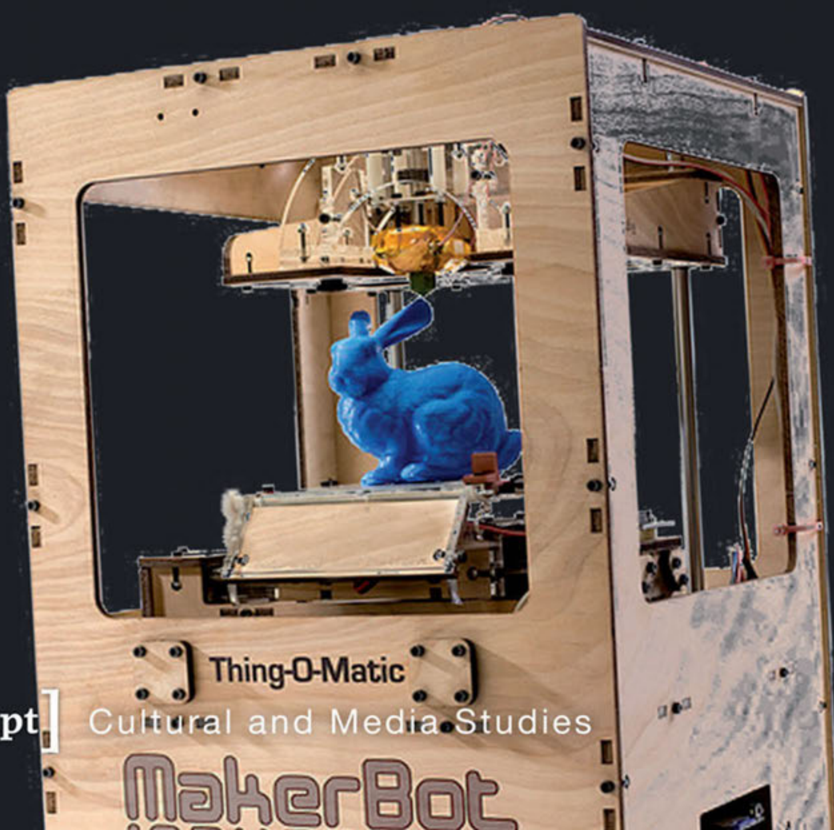
JULIA WALTER-HERRMANN,
CORINNE BÜCHING (EDS.)

# FabLab

## OF MACHINES, MAKERS AND INVENTORS




[transcript] Cultural and Media Studies

Julia Walter-Herrmann, Corinne Büching (eds.)
FabLab

**Cultural and Media Studies**

Julia Walter-Herrmann, Corinne Büching (eds.)

# FabLab

## Of Machines, Makers and Inventors

[transcript]

This book arose at the University of Bremen in the working group »Digital Media in Education«, supported by the »VW-Foundation«, Hannover, GER.

**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

**© 2013 transcript Verlag, Bielefeld**

All rights reserved. No part of this book may be reprinted or reproduced or utilized in any form or by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying and recording, or in any information storage or retrieval system, without permission in writing from the publisher.

The cover design by Kordula Röckenhaus (Bielefeld) is based on a photography of the ›Makerbot Thing-O-Matic‹ by Makerbot Industries (www.makerbot.com), source: www.flickr.com. This file is licensed under the Creative Commons Attribution 2.0 Generic license (http://creativecommons.org/licences/by/2.0/deed.en).
Composition and editorial by Julia Walter-Herrmann and Corinne Büching
Printed by Majuskel Medienproduktion GmbH, Wetzlar
ISBN 978-3-8376-2382-6

# TABLE OF CONTENTS


## Introduction

**Notes on FabLabs**
Julia Walter-Herrmann & Corinne Büching | 9

## The Movement

**Notes on the Movement**
Karsten Joost | 27

**FabLabs – A Global Social Movement?**
Julia Walter-Herrmann | 33

**Homo Fabber and the Law**
Lambert Grosskopf | 47

**Gendered FabLabs?**
Tanja Carstensen | 53

**Fabricating Environments for Children**
Irene Posch | 65

## Materiality and Virtuality

**Notes on Materiality and Virtuality**
Bruce Sterling | 77

**Considering Algorithmics and Aesthetics**
Frieder Nake | 79

**Digital Realities, Physical Action and Deep Learning – FabLabs as Educational Environments?**
Heidi Schelhowe | 93

**A Universe of Objects**
Corinne Büching | 105

## Maker Culture

**Notes on Maker Culture**
Eva-Sophie Katterfeldt, Anja Zeising & Michael Lund | 123

**The History of Production with Computers**
Bernard Robben | 127

**Maker Culture, Digital Tools and Exploration Support for FabLabs**
Eva-Sophie Katterfeldt | 139

**Thoughts from the Road of a FabLab Nomad**
Jens Dyvik | 149

## Technology and Infrastructure

**Notes on Technology and Infrastructure**
Bre Pettis | 159

**Machines for Personal Fabrication**
René Bohne | 163

**Digital Fabrication in Educational Contexts –
Ideas for a Constructionist Workshop Setting**
Nadine Dittert & Dennis Krannich | 173

**Making the Third Industrial Revolution – The Struggle for Polycentric Structures
and a New Peer-Production Commons in the FabLab Community**
Peter Troxler | 181

## Community and Environment

**Notes on Community and Environment**
Bart Bakker | 199

**Digital Fabrication and 'Making' in Education – The Democratization of Invention**
Paulo Blikstein | 203

**Urban Development with FabLabs**
Axel Sylvester & Tanja Döring | 223

**Small Ideas, Big Opportunities – FabLab at Vigyan Ashram Pabal, India**
Yogesh Ramesh Kulkarni | 231

**Affordable Medical Prostheses Created in FabLabs**
Alex Schaub | 239

## Epilogue

**FabLabs: Thoughts and Remembrances**
Sherry Lassiter | 249

**List of Authors** | 259

# NOTES ON FABLABS

JULIA WALTER-HERRMANN, CORINNE BÜCHING

Figure 1: Laser-cut and 3D printed objects by Oliver Niewiadomski at fab*digitalgardens in Bremen, Germany (Source: Photography by Justus Holzberger).

*Koothrappali, PhD*: You know, there is a way we can
get action figures to look exactly like us.
*Wolowitz*: Oh yeah? How's that?
*Koothrappali, PhD*: Two words: 3D printer! [...] they are an engineer's dream.
Anything you can design a 3D printer can make out of plastic [...]
*Wolowitz*: And we can make stuff we need for work with it:
prototypes of my CAD/CAM designs, specialized tools ...
*Koothrappali, PhD*: Not to mention 'Malibu Koothrappali'
in his totally bitchin' dream house.[1]
*Big Bang Theory*

"The digital culture's dynamics have led to a general acknowledgment of data production as the most important future option. However, the production of things seems to be outdated: Factories are not sexy!" (Boeing 2010, own translation) At the same time, there are developments and hints suggesting the digital future "lies outside the box, in making the box" (Gershenfeld 2005, p. 17). One will not be limited to making boxes, though. Since new technologies and machines enable people to easily produce chess pieces, jewelry, computers, batteries, teeth, yet action figures that look exactly like oneself (like proclaimed in the TV series Big Bang Theory) and all the other things one can imagine. The concept of turning ideas into things is probably as old as mankind. For a long time, one has been able to read and hear about enchanted lamps, mysterious stones and unknown cases that can make wishes come true and turn words into real objects. This fantasy has persisted over decades. In the 1980s, Star-Trek's spaceship Enterprise had a 'replicator' on board, a machine that could create any inanimate matter on demand.

In the present digital culture, digital data can transform into material objects and the formerly fictional idea of such a 'magic machine' has been turned into reality, namely by the further dissemination of small, digitally controlled production machines in FabLabs, so-called "labs for fabrication" (Gershenfeld 2005, p. 12), that are accessible for a broad public. These machines "are the pint-sized, low-cost descendants of factory-scale, mass manufacturing machines" (Lipson & Kurman 2010), for example 3D printers, laser cutters or CNC machines that produce objects on the basis of rapid prototyping, tooling and manufacturing (Chua et al. 2010, p. 18 et sqq.). Such production machines are able to print, cut or mill objects from data files without any human intervention.

Taking a look at the history and development of both fabrication devices and personal computers, one can imagine that digital fabrication devices will be accessible and used in everyday live in the near future. The first mainframe computers were huge, slow and expensive. To operate them, one needed to be an expert and nearly no one saw a general market for them. Computer pioneer Howard Aiken, a Harvard mathematician and creator of the Mark I calculator, even spoke of a demand of computers in total numbers of only five or six for all of the

1 | Taken from a dialogue between the characters of Rajesh Ramayan 'Raj' Koothrappali, PhD and Howard Joel Wolowitz from the CBS TV series Big Bang Theory, season 6, episode 14, first aired (USA), January 31st 2013.

USA (Ceruzzi 2003, p. 13). The story of digital manufacturing machines can be told likewise: Only twenty years ago, such hardware was huge, slow, expensive. To operate it, one needed to be an expert and nearly no one saw a general market for them. Back then, such machines were already in use in industrial manufacturing, but no one could ever imagine these machines getting established in private households or open accessible workshops. For a long time, people thought digital fabrication devices were only useful for the niche-economy of prototyping. Today such machines (some cost even less than $1000) can be found in every FabLab and even in some private households – and much more than just prototyping is done with them. At present, especially 3D printers, an essential part of every FabLab, increasingly get the media's and hence the public's attention. "A 3D printer is a computer peripheral[2] like any other, but instead of putting ink on paper, or data on a disk, it puts materials together to make objects" (Gershenfeld 1999, p. 65). The popularity of 3D printers can be explained as follows. On the one hand, 3D printers make it remarkably clear how an idea (or at least the virtual, digitally designed representation of an idea) can become a material object. On the other hand – particularly since there are affordable, easy-to-use, ready-made printers available in the market – this 'magic' now seems to be accessible for nearly everyone.

But FabLabs are neither chambers of magic nor mere accumulations of 3D printers and other fabrication devices. FabLabs are places where digital culture and material production merge and enter a new stage: There, one can find "collection[s] of commercially available machines and parts lined by software and processes […] developed for making things" (Gershenfeld 2005, p. 12). These machines are based on digital technologies and operated with computers. Usually, a number of 'conventional' tools, like hammers, saws, and screwdrivers, materials, like plywood, glue, and cardboard, and small electronics, like micro controllers, LEDs, and little motors, are added to the collection of machines in these workshops. In these facilities, people can create material objects that can be beautiful or practical, complex or simple, 'intelligent' or not. FabLabs are open for interested individuals, such as artists, hobbyists and students, but also for entrepreneurs who want to "move more quickly from an idea or concept to a physical object or prototype, or […] want to experiment with and enhance their practical knowledge of electronics, CADCAM[3], design, 21st century DIY" (Eychenne 2012, p. 5). The software used in FabLabs is usually available under Open Source (or comparable) licenses and therefore adaptable and developable (Delio 2004). Furthermore, a credo amongst "Fabbers" (Neef, Burmeister & Krempl 2005) advocates sharing the developed ideas among FabLabs and fabbers (Fab Charter 2012), mainly in the form of CAD files that are the prerequisites for the production of material objects. In doing so, a wide network of FabLabs around the globe, fabbers and files on various Internet platforms has already been established (Center for Bits and Atoms 2012). In this

2 | According to Eisenberg the commonly used expression 'peripheral' is not a well-chosen term for the promotion of such machines. He says, peripheral brings forth the idea of 3D printers and other manufacturing machines as being something unimportant, especially in comparison to 'the center of attraction' the computer itself (Eisenberg 2008, p. 62; explanatory note by the editors).

3 | CAD is an abbreviation for Computer Aided Design, whereas CAM is a common abbreviation for Computer Aided Manufacturing.

sense, FabLabs are globally connected, open workshops, where people can meet, collaborate, interact and exchange ideas, machines, tools, materials and software with the common purpose of making distinctive and digitally designed objects (from scratch) in an easy accessible and cheap way.

Neil Gershenfeld, physicist at the Massachusetts Institute of Technology's (MIT) Center for Bits and Atoms (CBA), USA, invented the concept of assembling modest production machines in small workshops for enabling everyone to make "almost anything" (Gershenfeld 2005, p. ix). The scientist installed the first FabLab in 2002[4] near his home university at the South End Technology Center in Boston, being supported by the National Science Foundation of the USA (Gershenfeld 2005, p. 25; Nunez 2010, p. 23). In 1998, Gershenfeld first offered a university course with the title How to Make (Almost) Anything, based on the use of professional production machines. "The workshops were designed for advanced Physical Sciences students in the throes of their research and promised to provide much needed experience on the kinds of high-tech fabrication tools" (Turner 2010, p. 29). When eventually, more than a hundred students signed up for the class, of which only a few had a background or at least any knowledge in 'cutting-edge' Physics and fabrication technologies, Gershenfeld started to wonder what all the architects and artists were doing in his class that had been planned for only ten students. The course instructor was even more surprised that the students' motivation to take the class was rather personal than scientific. The students wished to create "things they'd always wanted, but that didn't exist" (Gershenfeld 2005, p. 6), like missing or broken pieces of alarm clocks or 'artistic extravaganzas'. Surprisingly, all students managed to complete the course, dealing with the design, the use of computer-controlled machines and even the compulsory circuit building. They accomplished the course by spreading and exchanging knowledge within the huge and heterogeneous group. "The learning process was driven by the demand for, rather than the supply of, knowledge" (Gershenfeld 2005, p. 7), clarifies Gershenfeld. When the same scenario re-appeared year after year in his 'maker class', he realized the potential of a get-together of high-tech production machines with heterogeneous audiences and further developed the idea of establishing a permanent FabLab outside MIT, providing opportunities for tinkering, learning and creating for everyone. That was the moment FabLabs were born (Gershenfeld 2005, pp. 4-12)[5].

4 | Different authors name various origins and commencing dates of FabLabs, mostly depending on the discourses and movements they relate themselves to, such as hacker- or Open Hardware movements. All authors of this book refer to the labs that arouse in the outreach of MIT's CBA.

5 | Meanwhile, the course How To Make (almost) Anything is available online at the CBA's website, last viewed 15 January 2013 <http://fab.cba.mit.edu/classes/MIT/863.08/>, so that everybody who is interested can take Gershenfeld's class independent of being an MIT student. The web seminar is also an essential part of many FabLabs around the world, where the lessons are streamed via Internet on a weekly basis. The How To Make (Almost) Anything course offers instructions for students and interested people about digital fabrication and the use of high-tech manufacturing tools. The seminar is part of the Fab Academy, an online outreach program of the CBA that can be visited here, last viewed 15 January 2013 < http://www.fabacademy.org/>.

From the outset, Gershenfeld's fundamental idea was not only "to make (almost) anything" (Gershenfeld 2005, p. ix), but to make fabrication technologies accessible for 'almost anybody' and hence empower people to "start their own technological futures" (Gershenfeld 2005, p. 17). He states that we "had a digital revolution, but we don't need to keep having it. Personal fabrication will bring the programmability of the digital worlds we've intended to the physical world we inhabit" (Gershenfeld 2005, p. 17). The scientist compares the development of FabLabs with the rise of the Web 2.0, when tools and applications for composing, editing and sharing digital content online became increasingly available for everyone, turning users into prosumers. In FabLabs, the possibilities of digital fabrication become further accessible and prosumers can compose, edit and share (designs for) material artifacts (Gershenfeld 2006). These potentials are exponentiated by the idea of a FabLab as an early version of a "Personal Fabricator" (Neef, Burmeister & Krempl 2005, p. 20; Gershenfeld 1999, p. 64 et sqq.), a digital production machine at home. Such an expansion could have an enormous impact on the value of things, communal life, or even whole economies. By all means, Gershenfeld understands FabLabs and related technical progresses rather as a "concept for development" (Boeing 2010; own translation) than simply as high-tech production laboratories. FabLabs shall stand for a concept of reducing the uneven distribution between the few producers and the many consumers or at least herald a future that links itself to a pre-industrialized past: "Such a future really represents a return to our industrial roots, before art was separated from artisans, when production was done for individuals rather than the masses" (Gershenfeld 2005, p. 8). The idea of an individualization and democratization of (the means of) production caused the establishment of further FabLabs in India in 2002 and in Ghana in 2004 (Delio 2004), where people should be supported in producing things of personal need and desire and therefore reduce economic dependencies and develop a 'subsistent freedom'. A 'doing good factor' doubtlessly is an essential part of the approximately 120 FabLabs on five continents (Center for Bits and Atoms 2012).

Right from the start, all FabLabs have been operated based on the same basic principles "to empower, to educate, and to create 'almost anything'" (Nunez 2010, p. 24; his emphasis). This belief was already put on record by the CBA in the Fab Charter, sort of the FabLabs' 'constitution'. The Fab Charter furthermore sheds light on additional FabLab relevant aspects, such as open access to labs and machines for everyone, responsibility for own actions, machines and environment, free knowledge dissemination, the protection of intellectual property rights and the sustainability of FabLab activities (Fab Charter 2012). Since the establishment of the first FabLab, field practitioners and laboratory researchers gather regularly for various meetings. The International Fab Lab Forum and Symposium on Digital Fabrication takes place at different FabLabs around the globe each year (Center for Bits and Atoms 2012). These conferences are strongly supported by the International Fab Lab Association that was officially established in 2011. The Fab Lab Association is an association of around 200 active and dedicated FabLab members that aim at serving the FabLab community by sharing their experience working with digital fabrication and organize the widespread FabLabs and individuals (International Fab Lab Association 2012).

At present various authors enthusiastically declare the world to be in a phase of transition. "The New Industrial Revolution" (Anderson 2012) and the end of mass production are proclaimed likewise. Such predictions mainly draw on the increasing availability of new ways and machines for production, similar to those in FabLabs. MIT's Technology Review even set up a blog section about the topic, where the "Next Wave of Manufacturing" (Technology Review 2013) and a "manufacturing renaissance" (Technology Review 2013) were announced, thus the blog critically advices companies to "invent the manufacturing technology of tomorrow" (Technology Review 2013). However, the impacts of FabLabs spread into many different social fields, not only into the techno-economic sphere. In times of a digital culture and increasing individualization within changing societies, FabLabs are important places for corporate learning, working and playing with advanced technologies. Being a global movement and part of a rising maker culture, FabLabs are central for an understanding of the present (and future) world. The democratization of production comes along with a 'democratization of innovation' by various potential actors. That means that, in FabLabs, everybody can invent, create and modify things and everybody can become an artist. With relatively low constraints, people can design objects that are not only unique, but meet high design standards, too. Such an approach transforms the fields of arts and crafts, as FabLabs further promote an understanding of modern crafting, making, or DIY as a response to mass culture. Despite the potential of democratization of innovation through FabLabs, a frequently referenced concern focuses on the diversity of potential actors[6]. It should be taken into account that not only academic urban males in their late twenties participate in the FabLab culture. FabLabs may create initiatives to invite economically and socially disadvantaged people to FabLabs, e.g., by organizing special workshops for marginalized people. Another relevant aspect of FabLabs stresses their potential for learning that was already put down in the Fab Charter. In order to establish a creative culture of making instead of copying, FabLab-based activities may also be included in school curricula for problem-based learning, creative hands-on activities and developing skills for documenting and communicating ideas and problems efficiently.

But even if the praises and promises for FabLabs are high at the moment, new techniques and technologies never appear without contempt, criticism and fear. Aspects such as copyright – which have mainly affected music and filmmakers until now – will affect the manufacturing sector, too. In a world where one can remotely print the same objects virtually everywhere, this will not only develop international collaboration, but also challenge limitations of national legislation. The advantage that one can print his/her own spare parts to replace the broken original parts will bring about issues such as security, liability and warranty. The cases of printable weapons and digitally manufactured food incite discussions about the power of technology and user ethics. Meanwhile, many FabLab practitioners and activists are concerned with establishing business models for their FabLabs and improving the organizational structures supporting a global community.

6 | Various speakers at the conference FabLearn – Transformative Learning Technologies Lab, 2012, in Palo Alto, Cal., USA, raised these concerns. For more information see the website, last viewed 25 December 2012 <http://tltl.stanford.edu/fablearn2012>.