## PROTOTYPING

## MODELMAKING FOR PRODUCT DESIGNL



**BJARKI HALLGRIMSSON** 

# PROTOTYPING AND MODELMAKING FOR PRODUCT DESIGN

Second Edition

TRUNG TÂM THÔNG TIN THƯ VIỆN

07 07

• • 04703



Published by Laurence King Publishing Ltd 361–373 City Road London EC1V 1LR Tel: +44 20 7841 6900 email: enquiries@laurenceking.com www.laurenceking.com

First published in 2012. This edition published in 2020.

Design © 2019 Laurence King Publishing Ltd
Text © 2012 and 2019 Bjarki Hallgrimsson
Bjarki Hallgrimsson has asserted his right under the Copyright, Designs, and Patent Act 1988, to be identified as the Author of this Work.

Brand names, company names, and illustrations for products and services included in this text are provided for educational purposes only and do not represent or imply endorsement or recommendation by the author or the publisher.

The reader is expressly advised to carefully read, understand, and apply all safety precautions and warnings described in this book or that might also be indicated in undertaking the activities and exercises described herein to minimize risk of personal injury or injury to others. Common sense and good judgment should also be exercised and applied to help avoid all potential hazards. The reader should always refer to the appropriate manufacturer's technical information, directions, and recommendations before operating machinery or undertaking other hazardous activities. While operating machinery or undertaking such activities, the reader should proceed with care and follow specific equipment operating instructions. The reader should understand that these notices and cautions are not exhaustive.

Neither the author nor the publisher make any warranty or representation whatsoever, either expressed or implied, including but not limited to equipment, procedures, and applications described or referred to herein, their quality, performance, merchantability, or fitness for a particular purpose. Neither the author nor the publisher assumes any responsibility for any changes, errors, or omissions in this book. Both the author and the publisher specifically disclaim any liability whatsoever, including any direct, indirect, incidental, consequential, special, or exemplary damages resulting, in whole or in part, from the reader's use or reliance upon the information, instructions, procedures, warnings, cautions, applications, or other matter contained in this book. Neither the author nor the publisher assumes any responsibility for the activities of the reader.

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording, or any information storage and retrieval system, without permission in writing from the publisher.

A catalog record for this book is available from the British Library.

ISBN 13: 978 1 78627 511 0

Commissioning editor: Sophie Drysdale Development editor: Sophie Wise Senior editor: Gaynor Sermon Design: Alexandre Coco

Printed in China

#### PROTOTYPING AND MODELMAKING FOR PRODUCT DESIGN

BJARKI HALLGRIMSSON

Second Edition

### CONTENTS

I١	NTRODUCTION	3 Prototyping Interactive
	Definition of Prototyping	Electronic Products
	and Modelmaking6	Input and Output46
	Prototyping is a Form of	Programming
	Problem Solving7	Prototyping Setup47
	Modelmaking7	CASE STUDY Kurio Interactive
	Physical and Digital Prototypes 7	Museum Guide48
	Building by Hand and Using Digital Technologies8	MODELMANTHO
	Organization of this Book9	MODELMAKING
	Organization of this book	4 Principles and Choices for Modelmaking
	COTOTVOTNO	Principles of Modelmaking51
-	ROTOTYPING	Choices to Consider 52
1	How Prototypes are Used	5 Health and Safety
	Exploration	Goal 53
	User Testing	Hazards53
	Communication14	Personal Protective Equipment 57
	Design Verification	Risk Assessment58
	Technical Performance Testing 17	
	Safety Standards Testing	6 Space and Setup
	Prototyping in Different	Space
	Fields of Design	Basic Setup
	From Start to Finish: Comprehensive	7 Workflow
	Case Studies18	Basic Modelmaking Workflow61
	CASE STUDY Duo Gaming Family	Reverse-Design Workflow
	of Products	CASE STUDY Scanning a
	CASE STUDY Lytro Camera 3.0 23	Clay Model Helmet
	CASE STUDY ECOtality Blink Range of Electric Vehicle Chargers 27	
	CASE STUDY Xoran Portable xCAT Scanner30	8 Analog Modelmaking Tools
		Basic Toolset70
	CASE STUDY Ecobee3	Handheld Power Tools72
2	Prototyping Approaches	Stationary Power Tools 72
	The Difference between	Machine Tools75
	Prototyping and Manufacturing 35	9 Additive Manufacturing: 3D Printing
	Material Substitution	Steps in the 3D Printing Process 78
	Iteration	
	Low Fidelity vs High Fidelity 36	Technologies and Classifications 78
	Workmanship and Level of Effort 37	Powder-based Technology81
	Looks-like and Works-like Prototypes. 37	Material Extrusion Printing83
	CASE STUDY Candela Luau	Vat Photopolymerization
	CASE STUDY Chair_ONE and Myto 41	Material Jetting89
	one of the one of the order of	CASE STUDY Customization90

10 Subtractive Digital Machining	18 Modeling Clay
CNC Machining92	Types of Clay
Laser Cutting96	CASE STUDY Olme Spyder 160
11 Adhesives and Fillers	Working with Styling Clay 161
Glues	TUTORIAL Clay Helmet
Tapes	19 Casting
Fillers 101	Applications for Casting 166
TUTORIAL Additive Modeling	Casting Process
with Adhesives and Fillers 104	Casting Materials
40 0	CASE STUDY Casting Comic Figures 170
12 Paper	CASE STUDY Elastomeric Wristband 171
Applications for Paper	CASE STODY ETASEOMETIC WITSEDANG 1/1
Cross-Sectional Models	20 Painting and Graphics
Working with Paper and Board 110	Color
TUTORIAL Bread Toaster112	Texture 175
13 Foamcore	Gloss, Matt, or Metallic 175
Working with Foamcore116	Types of Paint
TUTORIAL Train Ticket Kiosk 120	Preparation
14 Polystyrene Foam	Application
Applications for Polystyrene Foam 125	TUTORIAL 3D Printer Part 179
Working with Polystyrene Foam 126	Labels and Decals
TUTORIAL Children's Walkie-talkie 129	21 Soft Goods: Sewn Textile Projects
TOTOKIAL CHILDLEN'S WALKIE-LAIKIE 129	Working with Textiles
15 Polyurethane Modeling Foam	Patterns
Applications for Polyurethane Foam . 132	Textile Hardware
Working with PU Modeling Foam 133	CASE STUDY Biogarmentry
TUTORIAL Game Controller 136	CASE STUDY OSAT Filament Printing 196
16 Thermoplastic Sheet and Extruded Shapes	CASE STODY COAT FITAMENT FITHEING 190
Working with Plastics	
Gluing Plastics143	
CASE STUDY Adaptive Ski System 146	
TUTORIAL Barbecue Utensil 148	
17 Wood	Glossary 199
CASE STUDY Leaning Clothes	Resources
Rack in Wiggle Board	Index
Applications for Wood	Picture Credits
Working with Wood	Acknowledgments

#### IMPORTANT NOTICE ON SAFETY

Chapter 5 of this book covers good health and safety practice, and a further series of safety checks have been included at the beginnings of Chapters 6 to 21 which cover tools, materials, and processes. Chapters 8, 9 and 10 feature an overview of typical modelmaking tools and machines, but these chapters do not provide specific instruction on tool operation, as it is beyond the scope of this book. The methods, processes, case studies, and tutorials in this book are general in nature and should never be attempted without proper consultation, training, and supervision from a professional shop technician. Although Laurence King Publishing and the author have taken steps to ensure the safety information provided is accurate and up-to-date at the time of writing, this information is not exhaustive, and they cannot assume responsibility for any improper use, changes, errors, or omissions. The reader should be aware that he or she is responsible for his or her own safety and, potentially, that of any nearby individuals when undertaking the types of activities described herein and should govern himself or herself accordingly.