A Work Project, presented as part of the requirements for the Award of a Master's degree in Finance from the Nova School of Business and Economics.

THE FUTURE OF ADDITIVE MANUFACTURING: MATERIALISE'S LBO – COMPANY & MARKET ANALYSIS

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Abstract

The Future of Additive Manufacturing: Materialise's LBO – Company & Market Analysis

This investment paper reviews the potential Leveraged Buyout of Materialise, a service provider and software producer operating in the Additive Manufacturing industry. An analysis of the company and market was conducted, facilitating the assessment of key market trends that enabled the creation of investment strategies set to improve the company in various areas and aspects. The result of this work presented Materialise as an attractive investment, with strong returns across a multitude of possible scenarios in the upcoming future.

Keywords

3D Printing, Additive Manufacturing, Materialise, Stratasys

Disclaimer

This report was developed for academic purposes, using non-verified publicly available information. As so, we take no responsibility for any action that might derive from the use of this paper for anything other than information.

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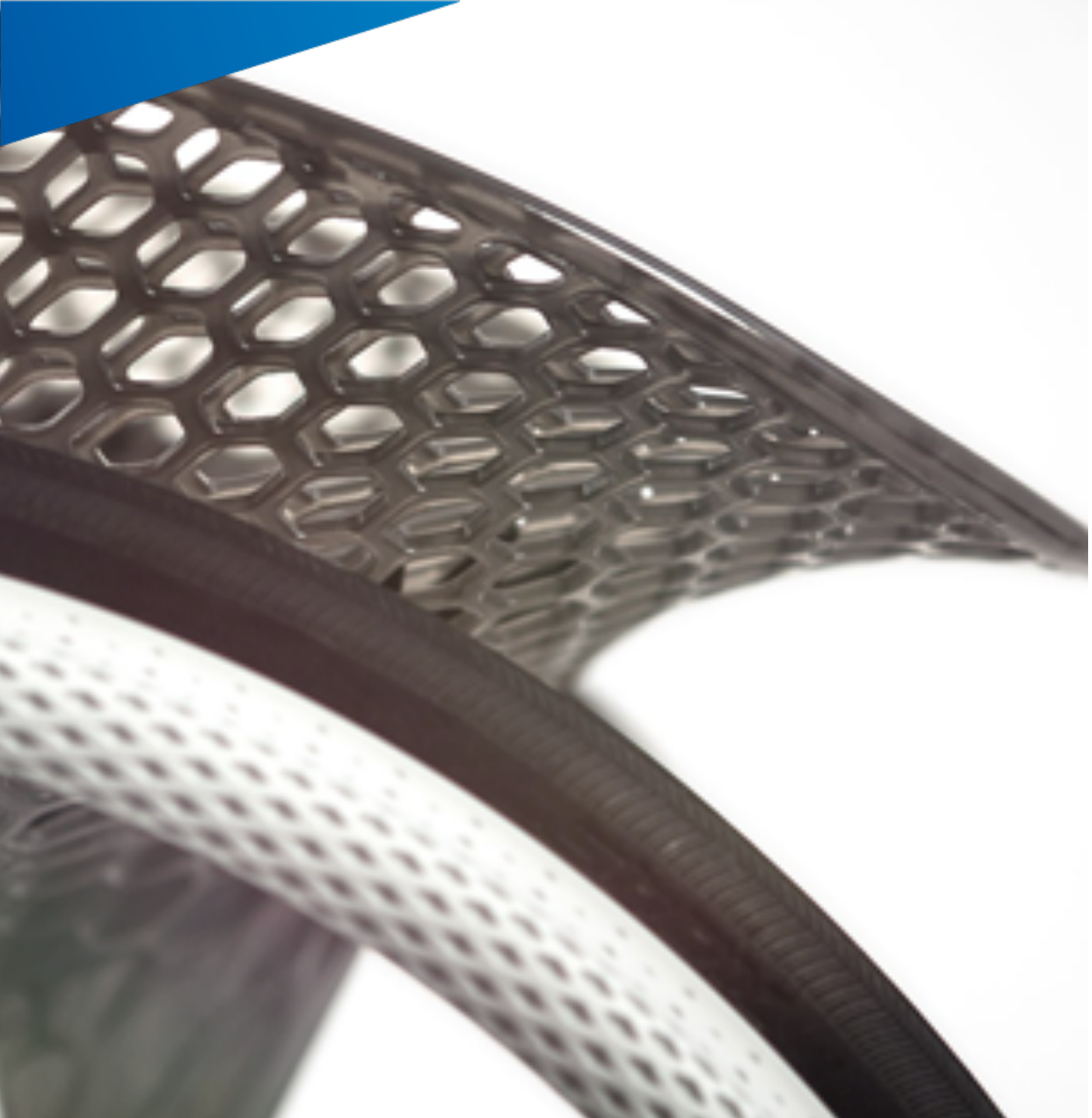


Group Paper

Materialise is a solid target, yielding a MM of 7.0x and an IRR of 35% over a 6-year investment period

Executive Summary

Company Overview

Materialise NV (NASDAQ: MTLS) is a **global provider** of software tools, medical solutions and sophisticated 3D printing services in the Additive Manufacturing (AM) market.

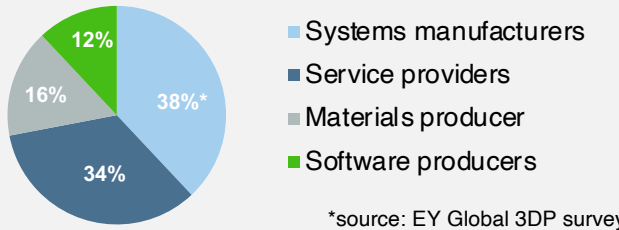
Incorporated in 1990 and headquartered in Leuven, Belgium, Materialise currently has over 2,000 employees and is present in **over 20 countries**.

The company is subdivided in three main segments: **Manufacturing**, **Software** and **Medical**, which combined offer products to over 8 different industries, including: Automotive, Aerospace, Consumer goods, Healthcare, Machinery, among others.

Market Overview

The Additive Manufacturing market is divided into four industries. Within this division, Materialise is both a **software vendor** and a **service provider**. The overall AM market is estimated to grow from $10.4bn in 2019 to **$45.7bn** in 2027 at a **CAGR of 20.3%**.

Share of Companies by Industry



*source: EY Global 3DP survey 2019

Exit Strategy & Returns

Materialise's transaction value (EV) is € 671M with an entry multiple of 25.1x EBITDA. The deal will be financed by 39% of Debt and 61% of Equity.

The exit will be performed in **2026**, with a multiple of 12.1x. The Fund's return is **7.0x MM** and **35% IRR**.

(in €M)

Deal Rationale

1. **Strong Competitive Positioning**
   Pioneer in 3DP, global reach and disruptive tech.
2. **Successful Acquisition History**
   6 acq. in the past decade with successful integration
3. **Growing Market**
   7-Year CAGR estimates vary between 18% to 27%
4. **Strong Financials**
   Increasing profitability and operating efficiency
5. **Highly Skilled Workforce**
   3DP expertise both in management and engineering

Value Creation Plan

Investment thesis relies on 3 strategies to derive growth:

A. **Organic Growth** by increasing focus in the APAC region through strategic partnerships, by strengthening Materialise's offer of metal-based printing which a growing AM area and by expanding the customer base in the Americas and Middle East.

B. **Optimizing Operations** by reducing SG&A and R&D costs as a result of the synergies generated by the strategic acquisition.

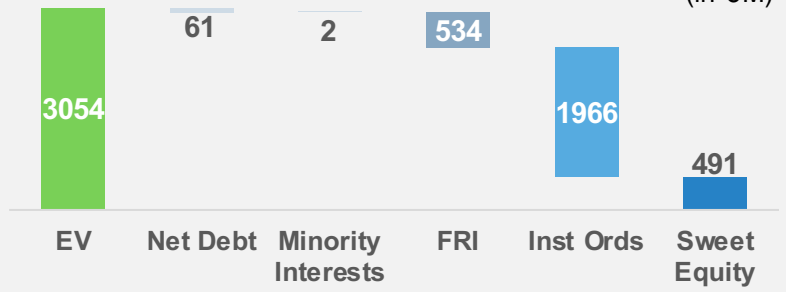
C. **Strategic Acquisition** of a Systems Manufacturer to strengthen Materialise's position in the AM value chain. This vertical integration would allow the company to become an all-in-one supplier.

Contingency Plan

In case the Strategic Acquisition is not successful, a **standalone scenario** of Materialise was performed with a capital structure of 45% of debt and 55% Equity.

In this scenario, exit will occur in **2027**, with a multiple of 25.1x. The Fund's return is **5.0x MM** and **24% IRR**.

(in €M)



Innovation-driven, Materialise operates in 3 different segments within the Additive Manufacturing landscape

materialise

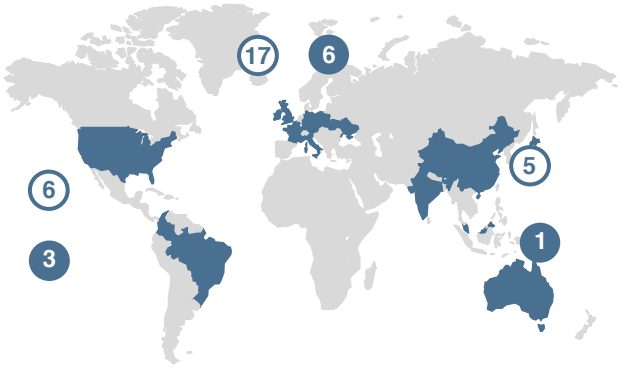
Company Overview | Company Profile & History

Company Profile

- Materialise NV (NASDAQ: MTLS) is a **global provider** of software tools, medical solutions and sophisticated 3D printing services in the Additive Manufacturing market.
- One of the largest and most long-established independent company in this sector, Materialise was incorporated on the **28th of June 1990** under the Belgian company law.
- The company currently holds **over 250 patents**, including 160 specifically related to medical applications.
- Multinational company established through a combination of **organic growth** and **acquisitions**.
- Materialise's main subsidiaries include **Engimplan**, **ACTech** and **RapidFit**

RapidFit+ a materialise company | ACTech a materialise company | engimplan a materialise company

Geographical Presence



28 **Corporate Offices**

Production Facilities 10

Global presence in over 20 Countries

Company Description

Corporate Headquarters: Leuven, Belgian

Market Segments: Manufacturing; Software; Medical

Number of Employees: 2,177

Financial Highlights (2019)

Metrics	5Y CAGR
Sales €196.7M (+ 6,5% vs. 2018)	≈ **16%**
Gross Profit €109.7M (+ 7,1% vs. 2018)	≈ **15%**
Net Profit €1.7M (- 43,0% vs. 2018)	**n.a.**
EBITDA €26.7M (+ 13,3% vs. 2018)	≈ **52%**

90 — **Foundation** of Materialise

95 — **First to provide** stereolithography printing in colour

Launch of **Materialise Mimics**, a unique software to produce anatomical models

00 — Pioneered large scale printing with **Mammoth Machines**

Launch of **NextDay**, an online ordering service

05 — Spinoff of **Materialise Dental NV** & 100% sale

Creation of **RSM software**, automation process for customized hearing aids

Introduction of **i.Materialise**, an online 3DP service

Automated support structure with **Materialise e-Stage**

10 — Spin off **RapidFit NV** into a separate fixtures business

Acquisition of **Marcam Engineering GmbH** focused on software solutions for metal printing

Acquisition of **RS Print,** JV focused on custom footwear technology

Materialise **goes public** on NASDAQ

15 — Acquisition of **Cenat BVBA**, proprietary technology on machine control

Acquisition of **e-prototypy SA**

Partnership w/ **Fluidda** focus on pulmonary solutions

Acquisition of **ACTech**, manufacturer of metal parts

20 — Acquisition of **Engimplan**, CMF producer

Strategic alliance with BASF, largest chemical producer in the world

Sources: Annual Report; Koyfin.com

Company & Market Overview | Value Creation & Business Plan | Exit & Returns | Exit Options & Due Diligence

Materialise's core foundation is set on 3 main pilars: 3D Printing, Software Development & Engineering

Company Overview I Business Model

Manufacturing Segment

B2B service provider of **3D printing solutions through the co-creation, prototyping and consultancy services** with Materialise's engineers and designers, enabling the production of very complex parts or products using various materials and technologies, on demand.

Software Segment

Provides the necessary **sophisticated software tools** to use additive manufacturing to produce the highest standards' products regardless of complexity levels. It specializes in **workflow software** and is the backbone of 3D printing. It also provides **training and consulting services** for its products. It can also be sold as a standalone product.

Medical Segment

Provides customers with **medical devices** printed in-house such as **surgical guides and implants**, **licenses** to medical **software packages** and **software maintenance contracts** to ensure the level of precision and accuracy required in Certified Medical Printing. Pioneering segment that revolutionizes the care for patients' lives.

Catalysts
- Freedom of Design
- Mass Customization
- Shortens time to Market
- Digital Supply Chains

Industries
- Automotive
- Aerospace
- Eyewear
- Consumer Goods
- Architecture
- Art & Fashion
- Healthcare
- Machinery

3D printing Software Development Engineering

Values
- Accessibility,
- Performance,
- Risk reduction
- Status

Channels
- Direct sales force
- Website
- Third-party distributors
- Engineers

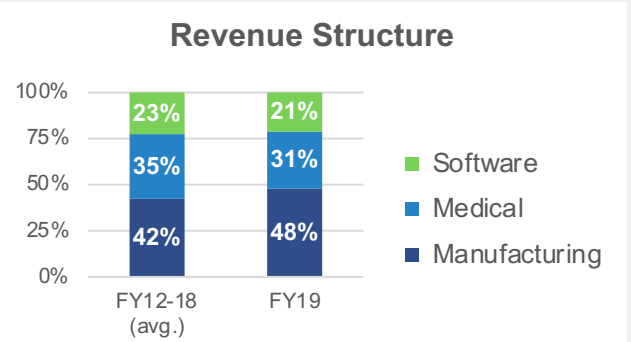
Resources

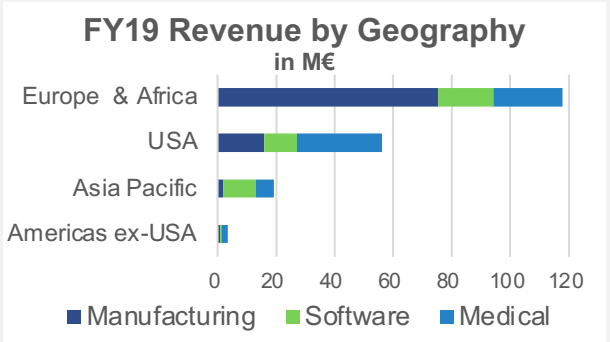
Human resources are central to business performance, with top-level engineers, developers, designers and salespeople. The **industrial 3D printers** and **issued patents** are also crucial for MTLS to conduct business.

Customer Relationships

Materialise assists its customers with **support & training services** and even a **self-service component.**

Revenues

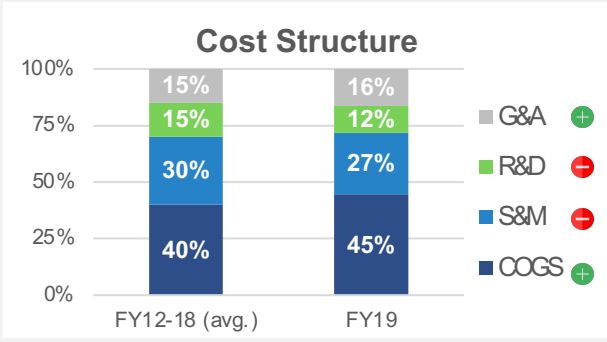




Revenue is generated primarily by (i) the sale of software; (ii) 3D printed & complex manufactured products and services

Changes in revenue structure have been heavily affected by the acquisition of ACTech, boosting manufacturing's share of total revenue.

Costs



Source: MTLS Investor Presentation 2018

Company & Market Overview | Value Creation & Business Plan | Exit & Returns | Exit Options & Due Diligence

Materialise Manufacturing generates revenues from the sale of parts, design and engineering services

Company Overview I Manufacturing Segment

FY19 Highlights

- **Revenues** €94M
- **Revenue Share** 48%
- **Growth rate** 16.4%
- **EBITDA** €12M
- **EBITDA mg** 13%
- **Employees** 775 FTE

Revenue Model: The 3D Printing Process

1 Rapid Prototyping

- **Prototypes are essential** to verify the product design with a model that matches the real product, or **to perform form, fit and function** tests, in order to meet the customer's requirements.
- Rapid Prototyping allows designers and engineers to **execute fast and frequent revisions of their designs**. Thanks to a variety of available technologies and materials, 3D-printed prototypes work for both visual and functional testing.

2 Additive Manufacturing

- **Printing of 3D products** to industrial and commercial customers.
- **Co-creation**: Materialise works together with customers during the 3D printing process to solve complex design challenges and to discuss how the introduction of 3D printing can affect product development, manufacturing workflow, business models and customer experiences.
- ***i.materialise***: Online service where customers can buy 3D printed products or create their own and offer them for sale to others through this platform.

3 Design and Engineering

- Services provided by highly specialized designers and CAD engineers that offer design and software support for additive manufacturing, including **remodeling and file preparation**, as well as **3D scanning and measuring**.
- These services are intended to add value to the product design, ranging from **improved performance to lowered cost**.

Strategy

*"Printing **on demand** in one of the world's largest 3D printing factories while **improving software solutions** and **acting as incubators** for new verticals through the host of co-creations with industry leaders."* - Materialise Investor Presentation

Sales and Marketing

The distribution of the **manufacturing services** is carried out by:

- Sales force
- Online portal
- Complex product offerings are addressed directly by specialized sales managers
- Straightforward products can be ordered directly through the automated system "**Materialise OnSite**".

Customer Segments

The customer base for the manufacturing segment are included in the following industries:

- Automotive
- Aerospace
- Healthcare
- Industrial machining art and design
- Consumer products

Ecosystem Partners

AIRBUS, VOLVO, TAILORED-FITS.com, BASF, Microsoft, Samsonite, HOYA, kipling, phits, Panasonic

Sources: Annual Report, MTLS Investor Presentation 2018

Materialise's software generates revenue mainly from software licenses and maintenance contracts

Company Overview I Software Segment

FY19 Highlights

- 10 > customers 22% of Revenue
- Revenues €42M
- Revenue Share 21%
- Growth rate 11.5%
- EBITDA €14M
- EBITDA mg 33%
- Employees 303 FTE

Main Products

MAGICS

Revenue Model

1. Sources of revenue in this segment are **maintenance contracts, software licenses, and hardware controller sales** along with custom software development services.
2. **Licensing software products** can be done perpetually or on a time-basis, along with annual maintenance contracts for software updates or support

Magics' applications include:

- repairing and optimizing 3D models & analysing parts
- designing support structures
- making process-related design changes on STL[1] files
- process planning & documenting customer projects
- nesting multiple parts in a single print run

Further offerings help complement the Magics' Platform that provide automation and other productivity improvements.

1) Magics Essentials: entry-level package offering premium data preparation functionality which is used together with machine build preparation software.

2) Magics Print: conglomerates the key build preparation tools and straightforward build file generation technology (offered to machine manufacturers as a product enhancement to their machines' sale).

Upgrading to the expert Materialise Magics provides full data and build preparation functionalities in one package:

- *Streamics*
- *3-maticSTL*
- *e-Stage*
- *Build Processors and Machine Control Software*
- *Materialise Controller*
- *MiniMagics and MiniMagicsPro*

Strategy

*"Offer proprietary software worldwide through programs and platforms that enable and **enhance the functionality of 3D printers and 3DP operations**"* – Materialise Investor Presentation

Sales and Marketing

The distribution of the **software** is carried out by:

- OEM Partner Sales
- Direct Sales
- Third-Party Distributors

Local offices offer technical help before and after the sale. OEMs and dealers often distribute software products combined with 3D printers to enhance the printers' value proposition and application.

Customer Segments

The customer base includes:

- 3D printing OEMs
- Manufacturers in other industries: consumer goods, automotive, aerospace, and hearing aid industries
- R&D departments
- Internal & External 3D printing service offices.

Ecosystem Partners

HP, HCL, EOS, Hyundai, Siemens, Onshape, Nissan, PTC, Tata, Toyota, Synnex Corporation, simufact

[1] See glossary for the definitions

Sources: Annual Report, MTLS Investor Presentation 2018

Materialise Medical generates revenues from two sources: Medical Software and Clinical Services

Company Overview I Medical Segment

FY19 Highlights

- **Revenues** €61M
- **Revenue Share** 31%
- **Growth rate** 16%
- **EBITDA** €11M
- **EBITDA mg** 18%
- **Employees** 763 FTE
- **3D Printing Machines** 32

Subsegments

Medical Software

- Materialise's software allows medical-image based analysis, engineering and 3D printed customized designs of surgical guides, implants and other anatomical models.
- Materialise generates revenues in this sub-segment by **selling licenses** to its medical **software packages** (eg. *Materialise Mimics/ 3-matic/ OrthoView/ ProPlan CMF)* and **software maintenance contracts**.
- **Materialise Mimics** is a medical software that allows 3D models to be printed accurately from medical imaging-data eg. CT or MRI's. Currently, there are over 250 hospitals worldwide that use Materialise Mimics Technology, especially in the Cardiac, Orthopedic, Vascular, Neurological and Hepatobiliary areas.

Clinical Services

- Materialise provides customers with 3D printed **surgical guides** and patient specific **medical implants**, allowing doctors to pre-operate in models with the exact scenario they will face in the actual surgical intervention.
- The procedure to develop a customized implant involves: 1) Sending Materialise a CT scan; 2) Materialise's clinical engineers to organise a plan and design a proposal; 3) Doctors evaluating the proposal and give feedback; 4) Materialise producing and shipping the personalised implant, custom instruments and bone models to support the surgery.
- The 3D printed surgical guides include: shoulder, osteotomy, knee and hip replacement surgeries, whilst the 3D printed implants are for shoulder, hip and CMF implants.

Strategy *"Offer products and services that **address long-term trends in the medical industry** towards **personalized, functional and evidence -based medicine**"* - Materialise Investor Presentation

Sales and Marketing

The distribution of **medical software** is carried out by:

- Direct sales force
- Website
- PACS partners

The distribution of **3D printed medical devices** is executed through agreements with collaborative partners. Clinical services may also be carried out by Materialise's own **engineers** that developed close connection with key customers.

Customer Segments

The **customer base** for the Medical Segment products and services include:

- Medical Device Companies
- Hospitals
- Universities
- Research Institutes
- Industrial Companies

Ecosystem Partners

DePuy Synthes, SIEMENS Healthineers, ZIMMER BIOMET, MATHYS, Corin, MicroPort, EPISURF Medical, sonova, stryker, Exactech, formlabs

Sources: Annual Report, MTLS Investor Presentation 2018

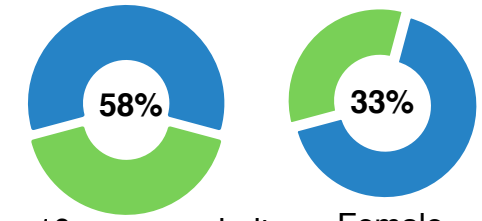
Materialise's Board of Directors transferred all management powers to the Executive Committee

Company Overview | Management Team

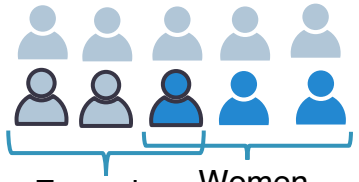
	KEY MEMBERS	EXPERIENCE	CAPABILITIES	FIT VALUATION
Executive Committee	 **Wilfried Vancraen** Founder & CEO **30** years	Prior experience: engineering and consulting. Founded Materialise in 1990 and since then has been recognized with several awards as the most influential person in Additive Manufacturing and one of the biggest contributors to the industry (RTAM/SME Industry Achievement Award, 2013 Visionaries! Award)	Product and Industry expertise: Vision, Technical Know-how, Passion.	
	 **Peter Leys** Executive Chairman **7** years	Prior to being appointed director and Executive Chairman in 2013, Mr. Leys was a Corporate Finance Partner at Baker & McKenzie CVBA. He holds a Candidacy Degree in Philosophy from KU Leuven and Master of Law degrees from the University of Georgia and the KU Leuven.	Financial expertise: M&A knowledge, capital markets understanding, contract building & negotiation, philosophy and law.	

Key Metrics

EXECUTIVE COMMITTEE

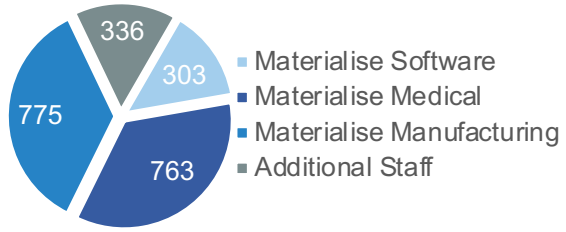


BOARD OF DIRECTORS



SHAREHOLDER STRUCTURE

EMPLOYEES



The Executive Committee is composed by 12 members

The BoD is composed by 7 fully independent members. There are 2 committees: 1) Audit & 2) Remuneration and Nomination Committee

The above graph refers to the beneficial ownership of Materialise's ordinary shares as of April 24th 2020.

Materialise employed 2,177 people in 2019, growing the team by 8.4% YoY.

Sources: See Appendix 1 for further information on the Management Team

Sources: Annual Report, Investor Relations

Management Team

Company Overview

Additional Executive Committee members

Hilde Ingelaere

Education: 2 Masters - Bioengineering and Business Administration; Experience: Cardiovascular clinical research and business analyst; Materialise: Joined in 1990, became a director in 1997 (managed HR, legal and finance departments) and became Executive VP of MTLS Medical in 2011;

Bart Van Schueren

Education: Master in Mechanical Engineering and PhD in SLM Sintering; Experience: Worked as a liaison engineer & set up research activities of a Co. Materialise: Joined in 1995 and ran the 3D printing service bureau. Became Executive VP in 2011 and CTO in 2016;

Johan Pauwals

Education: Master in Electro-Mechanical Engineering w/ Stereolithography; Materialise: Joined in 1990 and worked as a software sales manager, Director of Sales and in 2011 became Exec. VP being responsible for global software;

Johan Albrecht

Education: Master in Corporate Finance; Experience: CFO & member of the Executive Committee (EC) & Director of a global laboratory (BARC NV); EC of Cerba European Lab (acquirer of BARC); Materialise: Joined in 2015 in representation of Alfinco BVBA;

Steafaan Motte

Education: 2 Master - Mathematics and Applied Informatics; Experience: Software architect and project manager of NXP Semiconductors; Materialise: Joined in 2010 for the cranio-maxillofacial business, in 2012 became the Director of the Clinical Business Unit and in 2015 was VP & General Manager of MTLS Software;

Brigitte de Vet-Vei

Education: Master in Business Administration majoring in Engineering; Experience: VP at Cordis Neurovascular and GM. Became CEO of Acertys group (provider of medical devices and software); Materialise: Joined in 2016 in representation of De Vet Management BVBA as a VP for the Medical segment;

Jurgen Laudus

Education: Master in Engineering; Materialise: Joined in 2001 as a project manager, Rapid Tooling sales support and production management, International Production Manager for the AM services and Sales Manager. Became VP of the manufacturing segment;

EXECUTIVE COMMITTEE

Name	Age	Gender	# years at Materialise NV	Position
Wilfried Vancraen	58	Male	30	Founder, Director & CEO
Peter Leys	55	Male	7	Executive Chairman
Hilde Ingelaere	58	Female	30	Director & Executive VP - Medical
Johan Pauwels	52	Male	30	Executive VP - Software
Bart Van der Schueren	53	Male	25	Executive VP & CTO
Johan Albrecht	56	Male	5	Executive VP & CFO
Stefaan Motte	43	Male	10	VP & Materialise Software segment
Brigitte de Vet-Veithen	49	Female	4	VP & Materialise Medical segment
Jurgen Laudus	41	Male	19	VP & Materialise Manufacturing segment
Eduard Crits	61	Male	2	CIO
Conny Hooghe	54	Female	3	VP & Human Recources
Carla Van Steenbergen	44	Female	17	VP & CLO

BOARD OF DIRECTORS (BOD)

Name	Age	Gender	# years at Materialise NV	Position
Wilfried Vancraen	58	Male	30	Founder & CEO
Peter Leys	55	Male	7	Executive Chairman
Johan De Lille	57	Female	14	Independent Director
Hilde Ingelaere	58	Female	30	Director & Executive VP - Medical
Pol Ingelaere	84	Male	9	Independent Director
Jurgen Ingels	49	Male	7	Independent Director
Jos Vander Sloten	57	Male	13	Independent Director
Lieve Verplancke	60	Female	5	Independent Director
Bart Luyten	43	Male	3	Independent Director
Volker Hammes	56	Male	2	Independent Director

Source: Annual Reports; Materialise's Website

PESTLE Analysis

Market Overview

Political

- 3DP requires political intervention as it could threaten people's security. Governments may need to control the dispersion of 3D printers by developing a database with all the locations and holders of 3D printers.
- Government may need to intervene in order to prevent the production of **illegal products** that could lead to the creation of black markets.
- Finally, another issue that requires political intervention is the 3DP of designs that have **intellectual property rights.**

Economic

- Given the current economic outlook, **subsidies and grants** for research and development are likely to fall, which will surely impact the 3DP market.
- Likewise, **taxation** is expected to rise in the overall economy both direct and indirect.
- Finally, the private sector will also face great challenges accessing **debt markets** at reasonable conditions.

Social

- 3DP allows companies to run their production in any part of the world. This will create **pressure on the "traditional" manufacturing market** as there is great concentration of production and employment in industrial regions.
- The rising trend for the use of **social networks** may play a crucial role in the evolvement of 3DP. People will want to share their own customized 3D printed designs with friends, family and society as if they were sending photos or videos.

Technological

- 3DP is considered a **disruptive technology** in the manufacturing market, as it allows for the production and sharing of customised products and designs.
- However, the 3DP market has **not yet reached its peak** or maturity, as new technologies arise allowing people to model even more their designs and use different materials.

Legal

- The 3DP market highly relies on **intellectual property (IP)**. Manufacturers and software designers are protected by patents for a limited number of years. However, with the growth of the 3DP market new legislation will be required.
- As it was mentioned in the political factors, the breach of IP rights and contraband production are issues that put constrains on the development of the 3DP market and that call for heavy legislation.

Environmental

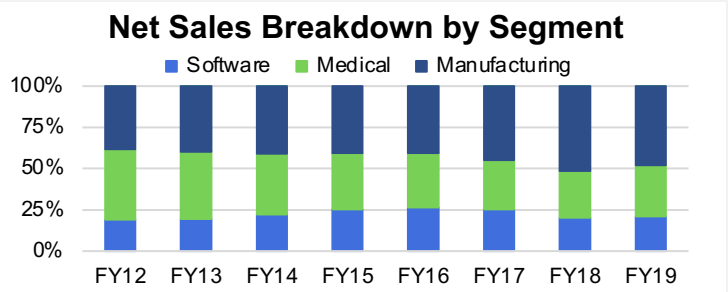
- When it comes to **mineral resource consumption** and **water waste**, 3DP is considered more sustainable than the traditional industrial manufacturing process.
- On the other hand, researchers claim that the 3DP process has high **energy demands**, which can contribute to the emissions of Greenhouse Gases (GHG's).

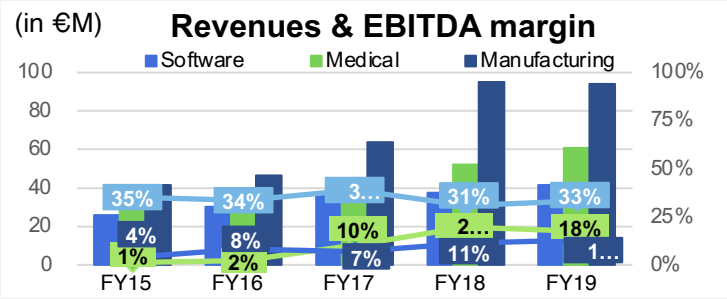
Source: Corporate Finance Institute

Strategic acquisitions and investment in S&M and R&D enabled revenue growth and margin improvement

Historical Financials I Income Statement

Income Statement (in €m)	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19
Software	11	13	18	26	30	36	37	42
Medical	25	28	30	35	38	43	52	61
Manufacturing	23	27	33	41	46	64	95	94
Total Revenue	**59**	**69**	**81**	**102**	**114**	**142**	**185**	**197**
Growth %	-	17%	18%	25%	12%	24%	30%	7%
Gross Profit	**35**	**42**	**49**	**59**	**68**	**80**	**102**	**110**
Gross Margin %	60%	60%	60%	58%	59%	56%	55%	56%
Research and development expenses	(9)	(11)	(15)	(18)	(18)	(20)	(22)	(23)
Sales and marketing expenses	(20)	(22)	(28)	(37)	(36)	(39)	(46)	(53)
General and administrative expenses	(8)	(9)	(12)	(15)	(20)	(25)	(32)	(32)
EBITDA (unaudited)	**5**	**8**	**5**	**3**	**8**	**13**	**22**	**26**
Adjustments to EBITDA	0	0	1	1	1	2	1	0
Normalized EBITDA (unaudited)	**5**	**8**	**6**	**4**	**9**	**15**	**24**	**27**
EBITDA margin %	9%	11%	7%	4%	8%	10%	13%	14%
Net profit	**1**	**3**	**2**	**(3)**	**(3)**	**(2)**	**3**	**2**
Profit Margin %	2%	5%	2%	-3%	-3%	-1%	2%	1%
			IPO					





Comments

1. The Medical Segment revenue growth from FY17-18 was entirely due to an increase in partner sales, especially in the business lines of CMF, shoulder and knee devices. From FY18-19, the acquisition of **Engimplan** contributed with **€2.4m additional revenue** and while observing continued growth from partner business sales (especially CMF).

2. The acquisition of **ACTech** resulted in **€43.4m additional revenue** from the sale of printed industrial and consumer products, causing the manufacturing segment to weigh 51.4% of revenues compared to 44.7% in FY17.

3. The stagnation of growth in manufacturing revenues due to a less favorable economic scenario in FY19 (i.e. trade war) broke the revenue trend, although partially offset by increases in other segments.

4. Increase in costs mainly reflect the acquisition of ACTech. Increasing operation costs mainly driven by S&M and G&A expenses, both largely composed by payroll expenses.

5. Materialise reaches profitability after increases in revenues from ACTech more than offset increase in costs.

Sources: Annual Report, Investor Relations

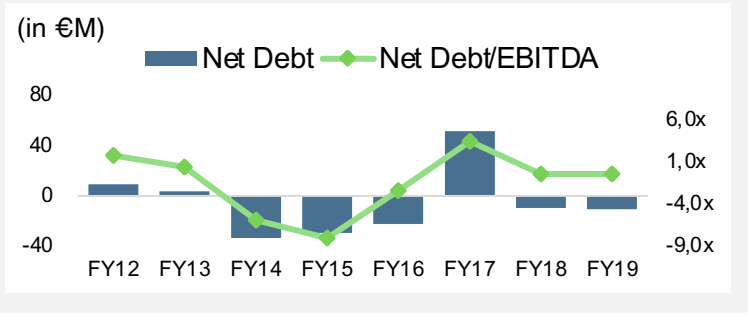
MTLS' Capital Structure suffered drastic changes from strategic acquisitions and equity capital increases

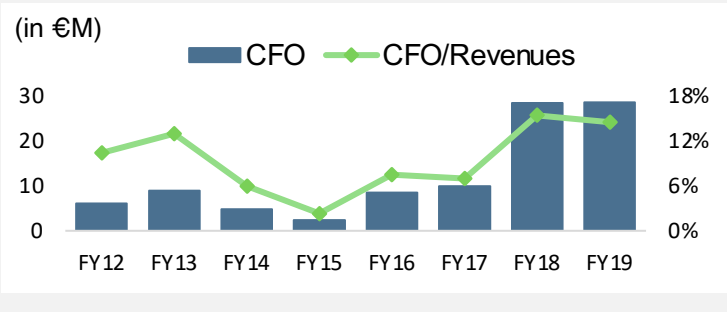
materialise

Historical Financials | BS & CFS

Balance Sheet (in €m)	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19
Cash and Cash Equivalents	6	13	51	51	56	43	116	129
NWC w/ Cash	4	7	53	46	48	35	96	107
Equity	**13**	**18**	**85**	**83**	**79**	**77**	**136**	**143**
Net Debt	**9**	**4**	**(34)**	**(30)**	**(22)**	**51**	**(9)**	**(11)**
Net Debt/EBITDA	2x	0x	-6x	-8x	-2x	4x	0x	0x
ROE	11%	19%	2%	-3%	-4%	-3%	2%	1%
ROA	3%	6%	1%	-2%	-2%	-1%	1%	0%

Cash Flow Statement (in €m)	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19
Normalized EBITDA	5	8	6	4	9	15	24	27
Income tax paid	0	0	(0)	(0)	(1)	(2)	(1)	(2)
CFO	**6**	**9**	**5**	**2**	**8**	**10**	**28**	**28**
Purchase of PPE	(4)	(2)	(10)	(9)	(12)	(28)	(18)	(13)
Acquisition of Subsidiary (net of cash)	0	(0)	(10)	(2)	0	(27)	0	(6)
CFI	**(5)**	**(3)**	**(31)**	**(3)**	**(13)**	**(59)**	**(22)**	**(26)**
Net Proceeds of Loans & Borrowings	3	1	(1)	1	12	42	14	17
Capital Increase in Parent Company	(1)	0	70	1	0	0	60	1
CFF	**2**	**1**	**62**	**(2)**	**9**	**38**	**65**	**11**
CFO/Revenues	10%	13%	6%	2%	7%	7%	15%	14%
CFO/Assets	13%	16%	4%	2%	5%	4%	9%	8%
CFF/CFO	39%	8%	1282%	-76%	109%	382%	230%	38%





Comments

1. In June 2014, Materialise went public and sold around 8 million ADS's at a price of $12.00 per ADS. According to Materialise's financial reports, the company received net proceeds from the **IPO** of approximately $88.3M.

2. In July 2018, MTLS closed a **private placement** of around 2M ordinary shares to BASF Antwerpen. One week later the company performed a **secondary public offering** of over 3M ADSs at a price of $13.00 per ADS. Collectively, these capital increases rendered approximately $65.2M in net proceeds for MTLS.

3. Usually in possession of more cash & eq. relative to its financial obligations, we can see a temporary switch in 2017 given a major increase in Loans & Borrowings to fund ACTech (€27.2M) and PPE (€27.7M).

4. In 2014, MTLS acquired **OrthoView**, an Orthopedic Pre-Operative Planning Software Co. In 2017, acquired **ACTech**, full-service manufacturer of complex metal parts. On August 2019, Materialise concluded the acquisition of **Engimplan**, a Brazilian company specialized in manufacturing of orthopaedic and CMF implants and instruments.

5. This increase in Loans & Borrowings reflect the financing of ACTech's acquisition, expansion of PPE and R&D projects.

Sources: Annual Report, Investor Relations

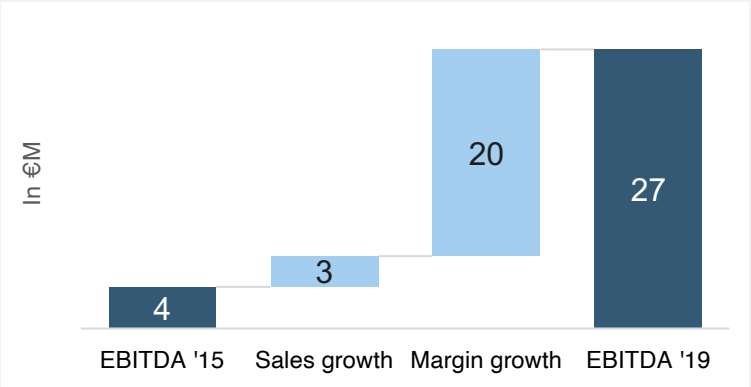
Materialise's strategic acquisition of ACTech in 2017 had a great impact on historic FCF's

Historical Financials I FCF

CAPEX (in €M)	FY15	FY16	FY17	FY18	FY19
Purchase of PPE	(9)	(12)	(28)	(18)	(13)
Proceeds from of PPE & intangibles	0	2	0	0	0
Purchase of intangible assets	(2)	(2)	(4)	(2)	(2)
Acquisition of subsidiary (net of cash)	(2)	0	(27)	0	(6)
CAPEX	**(12)**	**(13)**	**(59)**	**(20)**	**(22)**
Maintenance	(7)	(8)	(13)	(17)	(15)
Expansion	(5)	(4)	(46)	(3)	(6)

Free Cash Flow (in €M)	FY15	FY16	FY17	FY18	FY19
EBITDA	**4**	**9**	**15**	**24**	**27**
Depreciation & Amortization	(7)	(8)	(13)	(17)	(19)
EBIT	**(3)**	**1**	**2**	**6**	**7**
Operating Taxes	0	(2)	(1)	(0)	(3)
Maintenance CAPEX	(7)	(8)	(13)	(17)	(15)
Expansion CAPEX	(5)	(4)	(46)	(3)	(6)
Change in NWC	1	2	(7)	10	3
FCF	**(6)**	**(3)**	**(52)**	**13**	**5**

EBITDA Growth



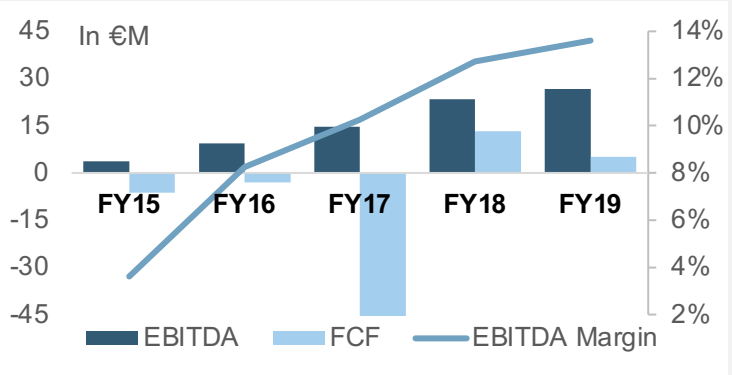
1 EBITDA experienced a constant growth since 2015 with a **CAGR of 73%**. The rise in EBITDA is mainly explained by the **EBITDA Margin improvement** and a smaller part driven by revenue growth.

CAPEX & NWC

2 **In 2017 Materialise acquired ACTech**, a German full-service manufacturer of complex metal parts, for a total of €28M in cash. This acquisition led to a drastic change in the expansion CAPEX and consequently a very negative FCF in 2017 of around €52M.

3 The Net Working Capital has been changing steadily over the period of 2015 to 2019. These changes are mainly explained by the acquisitions and strategic partnerships that Materialise established over the past few years. Not only ACTech in 2017 but also Engimplan in 2019.

Free Cash Flow



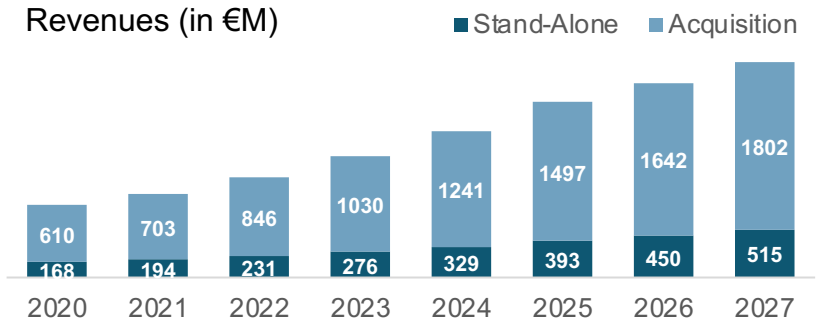
4 The FCFs have been unstable mainly due to the CAPEX, which includes acquisitions of subsidiaries. However, since 2018 the cash flows have been increasing driven by the EBITDA growth.

Sources: Annual Report, Investor Relations

Both scenarios show potential Top and Bottom-line improvements

Business Model I Overall Business Plan

Top Line



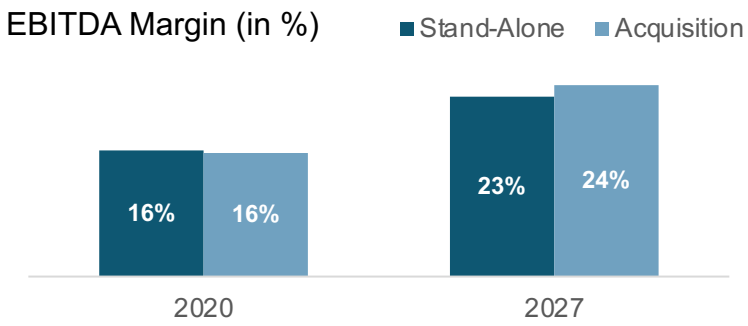
1 Standalone Scenario

Increasing focus in the **APAC** and **US** regions by engaging in strategic partnerships. Special focus in Workflow & CAD Software, in order to enable customized mass-production. Expand the offer of **metal-based printing**, key growth area with increasing demand in the AM industry. In terms of revenues, the period 2020-2027 has a **CAGR of 17.3%**.

2 Acquisition Scenario

This growth can be explained by the revenue synergies arising from the vertical and horizontal integration of Stratasys into Materialise's business. Post-acquisition the company becomes an **all-in-one supplier** which allows for the target of a larger customer base. In terms of revenues, the period 2020-2027 has a **CAGR of 16.7%**.

Bottom Line



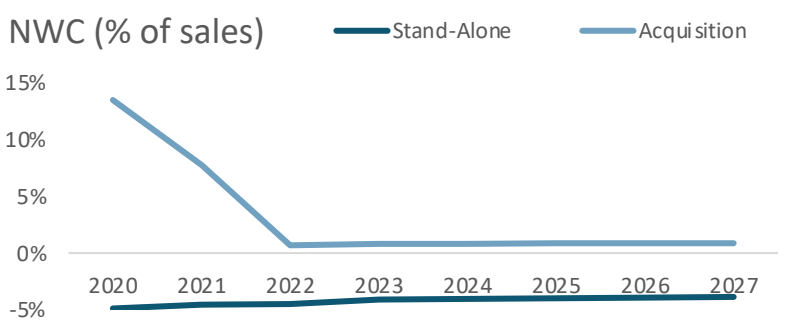
1 Gross Margin (GM)

Materialise already possesses a strong GM when compared to its top competitors. In 2019 Materialise's GM was 61% while Stratasys had a GM of 49%. Post-acquisition, Materialise's **operational efficiency** will contribute to the improvement of Stratasys margins. In addition, the company will also benefit from a **higher bargaining power** with suppliers.

2 EBITDA Margin

In the Stand-Alone scenario Materialise is expected to be able to improve its EBITDA margin at a **CAGR** of **5.2%** between 2020 and 2027. With the acquisition of Stratasys, the company will benefit from **R&D and SG&A synergies**, mainly in the Service Provider segment. This will result in a **CAGR** of around **6.4%** of the EBITDA margin between 2020 and 2027.

Investments



1 Net Working Capital (NWC)

In 2019, Materialise's **NWC** was **-4%** of revenues, meaning a quick generation of cash from operations, while Stratasys had **32%**. Post-acquisition, the company will hold a stronger bargaining power with its customers and suppliers. In the acquisition scenario, from 2020 to 2022 the NWC will fall steadily, until it remains constant at around 1% from 2022-onwards.

2 CAPEX

In the stand-alone scenario CAPEX will slightly decrease from 8% to 3% of sales until 2027. In the acquisition scenario, the CAPEX will require **larger investments** in order to streamline operations across countries. On the other hand, there will also be **divestures** in the geographical areas where both companies are present.

Individual Paper

The overall AM market, valued at $10.4bn in 2019, is expected to grow at a CAGR of 20.3% until 2027

Market Overview I General Market by Segment[1]

AM Industry by Area of Focus

Material Suppliers

DUPONT, EVONIK, METALPINE, 3DXTECH, PYROGENESIS

Software Vendors

LINK3D, materialise, SIEMENS, AMFG, AUTODESK

Service Providers

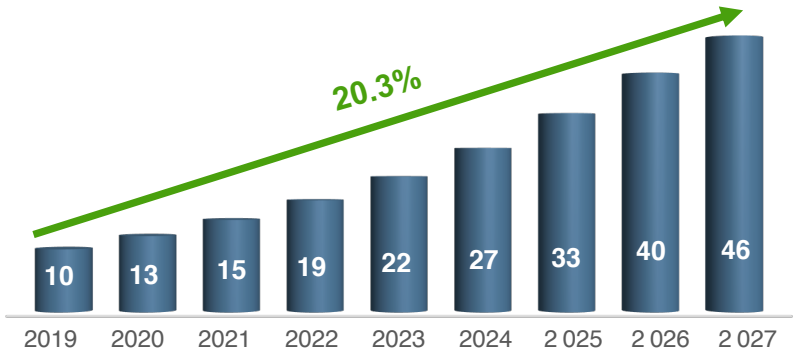
stratasys, 3D SYSTEMS, GE Additive, materialise, hp

Hardware Manufacturers

3D SYSTEMS, hp, ExOne, voxeljet, stratasys, GE Additive

- The AM market is divided into four industries. Within these divisions, Materialise is both a **software vendor** and **service provider**.
- As a service provider, Materialise distributes to multiple industries with special focus to the Medical.

AM Market Forecasts (in $bn)



- The overall AM market is estimated to grow from $10.4bn in 2019 to **$45.7bn in 2027** at a **CAGR of 20.3%**.
- By 2030, **3D printing** is expected to represent **2%** of the **global manufacturing market**.

Additive Manufacturing (AM), also known as 3D Printing (3DP), is a digital process that consists in producing very complex 3D structures with 3D model data. AM involves slicing three dimensional objects in layers and then adding them altogether layer by layer, using several technologies and materials. By contrast, traditional processes begin with a block of material only then removing parts of it in order to create the desired shape.

	Manufacturing Segment	Software Segment	Medical Segment
Forecast	Worth $5.3bn in 2019 this segment is expected to have a **CAGR of 16.9%** until 2025 and to reach **$16.5bn in 2027** at a **CAGR of 11.4%** over these 2 years. Service providers in 2019 represented **50%** of the overall AM market and projections indicate **41%** share in 2027.	The 3D printing software market is expected to grow from USD 470M in 2019 with an estimated **CAGR of 25**% until 2025. From then on, the growth will slowdown to a **CAGR of 15.8% until 2027**, reaching **$2.4bn**.	The Healthcare 3D Printing market was worth USD 1.12bn in 2019 and is expected to reach **USD 3.93bn in 2027**, having a **CAGR of 17.7%.**
Drivers	▪ **Metal** is becoming the most preferred material for 3DP. Its relative low cost, easy processing and resistance are critical traits for the Automotive, Aerospace and Electronics' industries. ▪ **Small Businesses** are emerging as a new market for 3DP service providers. They opt for 3DP solutions to perform visual and functional tests through rapid prototyping at low costs.	▪ **3D printer manufacturers:** New players are initially more focused on the development of hardware than the software component of their 3D printers, leading to an increase in demand for software developers. ▪ **Advances in technology** are increasing the quantity and the complexity of materials in one print run.	▪ **Geographic Expansion:** Despite the US being the largest market, Asia has the highest growth prospects; ▪ **Covid-19:** Supply chain disruptions led to 3DP to be widely utilized worldwide; ▪ **Switch in Manufacturing Processes:** 3DP is taking over traditional manufacturing processes due to being more accurate, durable and have a better performance;

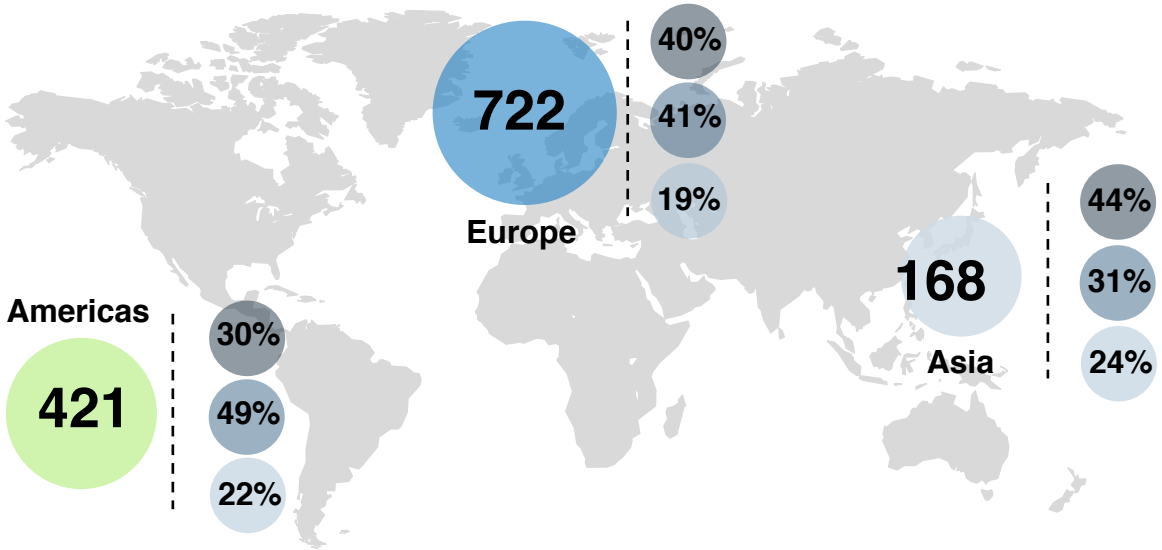
[1]Please refer to appendices 4 to 8 for more detailed information on each market

Sources: AMFG AM Landscape 2019; GlobeNewsWire; InvestorsHub

The AM market is in fast expansion, with the number of players more than doubling in the past 5 years

materialise

Market Overview I The Additive Manufacturing Landscape

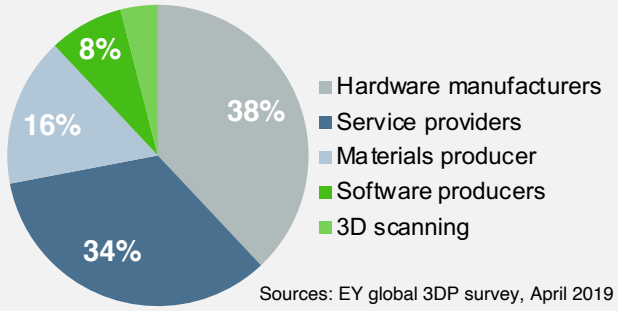


Global AM players landscape

- Materialise is an **established AM player** operating as (1) a **service provider**, offering contract manufacturing, design, engineering or technical consultancy, and as (2) a **software producer.**
- Other established players include:

stratasys 3D SYSTEMS eos

Share of Companies by Area



Sources: EY global 3DP survey, April 2019

Key Trends

- The Additive Manufacturing (AM) industry is **resurging and transforming** itself. Used mainly for **rapid prototyping** during the last decade, companies have found this technology increasingly useful in other areas, such **as industrial applications** with tooling and end-parts as prime examples.
- With **large corporations entering the market**, the landscape is evolving rapidly to the point where we begin to see the adoption of AM in **in-house production**, being incorporated in standard production processes.
- **Software is becoming critical for industrialization** and the workflow sub-segment is key for companies who want to manage and scale their 3D printing activities. An increasing need for greater visibility, centralization and automation will help leverage growth, and Materialise is set to play a key role.
- **Automation** is a key focus across segments in order to gain market share from the overall Manufacturing industry, by reducing the time needed to perform repetitive tasks.
- **Collaborations, partnerships and acquisitions** are expected to become a key trend for large companies who want to accelerate the adoption process of the technology.

What to expect?

1. Focus on **full-scale** industrialization
2. Clients will **in-house** 3DP operations, entering the market & becoming competitors
3. Wider range of **application-specific** materials
4. Increased focus on 3D printing **software development**
5. Shift towards **post-processing automation** due to demand for scalability
6. Increasing **diversity** in the AM landscape

Sources: EY Global 3DP survey 2019; AMFGAM Landscape 2019; GlobeNewswire

Materialise has the necessary tools and conditions to remain competitive in the foreseeable future

Market Overview I Competitive Dynamics

Porter's Five Forces [1, 2]

Competitive Rivalry

- Only 26% of the companies are listed, resulting in high unpredictability.
- Positive industry growth resulting in less completive actions to capture market share.
- Products produced within the industry the company competes in are highly differentiated.

Supplier Pressure

- Limited number of third-party suppliers. There is a standardization of products supplied, being less differentiated and with lower switching costs. The suppliers do not contend with other products within the industry.

Consumer Power

- High product differentiation reduces the threat of substitutability.
- Quality is important to buyers, meaning that buyers in the industry are less price sensitive.
- Increasing threat of buyers moving towards in-house production.

Threat of New Entrants

- Government policies require strict licensing and legal requirements fulfillment.
- Economies of scale are hard to achieve, making production more costly to new entrants.
- The industry requires high capital requirements and expenditure on R&D.
- The software segment, in contrast, has low barriers to entry.

Threat of Substitutes

- Few substitutes are available in the industry Materialise operates in, since the overall product offering is very specialized.
- There has been an increasing inflow of software companies in the market, so the substitutability of software products is expected to increase as well.

Competitive Advantage

- **Intellectual Property (IP):** Patents are essential for players who operate in an industry highly dependent on R&D investments. MTLS portfolio of IP features **290 patents** (expiring between 2020 and 2035) and **157 pending** patent applications (potentially effective for 20 years). Additionally, the company states that the failure or expiration of any **single patent** would not be material to their business or financial position.
- With no clear growth path, **business development** and **application know-how** are key factors for players in this industry, resulting in highly differentiated products. Materialise's unique product offering allows clients to tackle complex business problems that would otherwise have very limited and precarious solutions.

- Compelling financial profile
- Leading 3D printing and medical software provider
- Central positioning in rapidly-growing market
- Forefront of industrial and medical applications
- Diverse, blue-chip customer base with ample space
- Committed, visionary leadership team

USDm	Market Cap.	Revenues '19	Op. Margin	EV/EBITDA
Materialise	1,067	221	3.6 %	29.0x
Proto Labs	2,993	458	17.4 %	16.2x
3D Systems	831	629	(9.1) %	108.2x
Autodesk	51,379	3,138	11.4 %	74.0x
Stratasys	769	636	(1.7) %	11.5x
ExOne	141	53	(28.2) %	126.4x

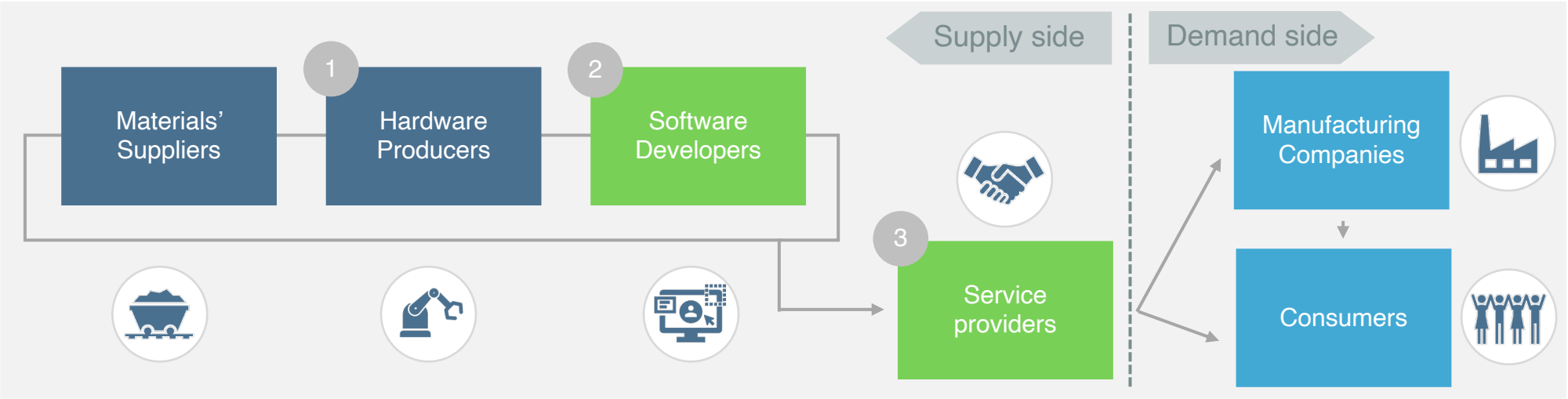
as of Jun 2020

Source: Koyfin.com; Annual Report; [1]Fern Fort University; [2]Essay48

Materialise's value chain is very complex and interdependent on each intermediary

Market Overview I Value Chain Structure

General Value Chain



Legend

- Value Flow
- Materialise's Suppliers
- Materialise's functions
- Materialise's end users

Individuals, companies from the automobile, aerospacial, consumer goods, design, heallthcare, etc industries

Value Chain by product segment

1 3 MANUFACTURING

- Materialise takes the role of Hardware Producer in regards to the Stereolithography technology, despite only producing for in-house utilization.
- This segment works as a Service Provider which utilizes the in-house produced software and procure machines and materials produced by other companies in order to develop its products.
- It provides its 3DP products to purchasers from several industries or even prototypes to individuals and in some cases (RapidFit+ fixtures) to OEMs.

2 SOFTWARE

- This segment works as an OEM as it produces the software tools which will be sold to 3D product manufacturers. They forge partnerships from where they extract the necessary data to produce bundled products tailored to its partners needs.
- This segment's suppliers consist on hardware producers, data engineers with the necessary skills to write the software programs and continuously improve its functionality.

2 3 MEDICAL

- This segment is supplied patients' data as well as the necessary material to produce sugical guides and alike products.
- Materialise takes a role both of an OEM when providing its medical software packages to medical device companies and of service providers when developing its surgical guides and implants that would be supplied to hospitals, research institutes etc.

Source: EY Global 3DP survey 2019

MTLS' price grew 98.6% YoY since September 2019 and rose by 208.9% since its bottom price in March 2020

Company Overview I Stock Performance (2014 - 2020)

IPO: Materialise's Initial Public Offering went through on the 30th June 2014 where 8M shares were sold at 12$, pricing MTLS at $96M. On the 7th July 2014, 1.2M shares from the IPO participant shareholders were sold at 12$, exercising their over-allotment option. The net proceeds of the IPO were used as a working capital buffer, to unfinanced capital expenditures, financing activities and general corporate purposes. On the 23rd of July 2018, MTLS did a public offering of 3M shares at $13 each.

2020

2014 - 2020

Highlights (8 Oct 2020)

PE Ratio = 436.7x

Trailing PE = 597.24x

EPS = 0.1€

52 week range $10.65 - $45.65

$\mathcal{B}$ = 0.77

3D Printing ETFs (eg. CBOE: PRNT, ARKQ) are gaining momentum has the market believes in 3D printing as a way to solve supply chain constraints caused by the coronavirus.

1. **26th Apr'17:** The Materialise World summit was a 2-day conference held in Bruxels where industry leaders of AM would give conferences which boosted Materialise's market recognition.
2. **Dec'18**: MTLS grew 42.3% during the month due to outperforming earnings expectations, announcing 0.04$ per share while the market expected only 0.01$. The market gained traction with this hot stock shich eventually led to its downward trend through January
3. **30th June'20**: End of Q2. Market had high expectations for Q2 results which was felt by the stock rise until the results were released Aug 6th.
4. **4th Mar'20**: Stock price dropped in consequence of the Covid-19 outbreak, as the market fell overall and since its earning announced were undercut by 67% in comparison to analysts projections of 0.03$ per share (even though revenue still increased 3.5% in Q4).
5. **18th May'20**: Market volatility. No specific underlying driver.
6. **30th Jul'20**: The company reported earnings per share of -0.04$ when the market was expecting -0.07$, thus outperforming expectations. Its Q2 results translate a 21.3% decrease in revenue.
7. **21st Sep'20**: Materialise announced it would make a strategic investment in Ditto aiming to develop a virtual eyewear try on platform. **2nd Sep**: MTLS reached a 52-week high.

https://www.marketbeat.com/instant-alerts/nasdaq-mtls-consensus-analyst-rating-2020-09/

The AM Services market, valued at $5.3bn in 2019, is expected to reach $16.5bn until 2027

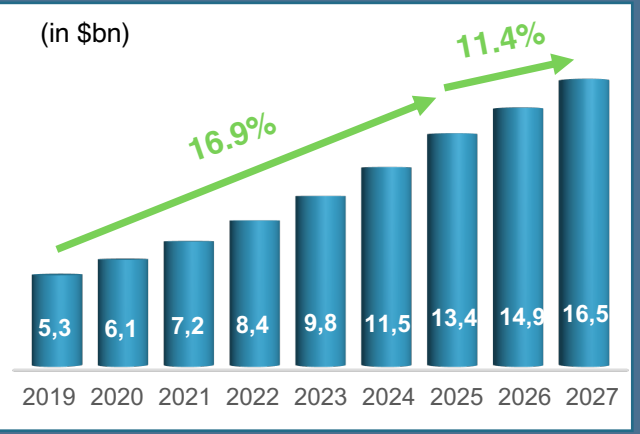
Market Overview I 3D Printing Services

AM Services Market

- Acquiring 3D printers requires **great capital investment** for companies, since it involves hiring experienced staff, buying software licenses, purchasing special materials and other maintenance costs.
- Bearing this in mind, companies end up recurring to 3D printing service providers, which give them access to **rapid prototyping**, **end-use production** and **visualization tools** at lower costs.
- 3D printing service providers allow customers to **customize their products** according to their needs and wants. Moreover, typically they work together with customers sharing their expertise and knowledge in **solving complex design problems** that may arise during the printing process.

Forecasts

- The AM Services market is estimated to grow from $5.3bn in 2019 to **$13.4bn in 2025** at a **CAGR of 16.9%** and to **$16.5bn in 2027** at a **CAGR of 11.4%** the last 2 years.
- Service providers in 2019 represented **around 50%** of the overall AM market, while in 2025 they are expected to lower their share to 41%.



Market Drivers

- **Small Businesses** are emerging as a new market for 3D printing service providers. Small companies opt for 3D printing solutions as they can perform visual and functional tests through rapid prototyping at relatively low costs.
- **Metal** is becoming the most preferred material for 3D printing. It's relative low cost, easy processing and resistance are critical traits for the Automotive, Aerospace and Electronics' industries.
- **Increasing Competition**, as Hardware manufacturers are slowing entering the AM services market, which allows them to target a larger market by selling 3D printers and offering 3D printing services to the same clients.
- **Increase in private-public funding** for 3D printing;
- **From Prototyping to End-use production:** Prototyping is the greatest source of revenue for most 3D printing service providers. However, in recent years there has been a shift in the 3D printing service market towards end-use production. As technology and quality control of 3D printers evolves, companies are starting to rely more on 3D printed customized production ready to use.
- **Geographic expansion**: North America, more specifically the US, is expected to continue to be global leaders in 3D printing. However, the Asian-Pacific region is growing fast with China aiming to become leader in 3D printing service providers. Finally, the Middle East presents great opportunities for 3D service provider companies, especially in the aerospace, medical and construction industries.

Segmentation

The market is segmented by 1**) Process:** Powder Bed Fusion, Binder Jetting, Material Extrusion, Sheet Lamination, Vat Polymerization and others; **2) Technology:** Sintering, Direct Metal Laser Sintering, Stereolithography and others; **3) Material:** Biochemical, Thermoplastic, Metal, Ceramic and others; **4) Application:** Aerospace, Art & Fashion, Automotive, Healthcare, Construction, Consumer products, Education, Equipment and others.

Key Players

Source: 3DP Media Network

3D printing software market is expected to grow at a CAGR of 25.1% until 2025 and 15.8% until 2027

Market Overview I 3D Printing Software

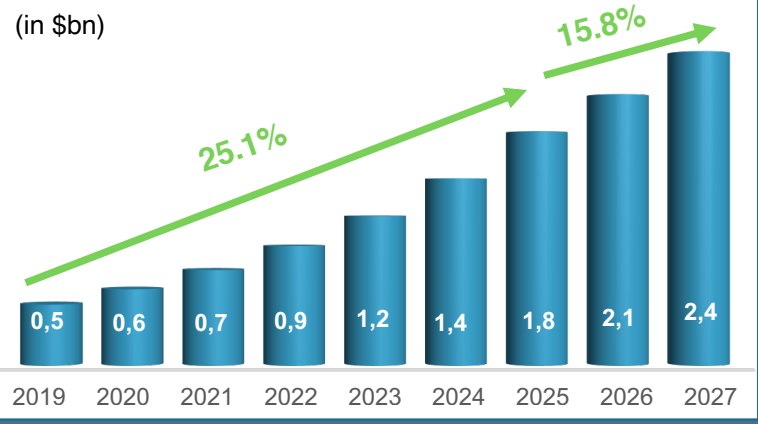
Software Market

The global 3D Printing software market is tied to the growth of the overall additive manufacturing sector. It is directly linked with both **Manufacturing Segment** and **Medical Segment.**
3D printing software encompasses all software required on the process of creating 3D printed products including:

- Process simulation
- Design
- Digital platforms
- Workflow and CAD-model slicing

Forecasts

- The 3D printing software market is expected to grow from **$470M in 2019** to achieve **$1.8bn in 2025** with an estimated **CAGR of around 25%**. From then on, growth will slowdown to a **CAGR of 15.8% until 2027**.



Market Drivers

- **Complex machines**: Increasing number of production centers across this industry running more complex mixes of machines from different manufacturers and based on various technologies.
- **Complex and customized end parts**: 3D printing will be increasingly used for the manufacturing of complex or customized end parts that are fabricated around a specific workflow pattern.
- **3D printer manufacturers:** The number of 3D printer manufacturers is increasing with certain new players initially focusing more on developing hardware than the software component of their 3D printers, what leads to an increase in demand for software developers.
- **New customers**: Besides manufacturers, **designers, artisans and individuals** are betting on the cutting-edge technology of 3D printing to create objects for numerous applications.
- **Application-specific tools**: In 2021 almost 30 percent of the 3D printing software market will come from tools designed specifically for anatomical models, surgical guides, consumer products, and others.
- **Metal printing:** Metal is among the biggest drivers of the additive manufacturing industry what will drive the growth in demand for **metal printing technologies**
- **Technology advances:** Due to the advances in technology, it has been possible to use more and more different materials simultaneously in one print run as well as to integrate multiple materials and complex shapes.

Segmentation

The market is segmented by 1) **Technology**: scanning for reverse engineering, CAD, CAE, CAM and others; 2) **Application:** printer-specific software solutions developed by printer hardware manufacturers, leading-edge software tools for generative design, mass customisation and multi-material printing; 3) **End user**: Manufacturers in industries such as Aerospace, Art, Automotive, Healthcare, Construction, Consumer products and others, R&D departments, 3D printing OEMs.

Key Players

AUTHENTISE · AMFG · AUTODESK · 3YOURMIND · stratasys · LINK3D · 3DPrinterOS Cloud 3D Printer Management · materialise · 3DSIM

Source: 3DP Media Network

3D printing in Healthcare, valued at USD 1.12bn in 2019, is expected to grow at a CAGR of 17.7% until 2027

materialise

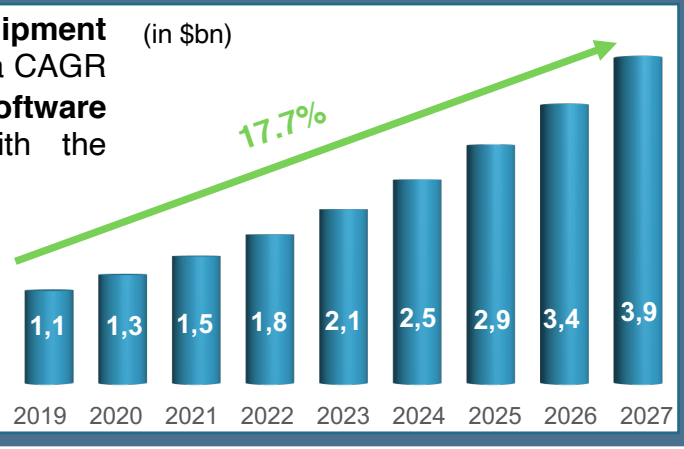
Market Overview I 3D Printing Medical

Medical Market

The medical applications of 3DP are complex structures as surgical guides, custom-made for a patient's specific anatomy, surgical instruments, implants & prosthetics (orthopaedic, orthotic and dental devices), and bioprinting organic objects like skin, bones, organs through stem cells (tissue engineering). 3DP enables:

- Patients: to be under anaesthesia for less time, lower risk of infection and higher probability of success; a faster recovery and shorter hospital stay;
- Physician: surgeries will take less time by using patient-matched devices instead of trying to customize a generic tools to the patients anatomy; the higher predictability enables surgeons to plan ahead thus lowering operating risks and increasing their success rates. Preclinical drug testing is being revolutionized as 3DP organs substitute animal testing;

- From 2020 to 2026, the **equipment segment** is meant to have a CAGR of 16% while the **software segment** would grow with the highest CAGR of 19%.
- The **APAC** medical device market was valued at USD 117M in 2017 and is anticipated to grow to USD 600M till 2026 at a CAGR of 19%.



Forecasts

Market Drivers

- **Manufacturing Processes Switch**: Demand for 3DP's perfect matched products is rising, as they entail flawless customizations, more affordable and less time consuming than traditional manufacturing processes; Orthopaedics and the dental industry are shifting to 3DP implants due to better durability, accuracy and performance;
- **Geographic expansion**: The Asia-Pacific Region is expected to grow at the highest CAGR worldwide as there has been the establishment of 3DP training, research and education centres, thus propelling the larger players to expand their operations and distribution networks into this market; Nonetheless, the US still dominates the medical devices market in terms of revenues and Europe is the 2nd largest market;
- **Demographics:** The Increase of the geriatric population expands the market for joints replacements and other prosthetics and implants, including organs transplant, thus boosting the Bioprinting segment;
- **End users attractiveness:** Hospitals are expected to absorb over half of the 3DP medical devices market share;
- **Strict Regulatory guidelines:** Despite FDA approval being easier as the market matures, several socio-ethical concerns arise due to the lack of quality assurance and process control driven by the lack of trained and specialised professionals in the area. More complex devices must comply with a larger set of guidelines.
- **Covid-19**: The shortages of medical supplies and equipment worldwide gave the opportunity to 3D manufacturers to support production and demonstrate their worth in quality and speed.

Segmentation Division

The market is segmented by 1) **Type of Product**: Surgical Guides, Surgical Instruments, Implants & Prosthetics, Tissue Engineering, by 2) **Application**: Dental, Spine, Orthopaedic, Hearing and others, by 3) **Technology**: Stereolithography, Selective Laser Melting, Fused Deposition Modelling, Digital Light Processing and others, by 4) **Raw Materials**: Metals and Alloys, Plastics, Biomaterial and others and by 5) **End User**: Hospitals, Research & Diagnostic Centres, Academic Institutions.

Key Players

stratasys, 3D SYSTEMS, RENISHAW apply innovation™, BMi, envisionTEC, materialise, 3T additive manufacturing, PRODWAYS GROUP, EOS, Arcam A GE Additive Company, CONCEPTLASER a GE Additive company

Source: Markets and Markets; Verified Market Research; The Business Research Company; Research and Market

Hardware Manufacturing market, valued at $2.9bn in 2019, is expected to grow to $11.4bn in 2027

materialise

Market Overview I 3D Printing Hardware

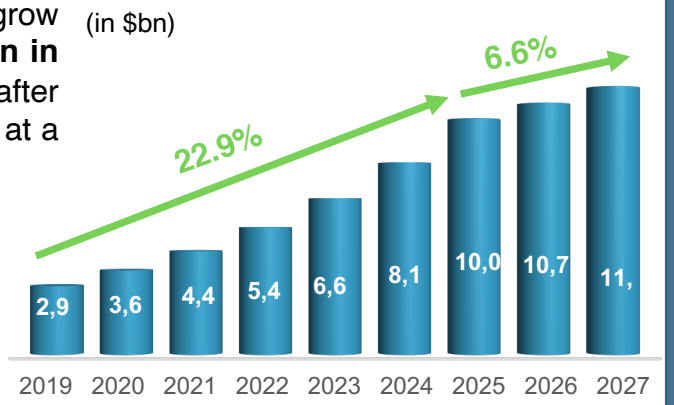
HM Market

- Hardware or Systems Manufacturers are considered the backbone of the AM value chain as they are the ones who **produce the 3DP machines**.
- They work as **suppliers** in the AM market of Polymer, Metal, Desktop, Composite, Electronics and Ceramic machines. Their clients can be **3DP Service Providers** or **Manufacturing companies** that want to start in-house production for rapid prototyping, visualization tools or end-parts.
- Each 3D printer has its own **specifications**: "build size/printing area, layer thickness, machine size and weight, production speed, operating conditions of temperature and humidity, power requirements and accuracy"*, and its own **technology:** Material Jetting, FDM and Stereolithography and other.

*source: Stratasys Ebook on 3D printers

Forecasts

- This market is estimated to grow from $2.9bn in 2019 to **$10bn in 2025** at a **CAGR** of **22.9%**, after which growth will be residual at a CAGR of **6.6% until 2027**.
- This market accounted for **28%** of the overall AM market **in 2019**, while in 2027 this is expected to slightly decrease their share to **25%**.



Market Drivers

- As production processes are shifting from traditional manufacturing into 3DP and as the AM industry gains traction, companies are starting to use 3DP services. This will greatly benefit Hardware Manufacturers, as companies will gain the know-how to use and acquire their own 3DP machines for **in-house production**.
- **Metal** is becoming the most preferred material for 3D printing. It's relative low cost, easy processing and resistance are critical traits for the Automotive, Aerospace, Construction and Electronics' industries.
- In recent years, there was a growing trend in the number of **partnerships** in the AM market. Hardware Manufacturers highly contributed to this trend by entering in collaborative agreements mainly with Material Suppliers and large manufacturing companies. The motives behind the development of these partnerships involve: "identifying new applications, developing new materials, integrating software in their own 3DP machines, improving 3DP techniques and gaining experience in a specific field."*
- AM players are expanding their roles in the value chain. Hardware manufacturers are slowing entering the AM services market, which allows them to target a larger market by offering 3DP services and afterwards selling 3D printers to the same clients. This trend is set to take a long course as well-established AM players are moving towards **vertical integration** of material suppliers and software producers in order to benefit from cross-selling, cost synergies and targeting a larger customer base as **all-in-one suppliers**.

Segmentation

The market is segmented by **1) Machine type:** Polymer, Metal, Desktop, Composite, Electronics and Ceramic; **2) Process:** Powder Bed Fusion, Binder Jetting, Material Jetting, Direct Energy Deposition Material Extrusion, Sheet Lamination, Vat Polymerization and others; **3) Technology:** Selective Laser Sintering, Direct Metal Laser Sintering, Multi Jet Fusion, Stereolithography, Digital Light Processing, Fused Deposition Modeling (FDM) and others;

Key Players

stratasys, 3D SYSTEMS, formlabs, envisionTEC, Carbon, hp, eos, XYZPRINTING, SLM SOLUTIONS, ExOne, GE Additive

Source: 3DP Media Network

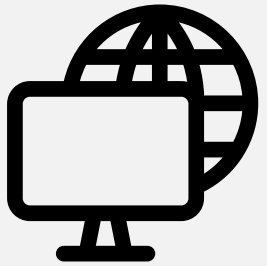
Closed vs. Open-Sourced Systems: Their importance in the Additive Manufacturing context

Individual Reflection

Open-Sourced System

- Free choice of material
- Compatible with all 3D software
- Free choice of supplier
- Adjustable Temperature
- Provides access to third-party developers

Closed System



- Limited choice of material
- No software choice
- Permanent supplier
- Fixed Temperature
- Higher reliability and consistency

Impact on Consumer Choice

- **High prices and cost of investments** pose as one of the biggest barriers to entry for consumers who wish to apply AM technologies in their production processes. With very **few open-sourced solutions** available in the market, consumers can't take advantage of this alternative that is know to provide more flexibility in terms of software and material choice.
- Consequently, this results in more **companies contracting service providers** since they offer relatively lower prices when compared to in-house production, but it is expected that over time **open-sourced software becomes more accessible**, driving the liberalization of materials supply and boosting competitiveness. This **could potentially hurt service providers** such as Materialise, not only in terms of prices but also regarding the flexibility of their services in order to compete with these alternatives. The reason it hasn't happened yet is due to manufacturers of closed-systems having strong positions in the value chain, allowing them to remain dominant. Additionally, although more expensive, closed system providers often offer more reliability in their products as they are specifically designed for specific purposes, while open-sourced can be more challenging to new consumers.

What is at stake?

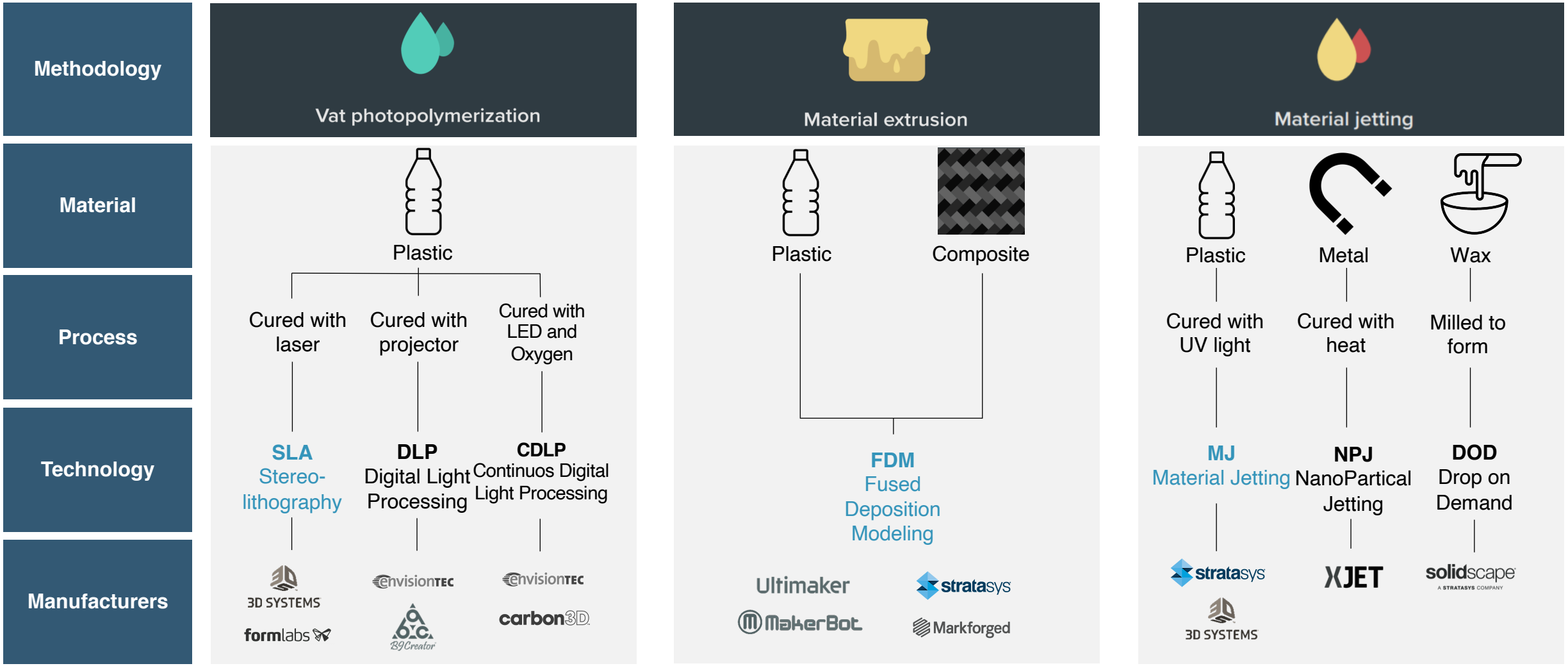
- With some large players already providing open-sourced systems, such as Stratasys, 3D Systems, Ultimaker or Formlabs, we have seen how beneficial this can be to AM technology since it **allows for external contributors to improve the product itself**. Additionally, **open-source system providers also benefit from other's R&D** in some way. Nevertheless, it is crucial that these companies give back to the community in order to keep development efforts balanced, since the company itself will benefit the most from this with its power to commercialize products that benefit from this R&D.
- While **open-source is a very attractive option in terms of marketing, shared R&D efforts** and we have to some extent product inoculation (i.e. less risk of rejection from consumers, since they can be improved), **the benefits of patenting are also evident** and eventually most companies must switch to closed systems due to cash flow commitments, growth and overall long-term sustainability. In essence, **open-source solutions can be very disruptive** and attractive to up-and-coming companies, but in order to reach a larger player status, **patenting becomes crucial** and thus reverting to closed systems.

materialise

Appendices

Materialise uses the Stereolithography, FDM and Material Jetting tecnhologies

Appendix 1 I Technologies Framework

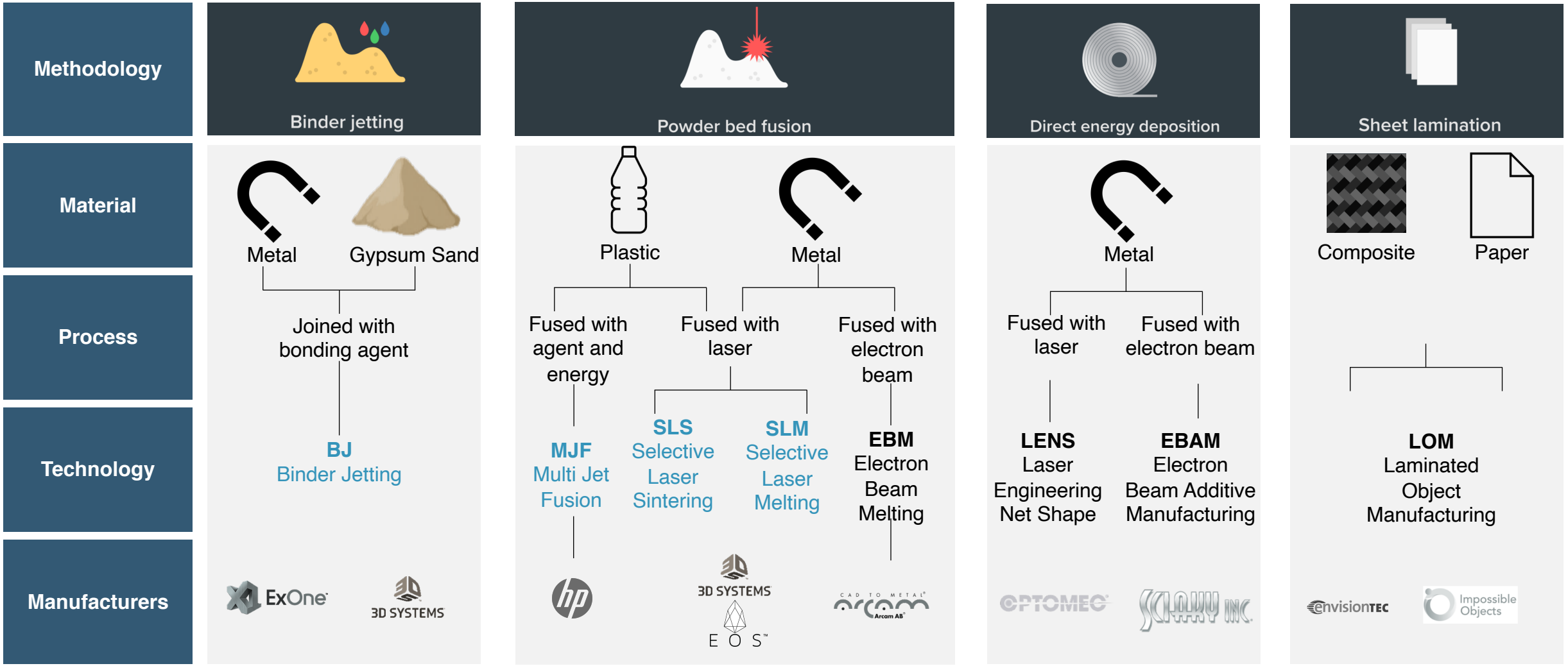


*techonology used by Materialise

Source: 3D HUBS: Additive manufacturing technologies - An overview

Binder Jetting, Multi Jet Fusion, SLS and SLM are some of the technologies used by Materialise

Appendix 2 I Technologies Framework



*techonology used by Materialise

Source: 3D HUBS: Additive manufacturing technologies - An overview

Patenting leads companies to develop their own technologies and these are some of the most commonly found

Appendix 3 I Technologies Framework

	Technology	Application	Materials Used
Stereo-lithography (STL)	The most popular technique in Additive Manufacturing. It simply consists in the conversion of photosensitive liquid into 3D solid plastics using a low-power laser and photopolymerization.	▪ Prototypes for various types of testing ▪ Investment Casting Patterns ▪ Optics, transparent covers & complex parts	▪ Poly1500; ProtoGen White; TuskXC2700T; Tusk kXC2700W; Taurus; Xtreme;
Fused Depos. Modeling (*FDM*)	One of the less costly techniques. FDM printers use a thermoplastic filament, which is heated to its melting point and then extruded, layer by layer, to create a solid object.	▪ Models used in early stages of product development ▪ Functional prototypes for testing purposes ▪ Manufacturing tools and end-use parts	▪ ABS; ABS-ESD7; PC; PC-ABS; Ultem 9085; ABSi; ABS-M30; ABS-M30i
Material Jetting *(or PolyJet)*	Considered as one of the fastest and most accurate 3D printing technologies. The process consists in jetting photopolymer droplets onto a build platform and solidifying them with a UV light.	▪ Prototypes for form-and-fitting testing ▪ Tooling patterns for plastic parts ▪ Thin walls and complex geometries	▪ Vero; VeroClear; Composite materials
Binder jetting (*or Powder Binding*)	This technology consists of spraying a liquid binder onto a bed of powder, solidifying the cross section of the piece, layer by layer. It is possible to print in color using this technology.	▪ Full color, realistic looking models ▪ Steel objects, mostly jewelry	▪ Sand; 420SS/BR steel; Titanium; Inconel; Copper
Multi Jet Fusion	One of the most cost-effective technologies. This innovative technology prints quickly while enabling extreme precision and dimensional accuracy.	▪ Cost-effective alternative to injection molding ▪ Prototypes for various types of testing ▪ Complex and lower-cost end-use parts	▪ Ultrasint TPU 90 A-01; PAS 12 (MJF)
Selective Laser Sintering (*SLS*)	Relatively new technology that uses a laser to sinter powdered material, aiming the laser automatically at points in space defined by a 3D model, binding the material together to create a solid structure.	▪ Mechanical prototypes ▪ Personalized manufacturing ▪ Low-volume production of component parts	▪ Ultrasint PA6 MF; PA 2210 FR; Polypropylene (PP); PA-AF (Aluminum Filled); PA 12 (SLS); PA-GF; PA 2241 PR
Selective Laser Melting (*SLM*)	Consists in the use a high power-density laser to melt and fuse metallic powders together. It is like SLS, however, it allows to fully melt the metal material into a solid 3D part.	▪ Fully functional prototypes ▪ Production tools ▪ Rigid Housing	▪ Aluminum (AlSi10Mg); Titanium (Ti6Al4V); Stainless steel (SS316L); Inconel (IN718)
Vacuum Casting	This process starts from a master model, typically using Stereolithography or Laser Sintering, then a silicone mold is produced by casting silicone around the master copy. After, the master is removed, leaving a cavity to make copies.	▪ Pre-launch product testing ▪ Small series of housings and covers ▪ Concept models and prototype	▪ Rubber-like polyurethanes, ABS-like polyruthanes, PE/PP-like polyruthanes

Source: 3D HUBS: Additive manufacturing technologies - An overview

Bibliography (1/2)

1) Company-related sources:

- "3D Printing Software And Services". 2020. Materialise. Accessed September 10. https://www.materialise.com/.
- 2020. Investors.Materialise.Com. Accessed September 17. https://investors.materialise.com/static-files/598b4b50-3c22-4503-8661-509ae1e0b6ba.
- "Investor Relations | Materialise NV". 2020. Materialise NV. Accessed October 7. https://investors.materialise.com/investor-relations.
- "Stratasys: 3D Printing & Additive Manufacturing". 2020. Stratasys. Accessed October 16. https://www.stratasys.com/.
- Proto Labs Inc. 2021. *Investor Home | Proto Labs Inc*. [online] Available at: https://protolabs.gcs-web.com/.
- Annualreports.com. 2021. *Materialise NV - Annualreports.Com*. [online] Available at: https://www.annualreports.com/Company/materialise-nv.

2) Financial Information:

- Koyfin.com. 2021. *Koyfin | Free Comprehensive Financial Market Data For Investors*. [online] Available at: https://www.koyfin.com/index.
- McKinsey & Company. "Valuation: Measuring and Managing the Value of Companies, 7th Edition: Strategy & Corporate Finance."
- Deloitte & Touche. 2016. "Selling, General & Administration (SG&A) Cost Reduction Focus."
- Deloitte AG. 2017. "Unlocking The Full Potential Of M&A". St. Gallen.
- McKenna, B., 2020. *Why This 3D Printing Stock Soared 42% In December | The Motley Fool*. [online] The Motley Fool. Available at: https://www.fool.com/investing/2019/01/12/why-this-3d-printing-stock-soared-42-in-december.aspx.
- MarketBeat. Accessed October 25. https://www.marketbeat.com/instant-alerts/nasdaq-mtls-consensus-analyst-rating-2020-09/

3) Market Reports:

- "3D Printing Medical Devices Market Size, Industry, Analysis & Forecast". 2020. Verified Market Research. Accessed October 14. https://www.verifiedmarketresearch.com/product/3d-printing-medical-devices-market/.
- Global 3D Printed Medical Devices Market Data And Industry Growth Analysis". 2020. Thebusinessresearchcompany.Com. Accessed October 14. https://www.thebusinessresearchcompany.com/report/3d-printed-medical-devices-global-market-report.
- Assets.ey.com. 2019. *3D Printing: Hype Or Game Changer?*. Available at: https://assets.ey.com/content/dam/ey-sites/ey-com/en_gl/topics/advisory/ey-3d-printing-game-changer.pdf
- "Global Additive Manufacturing Market 2019 Worth Over $10 Billion". 2020. 3D Printing Media Network - The Pulse Of The AM Industry. Accessed October 4. https://www.3dprintingmedia.network/the-additive-manufacturing-market-2019/.
- Market, 3D. 2020. "3D Printing Medical Devices Market - Global Forecast To 2022 | By Technology, Component & Product Type". Marketsandmarkets.Com. Accessed October 11. https://www.marketsandmarkets.com/Market-Reports/3d-printing-medical-devices-market-90799911.html.
- Markets, Research. 2020. "Global 3D Printing Medical Device Market (2019 To 2026) - Growth In The Ageing Population Worldwide Presents Opportunities". Globenewswire News Room. https://www.globenewswire.com/news-release/2020/04/28/2023150/0/en/Global-3D-Printing-Medical-Device-Market-2019-to-2026-Growth-in-the-Ageing-Population-Worldwide-Presents-Opportunities.html.

Bibliography (2/2)

- Reports and Data, h., 2020. *Additive Manufacturing Market Report | Global Analysis & Forecast*. [online] Reportsanddata.com. Available at: https://www.reportsanddata.com/report-detail/additive-manufacturing-market.
- 3D HUBS: Additive manufacturing technologies - An overview. Accessed October 11. https://www.3dhubs.com/knowledge-base/additive-manufacturing-technologies-overview/#vat-photopolymerization
- Markets and Markets:3D Printing Medical Devices Market. Accessed October 24 https://www.marketsandmarkets.com/Market-Reports/3d-printing-medical-devices-market-90799911.html
- Verified Market Research: 3D Printing Medical Devices Market Analysis. Accessed October 24. https://www.verifiedmarketresearch.com/product/3d-printing-medical-devices-market/
- The Business Research Company: 3D Printed Medical Devices Global Market Report 2020-30: Covid 19 Growth And Change. Accessed October 24. https://www.thebusinessresearchcompany.com/report/3d-printed-medical-devices-global-market-report
- Research and Market: Global 3D Printing Medical Device Market Outlook 2027. Accessed October 26. https://www.globenewswire.com/news-release/2020/04/28/2023150/0/en/Global-3D-Printing-Medical-Device-Market-2019-to-2026-Growth-in-the-Ageing-Population-Worldwide-Presents-Opportunities.html
- 3DP Media Network: Accessed December 10. https://www.3dprintingmedia.network/the-additive-manufacturing-market-2019/

4) Other related sources:

- Ge.com. 2021. *What Is Additive Manufacturing? | GE Additive*. [online] Available at: https://www.ge.com/additive/additive-manufacturing.
- "Materialise NV [SWOT Analysis] Weighted SWOT Matrix". 2020. Fern Fort University. Accessed October 6. http://fernfortuniversity.com/term-papers/swot/nyse/3740-materialise-nv.php.
- IATA: 2020 Forecasted losses in the Aerospace Industry. Accessed November 1. https://www.iata.org/en/pressroom/pr/2020-06-09-01/
- Counterpoint Research: COVID-19 Impact On Global Automotive Industry in 2020. Accessed November 1. https://www.counterpointresearch.com/weekly-updates-covid-19-impact-global-automotive-industry/
- Institute of Supply Management (ISM): COVID-19 Impact on manufacturing in 2020 Accessed November 1. https://azbigmedia.com/business/heres-the-impact-covid-19-will-have-on-manufacturing-in-2020/
- AMPower Report. Accessed November 2. https://additive-manufacturing-report.com/analysis/corona-impact/
- Rtoz.org. 2021. *3D Printing – Rtoz.Org – Latest Technology News*. [online] Available at: https://www.rtoz.org/category/3d-printing/.
- Corporate Finance Institute. Accessed November 15. https://corporatefinanceinstitute.com/resources/knowledge/strategy/pestel-analysis/; https://sites.google.com/site/headinthecloudsconsultancy/pestle-analysis
- HP's website. Accessed December 20. https://press.hp.com/us/en/press-releases/2019/hp-opens-new-3d-printing-and-digital-manufacturing-center-of-excellence.html?utm_campaign=Binder%20Jetting&utm_content=93919295&utm_medium=social&utm_source=linkedin&hss_channel=lcp-163996