

University of Groningen

Theory and history of geometric models

Polo-Blanco, Irene

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version

Publisher's PDF, also known as Version of record

Publication date:

2007

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Polo-Blanco, I. (2007). *Theory and history of geometric models*. [s.n.].

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

RIJKSUNIVERSITEIT GRONINGEN

Theory and History of Geometric Models

Proefschrift

ter verkrijging van het doctoraat in de
Wiskunde en Natuurwetenschappen
aan de Rijksuniversiteit Groningen
op gezag van de
Rector Magnificus, dr. F. Zwarts,
in het openbaar te verdedigen op
vrijdag 4 mei 2007
om 14:45 uur

door

Irene Polo-Blanco

geboren op 5 april 1977
te Vitoria, Spanje

Promotores:

Prof. dr. M. van der Put

Prof. dr. J. Top

Prof. dr. J.A. van Maanen

Beoordelingscommissie:

Prof. dr. K. Volkert

Prof. dr. D. van Straten

Prof. dr. F. Beukers

ISBN: 978-90-78927-01-3

NUR 910

Cover: illustration of the plaster model of the Clebsch diagonal surface,
by the sculptor Cayetano Ramírez López.

Published by Academic Press Europe, Groningen

www.academicpresseurope.com

To Pablo

Contents

Introduction	ix
1 Models of surfaces, a Dutch perspective	1
1.1 Introduction	1
1.2 Mathematical models in Germany	1
1.2.1 Brill and Schilling	2
1.2.2 Felix Klein, use and popularization of models.	4
1.2.3 Design and building of the models	4
1.3 Models in The Netherlands	5
1.3.1 An overview	5
1.3.2 The use of models in The Netherlands	7
1.4 Models in Groningen	8
1.4.1 Inventory	8
1.4.2 Restoration	11
1.4.3 History of the Groningen collection	12
1.4.4 The use of models in Groningen	15
1.5 Some series of models	18
1.5.1 Curves of degree 3 (Series XVII 2 a/b and XXV)	18
1.5.2 Ruled surfaces of degree 4 (Series XIII)	18
1.5.3 Cubic surfaces (Series VII)	19
1.5.4 The model of Clebsch diagonal surface	19
1.6 Conclusion	21
2 Smooth cubic surfaces	27
2.1 An introduction to smooth cubic surfaces	27
2.1.1 The 27 lines	28
2.1.2 Schläfli double six	30
2.1.3 The real case	31

2.1.4	Clebsch's result	31
2.1.5	Cubic surfaces as blow ups	32
2.2	Real cubic surfaces	34
2.2.1	Real lines and real tritangent planes	35
2.2.2	Examples	40
2.3	Algorithm for the blow down morphism	46
2.3.1	Examples: The Clebsch and the Fermat	52
2.4	Twists of surfaces over \mathbb{Q}	63
2.4.1	$H^1(\text{Gal}(\overline{\mathbb{Q}}/\mathbb{Q}), G)$	63
2.4.2	Explicit twists of surfaces	63
2.4.3	Twists of the Clebsch	64
2.4.4	Twists of the Fermat	75
3	Models of curves	87
3.1	Models of cubic curves over $\mathbb{P}^2(\mathbb{R})$	87
3.1.1	Results on cubic curves	89
3.1.2	Newton's classification of cubic curves	90
3.1.3	Möbius' classification	90
3.1.4	Twists of curves	98
3.2	Models of space curves	101
3.2.1	Wire models of space curves	101
3.2.2	String models of space curves	104
4	Ruled surfaces of degree 4	109
4.1	With two skew double lines	110
4.1.1	The limit case	121
4.2	With a double line and a double conic	122
4.3	With a double space curve of degree 3	124
4.4	With a triple line	125
5	A. Boole Stott and 4-D polytopes	131
5.1	Introduction	131
5.2	Boole Stott's life	132
5.2.1	Gems from the basement	132
5.2.2	The beginnings of four-dimensional geometry	133
5.2.3	Polytopes and modelling	134
5.2.4	A special education	134
5.2.5	Boole Stott's models of polytopes	137

CONTENTS

vii

5.2.6	Boole Stott and the Netherlands	138
5.2.7	An honorary doctorate	141
5.2.8	Boole Stott and Coxeter	142
5.3	Boole Stott's mathematics	143
5.3.1	1900 paper on sections of four-dimensional polytopes .	144
5.3.2	1910 paper on semi-regular polytopes	152
5.4	Conclusion	159
	Resumen	167
	Samenvatting	171
	Acknowledgements	175

