Driving Efficiency with Digital Production

Industrial 3D printers and practical innovations rooted in deep foundry and tooling experience

SPRING
2022
Industrial Binder Jet 3D Printing

ExOne™

SAND LAMPS

Designed by Sandhelden, printed on an S-Max® Pro 3D printer

OUR VISION

Sustainable Manufacturing Without Limitations

We're on a mission to deliver powerful 3D printers that solve the toughest problems and enable world-changing innovations.

The Digital Casting Future is Here

ExOne, now owned by Desktop Metal, is committed to making sand 3D printing accessible and easy to drive worldwide adoption

In 2015, Desktop Metal was founded with an audacious goal that had long eluded the 3D printing industry: mass production. We call our vision for efficient digital production, and all the benefits that come with it, Additive Manufacturing 2.0.

In 2021, our team was incredibly excited to welcome the experienced and trusted sand 3D printing team and technology at ExOne into #TeamDM, so that we could drive this important and mature technology into a new era of affordability, innovation, and ease of use.

The S-Max® Flex is an all-new patent-pending additive robotic manufacturing tool that leverages the best engineering and experience at both Desktop Metal and ExOne.

Truly worthy of joining the premium S-Max® family of printers, this new tool features a printhead that was designed from the ground up and is highly accurate and super fast — printing 115 liters per hour — delivering a quick payback and return on investment.

It's the most affordable sand 3D printer to ever be offered by ExOne, and it's the perfect tool for any foundry to get started in printing complex cores as one piece — reducing or eliminating assembly and labor.

It's just the start of many exciting new innovations to come. Follow me @ricfulop on Twitter, and I'd love to hear your thoughts.

Ric Fulop
CEO and Co-Founder

We Are Pioneers.
And Global AM Leaders.

Our team is passionate about transforming manufacturing with fast, flexible binder jetting technology

Since 1995, we've been on a mission to deliver powerful 3D printers that solve the toughest problems and enable world-changing innovations.

Our industrial 3D printing systems quickly transform granular materials — including silica and ceramic sand as well as reclaimed materials like re-pulverized concrete and wood pulp — into precision metalcasting molds and cores, innovative rapid tooling solutions, as well as functional end-use designs for consumer products and architectural restoration.

Industrial customers use our technology to:

- Save time and money
- Reduce waste
- Increase manufacturing flexibility
- Deliver designs and products that were once impossible

As part of the Desktop Metal portfolio, ExOne is home to the world's leading team of sand binder jetting experts. To realize the #TeamDM vision of bringing Additive Manufacturing 2.0 technologies for volume production to the market, ExOne offers a range of systems and services to integrate 3D printing into customers' operations.

OUR 360° PRODUCTS & SERVICES

- Industrial binder jet 3D printers
- 3D printed parts and tooling on demand
- Installation, training, and support
- Design, engineering, and logistics

INDUSTRIES & SECTORS WE SERVE

- Aerospace
- Automotive
- Art
- Construction
- Defense
- Energy
- Foundry
- Heavy Equipment
- Hydraulic
- Oil & Gas
- Pumps & Valves
- R&D

Learn more
exone.com/company

It Takes a Team

When you're working to solve the world's toughest problems with cutting-edge technologies, it truly takes a collaborative team that's open to the best ideas.

ExOne is proud to work with global experts and partners in academia and manufacturing to deliver the quality and repeatability necessary to bring a progressive manufacturing technology such as binder jetting from R&D and prototyping all the way to production.

At Formnext 2021 in Frankfurt, Germany, from left to right, Christophe Richard, Nexteam Group; Eric Bader, ExOne

ALTAIR
ANSYS
BMW GROUP
HOOSIER PATTERN INC.
Humtown Always Innovating.
KIMURA FOUNDRY AMERICA, INC.
NEXTEAM GROUP
OAK RIDGE National Laboratory
rexroth A Bosch Company
SIEMENS
VDMA Working Group Additive Manufactu

ExOne is Built on Values

As a leader in additive manufacturing for more than two decades, the ExOne team knows who we are and what we stand for—and what we don't.

We really listen. We tell it like it is. We don't spin. We care. We're in it for the long term. We want to make you successful. We want to partner with you to get there.

Most importantly, we really believe in making impossible projects possible through collaborative innovation.

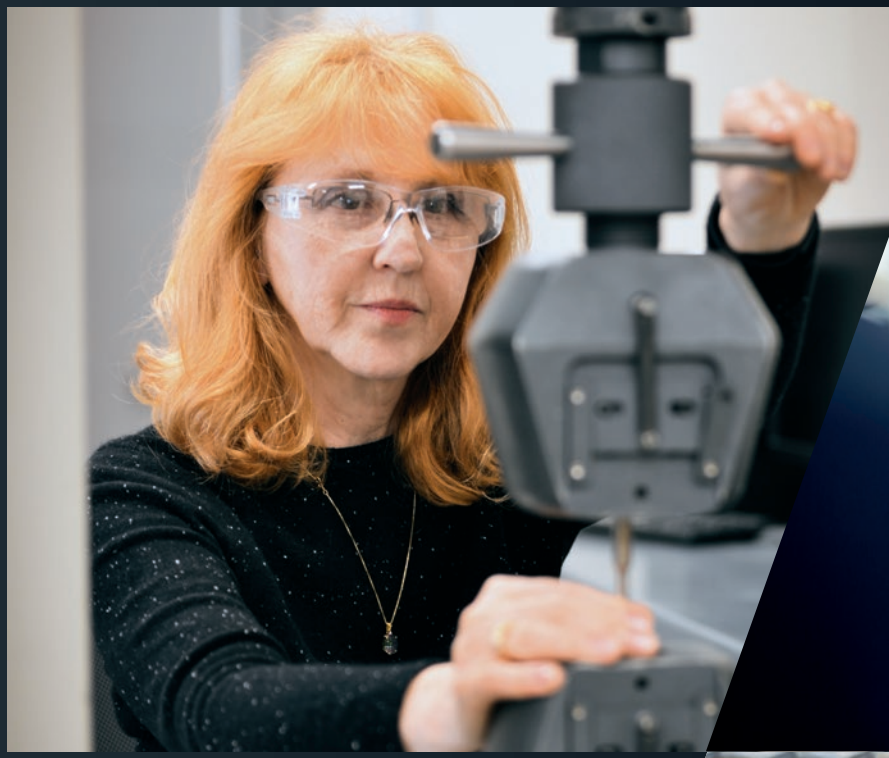
Learn more
exone.com/X1experts

INTEGRITY
In words and action.

POSITIVITY
We believe it's possible.

COLLABORATION
We build relationships.

INNOVATION
We deliver ideas that matter.



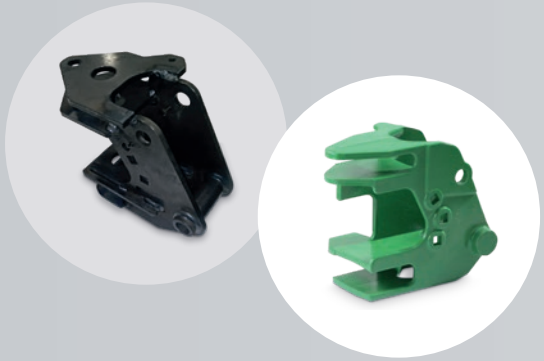
A dedicated team of world-class experts

At ExOne, We've Always Been Green

Binder jetting can deliver sustainability benefits at competitive costs and meaningful high volumes

From its inception as the 3D printing division of Extrude Hone in 1995, ExOne has always been focused on the sustainability benefits that binder jetting delivers. We might not have used the popular sustainability buzzword back then, but reducing the waste associated with traditional manufacturing processes and improving design freedom has driven us from the beginning.

That's why the ExOne logo has always been green, and it's why our R&D teams have been working so diligently for more than two decades to advance this technology.



2019 AFS Casting of the Year
This casting, enabled with ExOne sand 3D printing, consolidated 11 assembled part into one piece that reduced weight by 2.2 lbs and eliminated traditional tooling.

So, why is binder jetting so sustainable?

- Binder jetting fabricates using a wide-range of powdered materials, allowing for local material sourcing that reduces logistics and enabling new material innovations. Waste stream materials like re-pulverized concrete and upcycled sawdust can be repurposed into new products with the material flexibility our technology
- All-new lightweight designs that were not previously manufacturable are possible with binder jetting. That helps cars, planes and other heavy equipment consume less energy
- New designs enabled by binder jetting technology can deliver meaningful part consolidation that reduces waste and energy consumption along the supply chain by eliminating manufacturing process steps
- Binder jetting enables distributed manufacturing, closer to the point of use or assembly reducing energy consumption for shipping and de-risking supply chains
- Our most popular binder, furan, is made from renewable sources, such as corn husks, rice hulls, sugar cane, and other biomaterials
- Our inorganic binder uses a water-based geopolymer binder free of petroleum-based solvents and other volatile organic compounds (VOCs) — eliminating organic emissions during metalcasting

Yes, it's true that other 3D printing methods also reduce waste and offer some of these benefits, such as design freedom. So, here's what makes binder jetting truly unique:

> We can deliver all these benefits at speeds and volumes that are unmatched by other additive manufacturing technologies.

In other words, we can bring the benefits of 3D printing to a production environment at scale, delivering sweeping improvements that truly make a difference. ExOne delivers more sustainable parts made with sustainable technology in high volumes.

At ExOne, our entire global team is proud to offer a green, progressive manufacturing technology — because we believe technology has a role to play in solving the world's toughest problems.

We're delighted, too, that the world is getting more serious about getting green. Whether you print, pour or produce with ExOne's binder jetting technology, you can rest assured that you're 3D printing a better future.

TECHNOLOGY

The Binder Jet Revolution is Here

Binder jet 3D printing is one of the seven primary branches of additive manufacturing recognized by ASTM.

Widely regarded as one of the fastest and most flexible methods of 3D printing, binder jetting can bind an entire layer of powdered material together quickly by scanning a print bed with a gantry of printheads dropping binder. Because our technology doesn't melt material together during printing, it's also extremely flexible in the types of powders it can print — from metals to ceramics, such as sand, to recycled materials, such as wood pulp, pulverized concrete, or other types of refuse.

Within the field of AM, we view binder jetting as the Swiss knife of AM — fast, flexible, and capable of solving a wide range of problems.

- History of an innovative 3D printing technology
- Flexible materials and output types
- Print complex parts at high print speeds
- Top-quality results at production volumes

What is Binder Jetting?

Developed at MIT, first commercialized for metals by ExOne

Binder jetting is a method of 3D printing in which an industrial printhead quickly deposits a liquid bonding agent onto a thin layer of powdered particles, such as foundry-grade silica or ceramic sand. The process is repeated layer by layer, using a map from a digital design file, until the object is complete.

Initially developed at the Massachusetts Institute of Technology in the early 1990s, ExOne obtained the exclusive license to this inkjet-in-powder-bed method of 3D printing in 1996.

Two years later, ExOne launched the market's first commercial binder jet 3D printer for metals, the Rapid Tooling System known as RTS-300. In 2002, ExOne launched its first sand 3D printer, the S15.

Debuting in 2010, the S-Max® series became the world's leading sand binder jetting machines. After the acquisition by Desktop Metal in 2021, ExOne focused on expanding adoption of sand 3D printing in foundries, for tooling applications, and with innovative infiltrated designs that reduce lead times and costs.

Why Binder Jetting?

Fast and flexible, from materials to output types

With its wide, scalable gantry of printheads bonding a full layer together, binder jetting is regarded as one of the fastest forms of 3D printing for volumetric output. That helps manufacturers deliver sustainable, new, innovative designs with less waste at high volumes.

But that's just one part of the many reasons binder jetting is so incredibly attractive. When you're 3D printing powder at low temperatures without melting, as you do with binder jetting, you also have incredible flexibility in materials but also in product forms or, as we like to say, output types.

Binder jetting allows you not just to print a precise form, but to dial in the structure of that form in ways that few other forms of additive manufacturing, or even traditional manufacturing, can do.

ExOne has its long history in binder jetting development to thank for its understanding of these output types:

Bonded Parts are simply bound powder particles that require no further post-processing for their application. In sand 3D printing, this is a frequent output state for metalcasting when silica sand is bound with a binder such as furan.

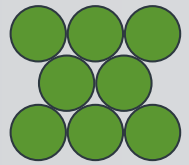
Infiltrated Parts are bonded powder parts that have been infiltrated with another material. Infiltration is simply when another material is wicked into the printed form — similar to water being wicked into a sponge.

Infiltrated parts start off as a 3D printed form in the chosen material that is infiltrated with resins to create durable tooling, construction materials, and consumer products.

For example, our tooling products start out as sand forms before they are infiltrated to make them durable for a variety of thermoforming, layup, or washout applications. The material flexibility of binder jetting is also leading to new sustainable products that use reclaimed waste material such as concrete or wood to shape unique furniture, instruments, or architectural designs before infiltrating them for strength.

Porous Parts are lightly or partially sintered parts. Some applications with technical ceramics benefit from strong porous structures.

OVERVIEW OF OUTPUT MATERIAL STATES



Bonded

Porous

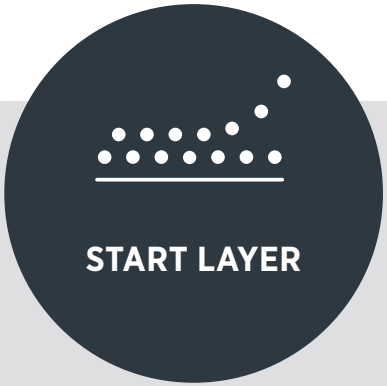
Infiltrated

Binder Jetting Process: Simple & Flexible

DIGITAL FILE PREP

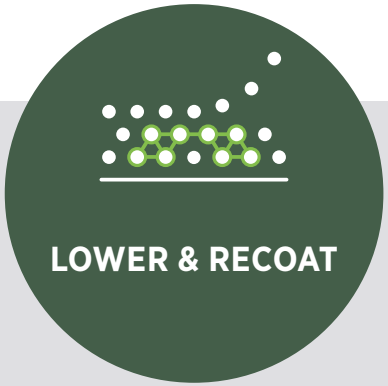
MACHINE & MATERIAL PREP

3D PRINTING



The recoater applies the first thin layers of powder — either sand, metal, or another material — in the print area or job box.

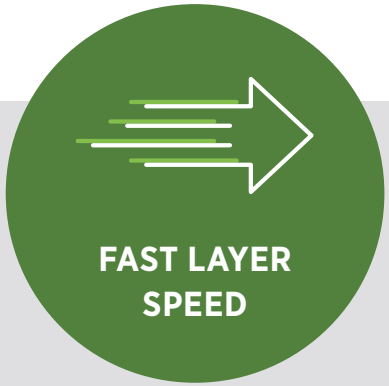
A gantry of industrial printheads selectively applies binder to the powder to bind particles together where desired. Different binders work with different materials to achieve desired results.



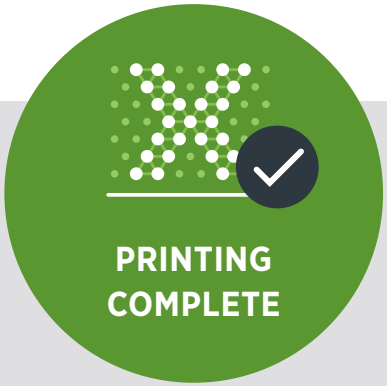
After each layer, the bed lowers for the next layer to be applied. Recoating is a critical step in binder jetting, as the consecutive powder layers must be precisely and compactly applied to deliver a high-quality precision part. Whether using coarse or fine particles, powder handling is a critical element of successful binder jetting.

Learn more
exone.com/bjt

Once the next powder layer has been applied to the print area, the stage has been set for the next layer of binder to be selectively deposited. This recoating-and-binding sequence is repeated until the part is complete.



With a full sweep of printheads, a binder jet 3D printer can complete a full layer very quickly. This is one of the core benefits of binder jetting compared to other additive manufacturing methods.



Once the print job has finished, parts can be removed from the print area or job box. Depending on the material and binder used, additional curing and post-processing steps may be necessary. For certain sand binders, parts should be cured in an oven or microwave. Metal parts typically require curing and sintering.

Next steps depend on application and specific materials

Sand Molds & Core (Page 28)	Tooling (Page 42)	Now by Desktop Metal Metal & Ceramics (Page 54)
CURING (Depending on binder)	DEPOWDER	CURING
DEPOWDER	COAT OR INFILTRATE	DEPOWDER
		DEBIND & SINTER

SUCCESS STORIES

Real Manufacturers, Real Binder Jet Solutions

Around the world, foundries have been using our binder jet 3D printing technology to deliver meaningful solutions to their customers and their bottom line. Whether it's through the speed that gets prototypes and products to market faster, part consolidation that delivers meaningful weight savings, or innovative new designs that were once impossible — ExOne customers are pioneering their own future with the latest technology that challenges the status quo way of manufacturing.

On these pages, learn how ExOne users are transforming the future with our exclusive binder jet 3D printing technology. What could you do with an ExOne 3D printer?

- Growing business with fast core and mold production
- Working efficiently with less labor
- Reduce core assemblies to increase yield
- Unique applications beyond the foundry

EISENGIESSEREI MEZGER

Sand Binder Jetting Speeds Delivery, Improves Quality

CHALLENGE

As an iron foundry that specializes in small and medium production castings in a variety of industries, Mezger was in need of a solution to produce high-quality cores quickly and with minimal labor. Speed in production was a main issue for the company, which also specializes in prototype development, limited-run series, and replacement parts.

SOLUTION

Integrating the S-Max® Pro allowed the company to offer complex designs and hybrid mold castings — where a conventionally produced mold is paired with a monolithic core that has been 3D printed. The high level of integrated automation enables stable 24/7 operation with remote monitoring via the Scout App. The speed of the digital workflow and S-Max® Pro machine allows the company to deliver cast parts to customer in as little as three days.

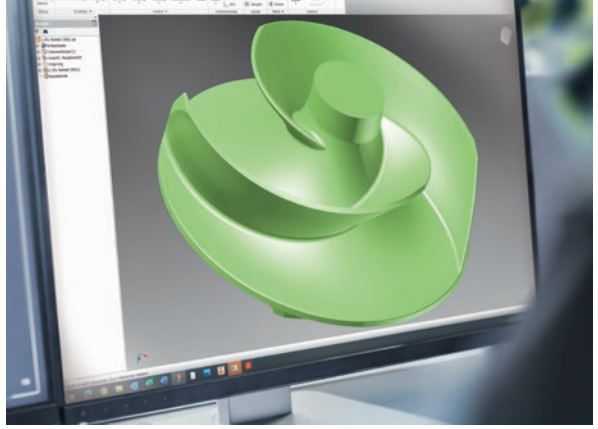
Valuing sustainability, the company utilizes the desanding station to recycle excess sand from the job box to minimize waste and disposal costs. By creating a semi-automated process, the furan desanding station allows the company to recover 95 % of the material with minimal labor and successfully integrate an 80 % recycled mixture into their production. Printing straight from CAD files has also reduced the number of models Mezger keeps in storage.

HIGHLIGHTS

High-quality molds and cores are completed in just 12 hours, while a raw cast part is completed in around 3 days. Diverse geometries and projects can be flexibly taken from the CAD model for every printing process. In the interest of sustainability, the desanding station helps capture recycling sand during each printing process, which is then added to the fresh sand for the next process, thereby minimizing waste and disposal costs.

*"We wanted the ability to produce competitively with **high-quality in a high-wage country** and do so quickly."*

Dieter Diebold,
Foundry Manager Mezger AG



VIDEO
See ExOne technology at the Mezger foundry
exone.com/mezgervideo

EISENGIESSEREI MEZGER

INDUSTRY / PRODUCTS
Machine- and hand-molded cast parts, metal processing and installation

HEADQUARTERS
Kallnach, Switzerland

EMPLOYEES
45

CUSTOMER SPECTRUM
Mechanical engineering, gas and water supply, district heating supply, engine and tool manufacturing

WEBSITE
www.mezgergroup.com

Eisengiesserei Mezger AG

FEATURES EXONE S-MAX® PRO

NUMBER OF JOB BOXES
2

ADDITIONAL DESANDING STATION
Vacuum extraction unit with funnel system for quick and clean desanding at the push of a button

ADDITIONAL FLUIDMATIC SYSTEM
Central, automatic material supply for a seamless printing process

SIEMENS MINDSPHERE & EXONE SCOUT APP
The machine-monitoring app Scout is a key step in ExOne's strategy to surround its printers with a complete digital workflow.

TRADITIONAL PROCEDURE

The cores for the iron cast are procured from an external supplier. As such it was not possible to react to customer requests or last-minute changes.

MANUFACTURING TIME
10 days

EXONE SAND PRINTING PROCEDURE

Preparation and post-processing times are reduced and the casting molds can be flexibly adapted to all changes.

MANUFACTURING TIME
Approx. 12 hours

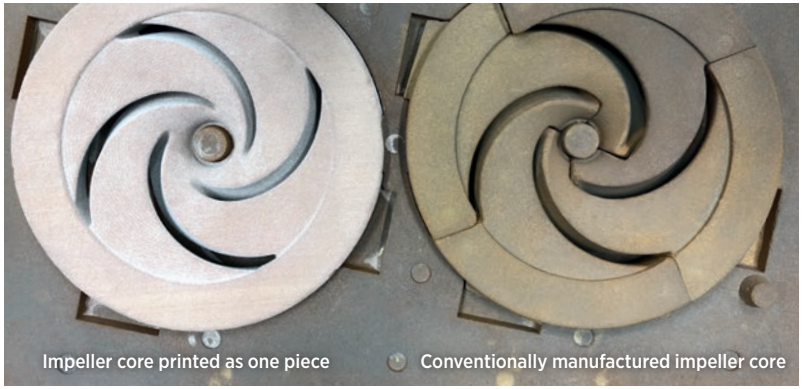
XYLEM WATER SOLUTIONS

Reduced Core Assembly Increases Yield at Lower Costs

CHALLENGE
Water pump impeller cores traditionally made with core shooters required four segments to be glued together with gum. This created a seven-day lead time and high scrap rates created by core gum gas or core drafts. Production was to be accelerated and the quality of the cores improved.

SOLUTION
Using the freedom of design of additive manufacturing, Xylem reduced the multi-part assembly to a single-piece. What was once four parts from the core shooter is now 3D printed as one monolithic core on the ExOne S-Max®, eliminating the need for assembly and the related defects from core gum gas pockets. Since the printer impeller cores have no drafts, the final castings require less post-processing, enabling streamlined operations. Production time was reduced from seven to two days, allowing Xylem to deliver impeller cores faster, at higher quality, and at a lower cost.

HIGHLIGHTS
ExOne binder jetting cut lead times over 70 % and enables just-in-time production as up to 480 cores can be printed in one 24-hour process. “The quality of the impeller cores has improved significantly, at the same time, the production costs have decreased by around 30 %” said Torbjörn Andersson, 3D Technician at Xylem.


Impeller core printed as one piece

Conventionally manufactured impeller core

XYLEM WATER SOLUTIONS

INDUSTRY / PRODUCTS
Water treatment, pumps, filters, heat exchanger

HEADQUARTERS
Rye Brook, NY, USA

APPLICATION
Impeller cores for casting water pump impellers

WEBSITE
www.xylem.com

FEATURES EXONE

3D PRINTER
S-Max®

MATERIAL
Silica sand with CHP binder

PART SIZE
220 mm (8.7 in) diameter
60 mm (2.4 in) tall

“The quality of the impeller cores has improved significantly through the 3D printing process. At the same time, the ***production costs have decreased by around 30 %*** *for certain parts.”*

Torbjörn Andersson,
3D Technician at Xylem

KIMURA FOUNDRY

Global Foundry Group Grows Business with Sand 3D Printing Innovation

"We researched 3D printers from around the world and chose ExOne printers for their ***high-end technology that delivered top-quality prints."***

Dr. Yoya Fukuda, President of Kimura Foundry America

CHALLENGE

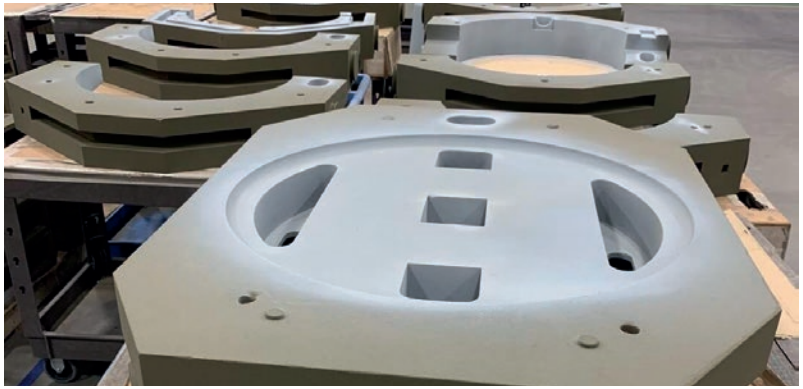
When embarking on their first international expansion, the Kimura Foundry Group looked to innovative solutions that help them deliver top-quality rapid casting prototypes. Kimura Foundry America built an entire facility focused on metalcastings with fast turnaround times, even of the most complex designs or for high-temperature pours.

SOLUTION

Building on the success of their parent company in Japan that saw revenue increase more than 500 % in the five years after investing in ExOne binder jetting, Kimura Foundry America produces core and mold without traditional patterns or tooling on three sand 3D printers. Recognizing additive manufacturing as the cornerstone of the next industrial revolution, Kimura built their entire greenfield facility in Shelbyville, Indiana around the ExOne binder jetting process.

HIGHLIGHTS

Embracing the digital metalcasting workflow, Kimura has significantly reduced lead times for customer jobs. Delivering prototypes in less than one week is a gamechanger for metalcasting, opening the door to quicker product development and new freedom of design. By concentrating their sandcasting capabilities under one roof, Kimura can iterate designs quickly based on solidification modeling, casting results, and customer feedback.



KIMURA FOUNDRY

INDUSTRIES SERVED
Automotive, Construction Machinery, Pumps, Industrial Equipment

LOCATION
Japan & United States

ALLOYS CAST
Precision iron, steel, specialty alloys, and compacted graphite iron

WEBSITE
www.kimurafoundry.com

FEATURES EXONE

3D PRINTERS
Ten ExOne sand binder jetting systems

MATERIAL
Patented formula ceramic sand material with a low thermal expansion

HOOSIER PATTERN

Pattern Shop Grows Entire Business with Binder Jetting Technology

CHALLENGE

In 2013, Hoosier Pattern recognized the coming change to the foundry industry. As a traditional pattern shop with CNC capabilities, they embraced 3D printing to open new business opportunities for both their additive and subtractive manufacturing operations.

SOLUTION

In 2013 Hoosier Pattern purchased its first ExOne S-Max®, making it the first pattern shop in North America to own and operate a sand 3D printer in-house. Today, Hoosier operates four S-Max® and one S-Max® Pro binder jetting systems. “We’re a traditional pattern shop, so we understand what it takes to assemble molds and cores because we build production tooling all the time. Now our 3D printing expertise allows us to do some really unique designs and increase our production volume,” said Dave Rittmeyer of Hoosier, explaining the combined industry knowledge that gives them an edge in the marketplace.

HIGHLIGHTS

Through a variety of projects, Hoosier pattern has worked with customers to replace a traditional core box with complex, 3D printed cores that allow continuous iteration of a serial production design in value-adding ways. After nearly a decade of 3D printed projects, from historical restoration and industry applications to Kickstarter campaigns, Hoosier Pattern continues to see additive manufacturing grow its business.

HOOSIER PATTERN

INDUSTRIES SERVED
Foundry molds and cores for automotive, aerospace, pump, consumer appliances, agriculture

LOCATION
Decatur, Indiana

ALLOYS CAST
A variety of metals, from ferrous to aluminum, cast by their customers

WEBSITE
www.hoosierpattern.com

FEATURES EXONE

3D PRINTERS
Four S-Max®, one S-Max® Pro

MATERIALS
Silica sand and furan binder
Silica sand with black iron oxide
Carbo ceramic

“Binder jetting is another tool in our toolbox and complementary to our CNC machines, but we know that ***it is the future of the foundry and pattern shop industry****.”*

Dave Rittmeyer, Customer Care & Additive Manufacturing Manager at Hoosier Pattern

DEEPTIME

Audio Startup Brings High-Fidelity Form and Function to Market

*"A two-year study conducted at the **Brno University of Technology** verified the acoustic properties of the finished material; **the sand structure manufactured on ExOne 3D printers is 86 % more rigid than MDF.**"*

Ondrej Chotovinsky,
Founder of Deeptime

CHALLENGE

Standard PC speakers are compact, but generally offer poor sound performance while quality equipment is often large and expensive. Deeptime sought to produce compact speakers that were both high-quality and visually appealing without a hard tooling investment.

SOLUTION

Working with the ExOne Adoption Center to 3D print uniquely shaped sand forms directly from CAD files, Deeptime now receives raw speaker housings to their facility in just seven days without any tooling necessary. Despite the raw sand being porous, which is not ideal of acoustic applications, the economic and design advantages of binder jetting allowed Deeptime to develop a proprietary solution to infiltrate the porous sand structures. The outstanding sound properties of the final products exceeded even the high expectations of the developers.

HIGHLIGHTS

Sand 3D printing was cheaper than plastic while providing more rigidity and allowing mass customization with no minimum order sizes. A study at Brno University of Technology showed Deeptime's speaker to be 86 % more rigid than MDF, leading to double the sound damping compared to a traditional speaker.

DEEPTIME

INDUSTRY / PRODUCTS
Innovative 3D printed speaker systems

HEADQUARTERS
Bustehrad, Czechia

APPLICATION
Sand 3D printed raw housing for sound system

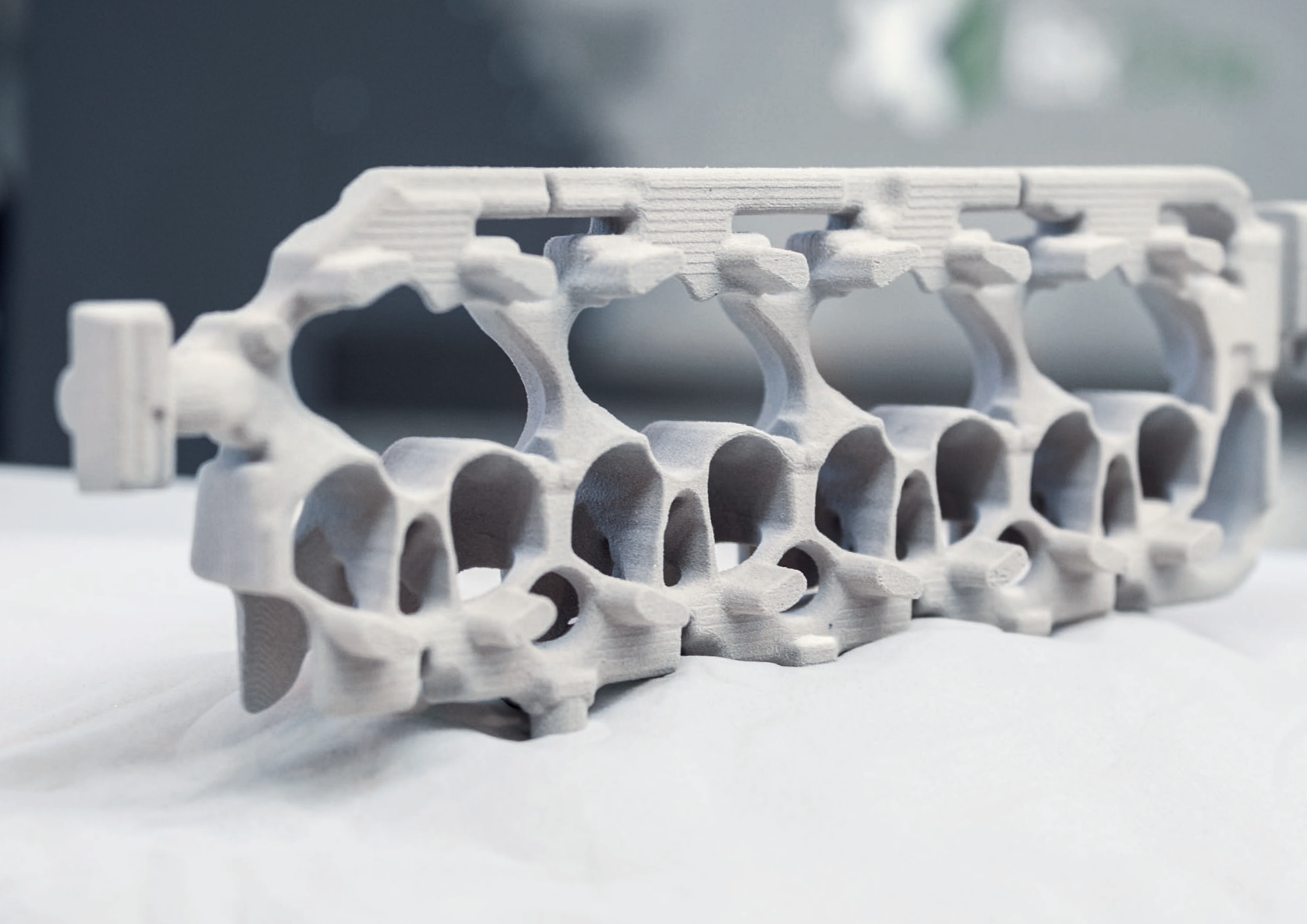
WEBSITE
www.deeptime.limited

FEATURES EXONE

3D PRINTER
S-Max® Pro

MATERIAL
Silica sand with furan binder

PART SIZE
208 × 117 × 222 mm



SAND PORTFOLIO

The 3D Printing that Revolutionized Metalcasting

ExOne sand 3D printers are transforming the centuries-old method of sandcasting by eliminating the need for hard tooling. The digital workflow saves time and money on pattern production and storage while enabling rapid geometry iterations and exceptional design freedom.

Consolidate cores, incorporate previously impossible rigging features into molds, and lightweight parts through complex organic designs. At the same time, deliver castings in mere days using binder jetting to produce cores the way they were meant to be made.

- Direct from CAD tooling-less casting
- Consolidated and complex sand molds and cores
- Automated production accessories
- Rigging design, virtual casting simulation, and sand 3D printing on demand

Affordability in Sand 3D Printing

Production tools for pattern shops and foundries looking for faster return on investment

ExOne, as part of the Desktop Metal family, strives to make Additive Manufacturing 2.0 practical in cost, speed, and material availability for a broad range of applications. Binder jetting technology helps foundries stay competitive and produce castings of any volume without the wait time and cost of traditional tooling. Easy to use and affordably priced large-format 3D printing also pushes innovation to deliver on our mission of driving AM 2.0 across all materials.

DIGITAL FILE PREP

MACHINE & MATERIAL PREP

3D PRINTING

Furan

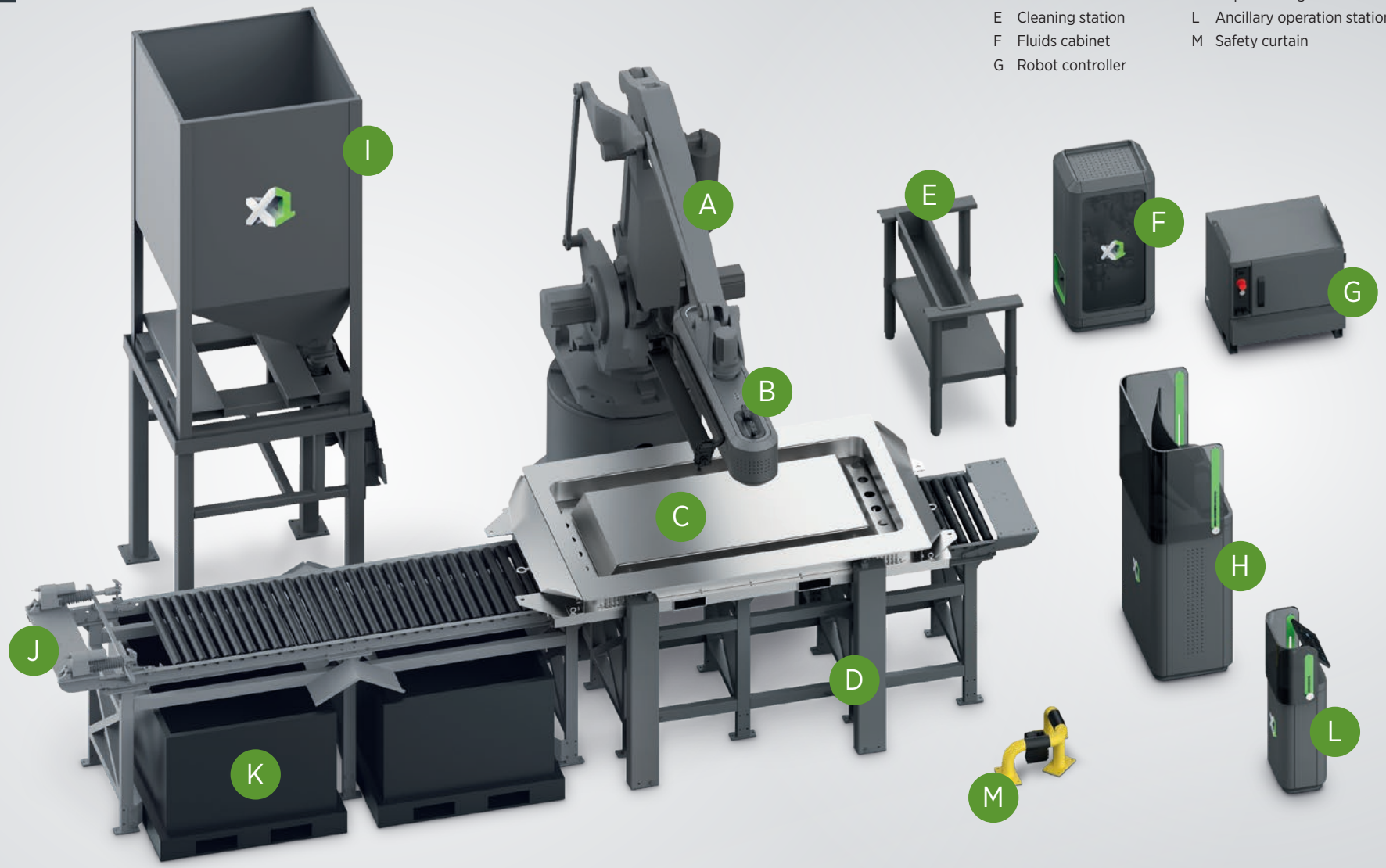
DEPOWDER

ROBOTIC SAND 3D PRINTER

Now available

Turnkey S-Max® Flex system and safety solution configurable to different space requirements

A Industrial robot
B Single Pass Jetting printhead
C Telescoping build box
D Build station
E Cleaning station
F Fluids cabinet
G Robot controller
H Printer operator station
I Bulk sand conditioning hopper
J Depowdering station
K Depowdering bins
L Ancillary operation station
M Safety curtain



S-Max® Flex

Robotic sand 3D printer to provide faster payback and easy integration into digital casting

Leverages the expertise of Desktop Metal and ExOne

Learn more
exone.com/s-max-flex

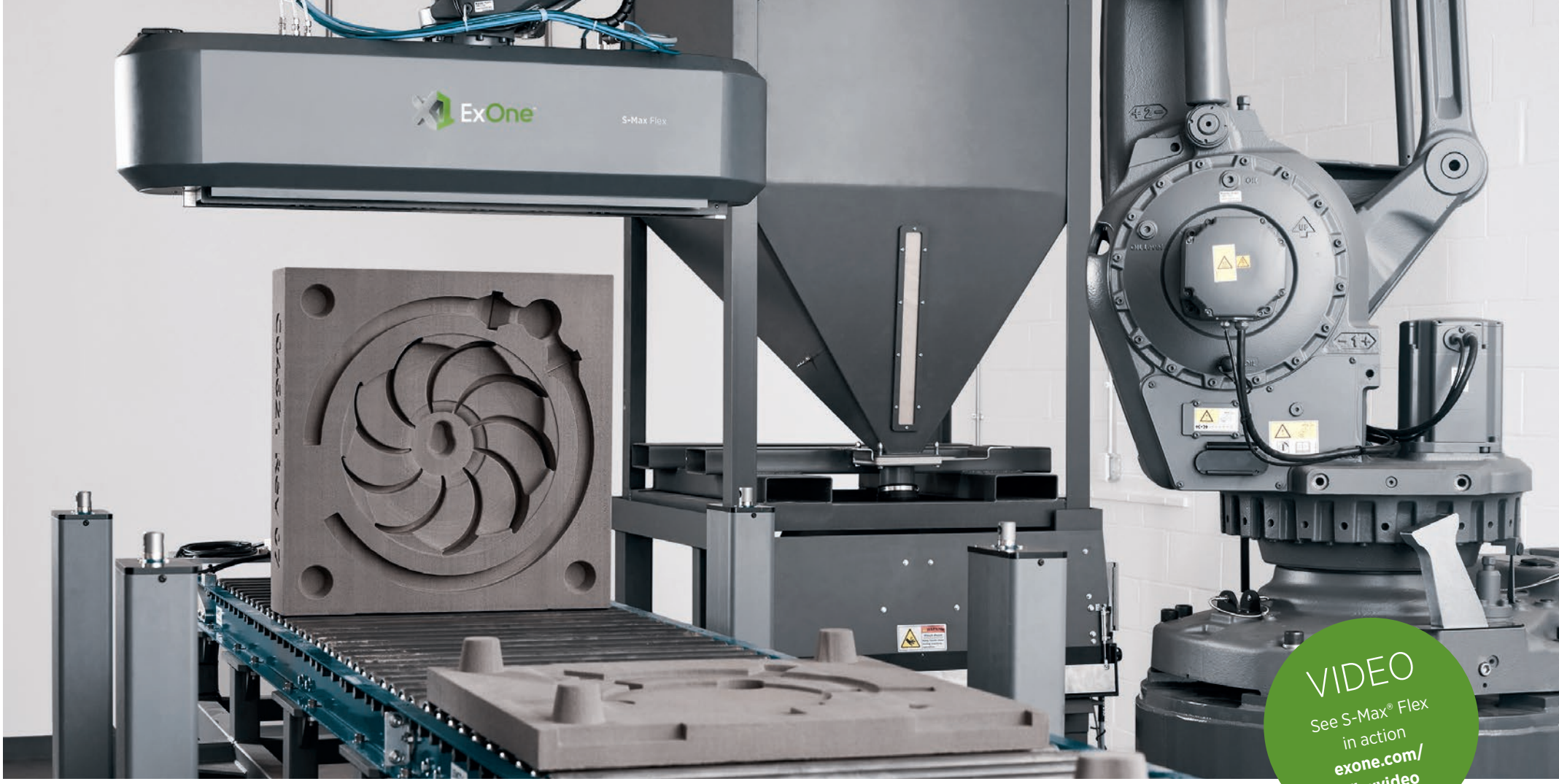
The all-new S-Max® Flex additive robotic manufacturing system features an industrial robot with an end effector using advanced patent-pending Single Pass Jetting (SPJ) to binder jet into a telescoping job box. With a semi-automatic bulk depowdering station and flexible footprint, users can build complex mold and core designs for rapid casting within one day. An important tool for foundries and pattern shops, the S-Max® Flex offers ease-of-use with quality and scalability at an affordable price.

- Robust, user-friendly design with a scalable architecture
- Easy-install printhead design
- Fast, flexible production
- Fabricate MFG software
- Precision 100-micron accuracy in XYZ space

APPLICATION
Binders: Furan

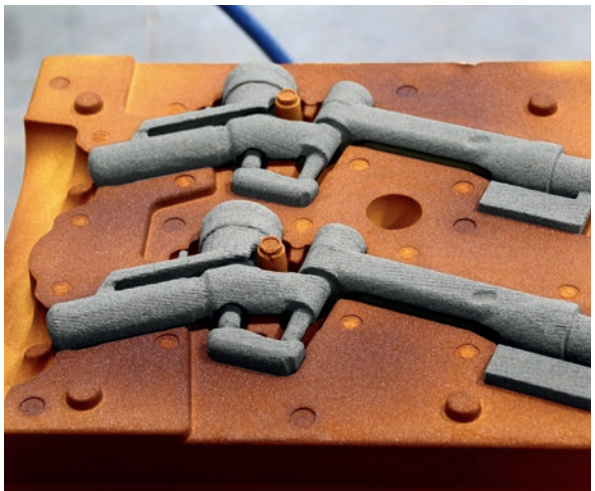
TECHNICAL DATA
Job box: L 1,900 × W 1,000 × H 1,000 mm (L 74.8 × W 39.3 × H 39.3 in)
Build volume: 1,900 l (67 ft³)
Build rate*: up to 115 l/h
Layer height**: 0.28 to 0.5 mm (280 to 500 µm)
Dimensional accuracy***: +/– 0.5 mm (500 µm)

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



VIDEO

See S-Max® Flex in action **exone.com/flexvideo**



Complexity is Simple

From complex prototypes to production in a few hours

Ultra-complex part geometries are at the heart of sand core and mold 3D printing. Whether producing previously impossible shapes, variable core geometries, or iterative design changes, most everything can now be done simultaneously in a single print. What's more, it can all be done in hours or days instead of weeks or months.

DIGITAL FILE PREP

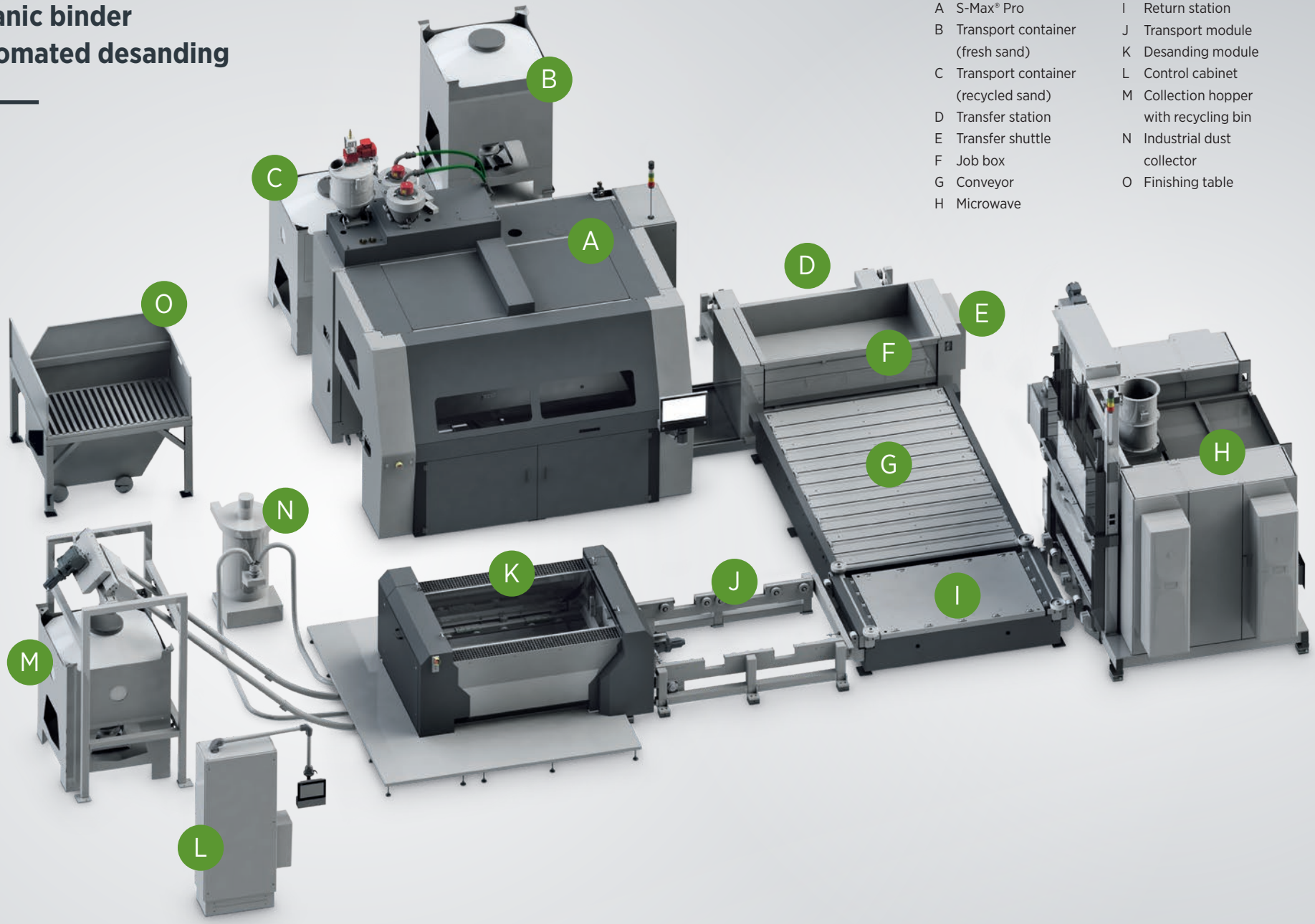
MACHINE & MATERIAL PREP

3D PRINTING

Next steps depend on application and specific materials

Furan	CHP	HHP	Inorganic
UNPACKING	UNPACKING	MICROWAVE CURING	MICROWAVE CURING
FINISHING	OVEN CURING	UNPACKING	UNPACKING
	FINISHING	FINISHING	FINISHING

Process using the example of inorganic binder with automated desanding



Sand 3D Printing Machines

S-Print®

Compact, flexible 3D printer delivering accurate and complex designs straight from CAD files

- Prototyping
- Rapid product development
- Short-run production

APPLICATION
Binders: Furan, CHP, HHP, Inorganic

TECHNICAL DATA
Job box: L 800 × W 500 × H 400 mm (L 31.5 × W 19.7 × H 15.8 in)
Build volume: 160 l (5.6 ft³)
Build rate**: up to 40 l/h
Layer height***: 0.2 to 0.5 mm (200 to 500 µm)
Dimensional accuracy****: +/– 0.5 mm (500 µm)

S-Max®

The original S-Max® for reliable core and mold production trusted in foundries around the world

- Prototyping
- Rapid product development
- Short-run production
- Continuous 24/7 production

APPLICATION
Binders: Furan, CHP

TECHNICAL DATA
Job box: L 1,800 × W 1,000 × H 700 mm (L 70.9 × W 39.4 × H 27.6 in)
Build volume: 1,260 l (44 ft³)
Build rate**: up to 125 l/h
Layer height***: 0.2 to 0.5 mm (200 to 500 µm)
Dimensional accuracy****: +/– 0.5 mm (500 µm)

Specifications are subject to change without notice. Some data may be dependent on size and characteristics of powder being processed.

ExOne's family of sand 3D printers is the most popular in the world for digital manufacturing of sand cores and molds for metalcasting. With our trusted machines, you can go from design to metalcasting in hours or days instead of weeks and months.

No more patterns needed for sand molds. No more molds needed for blowing cores. No jigs or fixtures needed for core assembly. Print complex cores in one piece. This is how cores were meant to be made.

Learn more
exone.com/sandprinters

S-Max® Pro

ExOne's fastest and smartest large 3D printer for core and mold production with any binder

- Prototyping
- Rapid product development
- Short-run production
- Continuous 24/7 production
- Serial production

APPLICATION
Binders for standard job box: Furan, CHP
Binders for box-in-box: Furan, HHP, Inorganic, (CHP)

TECHNICAL DATA
Job box*: L 1,800 × W 1,000 × H 400 / 700 mm (L 70.9 × W 39.4 × H 15.7 / 27.6 in)
Build volume: 720 l (25 ft³) / 1,260 l (44 ft³)
Build rate**: up to 145 l/h
Layer height***: 0.2 to 0.5 mm (200 to 500 µm)
Dimensional accuracy****: +/– 0.5 mm (500 µm)

* Available with 400 mm height with box-in-box or 700 mm height with standard job box. ** Depending on layer height. *** Depending on material. **** Depending on part size and geometry (0.1 % of part size).

Sand 3D Printing Accessories

Desanding Station

The semi-automatic desanding station for your job box is a technological solution that significantly accelerates the desanding process. The desanding station can be installed and retrofitted efficiently on all S-Max® and S-Max® Pro models.

- Reduce time and costs spent harvesting parts
- Efficiently use your job box by keeping it ready for print
- Intuitive operation simplifies material recycling

For S-Max® and S-Max® Pro printers with furan or CHP binders

Video
exone.com/desanding

APPLICATION
Furan and CHP binders in combination with silica and synthetic sands

TECHNICAL DATA
Dimension with platform: L 3,488 × W 3,337 × H 1,298 mm (L 137.3 × W 131.4 × H 51.1 in)
Dimension without platform: L 2,180 × W 1,767 × H 1,298 mm (L 85.8 × W 69.6 × H 51.1 in)
Piping standard: 5 m (196.8 in)

Automated Desanding Station

The pioneering automation technology in the ExOne desanding station can reduce job box material removal time by up to 95 %. A state-of-the-art PLC system and integrated sensors save labor costs and increase the speed of desanding cores.

- Fully automated desanding of 3D printed cores
- Increased Overall Equipment Efficiency (OEE)
- Improved ergonomics and work safety

For S-Max® Pro printers with inorganic, HHP and furan binders

Video
exone.com/autodesanding

APPLICATION
Inorganic, furan and HHP binders in combination with the box-in-box system for processing silica and synthetic sands as a standard molding material

TECHNICAL DATA
Dimensions: L 8,700 × W 3,300 × H 2,700 mm (L 342.5 × W 129.9 × H 106.3 in)
Total weight: ~ 3,000 kg
Supply voltage: 400 V, 50/60 Hz, 3-/N/PE
Pressurized air: 6 – 10 bar (dry and free of residual oil)

ExOne Scout

ExOne Scout is a secure Industry 4.0 app that provides real-time machine monitoring and analysis of ExOne production 3D printers on a wide range of digital devices, including smart phones and watches. ExOne Scout is now available for download in the Apple App Store and on Google Play. It's currently designed for use with sand and metal production 3D printers enabled by Siemens MindSphere, an Internet-of-Things operating system with multilayered security.

Users will now be able to connect ExOne 3D printers powered by Siemens MindSphere to Scout to simplify machine monitoring, receive real-time insights, and benefit from enhanced quality assurance and analysis.

What's more, smart phones and watches can now receive push notifications through Scout about job status, printhead speed, fluid levels, temperature, humidity, and other actionable manufacturing data.

APP HIGHLIGHTS

- Real-time machine monitoring
- Live insights and analysis
- Enhanced quality assurance
- Full reporting capabilities

Download from the Apple App Store and Google Play

AVAILABLE MACHINE INTEGRATIONS

S-Max® Pro production sand 3D printers enabled with Siemens MindSphere

Sand 3D Printing Binders

Furan

Self-Hardening Binder System

CASTING MATERIAL
Steel, Iron, Non-Ferrous Metal

LOI*
1.0–2.1%

CHARACTERISTICS**
Hot strength: 5–8***
Filigree character: 6–8
Strength: 7–8
Environmental impact: 5
Finishing: 5–6

MOLDING MATERIAL
Standard Process: Silica Sand
Alternative: Synthetic Sand

CHP

Cold-Hardening Binder System

CASTING MATERIAL
Steel, Iron, Non-Ferrous Metal, Bronze

LOI*
1.4–2.1%

CHARACTERISTICS**
Hot strength: 7–10
Filigree character: 10
Strength: 8–10
Environmental impact: 6
Finishing: 10

MOLDING MATERIAL
Standard Process: Silica Sand
Alternative: Synthetic Sand

HHP

Hot-Hardening Binder System

CASTING MATERIAL
Steel, Iron, Non-Ferrous Metal, Bronze

LOI*
1.5–2.1%

CHARACTERISTICS**
Hot strength: 9–10
Filigree character: 7–8
Strength: 9–10
Environmental impact: 4
Finishing: 7–8

MOLDING MATERIAL
Standard Process: Synthetic Sand

Inorganic

Inorganic Binder System

CASTING MATERIAL
Non-Ferrous Metal, Light Metal

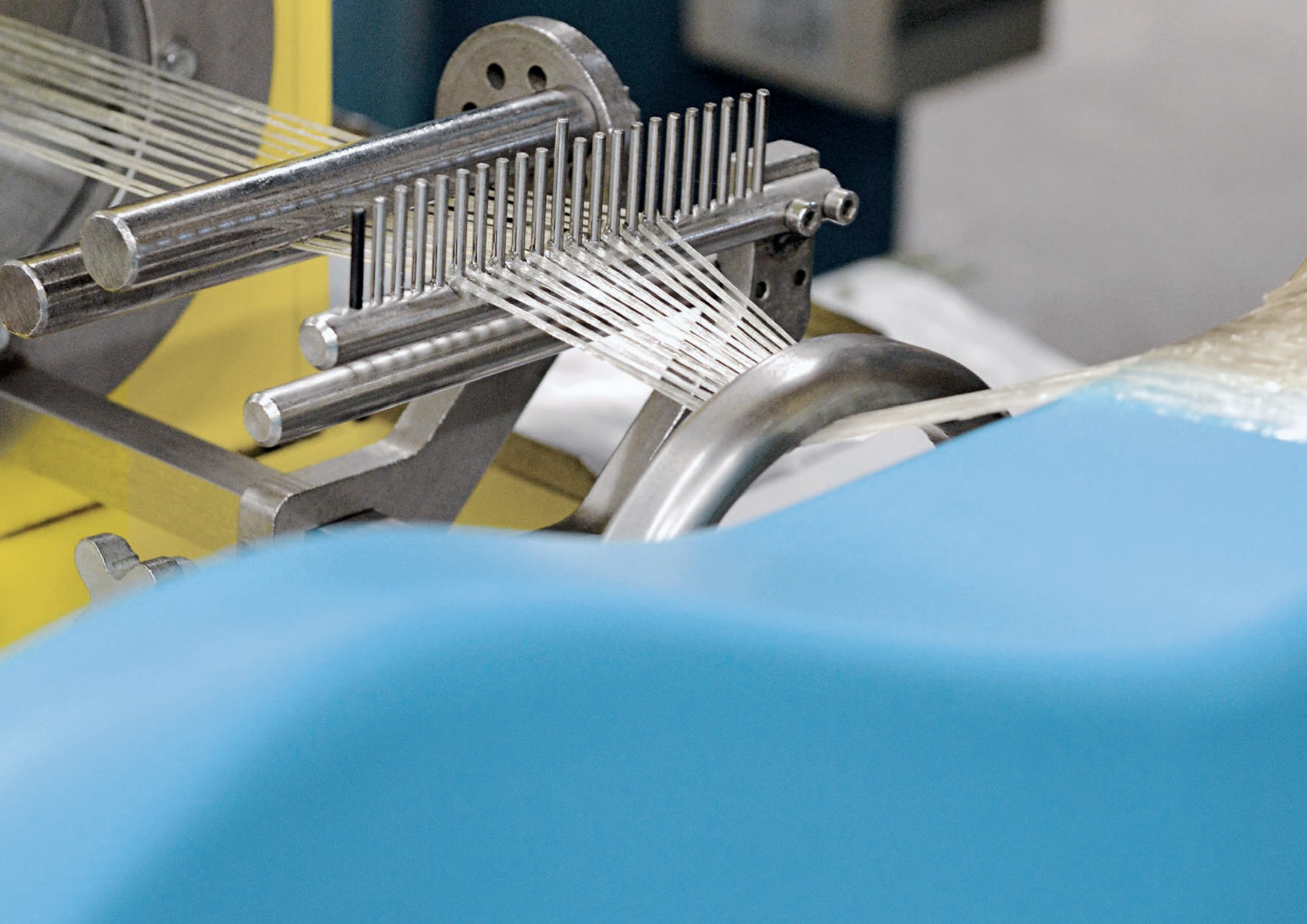
LOI*
~ 0.3%****

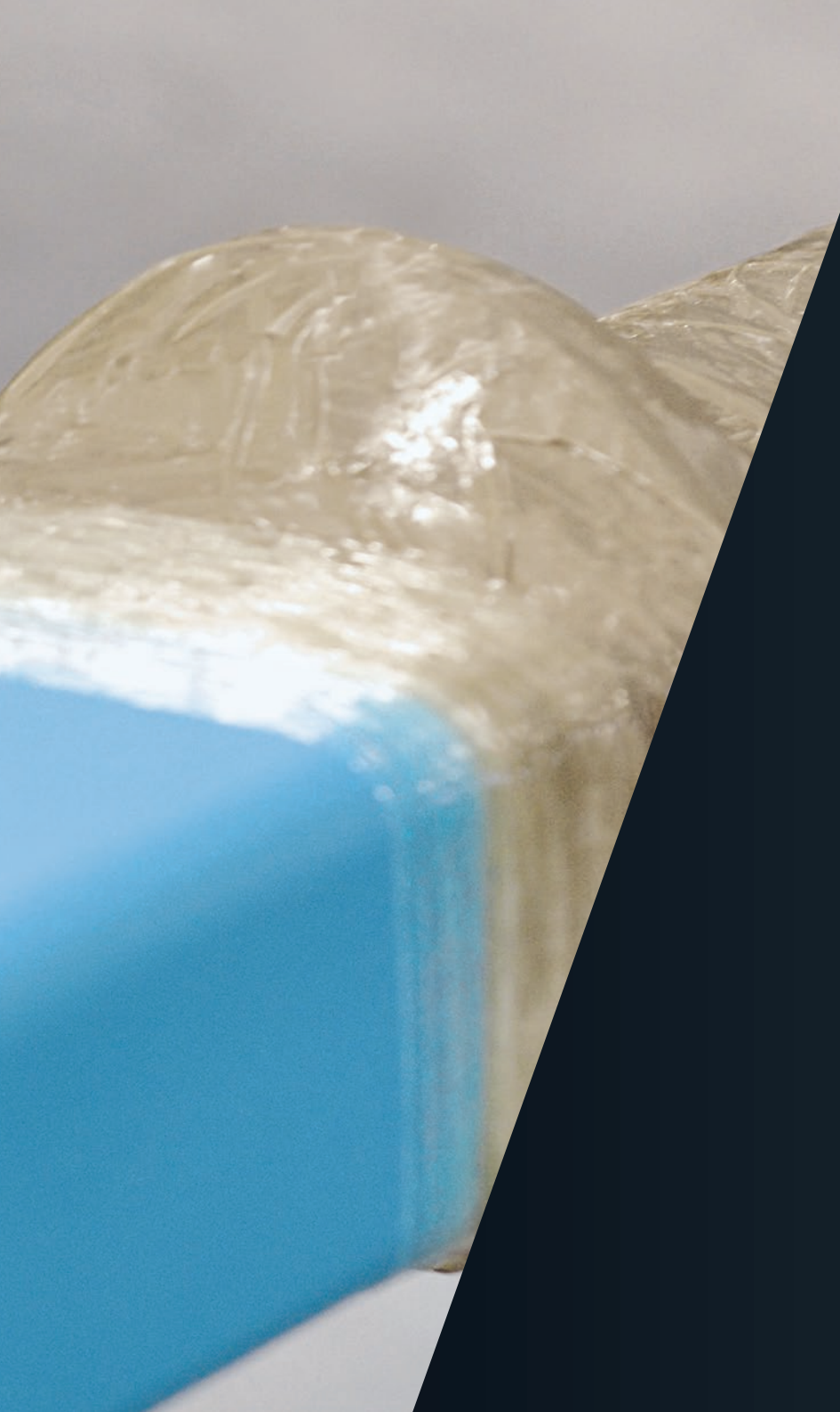
CHARACTERISTICS**
Hot strength: 3–4
Filigree character: 8–9
Strength: 5–6
Environmental impact: 10
Finishing: 9

MOLDING MATERIAL
Standard Process: Silica Sand
Alternative: Synthetic Sand or Combination

* Depending on chemistry. ** Characteristics dependent on precise sand and binder combination. Scale is 1 – 10, with 10 indicating most ideal conditions. *** With additive. **** Depending on molding material.


BINDER





SAND TOOLING

3D Printed Sand Rapid Tooling Solutions

ExOne recognizes the potential of sand to offer a cost-effective tooling solution with rapid turnarounds. With ExOne binder jetting machines at its core, the process takes advantage of the fast output and large-scale capabilities of the S-Max® family of machines to quickly create complex shapes that are transformed into tooling for a variety of sandcasting and forming applications.

Explore how ExOne is transforming the tooling landscape with 3D printed sand durable enough to produce metal, plastic, and composite end-use parts.

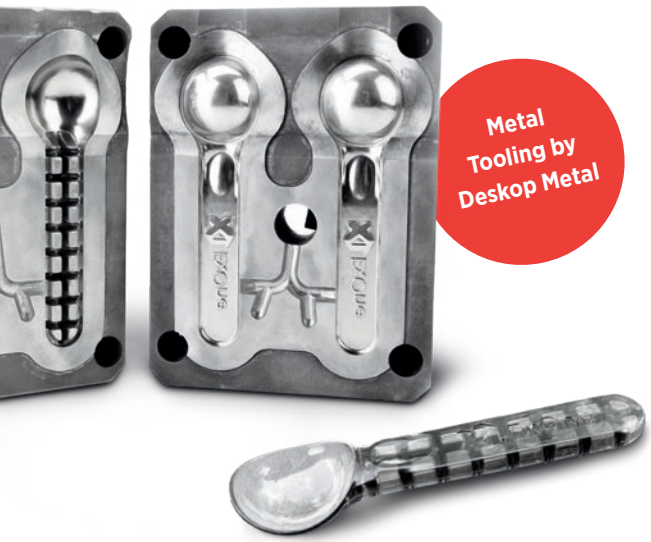
- Get to market faster without long lead times
- Design freedom for fast iterations and product variations
- Cost-effective, local tooling to de-risk supply chains
- On-demand production and complete systems

X1 Tooling

Learn more
exone.com/X1tooling

The broadest portfolio of 3D printed sand tooling options for the final production of plastic, composite, or metal parts

ExOne binder jet technology provides the speed of on-demand production with the nimbleness of local, digital tooling. Shorten lead times, lower tooling costs, and improve design flexibility with a range of 3D printed solutions for virtually any challenge.



X1 SandCast

ExOne's market-leading sand 3D printers quickly and accurately produce even the most complex sandcasting molds and cores. Trusted for more than 20 years, ExOne premium machine tools deliver innovative designs faster with organic geometries and consolidated assemblies that improve the quality and increase the complexity of cast products.

X1 ThermoForm

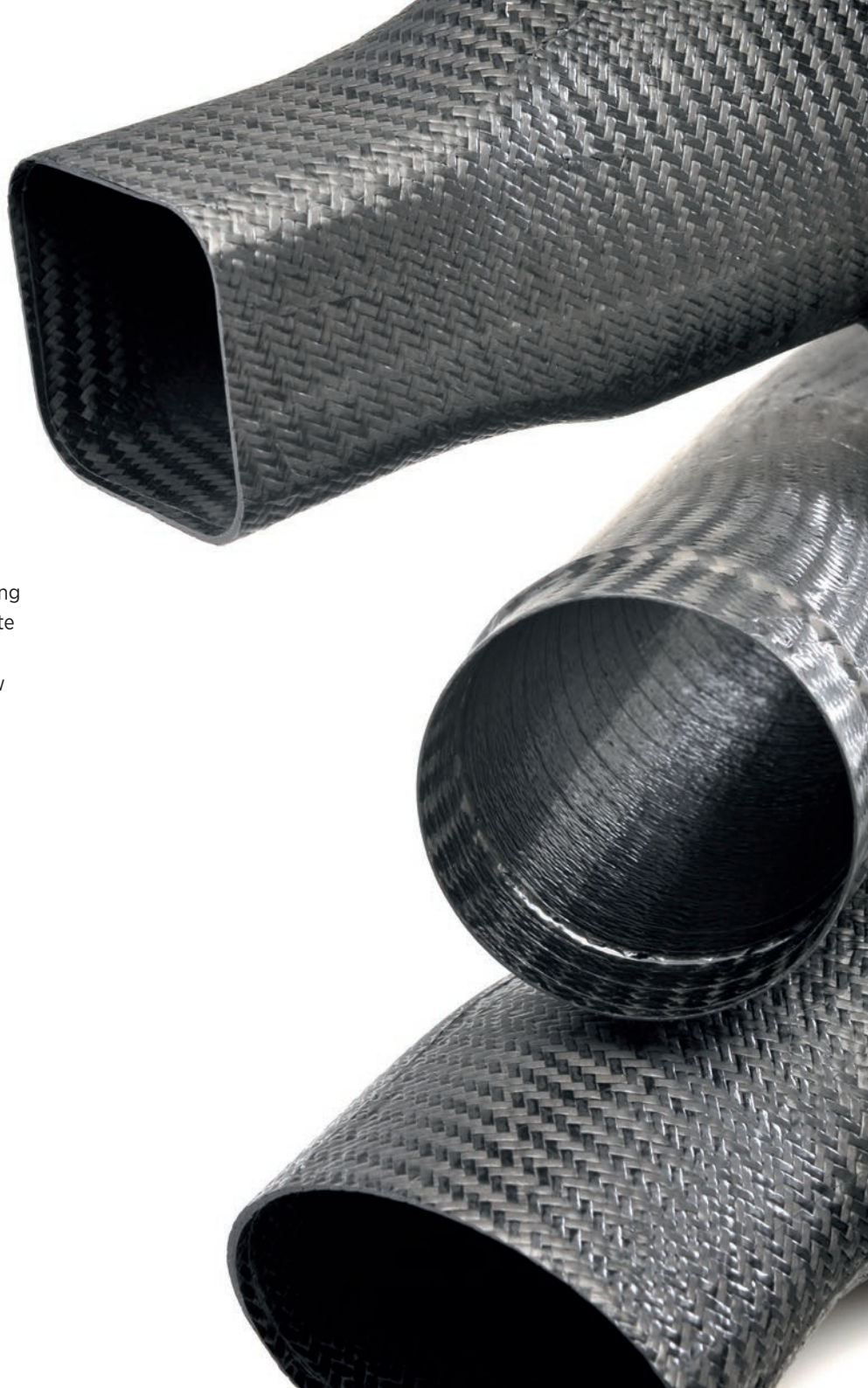
On-demand tooling for thermoforming, vacuum forming, or other compression tooling applications delivers tools more durable than other low-cost options that are able to withstand high temperatures, multiple hits, or even allow for full vacuum to be pulled in the forming process, all without delamination or failure.

X1 Layup

Get to composite layup faster with our patented infiltrated sand solutions. Whether low-cost prototyping or premium production tools, X1 Layup molds delivers complex geometries durable enough to withstand the temperatures and pressures of autoclave with a CTE comparable to aluminum and fast turnaround times.

X1 Washout

Eliminate the expense, lead time, and manufacturing challenges associated with production of composite parts with trapped geometries. X1 Washout creates a sacrificial 3D printed sand core for hollow objects that washes away with tap water after standard layup and autoclaving.



ORIGINAL APPEARANCE MANUFACTURING

3D Printed Sand Tooling Proves Durability in Production

CHALLENGE

To produce a cost-effective cosmetic option to cover vehicle rust damage without budget-busting structural repairs, OAM was in search of cost-effective vacuum form tooling that could reduce time to market while delivering true-to-factory-appearance quality. Aluminum tooling was both cost and time prohibitive, while traditional composite or metal tooling required long lead times, as well as maintenance and repair for production use.

SOLUTION

OAM turned to X1 ThermoForm 3D printed sand tooling. ExOne S-Max® systems build an entire job box layer-by-layer in under 24 hours, creating forms that are strengthened with resin infiltration and coated to provide the durability to withstand vacuum forming production. Two weeks after the design was finalized, OAM received its tool.

The company also researched alternative 3D tooling methods, but the CNC finishing path required for other large-format processes greatly increasing the cost relative to infiltrated sand tooling from ExOne.
With its in-house 3D scanner, OAM runs quality control scans to verify the accuracy of the tool over its lifespan. Comparison of scans after 100, 200, and 500 cycles proved an accuracy of 99.99% or better across the tool with no visible sign of degradation.

HIGHLIGHTS

In the world of consumer products, speed is the name of the game and X1 ThermoForm tooling saved over three months of lead time and was half the cost compared to aluminum tools used by OAM in the past.

With quality standards on par with Class A automotive on finished parts, precision tooling is a must. Tools must deliver high-quality pulls with a very smooth finish and OAM's X1 ThermoForm tool has demonstrated superior durability, delivering over 500 high-quality pulls to date.

> *"Product volumes that were not previously profitable are now viable and* ***variations previously cost-prohibitive are now opportunities*** *for expansion."*
>
> Zach Kowalik,
> CEO and Co-Founder of OAM

ORIGINAL APPEARANCE MANUFACTURING

INDUSTRY
Automotive

LOCATION
Ames, Iowa

PRODUCTS
Quick Covers exterior automotive panels

PRODUCTION METHOD
Vacuum formed ABS plastic

WEBSITE
www.oamusa.com

OAM original appearance manufacturing®

FEATURES EXONE

X1 TOOLING
X1 ThermoForm infiltrated sand tooling

PRODUCTION
Leetonia, Ohio

TRADITIONAL TOOLING

Original metal, composite, or wood required machining, which lead to long lead times. Aluminum was expensive, and other tools required repair and maintenance. Design constraints also limited vacuum hole placement.

MANUFACTURING TIME
3+ months for aluminum tool

X1 TOOLING

Rapid tooling production with sand 3D printing before infiltration and coating tailored to the requirements of a variety of tooling applications. The design freedom of additive manufacturing enables optimized positioning of production features like vacuum holes.

MANUFACTURING TIME
2 weeks after design was finalized


S-MAX Pro
ExOne
Job
Process Control
Process Analyse
07.10.2020 11:58
ExOne
2020_10_06_Marketing_Impeller
2 h 23 min
14 : 14
63
SOS
Schichten
+150,0
+149,4
+900,0
+0,0

SERVICES & SUPPORT

360° Products & Services

ExOne offers a comprehensive suite of services to successfully assist companies of all sizes in making a successful and low-risk transition from traditional to digital manufacturing.

Whether you want to simply order binder jetted parts or tooling as a service, explore new designs only possible with binder jetting, or work towards adoption of binder jetting for high-volume production, our world-class team of ExOne Experts can get you there.

We routinely develop mold packages to ensure done-in-one sandcastings and tailor tooling properties to meet the specialized needs of a variety manufacturers. We're confident we can support your goals, too.

- Industrial binder jet 3D printers
- 3D printed parts and tooling on demand
- Installation, training, and support
- Design, engineering, and logistics

3D Printing Services

Learn more
exone.com/SandServices

Engineering services and on-demand core and mold production

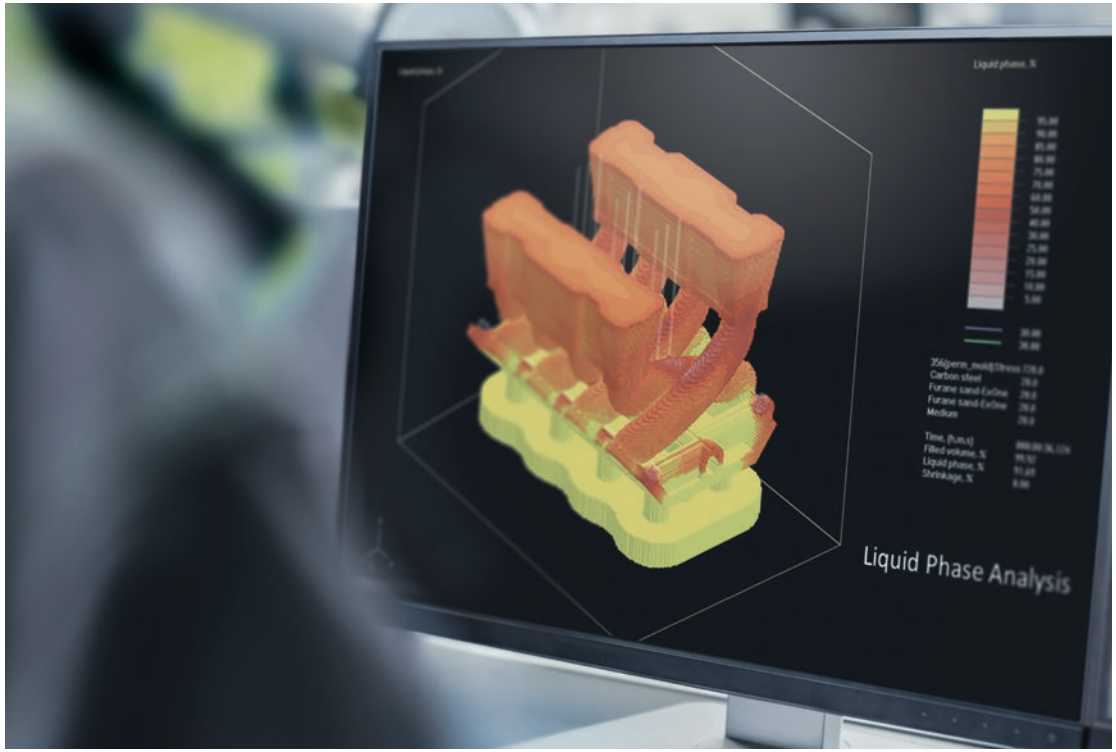
Our sand 3D printing service bureaus and network of sand 3D printing users serve foundries, manufacturers, and artists around the world with on-demand production. Whether precision metalcasting molds and cores on a tight schedule, infiltrated sand rapid tooling, or innovative customer product designs, we have the experts to help solve your production challenges.

- Fast, flexible, local production of metalcasting molds and cores as well as thermoforming and composite layup tooling or artistic designs
- Sandcasting design assistance to leverage done-in-one pours
- Connection to foundries with our printers that can pour your desired material

OneCast Service for Complex Metalcastings

Learn more
exone.com/OneCast

We pair virtual design and casting simulation with 3D printed mold and core packages with the goal of a done-in-one pour



Advanced software and 3D printing technology revolutionize what's possible with castings — quick turnarounds, successful first pours, and easy design changes are now a reality.

Our metalcasting experts help some of the world's most mission-critical manufacturers with complex rigging and riser design, fluid flow and solidification modeling, and detailed pouring parameters. We partner with you for the whole journey, from production of 3D printed molds and cores to foundry sourcing with mold assembly instructions.

Delivering Starts with Listening

KEY CONTACT

Rick Lucas
CTO of ExOne and SVP of
Future Markets Desktop Metal

- Material Development
- 3D Part Qualification
- Design, Engineering & Process Support
- OneCast Services
- 3D Program Design

PRINTERS

We've been the trusted partner of foundries for decades with binder jetting systems installed around the world. We're proud to take a vested interest in our customers' success with additive manufacturing. Before you even buy a printer, ExOne can help you evaluate whether binder jetting 3D printing is right for your business. We offer a range of systems that meet the needs of any foundry to make this transformative technology available to every manufacturer.

MATERIALS

Binder jetting is one of the most flexible additive technologies and can process a range of binder and print media. Our inorganic binder system helps decrease foundry scrap and environmental emissions while super-strength yet water soluble binders enable sacrificial tooling. In addition to traditional silica and ceramic sand, our systems process a range of powdered materials from upcycled wood byproduct to pulverized concrete.

APPLICATIONS

From the most complex metalcastings to unique consumer products, the freedom of design and on-demand production of binder jetting make the future of manufacturing possible today. S-Max® systems print sand for resin infiltration to produce durable tooling for plastic thermoforming, composite layup, and sacrificial washout applications. Similar techniques are used for architectural restoration or design and Forust, another brand in the Desktop Metal portfolio, upcycles byproducts from traditional wood waste streams into custom designs.

Learn more
exone.com/services

Industrial Binder Jet 3D Printers

As the global leader in binder jet 3D printers, ExOne sand printing systems are used and trusted by foundries and major manufacturers worldwide for mission-critical applications. Our machines are known for accuracy, reliability, and ease of use.

3D Printed Parts and Tooling on Demand

ExOne Adoption Centers (EAC) are premium 3D printing service bureaus, strategically placed in the United States, Asia, and Europe. Our EACs can binder jet your mission-critical sand molds and cores, rapid tooling, and infiltrated end-use designs.

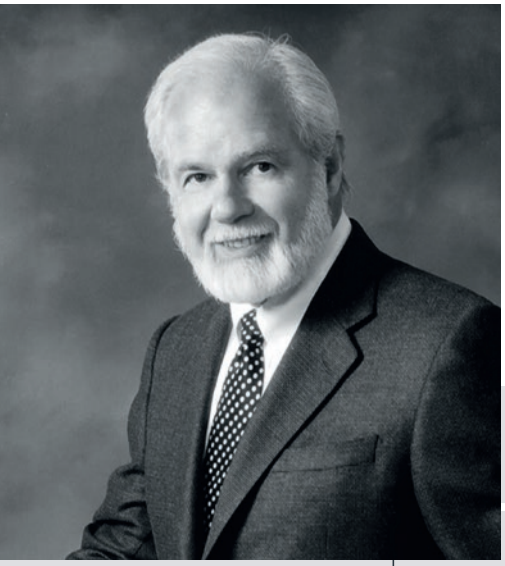
Installation, Training, and Support

Installing machines and training customers on how to successfully use an emerging, breakthrough technology isn't new to us. Our goal is to make you successful with our technology, providing all the information, hands-on training, and support you need — so you can untap new value.

Design, Engineering, and Logistics

Our experts help you evaluate your 3D printing application and assess the true cost of ownership of sand binder jetting. Our comprehensive suite of OneCast services support foundries with organic mold package designs and virtual casting simulations to ensure done-in-one metalcasting pours.

ExOne Milestones



1995

The Vision

Extrude Hone creates a “ProMetal” division to develop 3D printing. Company founder Larry Rhoades sees the potential of the new technology.

1996

The Patent

Extrude Hone obtains exclusive field-of-use license for patented 3D printing processes developed at the Massachusetts Institute of Technology (MIT).

1998

The Pioneer

Launch of the ProMetal RTS-300, the first metal 3D printer using binder jetting technology and the commercial realization of MIT’s invention.

2002

Entry Into Sand

Extrude Hone launches the S15 sand printer using binder jet technology.

2003

A Metal Workhorse

Extrude Hone launches the ProMetal R2, one of the company’s most robust and successful direct metal 3D printers using binder jet technology.

2005

ExOne Spins Off

Extrude Hone launches two new printers, the S-Print® sand and X1 Lab metal printer, and is sold to Kennametal.
The 3D printing division is spun off as “The Ex One Company.”

2007

A New Change

After Rhoades dies unexpectedly, ExOne is purchased by a company owned by S. Kent Rockwell, who has led the company since as Chairman of the Board of Directors.

2010 – 2013

The Printers

Launch of four printers: the S-Max®, a new version of the S-Print®, now a staple portfolio product, and the M-Print and M-Flex® metal printers.

2013

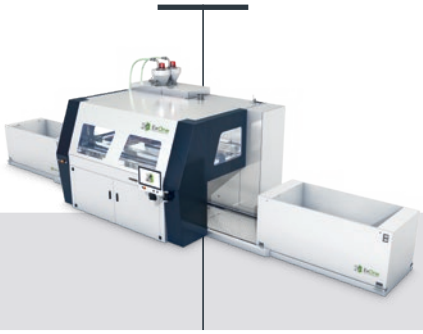
A Record Year

ExOne successfully completes its Initial Public Offering on Nasdaq, one of the most successful IPOs of the year. Shares of XONE begin trading.

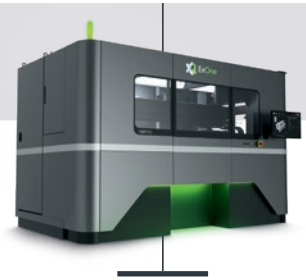
2014

Waves Of Sand

ExOne launches three new sand printers, including a new S-Max® and S-Print® models, continuing its market share gains in sand 3D printing.



2018



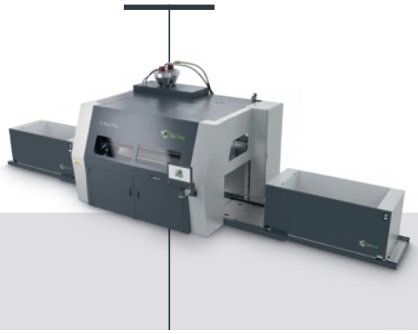
A New Metal Era

ExOne launches the Innovent+®, the X1 25Pro®, and the X1 160Pro™, a full family of metal 3D printers for processing MIM powders into dense parts without infiltration.

2019

High-Volume Production

ExOne launches the S-Max® Pro production sand 3D printer and the X1 160Pro™, the company's tenth metal printer and the industry's largest commercially available metal binder jetting system.



2020

The Next Generation

ExOne ships X1 25Pro® metal 3D printer and launches the new InnoventPro™ entry-level metal binder jetting System.

2021

#TeamDM

ExOne is acquired by Desktop Metal to advance the mission of Additive Manufacturing 2.0 across all materials.

#TeamDM

We're more than metal now. Our global team delivers production-capable printer platforms, materials and applications

At Desktop Metal, our portfolio of #TeamDM companies was carefully curated by the brightest engineering minds to drive the future of Additive Manufacturing 2.0, or production-volume 3D printing. We've paired 3D printing technologies that we view as truly production capable with performance materials and select applications and technologies to help drive the next generation of additive manufacturing. Achieving this goal requires delivering speeds and costs that compete with conventional manufacturing, as well as unparalleled reliability and uptime in 3D printing.

Our team is on a mission to deliver on this objective because we're passionate that AM 2.0 technologies can deliver more advanced parts and products that can truly change the world at high, meaningful volumes. From lighter, smarter vehicles to new sources of energy to completely customized patient care, our team is aggressively pursuing a sustainable and modern manufacturing technology future.

We view our #TeamDM companies and employees as the engineering athletes of the 3D printing world—the ones trying to lift AM higher.

The Desktop Metal Shop System
A turnkey print-sinter metal binder jetting system

Production 3D Printers

Desktop Metal

Founded in 2015 to make metal and carbon fiber 3D printing accessible to all engineers, designers, medical professions, and manufacturers.

Desktop Health

Founded in 2002 to deliver 3D printing and biofabrication solutions to drive the advancement of personal healthcare.

ETEC

Founded in 2002 to deliver industrial-grade polymer 3D printing solutions.

ExOne

Founded in 1995 to deliver industrial sand 3D printing solutions for foundries.

High-Performance Materials

ADAPTIVE3D

Founded in 2015 to design high-performance 3D printable resins.

FORUST

Founded in 2019 to build a greener future through 3D printed wood derived from two waste streams: sawdust and lignin.

Killer Apps & More

aidro

Founded in 1982, Aidro designs and produces high-quality hydraulic components for the energy and aerospace industries, using 3D printing.

aerosint

Founded in 2016 to deliver its patented selective powder deposition recoating technology that enables multi-material 3D printing.

Desktop Labs

Founded in 2021, Desktop Labs is driving production of dental products into a digital future for unparalleled efficiencies and customization for patients.

Forust™ recycled wood 3D printing
Using high-speed binder jetting for upcycling

The Desktop Health Einstein
Used with Flexcera™ material for printing beautiful, functional dentures

The ETEC Xtreme 8K
Large, top-down DLP polymer printing, including elastomers

ExOne™

ExOne has facilities and representatives around the world. To reach us, feel free to call or email us at the locations below, or visit us at exone.com/locations.

ExOne is now part of Desktop Metal's group of #TeamDM brands, which exist to make Additive Manufacturing 2.0 a reality so we can unlock the vast benefits of 3D printing at meaningful production volumes.

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