纺织服装高等教育“十二五”部委级规划教材
纺织工程专业双语教材

织物结构与设计（双语教材）

Woven Structure and Design

聂建斌 卢士艳 主编
陈晓钢 审

東華大學出版社

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内容简介

本书是为高校纺织专业双语教学需要而编写的，其对应的中文教材为《织物结构与设计》。

本书加入了大量的新知识、新技术，也可作为纺织工程技术人员开发新产品的参考。

本书在书页的边部加入了部分专业词汇的中文注释，以帮助读者提高阅读效率，并正确把握专业词汇含义。

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Perface
前　言

Document 4(2001) from China Ministry of Education requires that dual-language teaching should be practiced in some programs in all universities. This would obviously help Chinese university students to improve their English ability, and this policy has been considered as an effective measure taken towards the production of high quality international professionals. As to textile industry in our country, it is one of the most benefited industries from the open-door polices and is now entering global market in an impressive manner. Naturally, more professionals are expected urgently in the textile industry who are able to use English fluently to deal with technological and trade issues. This textbook is written for dual-language teaching for university students, and as a general reading reference.

This textbook includes all contents in the Chinese textbook *Fabric Structures and Design*, and has added some new information such as multi-layer fabrics. This textbook received satisfactory remarks from some specialists and students during the trial period.

The authors worked at their best to ensure the correctness in English grammar and language custom. Dr. Xiaogang Chen, senior lecture and Ph. D student supervisor of UMIST, UK was invited to be the auditor of this textbook and he has made corrections and examined the contents of the textbook.

The authors wish to thank the leadership of Zhongyuan Technology Institute, especially professor Delin Ling, the former president of the Institute, for their strong support and encouragement.

Comments and recommendations from readers are welcome.

国家教育部教高[2001]4号文件要求各大学在每个学科都有一些课程采用双语教学，这对提高我国大学生的英语使用能力很有帮助，对培养国际型高素质人才是一个非常好的举措，尤其是我们纺织行业，正在大步走向世界，从技术角度、贸易的角度都需要大量的、能熟练掌握英语的专门型人才，本书正是为高校纺织专业学生编写的双语教学教材，也可作为专业英语教材与读物。

本书包含《织物结构与设计》的所有内容，并增加了一些新的知识，如多层织物等，在试用中得到了专家和学生们的好评。

本书在语言上力求准确，符合英语习惯。英国 UMIST 大学纺织系陈晓钢博士，对本书进行了严格的修改和审查。

在编写本书过程中，得到了中原工学院领导、特别是老院长凌德麟教授的大力支持，在此表示诚挚的谢意。

热忱欢迎读者对本书提出宝贵意见和建议。

Introduction of the Author
作者简介

Mr. Jianbin Nie is currently a professor in School of Textiles, Zhongyuan University of Technology. He is also a National Excellent Teacher. He graduated from Northwest Institute of Textile Science and Technology(Xi'an) in 1982. He was a fabric designer in Beijing Wool Textile Research Institute from 1982 to 1993, and a senior fabric designer in Henan Textile Research Institute. He became an associate professor in Zhongyuan Institute of Technology in 1996.

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Mr. Nie is good at English due to his opportunities of English training and abroad experience. He had an English training at Beijing Second Foreign Language Institute from 1983 to 1984. He studied at UMIST U.K., from 1999 to 2000, and he worked as an expert at Bahir Dar University, Ethiopia, from 2001 to 2003.

WOVEN STUCTURE AND DESIGN, suitable for dual-language teaching, is a fruit of author's design skills, English ability and teaching experiences. It is convinced that this book will give a useful contribution to the dual-language teaching program.

聂建斌,中原工学院纺织学院教授,全国优秀教师,1982 年毕业于西北纺织工学院,1982—1993 年在北京毛纺织研究所产品研究室工作,1993—1996 年在河南省纺织研究院工作,1996 年至今在中院工学院纺织学院做教学工作。

聂建斌先生擅长于纺织品设计与开发工作,在长达 30 年的设计生涯中,他设计开发了千余种纺织新产品,并参加了国家"七五"攻关科研项目——"纯化纤毛呢产品的开发",主持了北京市科委的课题"毛麻产品的开发",并获科技进步二等奖。他还曾兼任二十余家工厂的技术顾问。

聂建斌先生具有丰富的学习和使用英语的经验,除在大学的学习外,1983—1984 年在北京第二外国语学院进修一年,1999—2000 年在英国 UMIST 大学纺织系留学一年,2001—2003 的在埃塞俄比亚 Bahir Dar 大学纺织系任教(英语讲授纺织品设计等课程)。

《机织物组织与设计》是一本适合于双语教学的教材,集作者扎实的专业知识、较深的英语功底和丰富的教学经验于一体,相信它在中国的双语教学改革中,一定能发挥较大的作用。

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Introduction to the Reader
审稿者简介

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Dr. Chen's research interests include protective textiles, 3D technical textiles, modeling of textile assemblies and CAD/CAM for textiles. Over the years, he has been the principal investigator for a number of research projects supervised numerous PhD, MPhil, and MSc students.

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陈博士的研究领域包括防护纺织品、三维技术纺织品、纺织材料几何和力学建模,以及纺织 CAD/CAM。多年来,陈博士在多个领域指导了一大批硕士和博士研究生。

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UNIT Ⅰ

General Knowledge and Simple Construction
基本知识和简单组织

Chapter One
General Knowledge on Woven Fabrics
有关机织物的基本知识

1.1 Cloth formation on loom

机织物的形成

机织物

Woven fabrics are formed by interlacing two mutually perpendicular sets of yarns. The simplest interlacing pattern is illustrated in Fig. 1.1, where eight warp and six weft threads are included.

纬纱/经纱

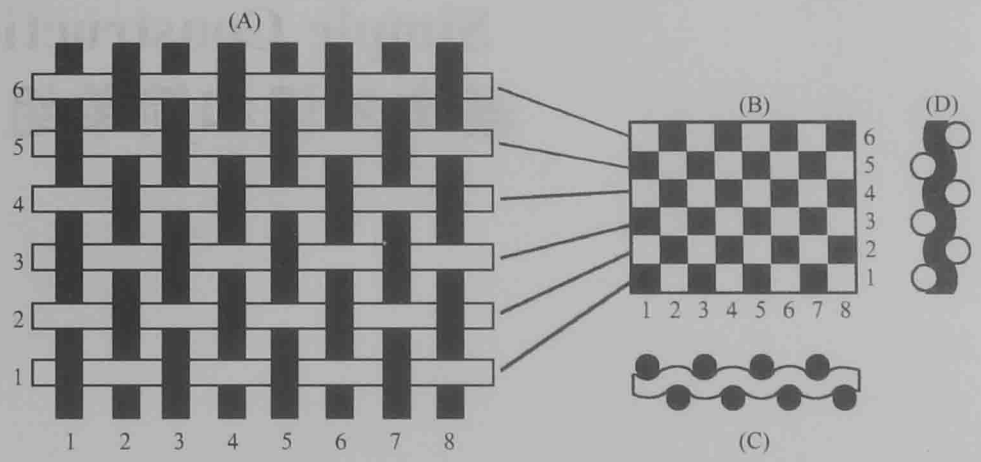

Fig. 1.1 Plan and section of plain weave

A textile designer must understand the influence of the process of cloth formation on fabric structures. In order to interlace warp and weft threads, the loom must carry out the five operations below.

织物结构

织机

The first three operations are the most important for cloth formations known as the primary operations. The other two operations are essential for continuous fabric production.

开口

梭口

(1) Shedding— separating the warp threads into two layers, one of which is lifted and the other is lowered to form the space for the weft insertion, which is called a shed.

引纬

梭子

(2) Picking— inserting the weft thread through the shed, sometimes by a shuttle.

打纬/纬纱

织口

(3) Beating-up— pushing the newly inserted weft, known as a pick, into the already woven fabric to the point called the fabric fell.

送经

张力

(4) Warp letting-off— delivering the warp to the formation zone at the required rate and at a suitable constant tension by unwinding it from the

weaver's beam.

(5) Cloth taking-up— moving fabric from the formation zone at the constant rate that ensures the required pick spacing, and winding the fabric onto a cloth roller. 卷取 卷布辊

The schematic diagram of a loom is illustrated in Fig. 1. 2, where the principal parts for the five basic motions are shown. The warp yarn 1 from the weaver's beam 12 passes round the back rest 2 and goes through the drop wires 3 of the warp stop-motion to the healds 4, which are intended for separating the warp threads for the purpose of shed formation. It then passes through the reed 5 that holds the threads at uniform spacing and is designed for beating-up the weft thread which is inserted into the triangular warp shed 7 by the shuttle 6. The shed is formed by two warp sheets (layers) and the reed. Temples hold the cloth at the fabric fell 8 to assist in formation of a uniform fabric, which then passes over the breast beam 9, round the take-up roller 10 and onto the cloth roller 11. 织轴/后梁/停经/片/综丝 筘 边撑 胸梁/卷布辊

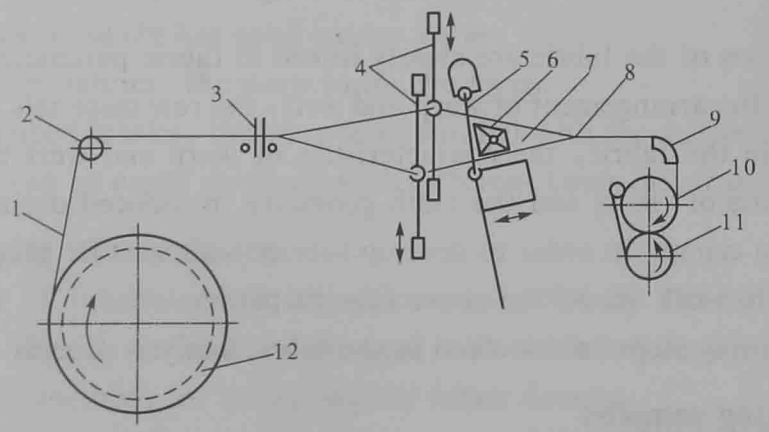

Fig. 1. 2 Schematic diagram of the loom

Besides the five basic motions, which perform the above operations the loom is equipped with a number of auxiliary motions, which are intended for automation, and control of the process of weaving, and for increasing the efficiency.

These basic motions ensure the required structure and properties of the fabric by controlling such parameters as the density of weft threads (pick-spacing), density of warp threads, the type of weave, and the crimp of threads. 缩率

The density of weft threads in the fabric is determined by the cloth take-up motion, which controls the rotary speed of the take-up roller.

The number of warp threads per unit of fabric width. i.e. warp density, depends on the count of the reed which is a part of slay motion, weft crimp and the number of threads drawn into one reed-dent. 筘座 筘齿

The influence of warp tension, which is controlled by the let-off motion, on the crimps of threads is well known. The level of warp tension affects the

weaving condition, and determines the yarn crimps in the fabric.

组织/踏盘多臂

The weave type is fully dependent on the type of shedding motion. Tappet shedding motions are used for simple fundamental weaves; dobbies are employed for more complex weaves, such as the derivative and combined weaves. For producing fabrics with large figured patterns, a jacquard shedding mechanism becomes necessary. The figuring capacity of jacquard shedding mechanism may range from hundreds to thousands threads and even more. The number of warp threads with different order of interlacement depends on the number of hooks used in the mechanism that represents its figuring capacity. The number of weft threads with different order of interlacement, i.e. weft repeat of the weave, can be changed by altering the number of perforated cards in the chain which is formed when the last card is joined to the first.

提花机

竖针

纬纱循环

1.2 Fabric analysis

样品分析

The properties of the fabric are closely linked to fabric parameters including the weave, the arrangement of warp and weft, the raw materials, the density of threads in the fabric, the characteristics of warp and weft threads, the characteristics of fibers and the cloth geometry introduced during weaving, such as yarn crimp. In order to develop fabrics with specific properties, it is imperative to work out all the above fabric's parameters.

组织

The following steps are involved in the fabric analysis process.

1.2.1 Making samples

取样

The sample should properly represent the characteristics of the fabric.

1.2.1.1 Location

The sample should be selected from the middle of the fabric. The distance from the selvage must be more than 5cm, and the distance from the end of the fabric must be more than 1.5 to 3m.

布边/布头

1.2.1.2 Size

The size of the sample varies depending on the characteristics of the fabric. 15cm×15cm are suitable for simple structure and fabrics with small patterns, and 20cm×20cm for fabrics with big patterns.

1.2.2 Identification of face and back of the fabric

正面/反面

外观

We can identify the face or back of the fabric according to the appearance of the fabric. The following points is helpful for efficient identification.

- The face of a fabric has a clear colour or patterns.
- For rib or corded fabrics, the face is usually more dense and smooth.

凸条

- For pile fabrics, the face has piles. 绒织物
- For double clothes, the faces have higher density, and use better materials. 双面织物
- For terry fabrics, the faces have denser loops.

1.2.3 Identification of warp and weft

We can identify the warp and weft directions according to the following points.

- The warp has always parallel with selvage.
- The warp may be sized, and the weft is not. 上浆的
- The warp usually has a big density.
- The warp direction may have reed marks. 筘痕
- The warp is more likely to ply yarn. 合股线
- The Z-twist yarns are used for warp, and S-twist for weft if the warp and weft are different in twist directions. Z捻/S捻
- The warp usually has higher twisted yarns.
- The warp usually has good quality yarns.
- For terry fabrics, the warp forms the loops. 圈
- For striped fabrics, the warp is in parallel with the stripes. 条
- Warp can be easily arranged with different kinds of yarns.

1.2.4 Density measurement

The density of fabric is very important, as it directly affects the fabric's appearance, handle, thickness, strength and warmth retention. There are two different methods for measuring the fabric density. 手感

1.2.4.1 Direct measurement

The fabric sample is placed on a flat surface, making sure it is not under tension or distorted. A piece glass is placed on top and the fabric is viewed through the lens. A magnified image of threads occupying the length and width of the piece glass square can be counted with the aid of a dissecting needle to pinpoint the individual threads in warp and weft.

If the piece glass is $2.5cm^2$, the threads in one direction of woven fabric will be determined by:

$$Thread\ density = threads\ counted/2.5 = threads\ per\ cm$$

1.2.4.2 Indirect measurement

This is carried out using an optical device known as a taper line grating. This is a flat sheet of glass with a large number of straight lines engraved on it in a tapered fashion so that their density increases from left to right when this is placed on top of a simple woven construction the threads interfere with the

line grating and an optical pattern is produced.

1.2.5 Crimp measurement

Crimp refers to the amount of bending that is done by a thread as it interlaces with the threads that are lying in the opposite direction of the fabric.

Fig. 1.3 shows the difference between the length of yarn (l_y) taken from a length of fabric (l_f), so

$$Crimp\ (c) = \frac{l_y - l_f}{l_f}.$$ ①

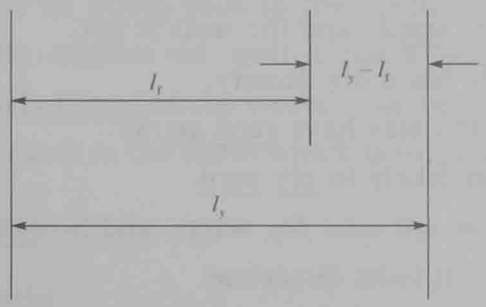

Fig. 1.3 Crimp

Often it is generally considered most convenient and preferable to use percentage values:

$$Crimp\ (c) = \frac{l_y - l_f}{l_f} \times 100/\%.$$

The use of calculations using the crimp formula is essential in determining the amount of yarn that is required for a particular circumstance or in assessing how much fabric can be produced from a known length of yarn.

缩率测试仪 Fig. 1.4 shows a crimp tester.

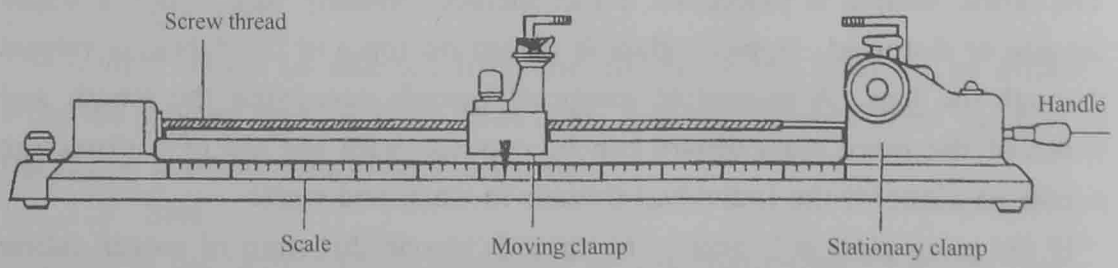

Fig. 1.4 Crimp tester

线密度

1.2.6 Linear density (tex) measurement

It is common to specify thread thickness as thread linear density in tex. The thread linear density indicates the weight in grams of 1km of thread. The formula is:

① 此公式和中文教材中的缩率有区别——编者注.

$$Linear\ density\ (\text{tex}) = \frac{1\,000\ G}{L},$$

here: G — the weight of the thread at the nominal regaing(g);

L — the length of the thread(m).

1.2.7 Fiber identification

The approach for fiber identification depends on whether a sample consists of one type of fiber or a blend of fibers. In the case of blends the quantitative analysis of the fibers may also be necessary. Fiber identification may be carried out using the following methods.

(1) Microscopically examination of the longitudinal and cross-sectional views of the fiber.

(2) Burning test.

(3) The use of solvents.

(4) Other chemical tests.

(5) Staining.

(6) Melting point determination.

(7) Fiber density.

It should be remembered that sometimes no single method can give a completely reliable indication of the identity of the fiber and that confirmatory tests are often advisable.

In order to determine whether more than one type of fiber is present, microscopical examination of the fiber is convenient.

1.2.8 Fabric weight

Fabric weight is economically important. It can be measured in two ways.

1.2.8.1 Weighting measurement

As absorbed moisture affects both mass and dimensions, it is important to precondition samples and carry out measurements in a standard atmosphere. 标准温湿度

Mass per unit area is expressed in grams per square meter (g/m^2), but it is not necessary to measure a square meter of fabric. A relatively small specimen is cut out, usually 10cm × 10cm, with the aid of a template. The specimen is then weighed accurately. 标样

$$Mass\ per\ unit\ area\ (g/m^2) = specimen\ mass(g) \times 100$$

1.2.8.2 Calculating measurement

Fabric weight is the weight of yarn per square meter in a woven fabric, which is the sum of the weight of the warp and the weight of the weft, so:

$$W\ (g/m^2) = \frac{10P_1 \times Tex_1}{(1 - a_1) \times 1\,000} + \frac{10P_2 \times Tex_2}{(1 - a_2) \times 1\,000},$$

here: P_1— warp density (ends/10cm);
P_2— weft density(picks/10cm);
a_1— warp take-up(%);
a_2— weft take-up(%);
Tex_1— warp linear density;
Tex_2— weft linear density.

色纱排列

1.2.9 Fabric structure and colour arrangement

It is necessary to know the method of fabric construction, e. g., a twill weave or a sateen weave. This is determined by viewing the fabric using a piece glass or a low magnification microscope.

织物的表示方法

1.3 Fabric representation

组织的表达法/组织

1.3.1 Methods of weave representation

The interlacing pattern of the warp and weft is known as the weave. Two kinds of interlacement are possible. The first kind—warp over weft—is called warp overlap and the second kind of interlacement—weft over warp—is called weft overlap.

经浮线
纬浮线

The interlacement is achieved by movement of the warp threads. The warp thread must be lifted to obtain a warp overlap; in this case the weft thread is inserted under the warp. When the warp thread is lowered, the weft thread is inserted above this warp thread and a weft overlap is obtained.

In order to identify the weave of a fabric, it is necessary to look at the face side of a fabric through a magnifying glass. The fabric, shown in Fig. 1. 1 (A), contains eight warp threads and six weft threads. At the point of intersection of warp thread 1 and weft thread 1, the warp thread passes over weft thread 1. This is a warp overlap. Examining the intersection of warp thread 2 and weft thread 1, one can see that the weft thread 1 is placed over the warp thread 2. This is a weft overlap. A weave is characterized combination of warp and weft overlaps arranged in certain orders. However, drawing such diagrams is a time consuming operation and, therefore, this method is not used by textile designers.

方格法
意匠纸

A practical method of weave representation called canvas method is widely used internationally. In this method, a squared paper, design-paper is employed. On this design-paper, shown in Fig. 1. 5, each vertical space represents a warp thread, and each horizontal space a weft thread. Each

交织点

square, therefore indicates an intersection of warp and weft threads. To show the warp overlap, a square is filled in or shaded. The blank square