GREATER EFFICIENCY, LOWER COSTS AND FASTER BUSINESS GROWTH THROUGH 3D SAND PRINTING

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20.09.2024

ExOne™

ABOUT EXONE

About ExOne

Sand binder jet 3D printing leadership for 25+ years

ExOne is part of #TeamDM on a mission to deliver production-capable 3D printers, materials, and applications

History

- Founded 1995
- Operations in Europe, Asia, and the Americas
- Acquired by Desktop Metal in 2021

We sell machines and services

- Machine engineering and manufacturing for sand and metal printers
- Sand molds and cores on-demand
- High density metal parts on-demand

Industrial markets

Foundries | Automotive Aerospace | Defense | Medical
Energy | Heavy Equipment | Architecture | Construction

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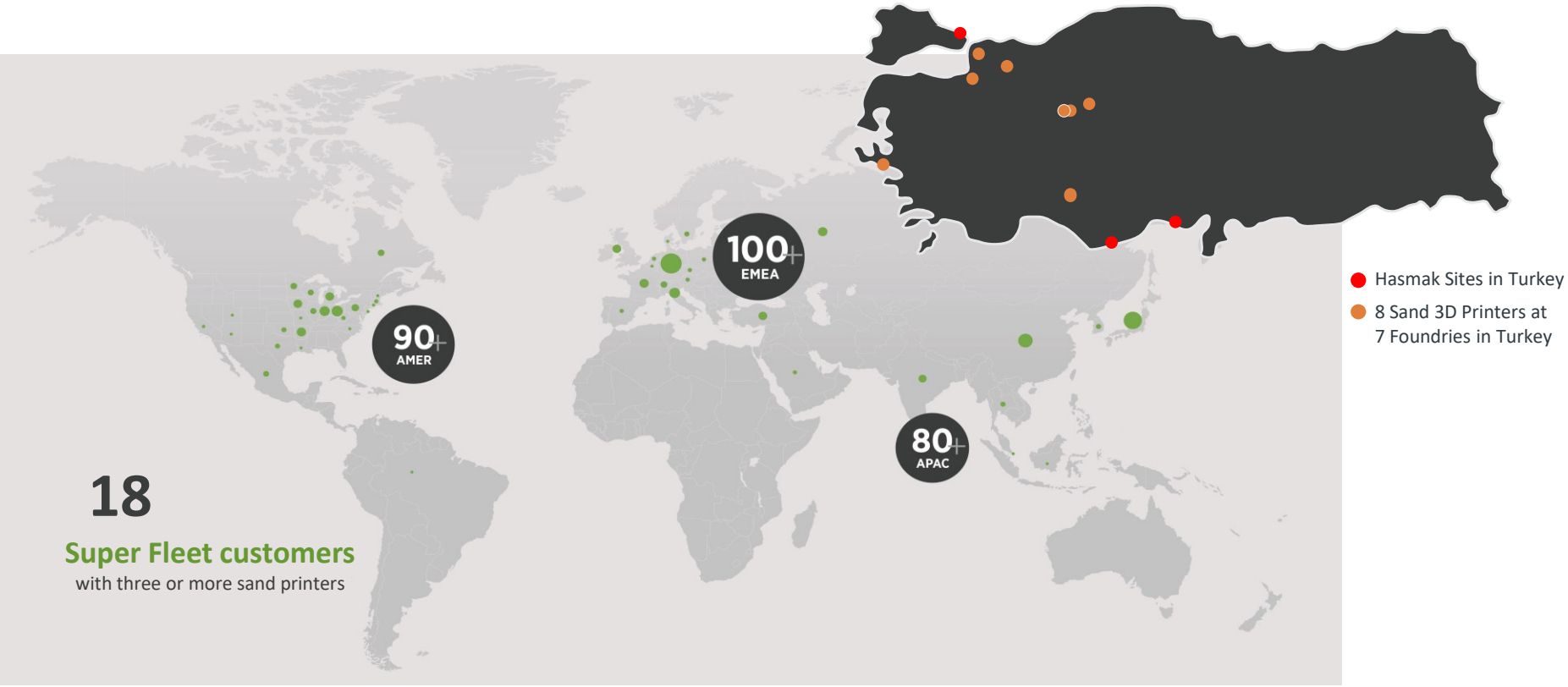
The World's Most Trusted Sand 3D Printing Systems

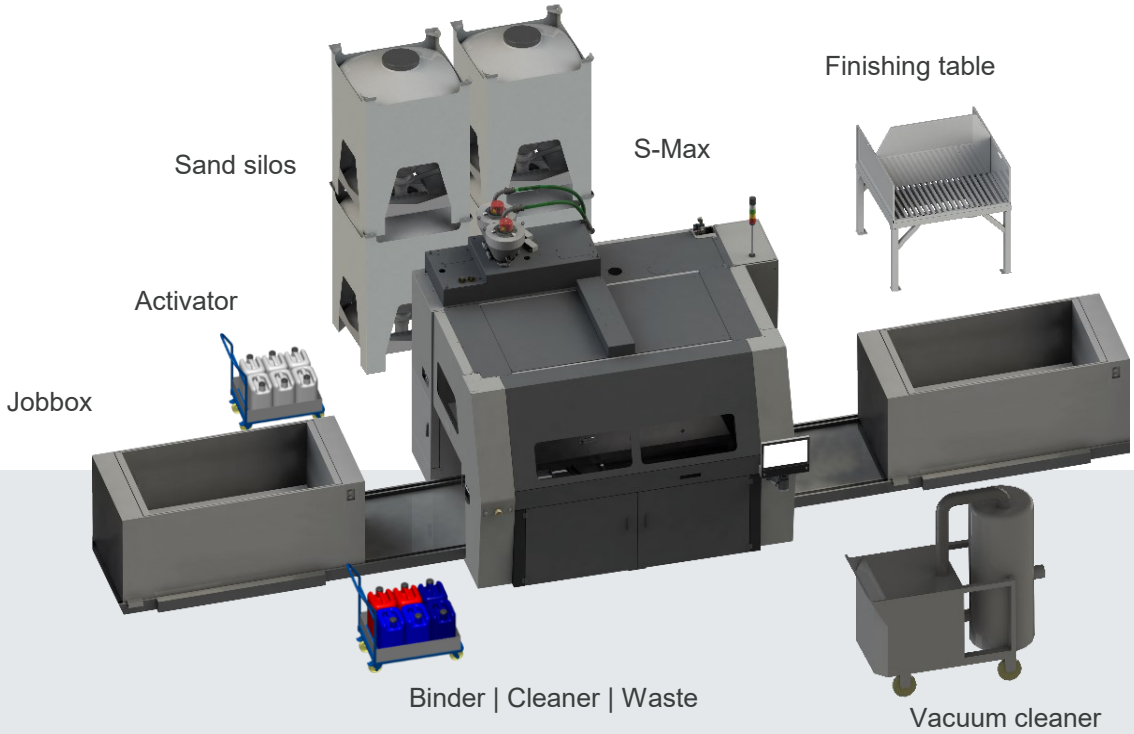


INTRODUCTION BINDER JETTING

Benefits of sand 3D printing

S-Max® Basic printing setup

- Double job box option
- For continuous 24/7 production
- Ideal for all cold hardening binder systems
- All-new automated industrial printhead
- Jobbox on motorized roller conveyor



Technical Specifications

Job box (L x W x H):	1,800 × 1,000 × 700 mm (70.9 × 39.4 × 27.6 in)
Build volume	1,260 l
Build rate *	up to 125 l/h
Layer height **	0.2 to 0.5 mm
Dimensional accuracy ***	+/- 0.5 mm

*Depending on layer height.
** Depending on material.
*** Depending on part size and geometry (0.1% of part size)

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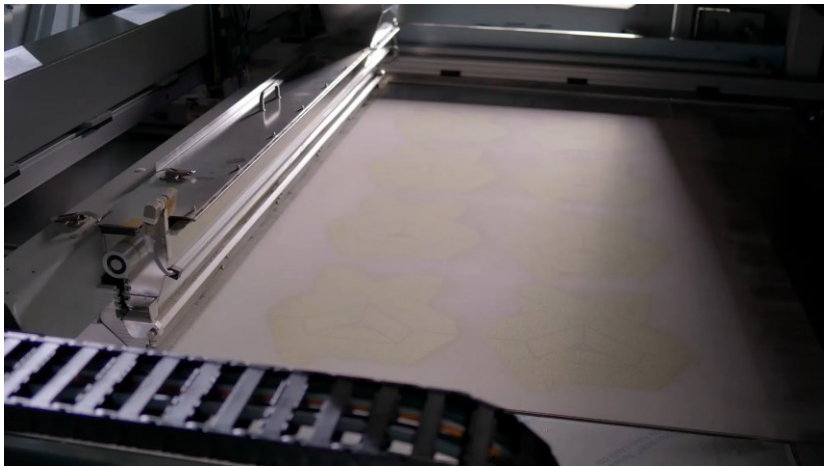
Introduction Binder Jetting

Binder Jetting Furan Process

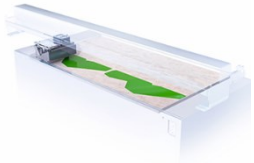
Video



Step 01

Apply sand

The recoater first applies the first layers of sand to the bottom of the job box.



Step 02

Apply binder

The printhead selectively prints a first layer of binder onto the activated sand.

Step 03

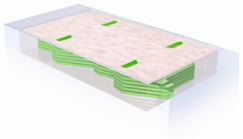
Lower platform

The construction platform in the Jobbox is lowered by one layer height.

Step 04

Apply sand

The recoater applies another layer of activated sand.



Step 05

Repeat

Steps 2-4 will be repeated up to the last layer of the whole printjob.

Step 06

Complete

The loose sand is removed from the job box and the printed parts are removed. A subsequent heat treatment is necessary for certain binder systems.

REASONS FOR USING THIS TECHNOLOGY

Reasons for using this technology

Hybrid Molding

Casting requirements

Create / analyze CAD + part design

CONVENTIONAL MOLD

Design pattern for mold

Manufacture pattern

Produce cope and drag

1-few weeks

PRINTED CORE

Create 3D design of core

Print core

12-24 hours

Assembly of mold and core

Post-process

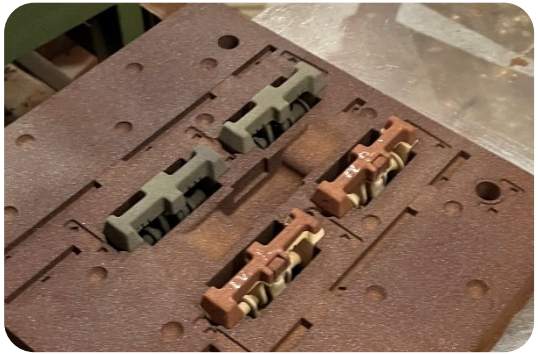
Pour casting

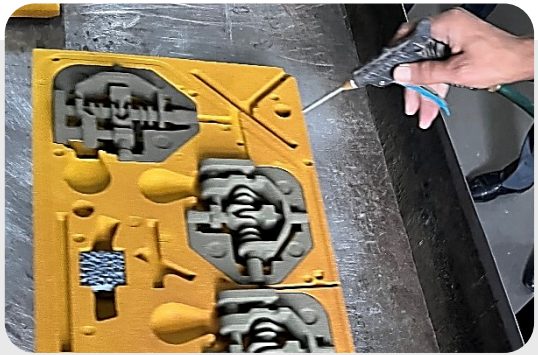
Eliminate time- and labor-intensive processes:

- ✕ Design core boxes
- ✕ Manufacture core boxes
- ✕ Assemble cores

Reasons for using this technology

Hybrid Molding

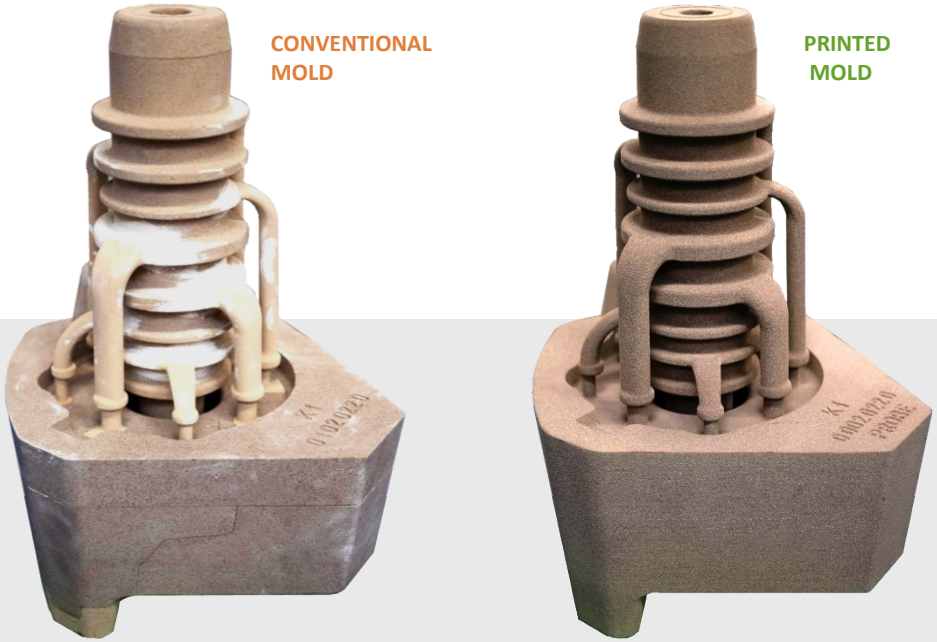




- The complex internal geometry of a casting usually presents the biggest challenge in production
- Large sand volumes can often be produced easily and economically using traditional manufacturing processes
- Small to medium sized complex parts are highly suitable for production using sand printers and enable production from very small quantities to series production

Reasons for using this technology

Core consolidation / reduction of the core package



- Core consists of several individual parts and must be assembled manually with core glue
- Increased risk for gas defects by more organic amount due to core glue
- Formation of flash on the contact surfaces on the casted part which must be removed in a time-consuming and cost-intensive process

Reasons for using this technology

Quality Improvement by core consolidation

Impeller Core via Core shooting machine

- Core consists of several individual parts and must be assembled manually with core glue
- Increased risk for gas defects by more organic amount due to core glue
- Formation of flash on the contact surfaces on the casted part which must be removed in a time-consuming and cost-intensive process

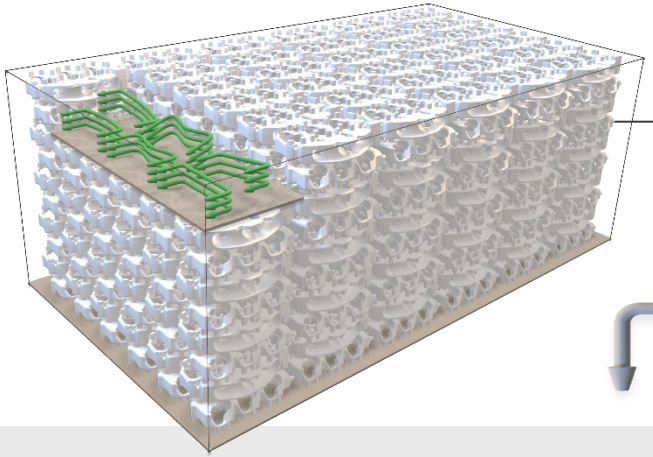
Printed Impeller on S-Max Printer

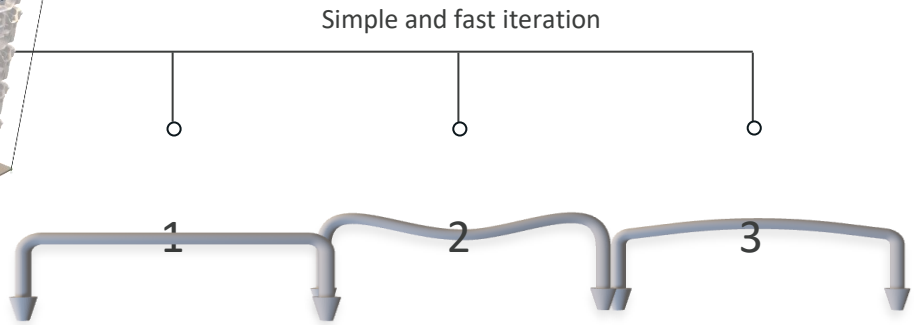
- Single core with closed surface which can be inserted directly into the mold
- No risk for casting defects cause by additional gas
- No or significantly reduced reworking on casted part necessary

Reasons for using this technology

Fast go to market by fast development or PoC

Produce different designs in one step only by changing CAD files





Digital manufacturing process

CAD-Design of casting according to casting requirements → CAD-Design of molds and cores → Printing mold and cores → **Assembly and casting**

Note

AM can be also used as a bridge technology

timeline based on the complexity		
low	medium	high
1 – 2 days	3 – 6 days	6 – 10 days

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Reasons for using this technology

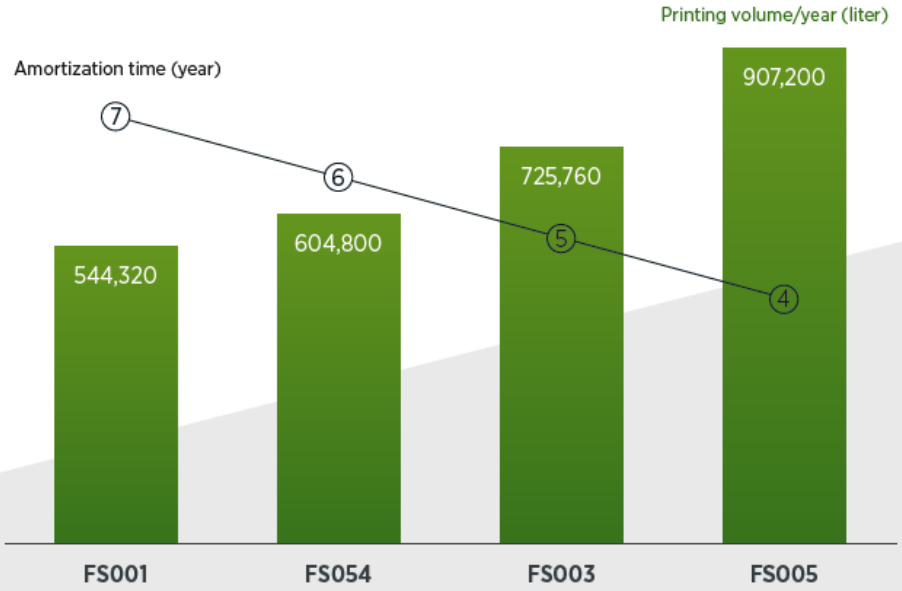
Speed up production by changing print medium

Calculation example of material printing performance on the S-Max Pro system with furan binder

	FS001	FS054	FS003	FS005
Printing time [hh:mm]	14:02	12:18	10:23	7:55
Build height [mm]	700	700	700	700
Layer thickness [mm]	0.28	0.32	0.38	0.50
Total layers	2,500	2,188	1,842	1,400
Seconds/shift	20	20	20	20
Job boxes/week	9	10	12	15
Packages/Job box	30	30	30	30
Packages/week	256	293	347	454
Packages/year	12,228	14,064	16,656	21,792
Performance	100%	114%	135%	177%

Basis of calculation

5 working days – 15 minutes job box change – 120 hours working week – 48 weeks



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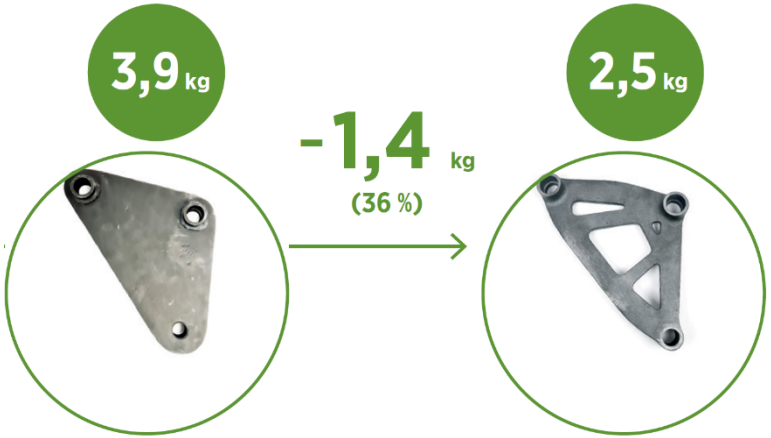
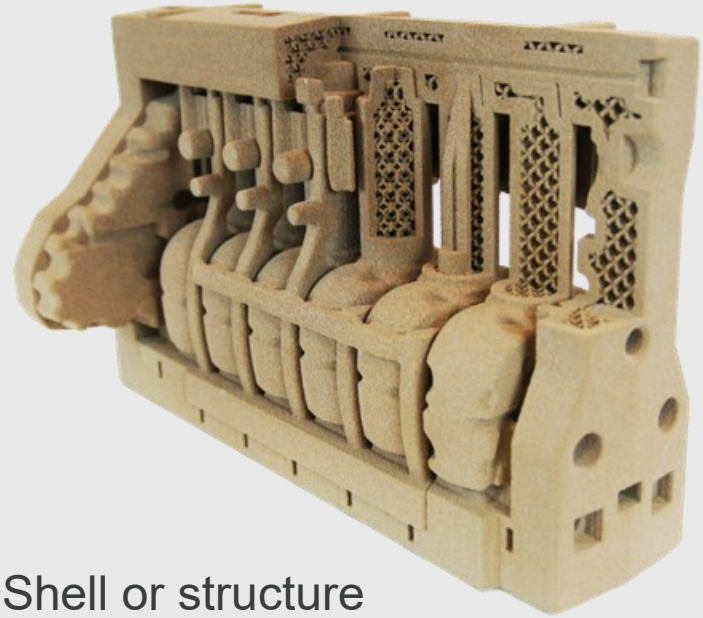
Reasons for using this technology

Cost reduction by less material resources

Topology optimization



- Less casting material needed
- Reduced CO^2 footprint



Shell or structure printed cores

- Less Chemistry in printed sand volume means also less risk for gas defects
- Improved desanding properties

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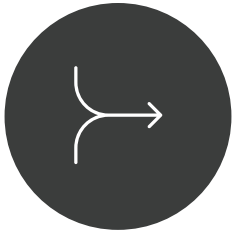
SUMMARY

Summary

Benefits of binder jetting technology

Hybrid mold

unites traditional manufacturing with modern production technology.



Simplify

processes by avoid unneccessary post process steps

Quality

Improvement by generating better surfaces through less flash lines

Speed up

Production by adopting process time on casting requirements

Lower costs

by reducing waste, consumables, process steps and related Labour costs & CO^2 footprint

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