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3D Printing: **Then & Now**

1989 to 2019

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Major Developments in 3D Printing

1. From a Technology to an Industry
2. From Rapid Prototyping to Additive Manufacturing
3. From Marble-Sized to Football-Sized


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From a Technology to an Industry

Why People Turned to 3D Printing

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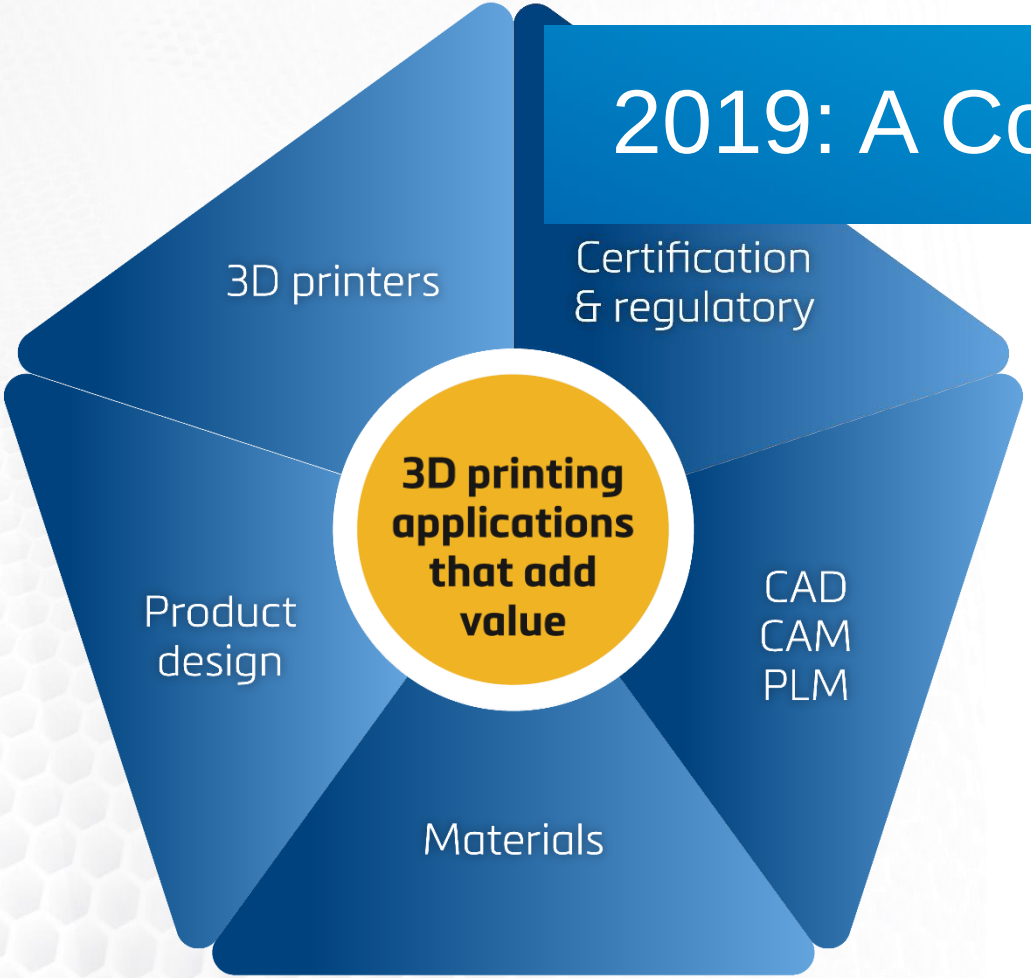
Design **Cost** **Time**

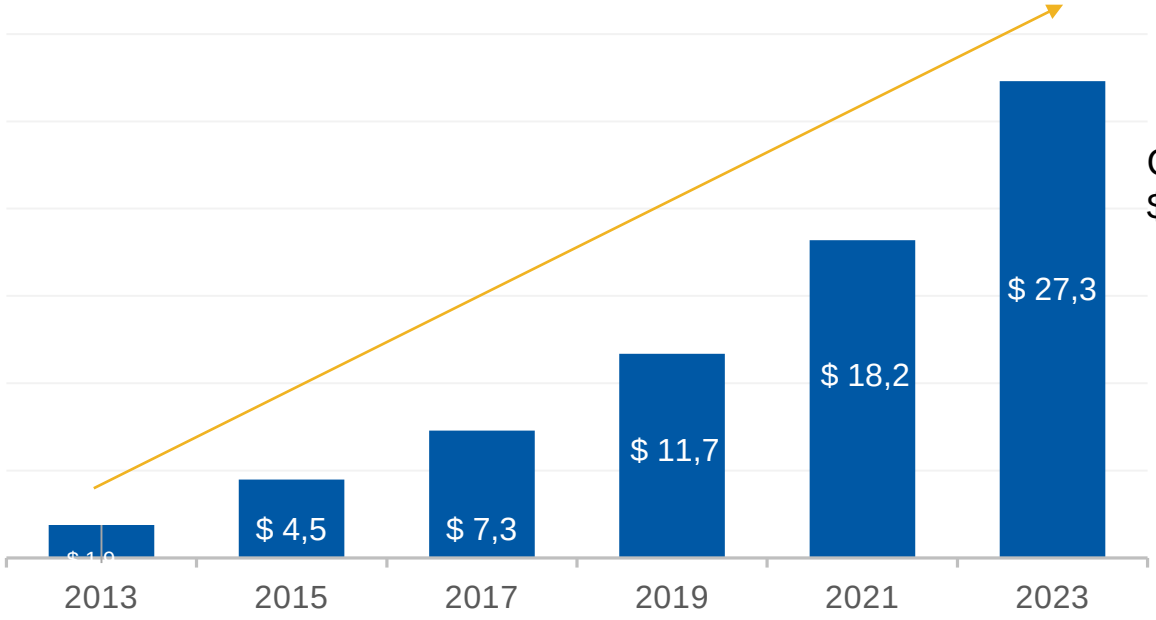
2019: A Complete Ecosystem



The central challenge is to link all the elements in the 3D printing ecosystem

The AM Industry

Double-digit annual growth for 20 of the last 29 years



In $billion
Projected growth by *Wohlers Report 2018*

Global Manufacturing Market of $12.8 trillion

- At $7.336 billion, AM represents only 0.057% of all manufacturing at the moment.
- If it grows to capture just 5% of this global market, it would become a $640 billion industry.

A Factory for 3D Printing

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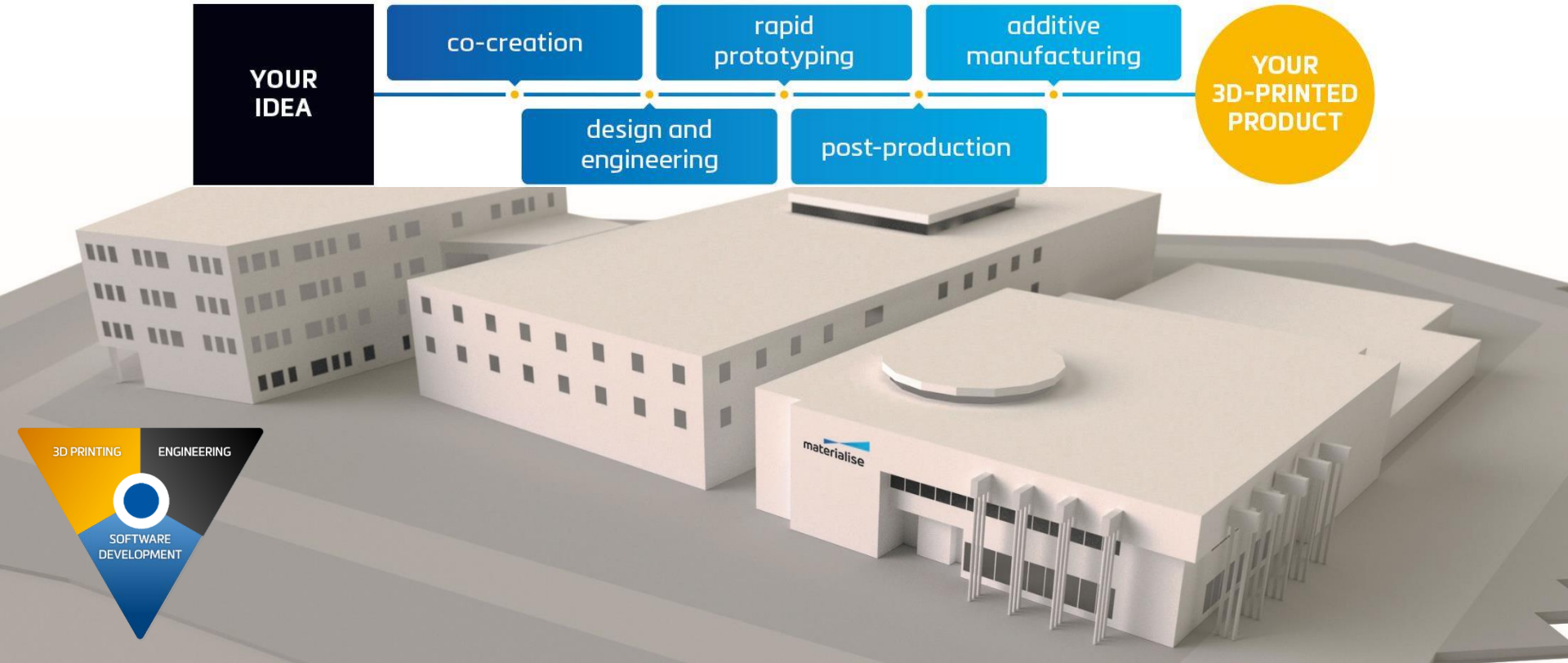

Quick facts

+1800 employees | **24** offices in **19** countries

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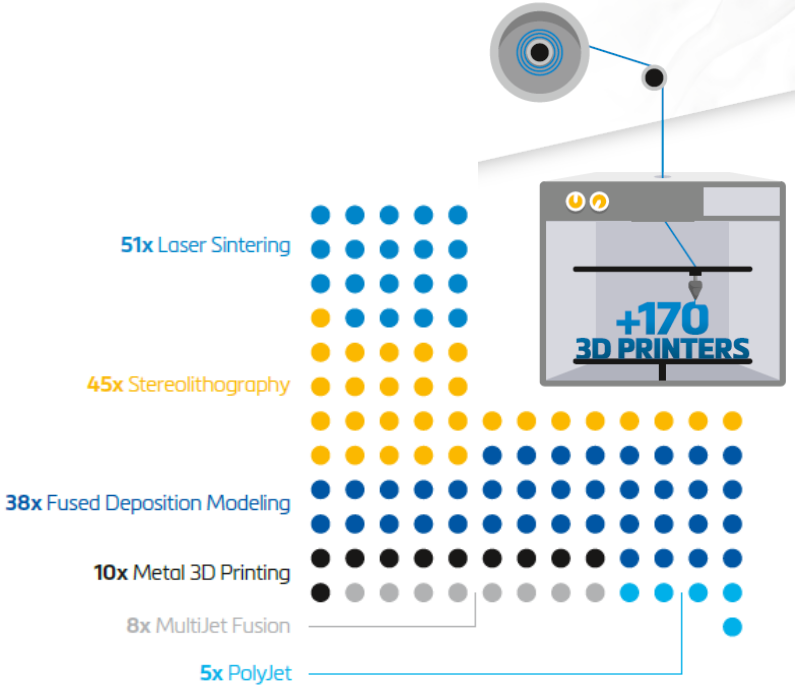

2,000+ parts printed daily

Plastics	ABS	PA	PC	TPU	ULTEM	+10 Photopolymers
Metals	Ti	Al	316L			

New: PP & Inconel IN718

ISO 9001, EN9100 and
EASA Part 21G certifications

From Rapid Prototyping to Additive Manufacturing

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GO Wheelchair by Layer Design

Rapid Prototyping: Match Reality Closer

Samsonite S’Cure suitcase prototype

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GO Wheelchair

Additive Manufacturing: Similar Is Not Good Enough

HOYA Vision Simulator manufacturing series

What is driving the rise of **serial production with AM today?**

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- Continuous improvement of technology (higher accuracy)
- More materials becoming available (including flame-retardant plastics and metals)
- Improved quality management keeping variable parameters under control
- Technology becoming cheaper and more accessible
- Increasing understanding of suitable applications

Challenges for Serial Production with AM

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Larger Quantities

- Developing the **optimal design** for cost and quality
- Identifying the ideal packaging
- Setting up **automation** to control cost & lead time
- Making the process **scalable**
- **Tracking & tracing**

Repeatable Quality

- Over 180 **parameters** influence surface, quality, accuracy and mechanical properties
- **Automation processes** can minimize risks & human error
- **Regulations** of each industry must be consistently respected

Process Integration

- With the **partner's** business
- With other **manufacturing technologies**

From Marble-Sized to Football-Sized

An Example: Small Series with AM

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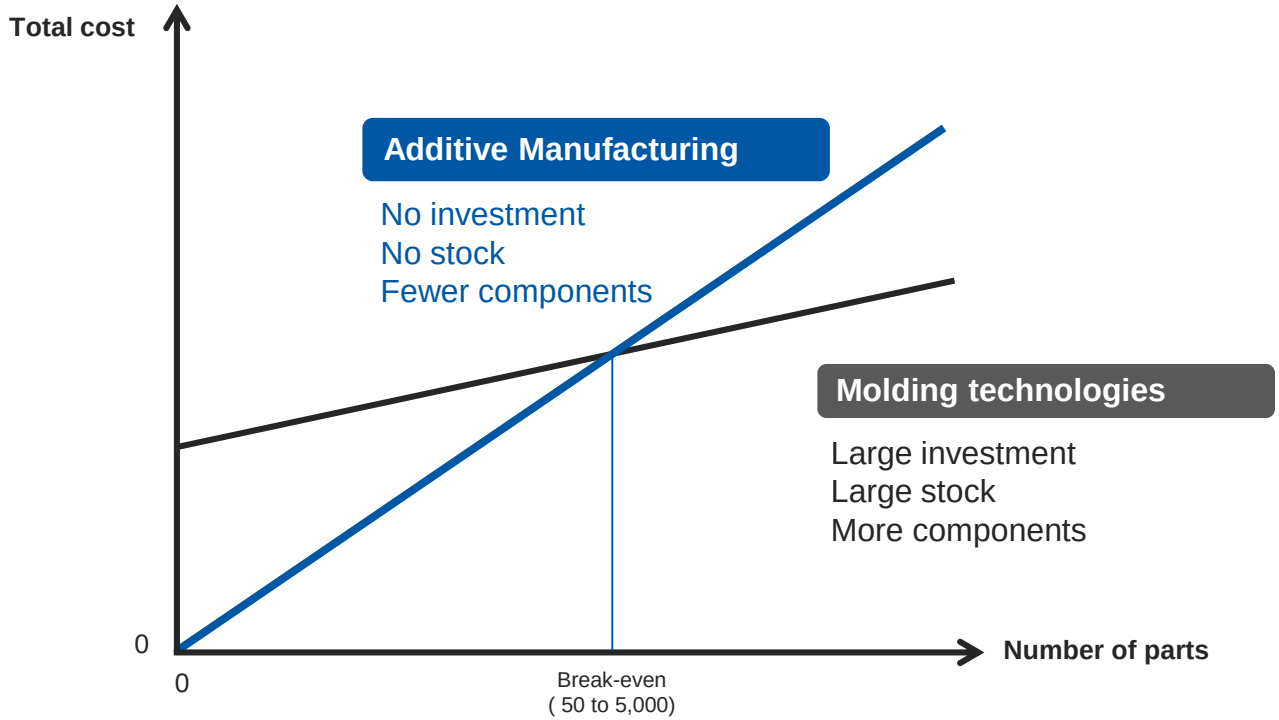

Additive Manufacturing of End-Use Parts

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The Marble Model

Phonak Hearing Aids

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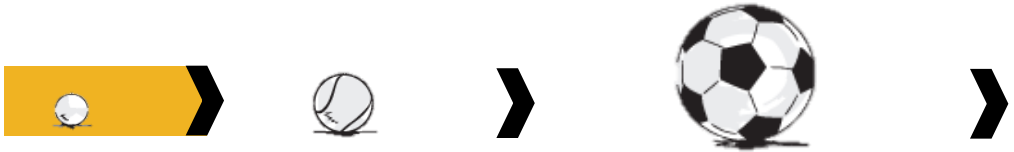
Additive Manufacturing of End-Use Parts

- Hearing aid production before 2000: labor-intensive, time-consuming, expensive
- Rapid Shell Modeling (RSM) hearing aids
- A digitized, automated process
  - Saves time, effort
  - Offers a more comfortable, acoustically optimized hearing aid



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Additive Manufacturing of End-Use Parts

- Large-scale publicity lighting on buildings, previously required injection molding: high cost, long production process
- 3D-printed LED strip connections
- From idea to final product within 10 days
  - Over 1,000 connections produced in a week
  - No investment in tooling
  - Design freedom allows for complex undercuts

Nedlight Eco LED Systems


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Additive Manufacturing of End-Use Parts

- Before foot scan and 3D-printed inner boot: expensive customization or mass-produced inner boots with less precise fitting
- 3D Printing enables mass customization: automation of design with individual fitment
- Added value of customized insoles for an athlete
  - Tailored to the individual’s anatomy
  - Accessible form of 3D-printed footwear

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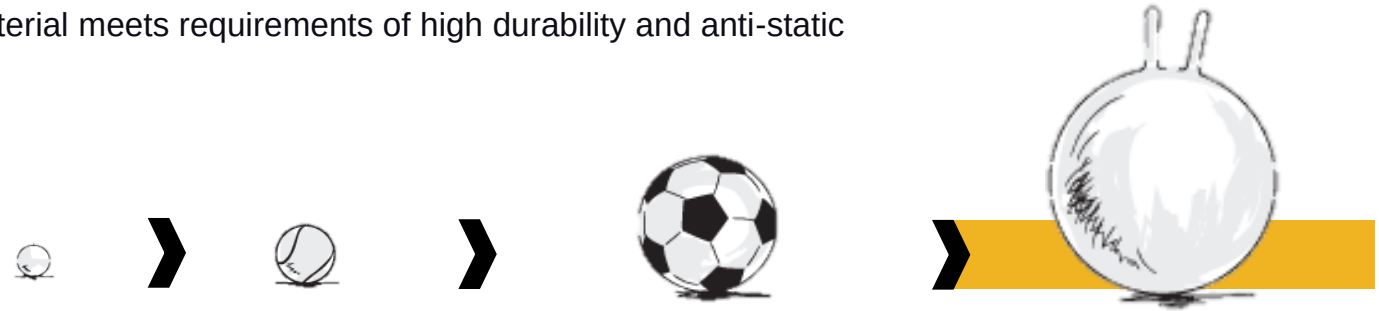
Additive Manufacturing of End-Use Parts

- Traditional manufacturing techniques for blaster housing: time-consuming, expensive and design-restrictive
- Solution: laser sintering in alumide
  - Allows for manufacturing complex shapes
  - No tooling investment
  - Material meets requirements of high durability and anti-static

Tractor-driven PiBlast by Pinovo



PART SIZE	PART COMPLEXITY	PROJECT VALUE	SERIES SIZE	PURPOSE
+	+	+	+	+
		‹ €1000		FUNCTIONAL
Ping pong ball	*No undercuts*	*Less than €1.000*	*1 to 10*	*Only functional*
-	-	-	-	-

How big is your part? Choose a ball of similar size above.

5 Parameters to Consider: 3DPrintBarometer.com

Calculate >

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Thank you for your attention!