纺织工程专业
双语教材

Woven Structure and Design

机织物组织与设计

聂建斌 主编
卢士艳 副主编
陈晓钢 审

中国纺织出版社
China Textile Press

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内 容 提 要

本书应高校纺织专业双语教学需要而编写，主要用英语介绍织物的组织与结构、织物的设计方法等，其对应的中文教材为我社出版的《织物结构与设计》。

本书还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用书。

本书在书页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，并准确把握专业内涵。

Abstract

This textbook is written for textile majors in Chinese universities to actualize dual-language teaching, which mainly introduces woven structure and fabric design. Its Chinese counterpart is the textbook Fabric Structures and Design published by our press.

This textbook has introduced large amount of new knowledge and new technology that are not included in other related books. The addition to the contents would make the textbook a suitable reference for textile engineers and technologists for new products development.

The book provides, in the page margin, Chinese translation and interpretation for the key vocabularies aiming to assist readers to read more efficiently and understand more correctly.

图书在版编目(CIP)数据

机织物组织与设计/聂建斌主编.—北京:中国纺织出版社,2004.12

纺织工程专业双语教材

ISBN 7-5064-3131-9/TS·1870

Ⅰ.机… Ⅱ.聂… Ⅲ.①机织物-织物结构-双语教学-教材 ②机织物-设计-双语教学-教材

Ⅳ.TS105.1

中国版本图书馆 CIP 数据核字(2004)第 103868 号

策划编辑:崔俊芳 冯 静 责任编辑:孙 玲
责任校对:陈 红 责任设计:何 建 责任印制:刘 强

中国纺织出版社出版发行
地址:北京东直门南大街6号 邮政编码:100027
电话:010—64160816 传真:010—64168226
http://www.c-textilep.com
E-mail:faxing@c-textilep.com
中国纺织出版社印刷厂印刷 三河永成装订厂装订
各地新华书店经销
2004年12月第1版第1次印刷
开本:787×1092 1/16 印张:14.5
字数:309千字 印数:1—3000 定价:34.00元

出版前言

进入21世纪，各高校纷纷在提高教育素质、与国际接轨方面进行积极探索。其中"双语教学"成为推进素质教育的又一着陆点。教育部于2001年8月发布文件，针对本科教学工作提出12项措施，其中明确要求各高校在三年内开设5%～10%的双语课程，并引进原版教材和提高师资水平。这使得高校双语教学势在必行。双语教学既是教育自身对课程设置的调整，也是社会发展对教育改革的必然要求。实施双语教学不仅可提高学生的英语水平，适应未来的发展，更重要的是提高我国综合国力和国际竞争力的需要。

通过问卷调查、座谈等方式，我们了解到双语教材的缺乏是高校实施双语教学的一大难点。作为科技出版社，我们拥有纺织、染化、服装、工美等专业人才，并和英美等国家的专业出版社、院校、协会保持着良好的合作，因此，我们希望利用自身专业优势，与高校合作出版双语教材，使之成为高校实施双语教学的先行兵。

经过广泛的调研、深入的讨论，我们在双语教材的内容、出版形式等方面形成了较完整的思路。目前，我社即将出版的双语教材按专业分为三个系列：纺织工程专业双语教材、轻化工程专业双语教材、服装专业双语教材。所选图书均为国外的经典教材，其内容与国内相关专业课程相近，便于学生在掌握专业基础知识的同时，开阔视野，提高语言应用能力。我们将力求出版形式多样化，既有原汁原味的影印本，又有中译本和中文注释版本。部分教材将配有多媒体光盘，更加丰富了教材的表现手段，有助于提高学生的英语听说能力。

可以说，这是我们在双语教材出版方面所进行的一次有意义的尝试，希望能对高校双语教学的开展起到抛砖引玉之用，也希望读者对双语教材的出版提出建议、意见，以便我们在今后的工作中逐步改进、完善。

出版者

2004年1月

Preface

前　言

Document 4 (2001) from China Ministry of Education requires that dual-language teaching should be practised in some programs in all universities. This would obviously help Chinese university students to improve their English ability, and this police 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 who specialized in the textile field. It may also be used as an English textbook for textile 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 lecturer 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,从技术的角度、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和读物。

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,给予了本书严格的修改和审查。

在编写本书的过程中,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 to the Author

作者简介

Mr. Jianbin Nie is currently an associate professor, and director of Textile Materials & Fabric Design Division in Zhongyuan Institute of Technology. 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 was a senior fabric designer in Henan Textile Research Institute. He became an associate professor in Zhongyuan Institute of Technology in 1996.

Mr. Nie is a qualified fabric designer, having 20 years experience in this field. He has designed thousands of fabrics varieties. He participated a "7th five-year plan" national program, on "Development of Woolen Fabrics Using Synthetic Fibers". He was one of the main investigators for the project "Development of Woolen Fabrics from Wool and Flax Blend" sponsored by Beijing Science Council, and awarded the second prize for scientific progress. He was an advisor for dozens of companies.

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 STRUCTURE 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，中原工学院纺织系副教授，纺织材料和纺织品设计教研室主任，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 年在河南纺织研究院工作，1996 年至今在中原工学院纺织系，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 20 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——“纯化纤呢绒产品的开发”，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 年在埃塞俄比亚 Bahir Dar 大学纺织系任教（用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。

Introduction to the Reader

审稿者简介

Dr. Xiaogang Chen is currently a senior lecturer in the School of Materials, The University of Manchester, U. K. He received his BSc and MSc degrees in Textile Engineering from Northwest Institute of Textile Science and Technology (Xi'an) in 1982 and 1985 respectively, and obtained his PhD degree in Textile Engineering from The University of Leeds, U. K. in 1991. After 3 years post-doctoral research in Heriot-Watt University, he joined UMIST as a lecturer in 1994 and became a senior lecturer in 2002. UMIST forms part of the new University of Manchester from October 2004.

Dr. Chen's research interests include protective textiles, 3D technical textiles, modelling 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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陈晓钢博士，英国曼彻斯特大学材料学院高级讲师，博士生导师，1982 年和 1985 年在西北纺织工学院取得学士和硕士学位，1991 年在英国里兹大学取得博士学位，在赫瑞一瓦特大学做了三年博士后研究，1994 年开始任教于 UMIST 大学纺织系，2002 年升任高级讲师。UMIST 于 2004 年 10 月成为新曼彻斯特大学。

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。

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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
机织物的基本知识

机织物的形成 1.1 Cloth formation on loom

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

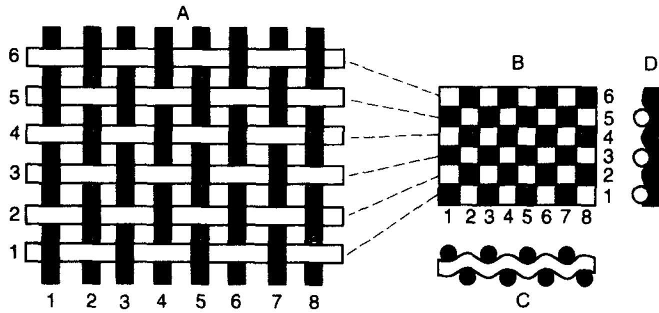

Fig. 1.1 Plan and section of plain weave

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

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 (1) *Shedding* —— separating the warp threads into two layers, one of which is lifted
梭口 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 (3) *Beating-up* —— pushing the newly inserted weft, known as a pick, into the
织口 already woven fabric to the point called the fabric fell.

送经 (4) *Warp letting-off* —— delivering the warp to the formation zone at the required
张力 rate and at a suitable constant tension by unwinding it from the weaver's beam.

卷取 (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 织轴
beam 12 passes round the back rest 2 and goes through the drop wires 3 of the warp 后梁/停经片
stop-motion to the healds 4, which are intended for separating the warp threads for 综丝
the purpose of shed formation. It then passes through the reed 5 that holds the 筘
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 边撑
assist in formation of a uniform fabric, which then passes over the breast beam 9, 胸梁
round the take-up roller 10 and onto the cloth roller 11. 卷绕辊

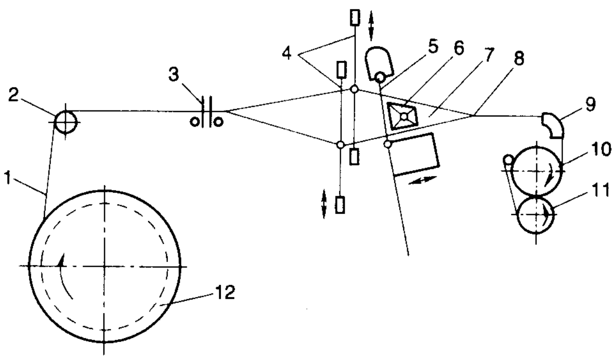

Fig. 1.2 Schematic diagram of the loom

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 筘座
of threads drawn into one reed-dent. 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.

The weave type is fully dependent on the type of shedding motion. Tappet 组织/踏盘
shedding motions are used for simple fundamental weaves; dobbies are employed 多臂机
for more complex weaves, such as the derivatives and combined weaves. For
producing fabrics with large figured patterns, a jacquard shedding mechanism 提花机
becomes necessary. The figuring capacity of jacquard shedding mechanism may
range from 100 to 2600 threads and even more. The number of warp threads with
different order of interlacement depends on the number of hooks used in the 竖针
mechanism that represents its figuring capacity. The number of weft threads with

纬纱循环 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.

样品分析 1.2 Fabric analysis

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 fibres 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.

The following steps are involved in the fabric analysis process.

取样 1.2.1 Making samples

The sample should properly represent the characteristics of the fabric.

- Location

The sample should be selected from the middle of the fabric. The distance from 布边/布头 the selvage must be more than 5 centimeters, and the distance from the end of the fabric must be more than 1.5 to 3 meters.

- 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.

正面/反面 1.2.2 Identification of face and back of the fabric

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.
- 凸条 For rib or corded fabrics, the face is usually more dense and smooth.
- 绒织物 For pile fabrics, the face has piles.
- 双面织物 For double clothes, the faces have higher density, and use better materials.
- 毛圈织物 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.
- 上浆的 The warp may be sized, the weft is not.
- The warp usually has a big density.
- 筘痕 The warp direction may have reed marks.
- 合股线 The warp is more likely to ply yarn.
- Z捻/S捻 The Z-twist yarns are used for warp, and S-twist for weft if the warp and weft are different in twist directions.
- 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 织物密度

- 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 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 2.5 centimeters square, the threads in one direction of woven fabric will be determined by:

$$\text{Thread density} = \text{threads counted}/2.5 = \text{threads per cm}$$

- 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:

$$\text{Crimp}(c) = \frac{l_y - l_f}{l_f}\bullet$$

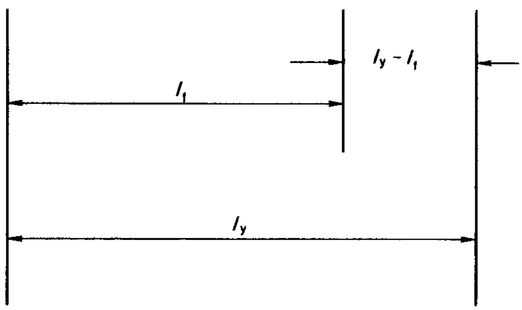

Fig. 1.3 Crimp

● 此公式和中文教材的缩率有区别。——编者注

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

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

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 缩率测试仪 much fabric can be produced from a known length of yarn. Fig. 1.4 shows a crimp tester.

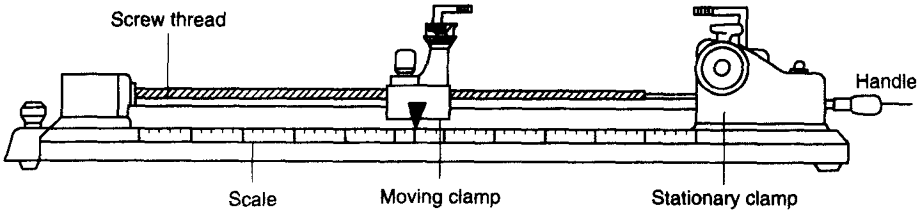

Fig. 1.4 Crimp tester

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 1 km of thread. The formula is:

$$\text{Linear density(tex)} = \frac{1000G}{L}$$

Where: G—— the weight of the thread in grams at the nominal regain; and
L——the length of the thread in meters.

1.2.7 Fibre identification

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

(1) Microscopically examination of the longitudinal and cross-sectional views of the fibre.
(2) Burning test.
(3) The use of solvents.
(4) Other chemical tests.
(5) Staining.
(6) Melting point determination.
(7) Fibre density.

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

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

1.2.8 Fabric weight

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

- 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

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

- 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:

$$W(g/m^2) = \frac{10P_1 \times Tt_1}{(1-a_1)\times 1000} + \frac{10P_2 \times Tt_2}{(1-a_2)\times 1000}$$

Where: P_1——Warp density (ends/10cm);
P_2——Weft density(picks/10cm);
a_1——Warp take-up(%);
a_2——Weft take-up(%);
Tt_1——Warp linear density;
Tt_2——Weft linear density.

1.2.9 Fabric structure and colour arrangement

色纱排列

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.

1.3 Fabric representation

织物的表示方法

1.3.1 Methods of weave representation

组织的表达法

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——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 1 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