

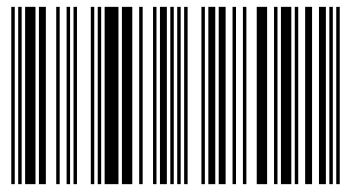
Textile materials differ in numerous aspects from conventional engineering materials. They are inhomogeneous, highly anisotropic and deformable, and can suffer large deformations and displacements within a plane at low stress under ordinary conditions and/or during normal use. Knowing their behaviour under low stress is the basis for the engineering planning of fabrics, product development, computer-aided design, and the numerical modelling and simulation of clothing and other products for technical applications. This monograph is aimed at providing a critical appreciation of scientific understanding in those areas related to complex deformations of textile structures. These contents are subdivided into two thematically-connected parts. Part I addresses the basic issues regarding the complex deformations of a textile structure and the simulation of drape performances, whilst Part II places emphasis on the 3D modelling of the human body, and clothing simulation. This monograph that builds practical, professional and academic foundations for tomorrow's engineers will be an essential reference for academics, professionals, students, researchers, and designers within industry.

Complex fabric deformations & modelling



J. Geršak

The monography was written by Jelka Geršak, Univ.-Professor for Clothing Engineering at University of Maribor, Marianna Halász and Péter Tamás, Assoc. Professors at Faculty of Mechanical Engineering of Budapest University of Technology and Economics and Livia Kokas Palicska, Assoc. Professor at Institute of Product Design of Obuda University.



978-3-659-32809-1

Geršak (Ed.)

J. Geršak (Ed.)

Complex fabric deformations and clothing modelling in 3D

Complex fabric deformations & modelling

 **LAP**
LAMBERT
Academic Publishing

J. Geršak (Ed.)

Complex fabric deformations and clothing modelling in 3D

J. Geršak (Ed.)

**Complex fabric deformations and
clothing modelling in 3D**

Complex fabric deformations & modelling

LAP LAMBERT Academic Publishing

Impressum / Imprint

Bibliografische Information der Deutschen Nationalbibliothek: Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über <http://dnb.d-nb.de> abrufbar.

Alle in diesem Buch genannten Marken und Produktnamen unterliegen warenzeichen-, marken- oder patentrechtlichem Schutz bzw. sind Warenzeichen oder eingetragene Warenzeichen der jeweiligen Inhaber. Die Wiedergabe von Marken, Produktnamen, Gebrauchsnamen, Handelsnamen, Warenbezeichnungen u.s.w. in diesem Werk berechtigt auch ohne besondere Kennzeichnung nicht zu der Annahme, dass solche Namen im Sinne der Warenzeichen- und Markenschutzgesetzgebung als frei zu betrachten wären und daher von jedermann benutzt werden dürften.

Bibliographic information published by the Deutsche Nationalbibliothek: The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at <http://dnb.d-nb.de>.

Any brand names and product names mentioned in this book are subject to trademark, brand or patent protection and are trademarks or registered trademarks of their respective holders. The use of brand names, product names, common names, trade names, product descriptions etc. even without a particular marking in this works is in no way to be construed to mean that such names may be regarded as unrestricted in respect of trademark and brand protection legislation and could thus be used by anyone.

Coverbild / Cover image: www.ingimage.com

Verlag / Publisher:

LAP LAMBERT Academic Publishing

ist ein Imprint der / is a trademark of

OmniScriptum GmbH & Co. KG

Heinrich-Böcking-Str. 6-8, 66121 Saarbrücken, Deutschland / Germany

Email: info@lap-publishing.com

Herstellung: siehe letzte Seite /

Printed at: see last page

ISBN: 978-3-659-32809-1

Copyright © 2013 OmniScriptum GmbH & Co. KG

Alle Rechte vorbehalten. / All rights reserved. Saarbrücken 2013

*C*OMPLEX FABRIC DEFORMATIONS AND
CLOTHING MODELLING IN 3D

*C*OMPLEX FABRIC DEFORMATIONS AND
CLOTHING MODELLING IN 3D

Edited by J. Geršák

J. Geršák, M. Halász,
P. Tamás, L. Kokas-Palincska

CONTENTS

<i>Authors' contact details</i>	<i>vi</i>
<i>Preface</i>	<i>vii</i>
Part I COMPLEX DEFORMATIONS OF TEXTILE STRUCTURE	1
1 STUDY OF THE COMPLEX DEFORMATIONS OF TEXTILE STRUCTURE	3
1.1 Introduction	3
1.2 Two-dimensional drape	5
1.3 Three-dimensional drape	23
1.3.1 Recent development in drape research	30
1.4 Characterising the static and dynamic drape of fabrics	37
1.5 Draping as an aesthetic performance of clothing appearance	48
1.6 References	56
2 MEASURING AND SIMULATION OF DRAPING PERFORMANCE	61
2.1 Introduction	61
2.2 Sylvie 3D drape tester – new system for measuring textile fabric drape	62
2.2.1 Equipment	63
2.2.2 Calibration	64
2.2.3 Processing the images	67
2.2.4 3D reconstruction	68
2.2.5 Measuring the drape parameters	69
2.2.6 Testing the new measuring equipment	71
2.3 Measuring based on 3D draping simulation	75
2.3.1 The model	78
2.3.2 Parameter estimation	81
	iii

2.4	Spectral function of drapes	82
2.4.1	Method for determining the spectral function of draping	83
2.4.2	Spectral function of fabric drapes	86
2.5	References	92
3	FABRIC DRAPE BEHAVIOUR AS FUNCTION OF SOME INFLUENTIAL PARAMETERS	95
3.1	Introduction	95
3.2	Relation between weave construction and draping properties	96
3.3	Relation between yarn twist direction and draping properties	102
3.4	Relation between finishing and draping properties	108
3.4.1	Effect of finishing on drapeability	110
3.5	Relation between sample size and draping properties	114
3.5.1	Measurement method	114
3.5.2	Measuring devices	115
3.5.3	Experimental materials	116
3.5.4	Preparation of samples	118
3.5.5	The measurement	122
3.5.6	Results and discussion	123
3.6	Applied dynamic impact on drape measurements	126
3.6.1	Dynamically influenced drapeability	127
3.6.2	Applied dynamic impact on drape measurements	129
3.6.3	Analysis of drape formation process and a proposal for improvement of fabric behavior modelling	133
3.7	References	135
4	ASYMMETRICAL BEHAVIOUR OF COMPLEX TEXTILE STRUCTURES	139
4.1	Introduction	139
4.2	Studying the causes of the asymmetrical behaviour of complex textile structures	140
4.2.1	Relationship between the structural parameters of fabrics and their behaviour	140
4.2.2	Relationships between the structural parameters of fabrics and their particular mechanical properties	144
4.2.3	Asymmetrical behaviour of fabrics	149
4.3	Studying the causes of asymmetrical behaviour of the fabrics built in the garment	155
4.4	Conclusion	157
4.5	References	159

Part II 3D MODELLING OF HUMAN BODY AND CLOTHING SIMULATION	161
5 REG-TRADE DEVELOPMENTS	163
5.1 Introduction	163
5.2 Results of projects and developments	166
5.2.1 Developments of Miralab	166
5.2.2 Project e-Tailor	172
5.2.3 Project Leapfrog	174
5.2.4 Project CAESAR	175
5.2.5 Developments of (TC) ²	176
5.2.6 Results of HKUST	178
5.3 Reference	188
6 MEASURING AND MODELLING OF HUMAN BODY BY SYLVIE 3D SYSTEM	191
6.1 Introduction	191
6.2 Sylvie 3D parametric modeler of human body	192
6.3 Measurement with photographs in the Sylvie 3D system	207
6.4 Measurement with the Sylvie 3D scanner	214
6.5 References	227
7 3D CLOTHING DESIGN BY SYLVIE SYSTEM	229
7.1 Introduction	229
7.2 3D design of clothes	230
7.3 Applications	244
7.4 Conclusions	247
7.5 References	247
<i>Index</i>	249

AUTHORS' CONTACT DETAILS

Univ.-Prof. Dr. sc. Jelka GERŠAK
University of Maribor
Faculty of Mechanical Engineering
Department of Textile Materials and
Design
Smetanova ulica 17
SI-2000 Maribor
Slovenia
Email: Jelka.Gersak@um.si

Assoc. Prof. Ph.D. Marianna HALÁSZ
Budapest University of Technology and
Economic
Faculty of Mechanical Engineering
Department of Polymer Engineering
Műegyetem rkp. 3
H-1111 Budapest
Hungary
Email: halaszm@pt.bme.hu

Assoc. Prof. Ph.D. Péter TAMÁS
Budapest University of Technology and
Economic
Faculty of Mechanical Engineering
Department of Mechatronics, Optics and
Information Engineering
Műegyetem rkp. 3
H-1111 Budapest
Hungary
Email: tamas@inflab.bme.hu

Assoc. Prof. Ph.D. Livia KOKAS PALICSKA
Óbuda University
Sándor Rejtő Faculty of Light Industry
and Environmental Protection
Engineering
Institute of Product Design
Doberdó út 6
H-1034 Budapest
Hungary
Email: kokas.livia@rkk.uni-obuda.hu

PREFACE

Textile materials differ in numerous aspects from conventional engineering materials. They are inhomogeneous, discontinuous, highly anisotropic, and deformable. They can suffer large deformations and displacements within a plane at low stress under ordinary conditions and/or during normal use.

In view of the specific behaviour of textile materials and growing requirements regarding the engineering planning of textile materials' quality parameters, investigations into textile structures' complex deformations and the relationships amongst the non-linear mechanical properties and material behaviour at low stresses gain in importance. Understanding and knowing about the non-linear mechanical properties of textile fabrics and their behaviour under low stress has become a starting-point for the engineering planning of fabrics and products made from them, quality control, product development, process and product optimisation and, last but not least, for computer-aided design, construction, and the numerical modelling and simulation of garments and other products for technical applications.

The following seven chapters provide an overview of complex fabric deformations and the 3D modelling of clothing. These contents that summarise the 10 year inter-university research work of four researchers from three Universities, i.e. University of Maribor (SI), Budapest University of Technology and Economics (HU) and Óbuda University (HU), are subdivided into two thematically-connected parts. Part I addresses the basic issues in the complex deformations of a textile structure. The first chapter provides a study of the complex deformations of a textile structure in view of the two- and three dimensional drape and outline of draping as an aesthetic performance of

clothing appearance. The measuring and simulation of drape performance and fabric drape behaviour as the functions of some influential parameters are given in the two following chapters. The asymmetrical behaviour of complex textile structures is described in the fourth chapter.

Part II places emphasis on the 3D modelling of the human body and clothing simulation. Chapter five gives an overview of the reg-trade development, resp. of those techniques used by computer-aided design systems in view of the spatial design, modelling, and virtual garment fitting. Chapter six reports on the measuring and modelling of the human body, where the Sylvie 3D system is used in modelling. Chapter seven reports on 3D clothing design using the Sylvie system and application of the Sylvie 3D system throughout the clothing industry.

The monograph is intended for a wide spectrum of readers, including students, researchers and academics, as well as professionals in the field of clothing design, engineering and other aspects of modelling and virtual garment fitting.

I would like to take this opportunity to thank all co-authors for their valuable time devoted to writing the chapters for this monograph.

Jelka Geršak

Part I

*C*OMPLEX DEFORMATIONS OF TEXTILE STRUCTURE

- 1 STUDY OF THE COMPLEX DEFORMATIONS OF TEXTILE STRUCTURE**
J. GERŠAK, University of Maribor, SI
- 2 MEASURING AND SIMULATION OF DRAPING PERFORMANCE**
P. TAMÁS and M. HALÁSZ, Budapest University of Technology and Economics, HU and L. KOKAS PALICSKA, Óbuda University, HU
- 3 FABRIC DRAPE BEHAVOIR AS FUNCTION OF SOME INFLUENTIAL PARAMETERS**
M. HALÁSZ, Budapest University of Technology and Economics, HU and L. KOKAS PALICSKA, Óbuda University, HU
- 4 ASYMMETRICAL BEHAVIOUR OF COMPLEX TEXTILE STRUCTURES**
J. GERŠAK, University of Maribor, SI