of the knitting needle to meet various knitting requirements. This is the basis for the whole fabric production of the computerized flat knitting machine. The goal of green manufacturing research is to provide theoretical and technical support for the implementation of green manufacturing. To implement green manufacturing, we must face a series of decision-making problems [9]. Green civilization requires that human production activities must meet ecological requirements, so that economic growth has the characteristics of sustainable development [10]. Green design reflects people's serious reflection on the environmental and ecological damage caused by modern science and technology culture, and also reflects the return of designer's morality and social responsibility [11]. This paper summarizes and compares the green knitting processes of several key process parts of knitted fabrics in different types of computerized flat knitting machines, providing references for manufacturers and process program designers.

The full-form knitting technology of computerized flat knitting machine is complex and requires high mechanical structure and control system. However, the high price of computerized flat knitting machines specially used for knitting fully formed fabrics has greatly limited the production scale of fully formed fabrics [12]. Due to the infinite possibility of fully formed knitting, the application field of fully formed products will be continuously expanded [13]. The four-needle bed computerized flat knitting machine technology developed with the full forming technology integrates the latest mechanical manufacturing technology, information technology, sensing technology, control technology, CAD technology, etc., so it has high research value and application prospect [14]. As green manufacturing is a big concept, it is a big system that involves every link in the product life cycle and even involves the multi-life cycle process of the product [15]. Therefore, it is not enough to establish its overall decision-making model. Instead, it should establish its specific decision-making model according to the main links involved in green manufacturing implementation to support the concrete implementation of green manufacturing [16]. Because of the wide range of knowledge and the complicated technical system, green design is more difficult to acquire, organize and utilize knowledge. Compared with traditional product design, the green design ability of enterprises depends more on the management application of green design knowledge. Ability [17]. Based on the green ecological concept, this paper analyzes the green process design of special weaving of computerized flat knitting machine.

2.ANALYSIS OF GREEN KNITTING PROCESS FOR FULLY FORMED FABRICS

In the domestic market, the full-form knitting technology is still immature, and the computer flat knitting machine manufacturers with independent intellectual property rights have not yet captured the market well. The full-form knitting technology has been continuously improved. The traditional fabric is made by cutting pieces, or separately knitting the front piece, back piece, sleeve piece and other parts, and then forming by sewing. The sinker and presser foot both have the function of pulling the loop. The sinker is arranged beside each knitting needle and can well control the loop forming process of the old loop and the new yarn of each knitting needle. By combining the needle with the holding sinker, the opening can be lifted with an empty needle when each new garment piece starts knitting [18]. The conventional weaving method uses a sheet-like structure to weave a yarn into a single piece and then stitch it, thereby completing the production of the entire knitted product. The production of full-form garments requires high quality yarns, otherwise it is easy to break yarns and cause weaving. Full-form garments tend to be more complex in pattern, and the number of running lines is large. If the stability of the machine is not enough, it is easy to cause problems such as yarn breakage.

The full-form knitting adopts a cylindrical structure, and the yarn is woven one by one. When different cylindrical rib structures reach the joint portion, a new coil is formed by coil overlapping. The basic idea of green design is to incorporate environmental factors and pollution prevention measures into product design at the initial stage of design. Taking environmental performance as the design goal and starting point of the product, we strive to minimize the impact of the product on the environment. The traditional product development model is based on the interests of individuals or some people, to meet the needs of users and solve problems as the starting point. This kind of development mode is only the design of product functions. Both manufacturers and users start from their own needs or interests, and rarely consider other factors [19]. Due to one-step forming of full-formed garments, if defects occur in the weaving process, the whole garment will be scrapped, resulting in waste of raw materials and increased workload. From the content of customer requirements, the content scope of customer requirements has also been expanded. In addition to common consumer requirements such as product function and performance requirements, there are also technical requirements of designers such as product engineering standards and safety requirements of product designers and manufacturers [20]. The establishment of a correct and applicable decision-making model and decision analysis based on it are the key to realize correct decision-making and an important way to provide decision-making reliability.

Green process planning decision-making is a complicated decision-making problem. According to the relevant methods in the decision theory, the decision on a problem usually consists of the steps of problem analysis, decision model establishment, decision analysis, comprehensive evaluation and decision-making. The establishment of the designer's user model provides a data base for user evaluation. User evaluation in product design includes the designer's ability evaluation and knowledge level evaluation. The general steps of evaluation are shown in Figure 1.

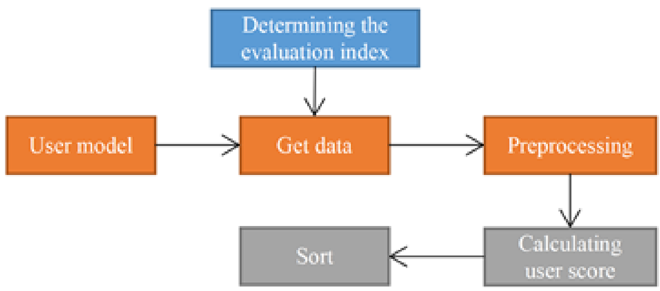

Figure1. User evaluation process

Primitive theory solves the problem and the green design has great similarity. It is used to describe and model the green design process in line with the designer's design thinking. Therefore, it has a congenital advantage. The given object K is the

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object, and A_c is the feature or feature set of the object K, forming an ordered triplet:

$$F_r = (A_c + Wtan\varphi)\left[1 - \frac{K}{iK}\left(1 - e^{\frac{iL}{k}}\right)\right] \quad (1)$$

Recycling design After the structural design and material selection, the task serial relationship elements are as follows:

$$d_i = \sqrt{(T_{xi} - x)^2 + (T_{yi} - y)^2 + (T_{zi} - z)^2} \quad (2)$$

After the improvement, it is also necessary to evaluate the improvement effect. The structural design task and the product environmental impact assessment task are coupled. The task coupling relationship is formalized with the relationship element as follows:

$$S_j = \sum_{i=1}^{N} w_{ij} X_i \quad (3)$$

The similarity between the product and the input requirement set. Similarly, the similarity of other products to the input requirement set can be obtained, as shown in Table 1.

Table 1. Similarity between each instance and output demand

Product	A	B	C	D	E
Similarity	0.876	0.742	0.778	0.829	0.654

It is directly woven on the computer flat knitting machine in one piece at a time. It can form a soft and comfortable knitted fabric without cutting or stitching. It not only reduces the labor required for suturing, but also avoids the consumption of raw materials caused by partial cutting and stitching of the fabric [21]. When the ordinary garment is folded, the direction of the transfer coil at the overlap of the coil faces outward, and the direction of the transfer coil at the overlap of the sleeve when the sleeve is closed is facing inward, so the details of the overlap of the coil when the body and the sleeve are closed are different. The green weaving design activity is product-centric, and all the green design factors are ultimately integrated directly or indirectly into the structure, function and behavior of the product through design knowledge, and become the green gene of the product [22]. When the sinker is pressed down, it plays the role of pulling and holding, and when the sinker is opened, the knitting needle pads the yarn. The decision-making problem of green process planning is a multi-objective, qualitative and quantitative complex problem, so the problem of solving the decision-making model is very complex, and it is impossible to solve it with the usual mathematical optimization method in general. In order to carry out fully-formed knitting on a double-bed computerized flat knitting machine, needle separation and needle selection must be carried out, while a four-bed computerized flat knitting machine can carry out fully-formed knitting by either full needle selection or needle separation and needle selection. In the process of green design, firstly, toxic and harmful materials should be avoided, and the materials themselves must be safe and environmentally friendly.

The end users or sales agents of the products put forward the green demand mainly to ensure the comfort of life and work and ensure the health, etc. Conditional frequent pattern tree mines the conditional frequent pattern tree of each item according to the header through FP-tree, also known as conditional database, and finally obtains frequent patterns according to this conditional FP-tree. As shown in Figure 2.

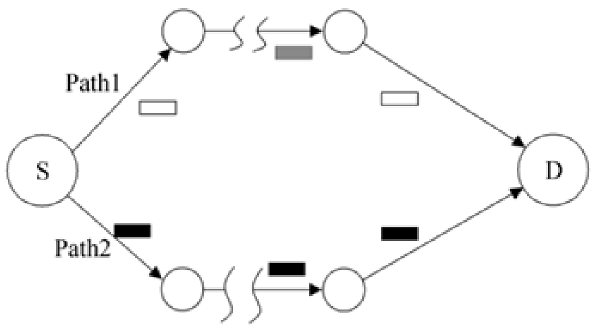

Figure 2. FP-tree

The understanding of green products should run through the whole process of product life cycle and cannot be limited to a certain process or a certain stage. The decision-making problem of process planning can be divided into process plan optimization and process parameter optimization. Different confidence levels have great influence on scheduling. Within a certain range, the lower the confidence level, the less carbon emissions. The influence of different confidence levels on scheduling objectives is shown in Table 2.

Table 2. Impact of different confidence levels on scheduling objectives

Confidence level	Lowest power generation cost	Minimal carbon emissions
0.9	135.24	0.691
0.7	157.68	0.874
0.5	138.92	0.315

When the data sets increase in sequence, the classification accuracy rate increases slowly and the growth rate gradually increases. The analysis may be due to the fact that most of the newly added training samples do not show the emotional phenomenon of misclassified data in the test set. However, under the condition of continuously increasing the data set of the training set, the correct rate has increased greatly, with the highest correct rate in the four sets of data set. Under the condition that the test set remains unchanged, the correct classification rate can be improved by appropriately increasing the amount of data in the training set. Figure 3 is a variation curve of the accuracy rate of three groups of experimental data.

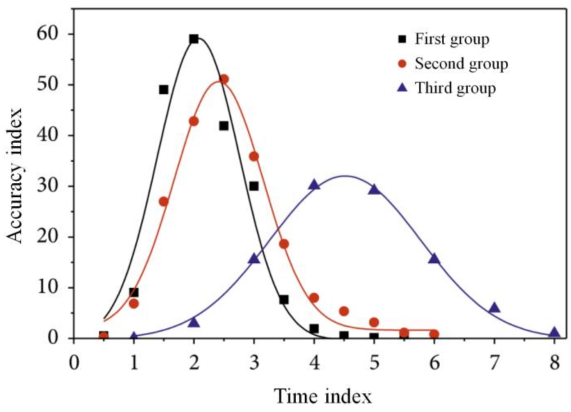

Figure3. Changes in the correct rate of experimental data

Since the manufacturer mainly regards the pursuit of maximum profit as the original motive force for developing products, it only considers the functions realized by the products or designs some relevant features according to the needs of users. Manufacturers often pursue the maximum profits in the short term without considering the long-term interests of the enterprise itself and human beings. Therefore, there are many deficiencies in product development, resulting in great adverse effects. During knitting, the front piece is first knitted, i.e. the rib stitch is knitted by half of the looping needles on the double needle bed, and after knitting, the loops of the rear needle bed are transferred to the corresponding non-looping needles on the front needle bed. Green design covers a wide range of areas, and every stage in the product life cycle is related to "green" [23]. Therefore, the green product model should not only include product knotting, geometry and other knowledge. The optimization of process plan is often to select the best or relatively optimal one from several possible process plans. Different styles and patterns have different problems. In the specific knitting process, we need to constantly find the shortcomings and take corresponding measures to improve them.

3.ESTABLISHMENT OF GREEN PROCESS PLANNING COMPUTER FLAT KNITTING MACHINE KNITTING MODEL

3.1Target System of Green Process Planning

Only a small number of double-needle bed computerized flat knitting machines can meet the needs of simultaneously knitting large body and sleeve body so as to realize full-form knitting. The production of green products will go through many processes from design to production. The competition faced by modern enterprises will be global, and the green index of products is also one of the main categories participating in the competition. It is this kind of competition that promotes the fundamental change of product design concept to green design. When knitting on computerized flat knitting machine, it is necessary to apply pulling tension to the fabric through pulling rollers, so as to facilitate the knitting and forming of coils. However, during full-form knitting, due to the retraction of needles, the number of longitudinal coils of each coil is not equal, and the uniform number of revolutions of the pulling roller makes the pulling tension of each longitudinal row uneven, thus making the full-form fabric not beautiful enough. Although feature-oriented product information model provides roughness, dimensional tolerance and other information, it lacks expression of the relationship between it and geometry, shape features and so on [24]. The concept of green design runs through the whole cycle of the product. Under the premise of not destroying the natural development, we should pay more attention to the function of the product, prolong its life and guarantee its quality.

There are some problems in the model, such as incomplete information and poor consistency of feature definition, which lead to the difficulty of feature recognition, and lack of uniform description of all aspects of product life cycle. In order to simplify the process of illustration, the complicated data calculation at the bottom is omitted, and the calculation is carried out only from the top two layers. Taking soybean milk machine as an example, it is assumed that the scores of importance and demand items are shown in Table 3.

Table 3. Overall design evaluation data

Demand	Demand weight value	Demand item score
Save time	7	20.3
Easy to clean	6	17.6
Small noise	9	22.5
Cost	5	15.3
No poison	8	20.6
Recoverability	5	16.7

On the basis of considering the use performance and technological performance of materials, combined with product design and technological planning, the energy consumption can be quantitatively analyzed [25]. The revenue components of the recovery plan include the reuse value of spare parts and the value of recycled materials. The reuse value of each spare part and the value of recycled materials are changed by 10%, 20%, 30% and 40% respectively. Figure 4 and Figure 5 show the changes in net income from recovery.

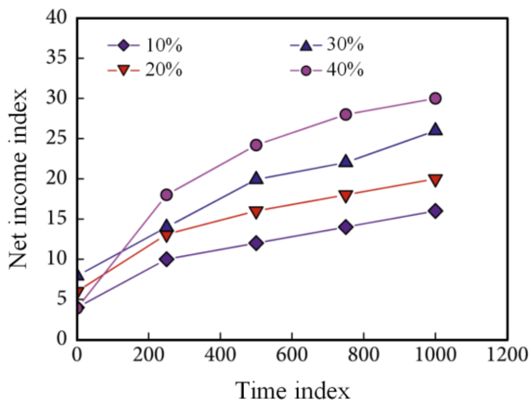

Figure 4. Reuse income change sensitivity analysis

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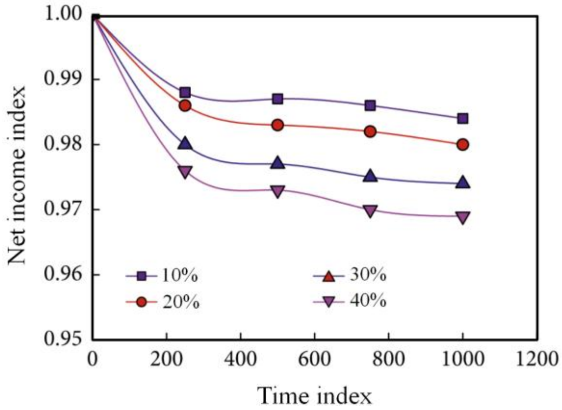

Figure 5. Sensitivity analysis of changes in reproductive income

One task is the premise of another task, and it is the premise of the third task. The third task is the antecedent of the first task. The formal description of the cyclic relationship is as follows:

$$D(\mathbf{V}_t, \mathbf{V}_t') = \sqrt{\sum_{i=1}^{c}\left(\frac{V_{ti} - V_{ti}'}{|V_{ti}| + |V_{ti}'|}\right)^2} \quad (4)$$

Establish the following formula to calculate the time for recalling:

$$p(x;\alpha,\beta) = \frac{\beta\eta(\alpha,\beta)}{2\Gamma(1/\beta)}\exp\{-[\eta(\alpha,\beta)|x|]^{\beta}\} \quad (5)$$

Then use the following fitting formula of forgetting curve to calculate the designer's stock of design knowledge that has been browsed:

$$\log\Gamma(x) = -\gamma x - \log(x) + \sum_{k=1}^{\infty}\left[\frac{x}{k} - \log\left(1+\frac{x}{k}\right)\right] \quad (6)$$

If the data mining algorithm can be organically combined with knowledge evaluation methods, it will help to improve the efficiency of data mining. The recognition rates of different algorithms on the database test set are shown in Table 4.

Table 4. Recognition rate of the same algorithm on the database test set

Method	Dynamic programming method	Branch and bound method	Backtracking	Ours
Recognition rate	13.36	35.87	52.95	80.35

After the knitting action is completed, the coil will be located in the lower needle bed. If a line specifies the front lower and lower needle beds, the front upper needle bed and the upper upper needle bed will not participate in the work. The classification accuracy rate corresponding to different fine tuning strategies, and 0 indicates the depth model initialized by Gaussian distribution with a mean of 0. 0⟹ 2 indicates the initial model to the final model. As shown in Table 5. The test performance on PPMI is shown in Table 6. The accuracy data is shown in Figure 1.

Table 5. Classification accuracy rate corresponding to different fine tuning strategies

Fine tuning strategy	0⟹ 2	0⟹ 3	0⟹ 2⟹ 3
Accuracy	92.26	96.79	98.99

Table 6. Test performance on PPMI

Method	SPM	SOF	Ours
Accuracy	34.32	18.79	56

The specific process can be shown in Figure 6. First, the minimum spanning tree is obtained, and then the cycle is controlled according to the conditions to cut off the edge with the largest weight. If two clusters need to be obtained, only one of the longest sides needs to be cut.

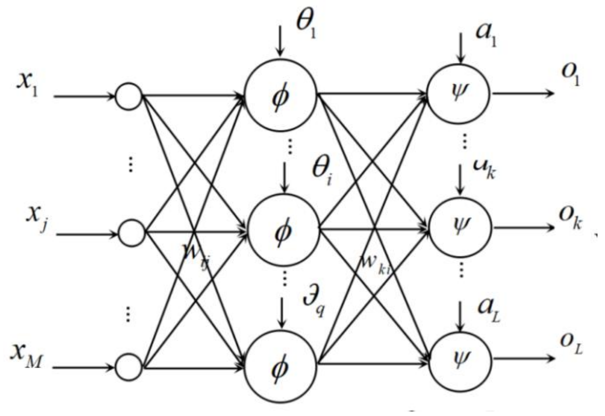

Figure 6. Spanning tree process

In full-form knitting, the front piece of the fabric is formed by using the front lower and rear upper needle beds, and the rear piece of the fabric is formed by using the rear lower and front upper needle beds, where the upper needle beds are all used to form reverse loops or auxiliary needle turning corresponding to the garment pieces. When designing the diagonal shoulder and inserted shoulder styles of knitted shirts, different models can be selected for knitting according to different diagonal shoulder sizes. When fully forming knitting, always ensure that the front and rear pieces are separated. When knitting or looping the front piece, use the front lower needle bed and the rear upper needle bed. After one line of knitting, the coils will be placed on the front and bottom needle beds, and then the back piece is knitted or moved, and the back and bottom needle beds and the front and upper needle beds will be used. Spring function provides gentle pressure to avoid unnecessary pressure on the coil leading to yarn breakage, so that the quality and texture of the fabric are significantly improved. Environmental factors should be taken into account in the stage of demand acquisition in green design. Demand analysis is an important symbol to distinguish green design from traditional design. Therefore, green product integration model needs to fully integrate the information of green demand analysis.

3.2 Variable Description of Green Process Planning

Green weaving design includes green material selection design, green manufacturing process design, product recyclability design, green service design and green recycling design, etc. Hidden security risks can cause panic. People began to miss the natural and pollution-free daily necessities of the past. The green design is to ensure that the selected materials are as green and environmentally friendly as possible. The use of sinkers on flat knitting machines is a new technological breakthrough, which aims to help the tongue needles form loops and improve knitting ability. When knitting tubular rib, the principle that the front piece is knitted on the even needles of the front needle bed and the rear piece is knitted on the odd needles of the rear needle bed is followed. In order to prevent holes from being generated between each row, loop collection treatment is carried out on loop holding needles adjacent to knitting edge loops. This method is generally used in the case of designing color strip color matching products and complex flower-shaped tissues, and using a large number of yarn guides or insufficient yarn guides after opening the slits. Environmental information is a collection of indicators of the environmental impact of a product throughout its life cycle. The main principle of its design is that the product is easy to sell and meets the basic functions required by the consumer.

The basic idea of green design is to integrate environmental factors and pollution prevention measures into product design at the design stage. Environmental performance is the product design goal and starting point. After selecting the removal path and direction, you need to access the removed parts and position them. This type of process is complex and the energy value is not easily quantified, and its energy consumption can be described by the ease of the process. It is represented by the accessibility and positioning of the disassembled object. Accessibility and localization

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can be qualitatively described by qualitative indicators, as shown in Table 7.

Table 7. Accessibility and location relevance

Accessibility	Degree of correlation	Localization	Degree of correlation
The removal path is clear	0.1-0.3	Parts can be grasped with one hand	0.1-0.2
Difficulty of directly approaching parts	0.4-0.8	The parts can be grasped directly with tools	0.3-0.6
Parts need to be moved to gain access	0.9-1.0	Parts interfere with each other seriously	0.7-1.0

The effect of each optimization strategy is related to its own complexity, number of times it is used and the screening rate of the optimization strategy. Alignment check optimization The complexity of each check is constant and only needs to be used once. The optimization complexity is as follows:

$$T(x,y)=\frac{x\bullet y}{\|x\|^2\times\|y\|^2}=\frac{\sum x_1y_1}{\sqrt{\sum x_1^2}\sqrt{\sum y_1^2}} \quad (7)$$

Comparing the output value of the network with the target value, the difference value corresponds to the error between them. The error is then propagated back from the output layer to the input layer. This error is a scalar function of the network weight. To define the error calculation method, namely loss function. For convenience, we use the quadratic loss function:

$$U_{ij}=\frac{H_{ij}}{\sqrt{\sum_{t=1}^{k}H_{it}^2}},i=1,...,n,\ j=1,...,k \quad (8)$$

Adjust the weight to move toward the direction of error reduction, as shown by the formula:

$$v_D=\eta\frac{u_D R_{ON}}{D}i(t) \quad (9)$$

Its η represents the learning rate, which is also the scale of weight change. The weight update rule is:

$$M(t)=u(t)/i(t)=R_0\sqrt{1-2\eta\Delta R\Phi(t)/Q_0R_0^2} \quad (10)$$

Next, we introduce the calculation process of error response propagation. Firstly, the weights from the hidden layer to the output layer are considered, and the error is not an explicit function of the weights. In other words, the weight cannot obviously determine the change of the error function, so we use the chain rule to calculate the partial derivative of the weight with respect to the error:

$$l^2=\frac{4\varepsilon_0U_0}{9eZN_i}[\sqrt{(1+\frac{u(t)}{U_0})^3}+\frac{3u(t)}{U_0}-1] \quad (11)$$

By the same token, we can deduce the update rule of weight from output layer to hidden layer:

$$i(t)=\frac{\pi D^2ZN_ie}{4}(v_i+\frac{dl}{dt}) \quad (12)$$

The accuracy rate and recall rate are inversely correlated. When the accuracy rate is high, the recall rate will not be very high. When the accuracy rate is low, the recall rate will be relatively high. When the distance is less than 0.3, the accuracy rate is higher and the overall detection rate is lower. When the threshold value is greater than 0.5, the accuracy rate decreases and the overall detection rate increases, so when the threshold value is between 0.3 and 0.5, their comprehensive index values are relatively good. The relationship between threshold setting and accuracy, recall and value is shown in Figure 7.

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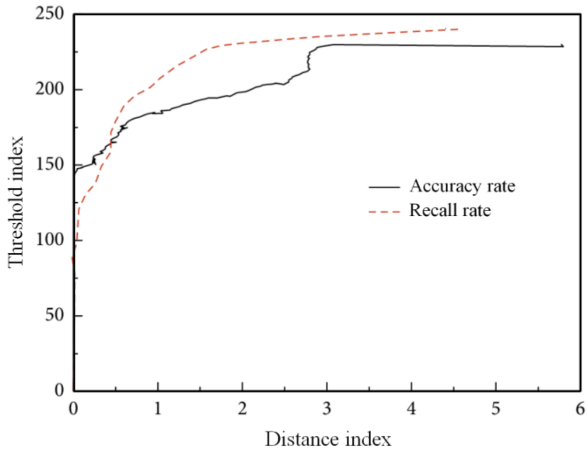

Figure 7. Relationship between threshold setting and accuracy and recall

Based on the common two-needle computerized flat knitting machine, the four-needle computerized flat knitting machine is more mature in forming requirements. In the design, users can be invited to evaluate the products to be released or already released as well as design prototypes, and iterative design can be carried out through analysis of evaluation data until the goal of usability is reached. When the extracted information deviates too much from the user's original intention and exceeds the customer's bearing area, customer satisfaction will drop rapidly.Whensummarizing customer requirements,the quality loss of demand information must be reduced, and the relationship is shown in Figure 8.

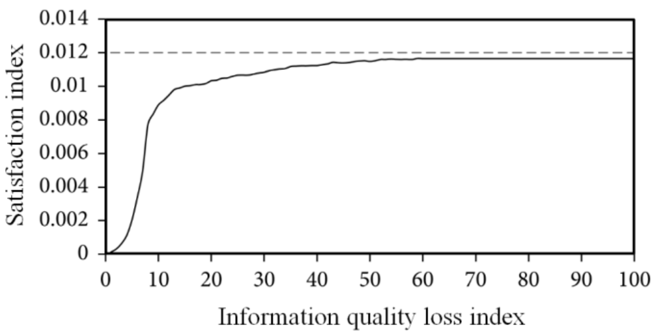

Figure 8. Relationship between Quality Loss of Demand Information and Customer Satisfaction

Since the height must be kept the same at the rib opening position and the sleeve body merging position, but the length of the sleeve piece and the large body is not necessarily equal, the height should be adjusted by means of local knitting after the number of revolutions of the sleeve under the hanging shoulder and the body are evenly distributed. As the double-bed computerized flat knitting machine has the above knitting functions, the fully formed fabric can be woven by adopting the needle separation and needle selection method. Yarn tension is a very important parameter in the weaving process of fully formed garments, and the magnitude and stability of tension are directly related to the product quality, production efficiency and smooth subsequent processing. The positions of all yarn guides are continuously monitored. If the fabric width changes, the yarn guides will automatically adjust their positions. People should rationally develop nature on the basis of maintaining the ecological balance and limit the mode of production and consumption of human beings within the range that the ecological system can bear. In order to realize green civilization, the traditional single economic growth mode must be changed.

4.CONCLUSIONS

With the development of science and technology, computer flat knitting machine process design, knitting methods and skills, plate making design, software upgrade and many other details are updated, different models have their own advantages. It has become possible to commercialize fully formed products by bringing them into the market with the combination of design and process. Based on the research of green design and customer-oriented design at home and abroad, this paper discusses the green design method for special knitting of computerized flat knitting machine. This paper analyses the function and significance of the green degree evaluation system, and draws lessons from the existing green degree evaluation methods from the characteristics of the special knitting design and development of computerized flat knitting machine. A green evaluation model for knitted products in the design stage is proposed, and the realization idea of

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the model is discussed in detail. Through the study of green design theory, the guiding role of green design theory in product design and the analysis of cases, it is deduced that the application of green design concept in product design is our inevitable choice. In today's grim environment, green design is not just a slogan. It should be the design thinking and design behavior that are put into practice. Green design needs to be popularized, popularized and widely applied.

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