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Innovation and  
Industrial Management



# The role of Maker Movement elements in startup's product development

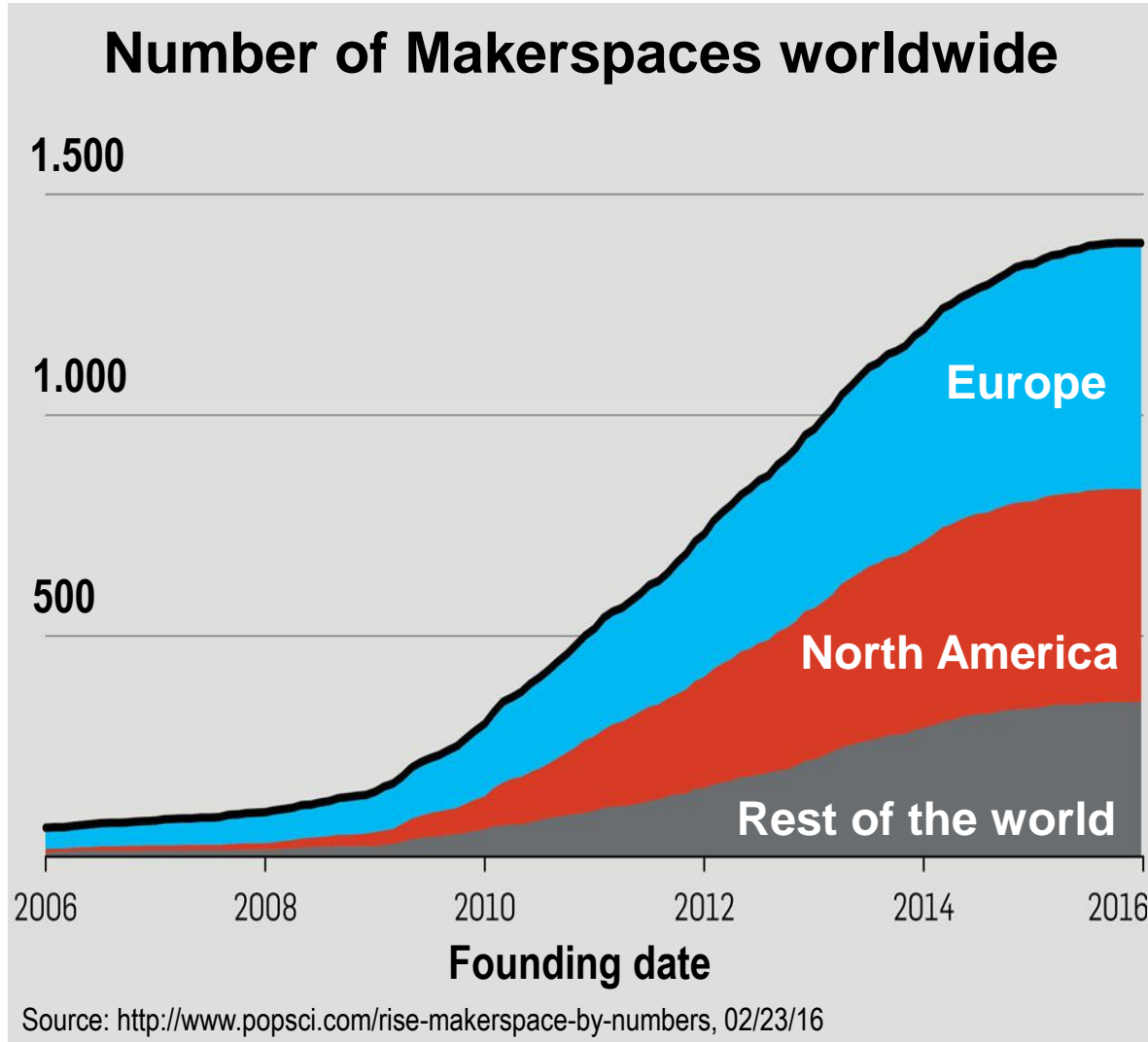
A match between the needs of hardware startups and the offered Maker Movement elements

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Head of the department Prof. Dr. Christian Ramsauer

# The rise of Maker Movement

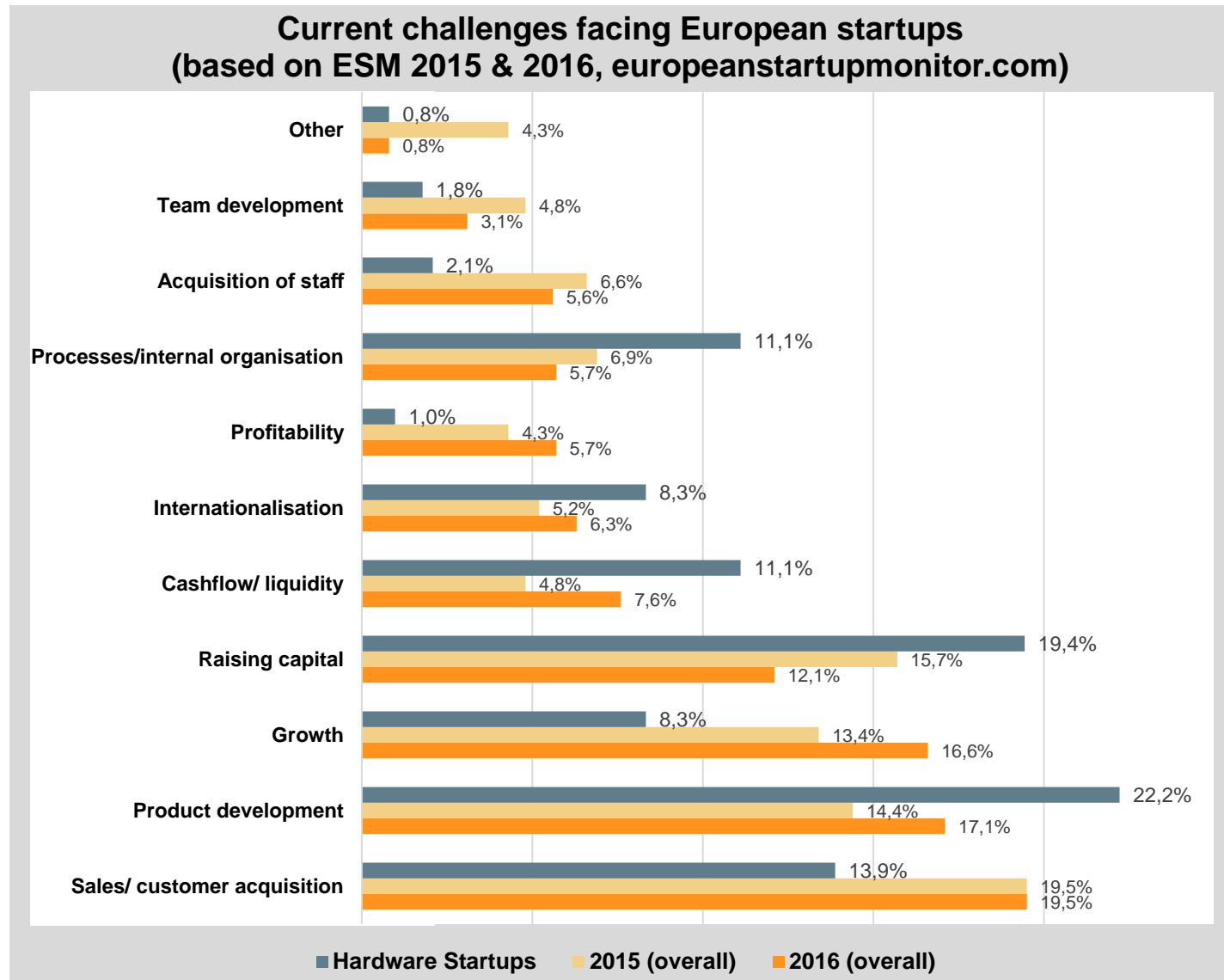
Maker Movement is a catalyst for innovation and entrepreneurship



- The **Maker Movement enables every individual to invent and build hardware products themselves** by having easy access to capabilities for designing, manufacturing, distributing and knowledge. (Neil Gershenfeld, MIT, 2012)
- Today, many of **these capabilities are hosted in Makerspaces**. These are the places where the next great hardware products will occur. (Brian Krzanich, CEO of Intel, 2014)
- A single makerspace (TechShop) in the Bay Area catalyzed \$10B in shareholder value, \$2B in annual sales, \$200M in annual salaries.... created by members who have **come in and picked up the skills that they needed to start a business**. (Mark Hatch, CEO Techshop, Jan 2015)

# Needs of startups

... they are facing difficulties in e.g. product development



- A startup is a **temporary organization** used to **search for a repeatable and scalable business model.** (Steven Blank; Stanford University, University of California Berkeley)
- **Hardware startups** with sensors, microcontrollers and similar will bridge the analogue and the digital worlds. (The Economist, Jan 2014)
- Studies so far focus on software startups, further research will be needed to assess new programs emerging to serve biotech and **hardware startups...** (Science Magazine, Issue 6240; Jun 2015)
- Startups like the **Pebble smartwatch** and the **Nest thermostat** are proof positive that the next **great hardware products won't necessarily be born within the walls of large, traditional corporations, but in makerspaces.** (Techcrunch.com, Aug 2015)



(Jobs and Wozniak, 1971, <http://i.dailymail.co.uk/>)



(UnternehmerTUM Makerspace, 2016, <http://makerspace.de/>)

# The cross influence of **Maker Movement elements** and **product development especially in hardware startups** has not yet been scientifically investigated

## Research questions

1. **What is a hardware startup and what are the main challenges of them?**
2. **Which Maker Movement elements do exist?**
3. **Why do startups choose to realize their product in a Maker Movement infrastructure?**
4. **Which Maker Movement elements support product development of European startups?**
  - resulting in higher success rate, reduced product costs, shortened product development time, increased product quality, ...
5. **How should an ideal set of Maker Movement elements for hardware startups look like?**

## Hypotheses

**The use of proper set of Maker Movement elements solve the critical issues in product development of European hardware startups.**

**"The Maker Movement is now at that point in time to go from hobbyists to professionals ..."**

– David Li, Maker Movement in China 2017

**"And the good news is, is that new tools and technologies are making the building of things easier than ever..."**

– President Obama at the White House Maker Faire 2014

# Expected output: Maker Movement ecosystem configurator

A design tool for makerspaces to support hardware startups

## 1 Input – focus area makerspace design

▶ Which category of startups should be supported best?

▶ In which stage of development should startup be supported?

- **Seed Stage** (concept development, no revenues yet)
- **Startup Stage** (completion of a marketable product (MVP); initial revenues and/or users)
- **Growth Stage** (strong sales growth and/or user growth)
- **Later Stage** (established market player/trade-sale or IPO is planned or imminent)
- **Steady Stage** (the startup does not have, intentionally or unintentionally, any substantial growth)

▶ ...

- High amount of makerspaces was created in the past but no **clear picture what is really needed to foster entrepreneurship/ startups is available**
- Current makerspaces are struggling because of **low utilization/ mismatch of their offerings to the ecosystem**

## 2

data based configuration

	Product costs	development time	Quality of product	Startup network	...
Meet likeminded and inspiration (MakerFair, CES)	2,41	1,98	2,30	2,09	2,19
Experts' table on xyz (Meetup)	2,78	1,20	2,08	2,41	2,12
Crowd based building instructions (Hackster.io, instructables)	2,59	1,09	2,23	1,97	1,97
Workshop on xyz (3D printing, laser cutting, ...)	2,65	1,42	2,26	2,02	2,09
Collection of articles to generate knowhow (Fictiv Hardware Blog, MAKE magazine, maker.blog, Open IDEO,...)	2,57	1,35	1,67	2,12	1,93
Database of maker resources - from workspaces to factories - maker.map (Maker's Row)	2,37	1,50	1,91	1,87	1,91
Community (PCB) order platform (OSH Park)	2,04	1,92	1,59	2,28	1,96
Open-source hardware (Arduino,...)	2,98	1,23	1,59	1,80	1,90
Access to FabLab machines (3D printer, laser cutter)	2,88	1,39	2,32	2,23	2,21
Access to woodshop (CNC router, saw, sander,... for wood)	2,59	1,81	1,58	2,45	2,11
Access to metal shop (CNC router, welding, lathe, jet water cutter,... for metal)	2,15	1,55	1,89	2,56	2,04
Access to electronics workshop (Circuit board production tools, soldering iron, testing equipment,...)	1,99	1,27	2,35	2,25	1,97
Access to craft machines (sewing machine,...)	1,48	1,18	2,08	1,86	1,65
Rent a micro factory (FirstBuild)	1,91	1,61	2,41	2,32	2,06
Free and easy 3D CAD software (SketchUp, Autodesk 123D)	1,36	1,37	2,01	2,49	1,81
Free and easy PCB software (Upverter, KICAD, Curitlab)	1,59	1,15	1,84	2,65	1,81
Open CAD files repository (GrabCAD, Thingiverse)	1,76	1,08	1,52	2,28	1,66

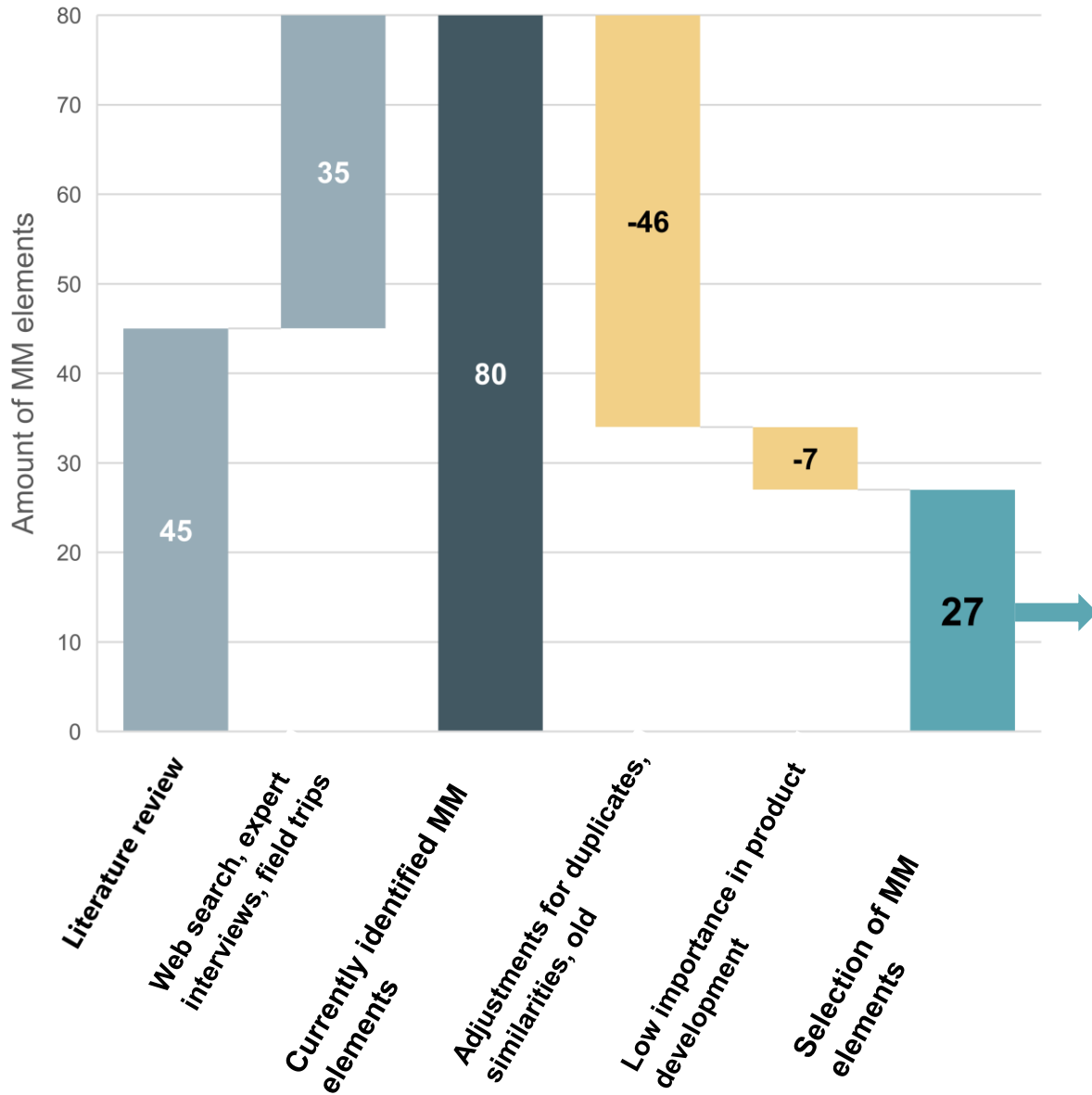
## 3

Output – recommended action and focus area

	Needed room m <sup>2</sup>	Running costs	Scalability	...
Meet likeminded and inspiration (MakerFair, CES)	0	€	yes	
Experts' table on xyz (Meetup)	30	€€	yes	
Crowd based building instructions (Hackster.io, instructables)	0	€	yes	
Workshop on xyz (3D printing, laser cutting, ...)	30	€€	no	
Collection of articles to generate knowhow (Fictiv Hardware Blog, MAKE magazine, maker.blog, Open IDEO,...)	0	€	yes	
Database of maker resources - from workspaces to factories - maker.map (Maker's Row)	0	€	yes	
Community (PCB) order platform (OSH Park)	0	€	yes	
Open-source hardware (Arduino,...)	0	€	yes	
Access to FabLab machines (3D printer, laser cutter)	30	€	no	
Access to woodshop (CNC router, saw, sander,... for wood)	100	€€€	no	
Access to metal shop (CNC router, welding, lathe, jet water cutter,... for metal)	100	€€€	no	
Access to electronics workshop (Circuit board production tools, soldering iron, testing equipment,...)	20	€€€	no	
Access to craft machines (sewing machine,...)	40	€€	no	
Rent a micro factory (FirstBuild)	100	€€	no	
Free and easy 3D CAD software (SketchUp, Autodesk 123D)	0	€	yes	
Free and easy PCB software (Upverter, KICAD, Curitlab)	0	€	yes	
Open CAD files repository (GrabCAD, Thingiverse)	0	€	yes	

Focus area

# Next step: Catalog of Maker Movement (MM) elements



27 Maker Movement elements can be categorized in 9 groups

<p>Free design software</p>	<p>Open-source hardware &amp; software</p>	<p>Connect with likeminded (online/physical)</p>
<p>Knowledge sharing platforms</p>	<p>Inexpensive/rentable infrastructure</p>	<p>International Shipping &amp; vendors</p>
<p>Seed capital from crowdfunding sites</p>	<p>E-commerce &amp; customer feedback</p>	<p>Other</p>

# Research design is multiple-case study research method

...based on Robert Yin, 2009, Case Study Research

## Plan

1

### Literature Review (Desk Research)

- Product development of startups
- Maker Movement

2

### Preliminary study

- Field trip and expert discussions; 25 makerspaces have been visited worldwide
- **What is a hardware startups and what are the main challenges of these?**
- **Which Maker Movement elements exist?**

3

### Design & replication

- European hardware startups focusing on product development
- Multiple cases in European university based startup hotspots

4

## Embedded multiple-case studies

### Prepare guided interviews

Which Maker Movement elements support product development of European startups?

case 1..n

### Collect

Interviews, documents, archival data, direct observations

### Analyze evidence with cross-case synthesis

Generate word table (Maker Movement elements) for cross- case pattern

5

### Revise, discussion and conclusion

Bringing case studies results to closure

# The scientific world focuses mainly on education & learning sciences, **publication on entrepreneurship are limited**

## Selected own publications

- **Development of an educational program using capabilities of (academic) Makerspaces**, ISAM 2016, MIT Cambridge, USA
- **Academic teaching at digital fabrication laboratories in the field of mechanical engineering**, EDULEARN16, Barcelona, Spanien
- **Einfluss der Maker Movement auf die Forschung und Entwicklung, Industrial Engineering und Management**, 2016, Gabler Verlag
- **A Fablab as part of a new kind of business incubator for hardware startups**; 11th International Fab Lab Conference and Symposium, 2015, Cambridge, USA
- Litts, Breanne K. (2015): **Making Learning – Makerspaces as learning environment**, Dissertation, University of Wisconsin
- Wilczynski, Vincent (2015): **Academic maker spaces and engineering design**, Paper, Yale University
- Schön, Sandra; Ebner, Martin; Kumar, Swapna (2014): **The Maker Movement. Implications of new digital gadgets, fabrication tools and spaces for creative learning and teaching**, In-Depth, Journal Article
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- Anderson, C. (2012). **Makers: the New Industrial Revolution**. New York, Crown Business.
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- Thornton, P. H., D. Ribeiro-Soriano and D. Urbano (2011). "**Sociocultural Factors and Entrepreneurial Activity: an Overview**." International Small Business Journal 29(2): 105-118.
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# Maker Movement - Roots?

Dale Dougherty: "why don't you call it Make? Everyone likes to make things." He goes on: "So, I started using the word makerspaces, because I was interested in getting them into schools, and I didn't want to get into the semantics of hacking versus making."

