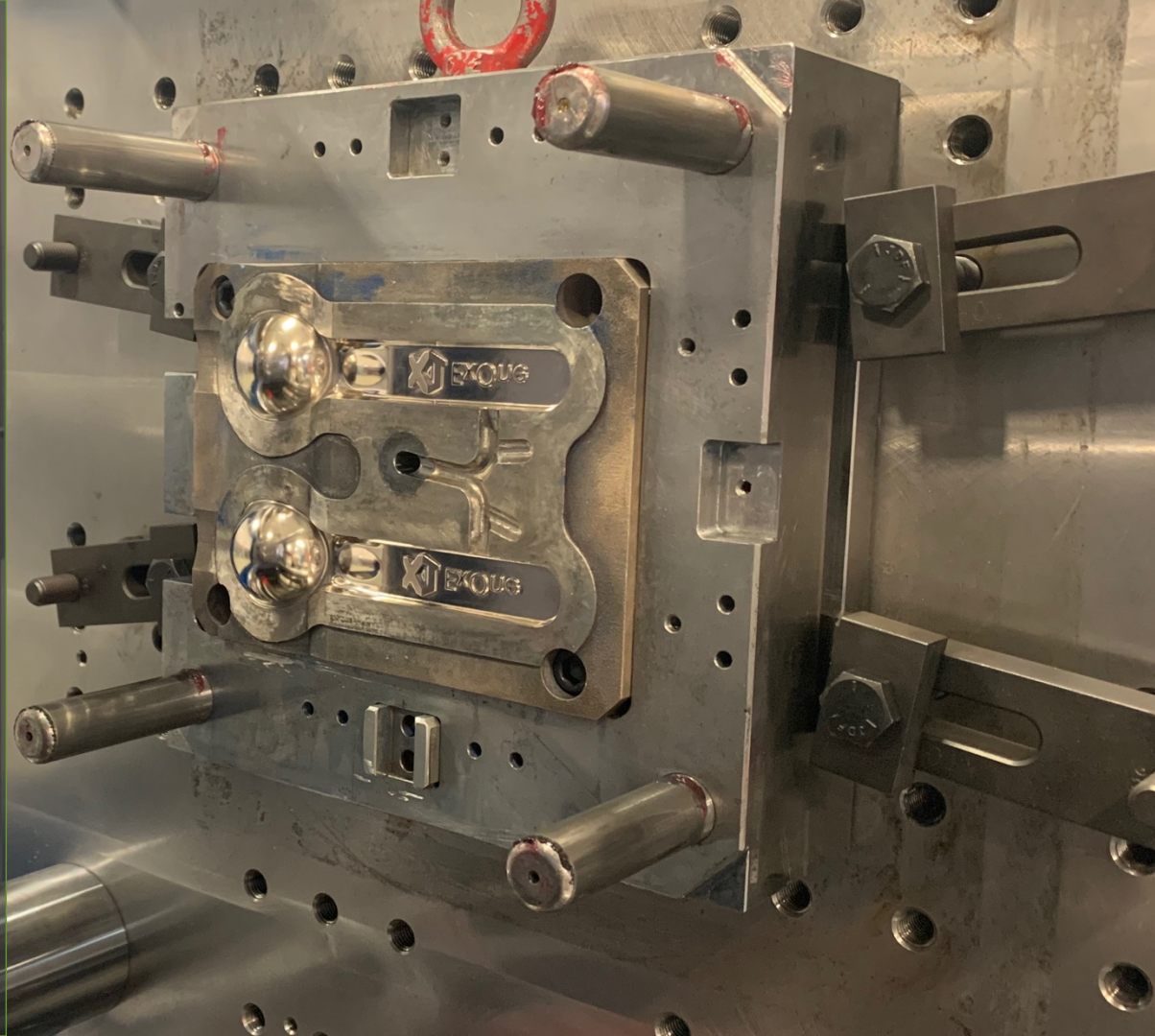
FAST X1 TOOLING SOLUTIONS TO SOLVE SUPPLY CHAIN DELAYS

Rick Lucas, ExOne CTO, and VP, New Markets, with special guests North American Mold, and ExOne team members

Wednesday, Oct. 27



Today's Agenda

1. Event Overview
2. Launch of X1 Tooling Portfolio
3. ExOne, and our 3D Tooling History
4. Why Use Binder Jetting for Tooling
5. Who's Already Using Tooling?
6. Introduction to X1 Tooling for Plastics

Rick Lucas

Chief Technology Officer &
VP, New Markets
Rick.lucas@exone.com

ExOne

Today's Agenda

You're invited for any part of today's session that you're interested in

01 X1 Tooling for PLASTICS
1-2 p.m. EDT

- X1 Metal Tool
  - Plastic Injection Molding
  - Blow molding
  - Other forming
- X1 ThermoForm
  - Compression forming and molding apps
  - Large-format

02 X1 Tooling for COMPOSITES
2-3 p.m. EDT

- X1 Layup
  - Where does X1 Layup fit?
  - Application examples
  - Design guidelines
- X1 Washout
  - Core benefits
  - Process overview

03 X1 Tooling for METALS
3-4 p.m. EDT

- X1 MetalTool
  - Direct printing end-of-arm tooling, cutting tools and more
- X1 SandCast
  - Sandcasting molds and cores for metalcasting
- X1 DieCast
  - In development

Housekeeping Items

- Today's Session will be recorded and available On Demand for sharing
- A Q&A will follow each session, and we will answer questions via email
- We will distribute slides after today's event via email

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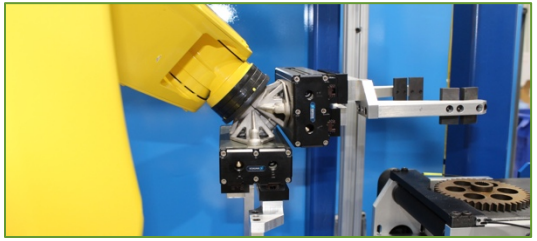
The New X1 Tooling Portfolio

The 3D printing industry's broadest portfolio of tooling for final production (not just prototypes)

PLASTICS	COMPOSITES	METALS
		
X1 MetalTool	X1 Layup	X1 MetalTool
		
X1 ThermoForm	X1 Washout	X1 SandCast

ExOne

The ExOne Company | Overview

Binder jet 3D printing leadership for 20+ years

The global leader in binder jet 3D printing solutions for industrial customers

FOUNDED IN 1995

- Began in 1995 as the 3D division of Extrude Hone
- Today, we're global leaders with operations in Europe, Asia, and the Americas
- More than 288 issued and pending patents

WE SELL MACHINES AND SERVICES

- Binder jet 3D printers – sand, metal, ceramics, and composites
- 3D printing services:
  - 3D printed parts
  - Design for additive manufacturing services
  - Customer development of machines, materials

HIGH-VALUE PARTS

- Sand molds and cores
- Direct metal 3D printing
- Direct ceramic 3D printing
- 3D printed tooling solutions

INDUSTRIAL MARKETS

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

RAPID GROWTH

- 2021 revenue up 30% in First Half
- Year-to-date backlog for machiens is up 27%

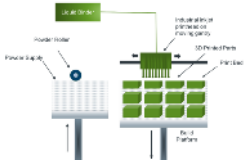
ExOne

The ExOne Company | A History of Market Leadership

Highlights of an emerging technology leader

1995
Extrude Hone creates the "ProMetal" division to develop 3D printing

1996
Extrude Hone obtains exclusive field-of-use license for patented 3D printing processes



1998
RTS-300, the first metal 3D printer

2002
S15, the first sand 3D printer

2005
The ExOne Company formed. Launch of S-Print® sand printer and X1-Lab® metal printer

2007
S. Kent Rockwell acquires and leads the company as Chairman of the Board of Directors

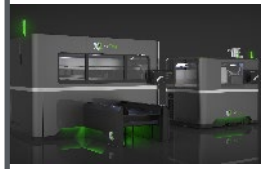
2010 - 2013
Launch of four all-new 3D-printers: S-Max®, S-Print® 2.0, M-Flex® and M-Print®

2013
Initial public offering NASDAQ: XONE

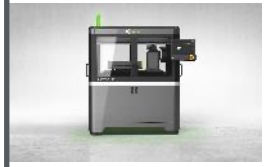
2018
Launch of the new Innovent+® and X1 25Pro® metal 3D printers

2019
Launch of the S-Max® Pro sand production 3D printer and the X1 160Pro™, ExOne's tenth metal printer

2020
Shipping of X1 25Pro® and launch of the new InnoventPro™ entry-level system



2021
Shipping of InnoventPro™ metal binder jetting system



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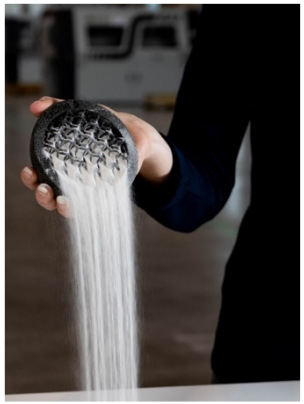
Binder Jetting | Overview

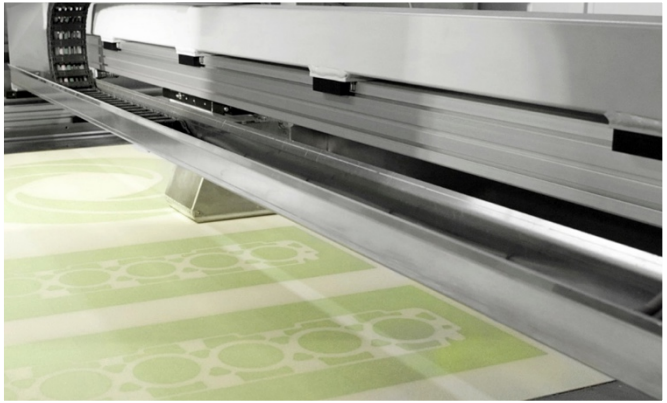
Patented in 1993 by Massachusetts Institute of Technology

POWDER → **BINDER** → **PRINT EACH LAYER**



Sand, Metal, Ceramics, Composites

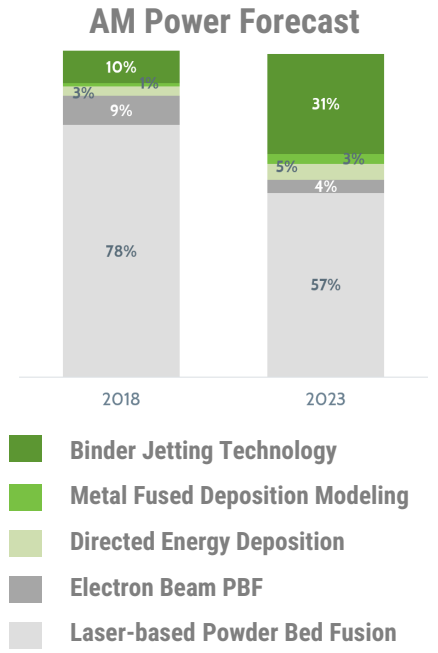
Liquid binder adheres powder and layers together



- Layer of powder is spread into the print bed
- Industrial printhead lays down binder fast sweeps.
- Recoater dries layer and lays down fresh powder
- Process is repeated until the part is complete and ready for post-processing.

CORE BENEFITS

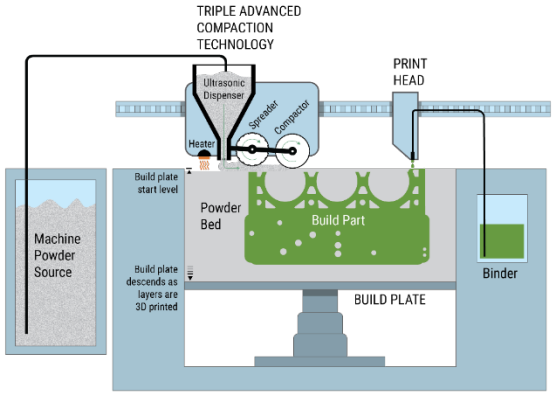
- High processing speeds
- Scalable, large systems
- Small or large parts
- Many materials
- Low operating cost
- Easy to operate



ExOne

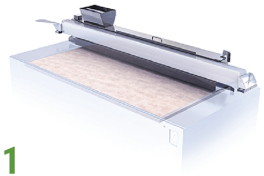
Binder Jetting | Process Overview

Liquid binder applied to powder to form parts and tooling

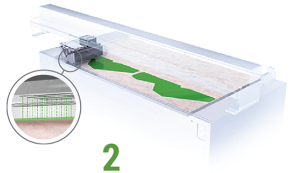


Digital File Prep → Machine & Material Prep

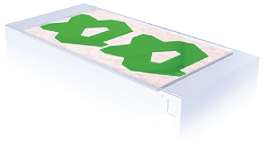
3D Printing



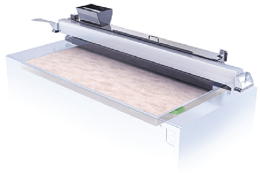
1 Powder is deposited.



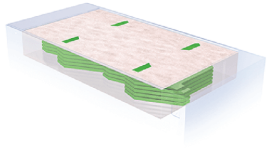
2 Inkjet applies binder.



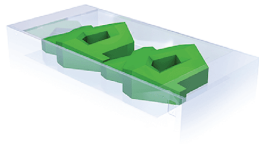
3 Each layer is printed fast.



4 Powder is recoated.



5 The process repeats.



6 3D printing is complete.

Next steps depend on application and specific materials →

- Sand molds & cores → Depowder → Cure optional
- NEW Sand tooling → Depowder → Coat or Infiltrate
- Metal and ceramics → Cure → Depowder → Debind & Sinter

ITERATIVE PROCESS WITH BIG PAYOFFS

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Binder Jetting | Fast and Maturing 3D Method

Only method that completes full layers quickly

- Binder jetting is regarded as the fastest 3D printing method, and it's also mature and proven
- Because it doesn't use a single point to draw out parts (unlike laser, nozzle, etc.), it is much faster than other methods
- To add speed, other systems must add more lasers, nozzles, which adds to cost of system
- Binder jetting is a relatively mature technology, in development since the early 1990s, with the first machine launched 20+ years ago

EFFICIENT & MATURE METAL 3D PRINTING

Powder Bed Fusion (SLM, DMLS, EBM)	Directed Energy Deposition	**Binder Jetting**	Sheet Lamination	Material Extrusion (ME)	Material Jetting
Laser (single point or points)	Laser (single point)	Industrial printhead deposits binder in large sweeps	Ultrasonic localized welding of metal sheets	Nozzle (single point)	Prints metals suspended in nanoparticles
Early 1990s	Mid-1990s	1998, RTS-300	2011	2017	2017

Binder Jetting | Applications by Porosity

From large particles to infiltrated materials to dense, single-alloy, ultra-fine powders

Product Forms

Coarse Powders

Bonded

Partially Sintered

Infiltrated

Highly Sintered (Coarse)

Materials (D50>20µ): Minerals, Ceramic, Carbon, Glass, Ceramic, Metal

Markets:

- Sand casts molds
- Low density single-alloy parts < 90%, Filters
- Metal and ceramic matrix
- Other course powder non-metallics
- Castings - high density single-alloy
- Tooling

Product Forms

Fine Powders

Bonded

Partially Sintered

Infiltrated

Highly Sintered (Fine)

Materials (D50 <20µ): Minerals, Ceramic, Glass, MIM, CIM powders

Markets:

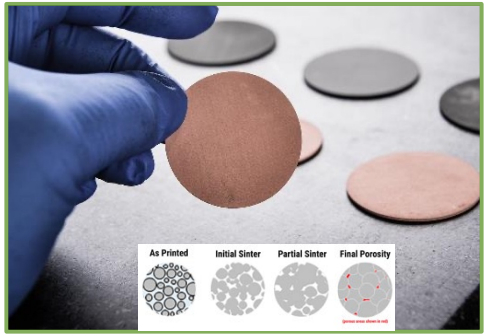
- MIM
- CIM
- Investment castings
- Machined parts
- PM parts
- Ceramic matrix
- Cutting tools
- Wear parts

Bonded

Partially Sintered

Infiltrated

Highly Sintered



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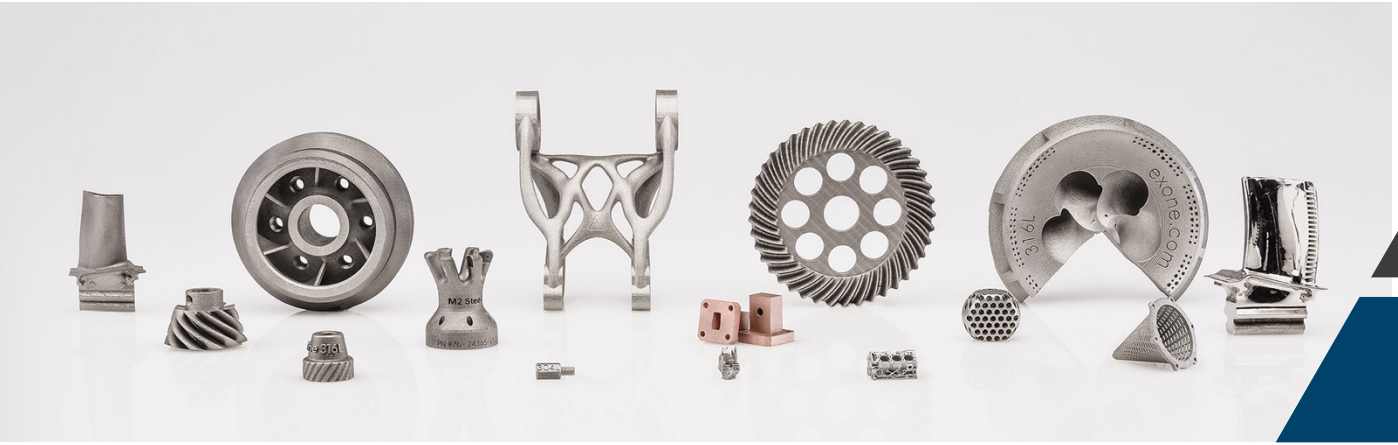
Binder Jetting | Material Flexibility & Qualification

3D print more than twenty metal, ceramic, and composites – plus R&D

- Durable tooling materials for metal tools: 420i, 316L, M2 qualified
- Customer Qualified: H11, Aluminum 6061 and more
- In Development: H13, 4140 and more



R&D QUALIFIED: Have passed a preliminary qualification phase by ExOne and are deemed printable, supported by ongoing development.

CUSTOMER-QUALIFIED: Qualified by customers with their own standards and being successfully 3D printed for their own applications.

THIRD-PARTY QUALIFIED: Have passed rigorous tests over multiple builds and have verified material property data from an independent third party. General marketplace readiness.

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ExOne | Comparing Final Part Density

From large particles to infiltrated materials to dense, single-alloy, ultra-fine powders

EXONE BINDER JET 3D PRINTING PART DENSITIES

50%-60%

ExOne Pre-Sintering "Green" Part Density

ExOne Final Sintered Density (97-99% for most metals)

91% 92% 93% 94% 95% 96% 97% 98% 99% 100%

Press and Sinter or PM (85-93%)

Metal Injection Molding or MIM, (96-98%, w 98% being most common)

Metal Castings, Gravity (95-97%)

Metal Castings, Low Pressure (97-98%)

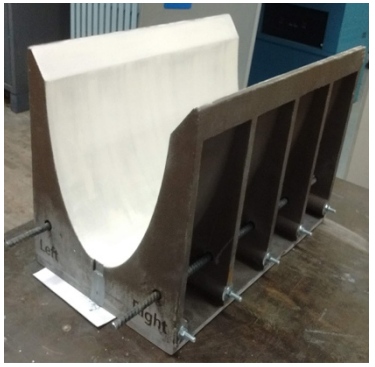
Wrought Parts (>98%)

TRADITIONALLY MANUFACTURED PART DENSITIES

Freshmade 3D Acquisition & New Material Options

New, large-format infiltrated tools for wide variety of applications

- Youngtown, Ohio startup company, acquired by ExOne in April 2021
- Patented process: 3D printed sand forms infiltrated with resin create durable tooling, restoration pieces and more
- ExOne machines at the core of the process
- Fast output and large-scale capabilities
- ExOne's resin-infiltrated sand 3D printing a finalist in the 2021 Awards for Composites Excellence (ACE) at CAMX, the Composites and Advanced Materials Expo



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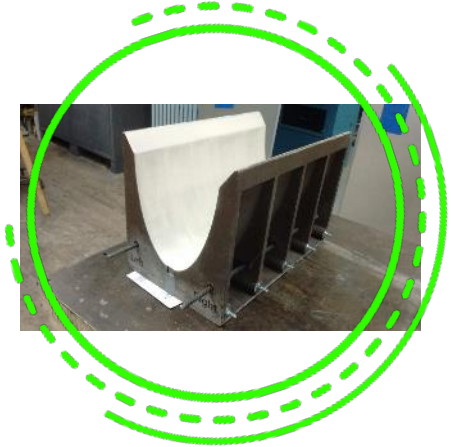
X1 TOOLING IN USE TODAY

X1 Tooling | Composite Layup Tool

Reduced turnaround tooling times with comparable CTE performance

INDUSTRY Tooling & Fixtures
APPLICATION Leading edge airfoil composite layup tool
LOCATION Dayton, Ohio
CHALLENGE Project to identify an alternative process or material with comparable properties to existing composite layup tooling solutions. Multiple processes and materials were tested by the University of Dayton Research Institute and Youngstown State University.

SOLUTION
3D PRINTING ExOne S-Max®
MATERIAL Silica sand infiltrated with epoxy and coated for composite
BENEFITS The composite layup tool demonstrated a CTE of 19.67 µm/m°C; a performance better than aluminum (~23µm/m°C) and comparable to stainless steel (~18 µm/m°C). Sub-scale testing successfully demonstrated 10 cycles of 350°F and 100psi in autoclave before a full-size large-scale tool was printed in two halves, bonded together, and delivered in a few weeks.



After successful sub-scale testing, a final tool could be completed and delivered to the University of Dayton Research Institute for autoclave layup in under three weeks

ExOne

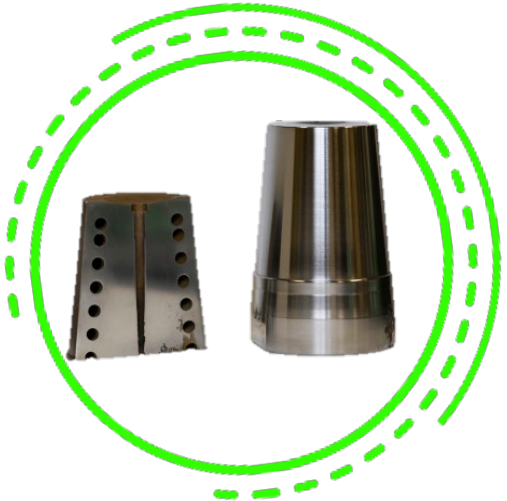
Binder Jetting | On-Demand Metal Tooling

Case Study at
Exone.com/H13Cup

3D printed in under 2 days with increased complexity for optimized production

INDUSTRY Tooling & Fixtures
APPLICATION Injection molding tool
LOCATION Oak Ridge, Tennessee
CHALLENGE Traditionally machined tools require long leads times and are limited at incorporating advanced geometries, such as conformal cooling channels. Injection molders needed tooling that could be produced quickly with complexity for high productivity production.

SOLUTION
3D PRINTING ExOne M-Flex®
MATERIAL H13 Tool Steel
BENEFITS The durable H13 tool was 3D printed and sintered to full density. After post-processing molded cups were produced off the printed tool in less than 32 hours while conformal cooling channels increased manufacturing productivity by reducing cooling times during production.



"We believe that using the right additive manufacturing technologies in the right applications like tooling will not only drive down cost and time but also produce tools that outperform traditionally manufactured ones."

Amy Elliott, Ph.D., Research Scientist, Oak Ridge National Laboratory

ExOne

Binder Jetting | All-New Green Innovations

ExOne porous metal tooling enabling sustainable wood-based plastic replacement

Celwise AB in Sweden has developed a method to use specially designed mixes of pulp to create water-resistant, plastic-like products using ExOne's unique porous tooling options. Products made with Celwise technology replaces single-use plastics with a renewal, biodegradable product.

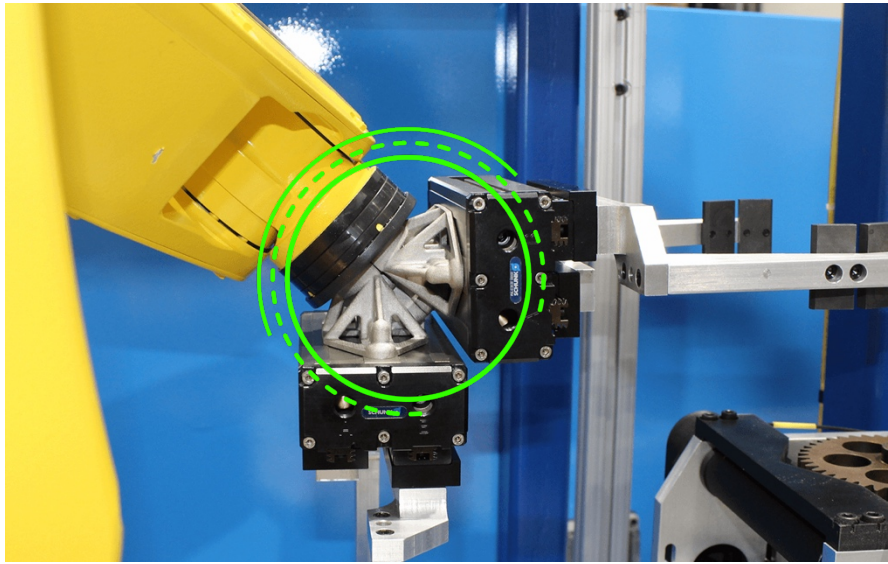
INDUSTRY Packaging, Containers, Other Plastic/Paper Goods
APPLICATION Porous Metal Tooling (Made Possible with Binder Jet)
LOCATION Sweden
SOLUTION
PRINTER ExOne M-Flex®
MATERIAL 316L Stainless Steel
BENEFITS Unique tooling provided through binder jetting technology are a critical enabler of Celwise's technology. The tools make different thicknesses and densities to give the end product the desired design and function.

Unique Celwise tooling, which is made with binder jet 3D printing, are the core of the technology and made from a combination of materials and heating elements in a 3D printing process. There are three types of tools in each machine – forming, transferring and pressing – to produce goods that will disrupt the paper and plastic industry.

Binder Jetting | Lightweight Robotic Arm Tooling

Delivered affordable, durable and **lightweight** solution using less energy

INDUSTRY Automotive Parts Manufacturing
APPLICATION Robotics – End of Arm Tooling
LOCATION Saint Marys, PA
CHALLENGE Develop a strong, lightweight end of arm tooling attachment for a high-volume precision inspection application with varying weight requirements. The complex part enables two tools to sit at a 90-degree angle to each other on one arm.



SOLUTION
3D PRINTER ExOne Innovent+®
MATERIAL 17-4PH Stainless Steel (D90 of 22 µm)
PART SIZE 4.5 x 2 x 2 in. (12 x 5 x 5 cm)
WEIGHT 95 grams
COST $150 prior to finishing (compared to $672 for DMLS)
BENEFITS Generative software produced a lightweight design that could only be manufactured with 3D printing. Binder jetting was one-fourth the price of laser powder bed fusion. Final materials met MPIF standard 35 and customer requirements.

"It was one-fourth the cost of DMLS, and we did it in a strong material that reduced the payload on the robot. As Allegheny Electric Service rolls this technology out, it's going to be a bigger savings for their customers."

- Chris Aiello, VP, Business Development FreeFORM Technologies for Allegheny Electric Service

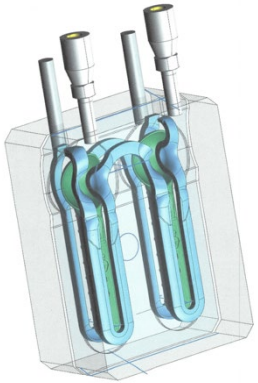
Binder Jetting | X1 MetalTool 420i

Successfully printing injection mold inserts

INDUSTRY Consumer Goods
APPLICATION X1 MetalTool 420i or plastic injection molding

DETAILS

- End-to-end production, from design to final parts, in two weeks
- Designed, binder jet printed and sintered to near net shape in 4-5 days
- Finish machined and hand polished in remaining time in 4-5 days
- Injection molding on final day
- Conformal cooling channels used in the draw of the ice cream scoop
- Cycle time on the the Sumitomo (SHI) Demag SE180EV-A – a high-performance, all-electric injection molding machine – offered a gate-to-gate cycle time reduction of 33%
- North American Mold ran parts off the tool in food-safe polycarbonate material, lupilon™ S-2000R, provided by Mitsubishi Engineering-Plastics Corporation



"We believe this technology can revolutionize toolmaking for plastic injection molding, blow molding and more."

Rick Stephens, North American Mold

ExOne

Today's Presenters

Rick Stephens

- North American Mold, Auburn Hills, MI
- X1 MetalTool

Rich Wetzel

- ExOne Applications Manager
- X1 ThermoForm

X1 METALTOOL
AT
NORTH AMERICAN MOLD

About North American Mold

Long history of molding plastics for the automotive industry

- A division of North American Assembly in Auburn Hills, MI
- 20+ years
- Tier 1 automotive supplier
- Customers include virtually all automakers and suppliers
- Specialty areas include performance air induction systems, low-volume and specialty products

ExOne

Additive Manufacturing at North American Mold

Pioneering the capabilities of 3D printing in the plastic forming market

- Progressive supplier with additive technologies specific to injection/blow mold tool development
- Technologies include Essentium, Formlabs, Markforged, etc.
- How we currently use 3D printing today
  - Part prototypes
  - Tool prototypes
  - Low-volume runs
  - Developing new tooling techniques
    - Challenging and innovative part designs
    - Cycle time reduction

ExOne

First Experience with ExOne and Binder Jetting

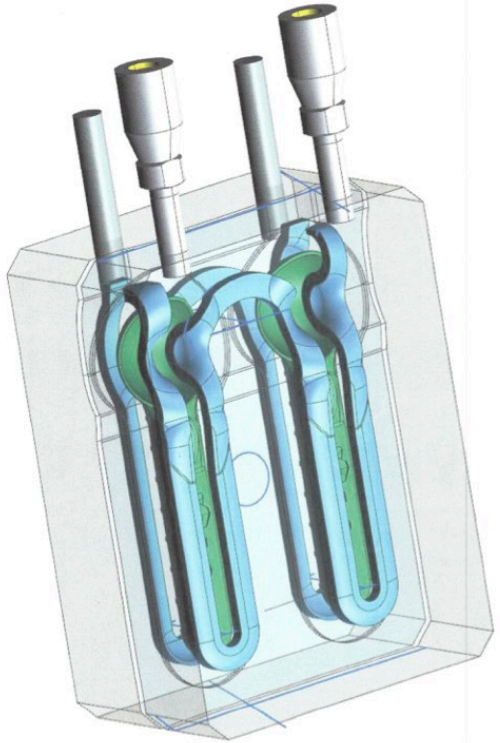
Automakers, NA Mold, and ExOne came together with goal of better, faster, less expensive tooling

- Ran preliminary testing in a variety of areas
  - 420i steel-bronze material
    - Tested for injection molding
    - Tested for blow molds
  - 316L pure stainless steel
    - Tested for injection molding
  - All test parts delivered success
    - Printed and machined tools delivered products as intended
  - Surface treatments tested
    - Successful acid/laser etching
    - Polishing to diamond finish (316L)
    - Polishing to 900 Ra (420i)

What NA Mold Learned about Binder Jetting Tools

Long history of molding plastics for the automotive industry

- Extremely exciting opportunity with many benefits
  - Durable 3D printed tools
    - Production-intent tooling for prototype
  - Reduced machining
    - Finish machining required
  - Conformal cooling channels
    - Reduced cycle times substantially
  - Speed
    - End-to-end parts in as little as two weeks, depending on design



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Standard Surface Finishing

Regular finishing of X1 MetalTool possible for 420i and 316L prints

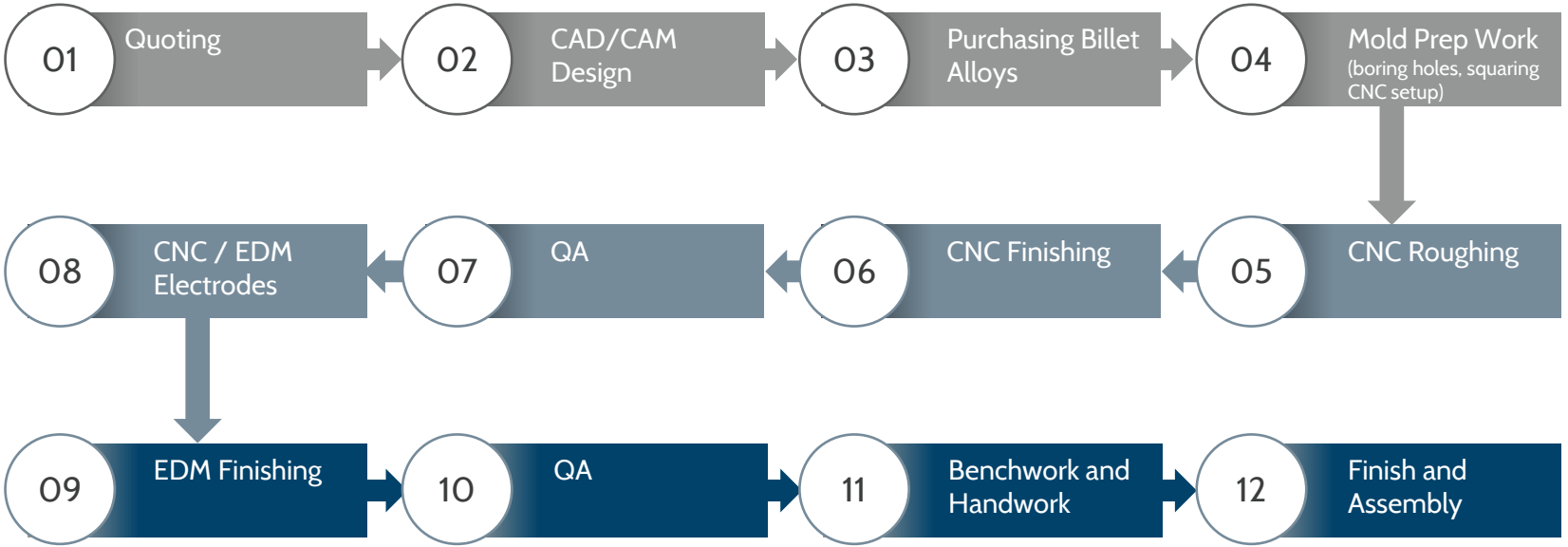
- Acid Etching
- Laser Detailing
- Polishing to Diamond Finish
- Regular handwork still required for finishing

Acid etching of X1 MetalTool 420i top; Laser etching of same material, bottom. North American Mold ran successful tests on mold

Diamond finish of X1 MetalTool successfully tested by North American Mold

Reduced Processing Steps

Traditional Process steps



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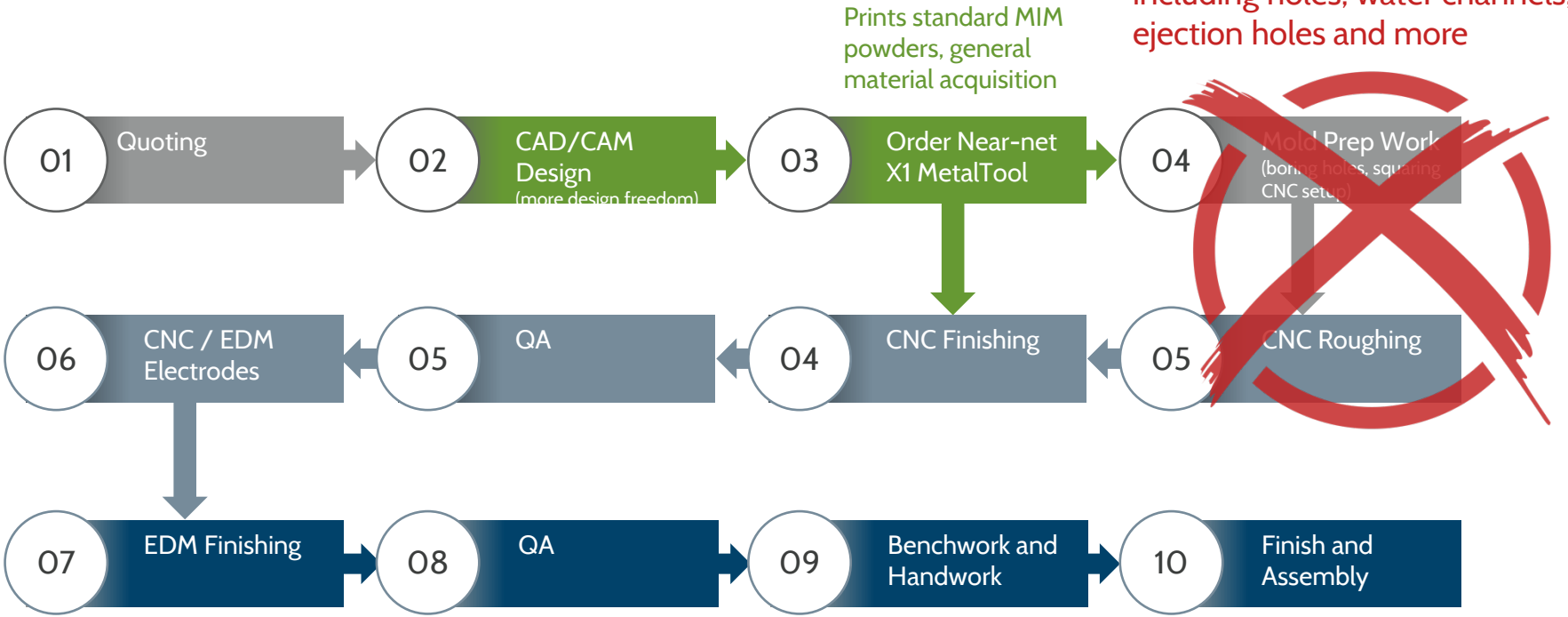
3D Printing Processing Steps

Traditional Process steps

SAVE HOURS TO DAYS WITH EACH TOOL: All features 3D printed directly into tool, including holes, water channels, ejection holes and more



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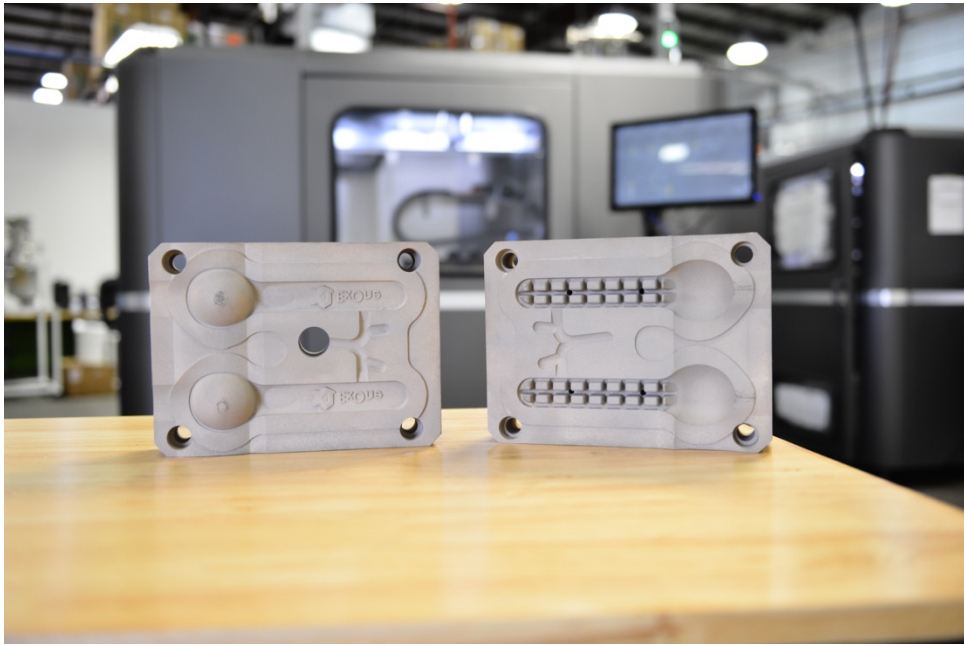
Most time saved in machining

Long history of molding plastics for the automotive industry

- No roughing
- Finish machining only
- No boring of holes
- No gun-drilling of water lines
- Drill and tap holes printed into the tool
- Details can be 3D printed right into the part



ExOne

New Standard in 3D Tooling for Volume

X1 MetalTool 420i can go from prototype to production

- Tools are durable to be used for BOTH initial prototype and production usage
- Plastic tooling today cannot support production tooling requirements
- Only for prototype and low-volume runs
- X1 MetalTool can be welded and machined like traditional tooling so engineering changes can be easily incorporated

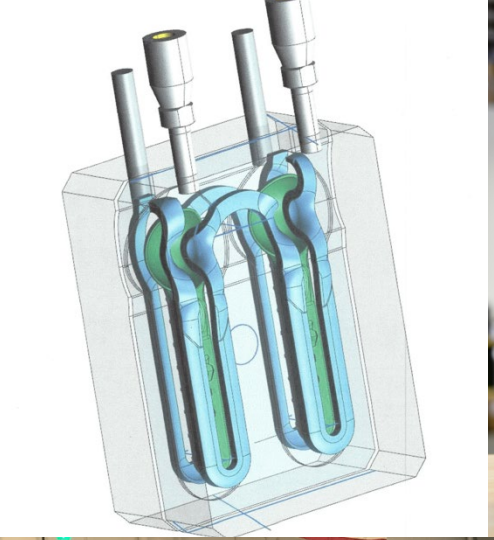
Demonstration Project

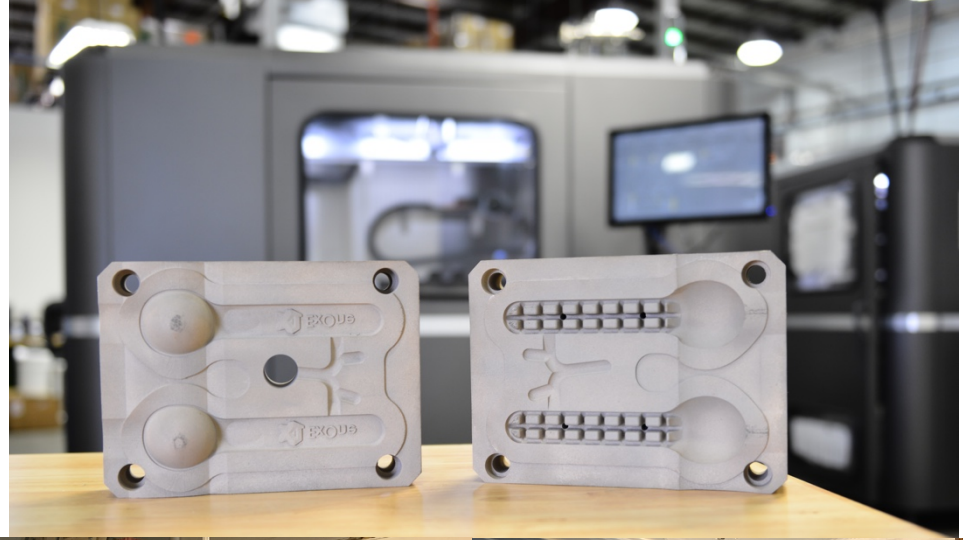
Quick-turn inserts in durable 420i for production requirements

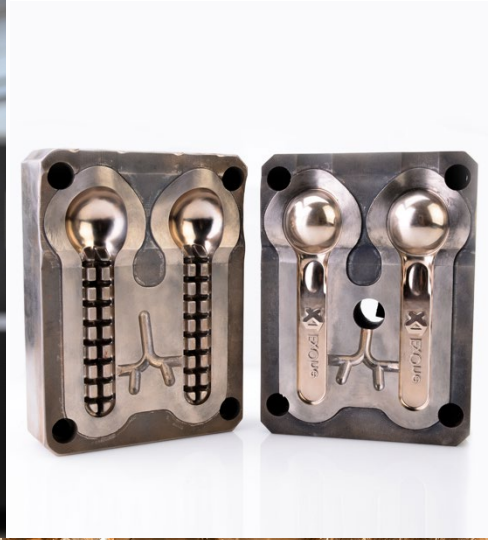
DETAILS

- End-to-end production, from design to final parts, in two weeks
- Designed, binder jet printed and sintered to near net shape in 4-5 days
- Finish machined and hand polished in remaining time in 4-5 days
- Injection molding on final day
- Conformal cooling channels used in the draw of the ice cream scoop
- Cycle time on the the Sumitomo (SHI) Demag SE180EV-A – a high-performance, all-electric injection molding machine – offered a gate-to-gate cycle time reduction of 33%
- North American Mold ran parts off the tool in food-safe polycarbonate material, lupilon™ S-2000R, provided by Mitsubishi Engineering-Plastics Corporation

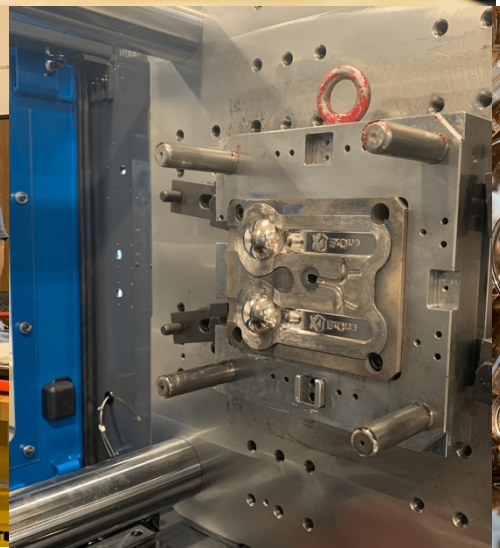
ExOne








Sumitomo
SHI DEMAG
SE180EV-A

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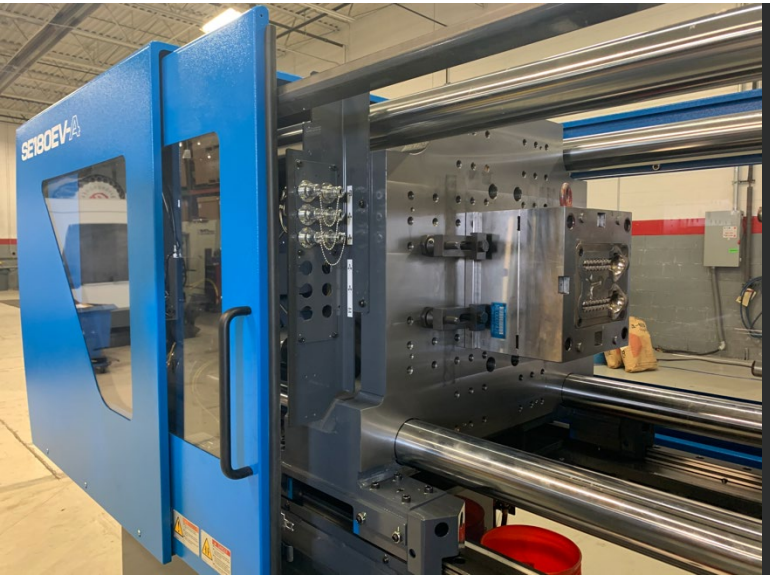
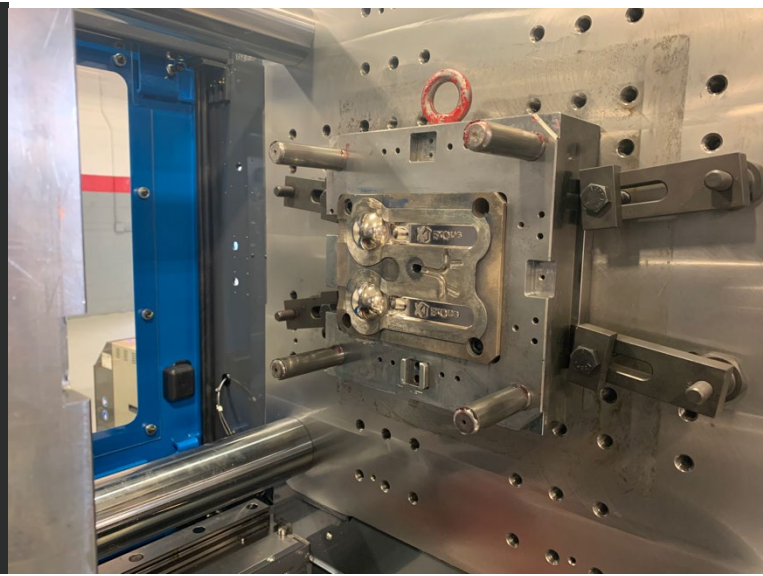
NA Mold Collaborating ExOne on Tooling Services

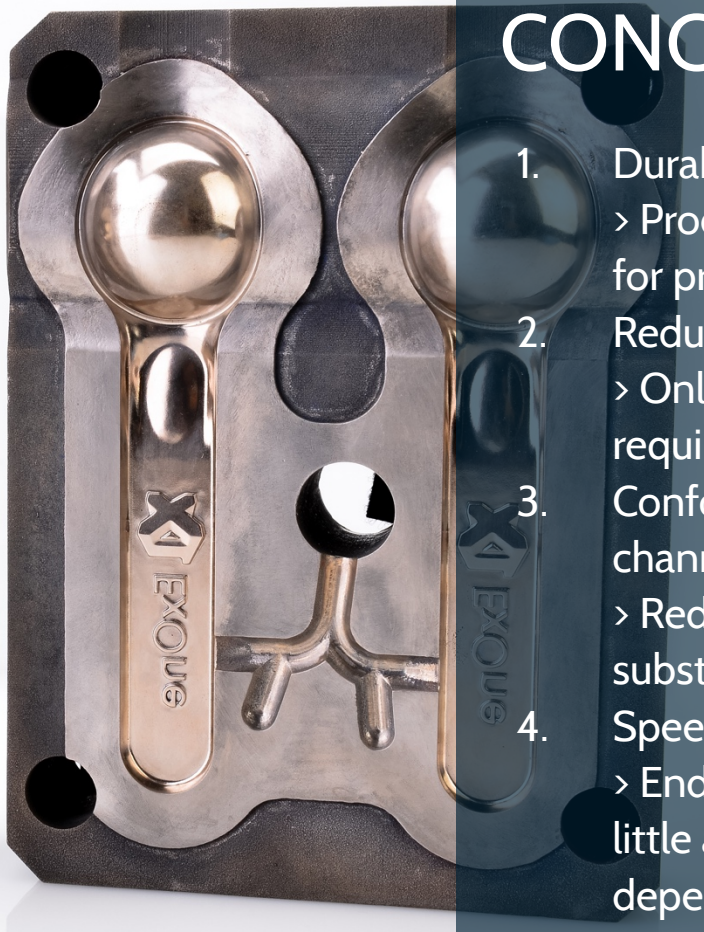
Can assist with quotes, design services, and start-to-finish tooling and part production



- Quoting
- Tooling Design Consulting
- All Finishing Work
- Final Molding



"We believe ExOne's technology will completely change toolmaking processes for injection molding, blow molding and other tooling applications. Toolmakers and molders can reduce their lead times to market by weeks with this technology."
– Rick Stephens of North American Mold



CONCLUSION

1. Durable 3D printed tools
   > Production-intent tooling for prototype
2. Reduced machining
   > Only finish machining required
3. Conformal cooling channels
   > Reduce cycle times substantially
4. Speed
   > End-to-end parts in as little as two weeks, depending on design

INTRODUCING X1 THERMOFORM

What is Infiltrated Sand Tooling?

A cost-effective tooling solution with fast turnarounds

A patented application of infiltrating and coating 3D printed sand forms to deliver tooling that eliminates weeks or months of lead time and the high costs associated with traditional tooling.

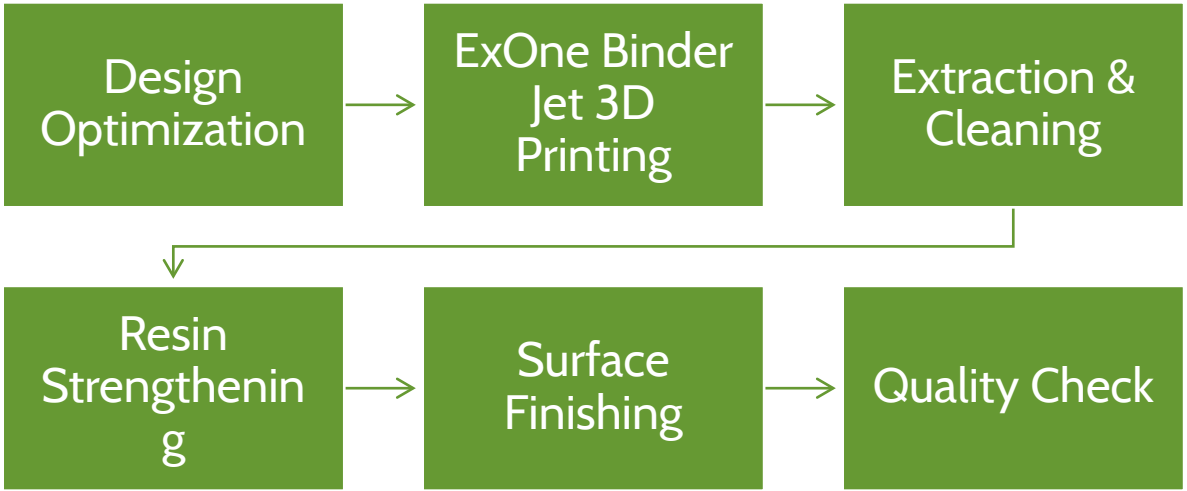
Durable enough for use with every vacuum formable plastic to withstand:

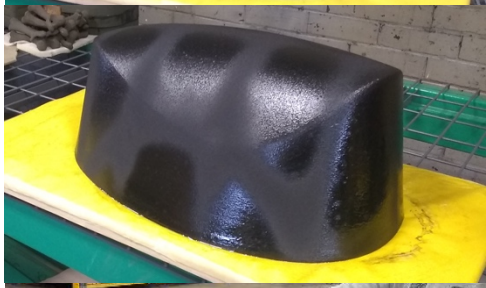
- High temperatures
- Full vacuum in the forming process
- Proven over hundreds of cycles with ongoing testing on upper limits

ExOne

Infiltrated Sand Tooling | The Process

3D printed sand for versatile tooling





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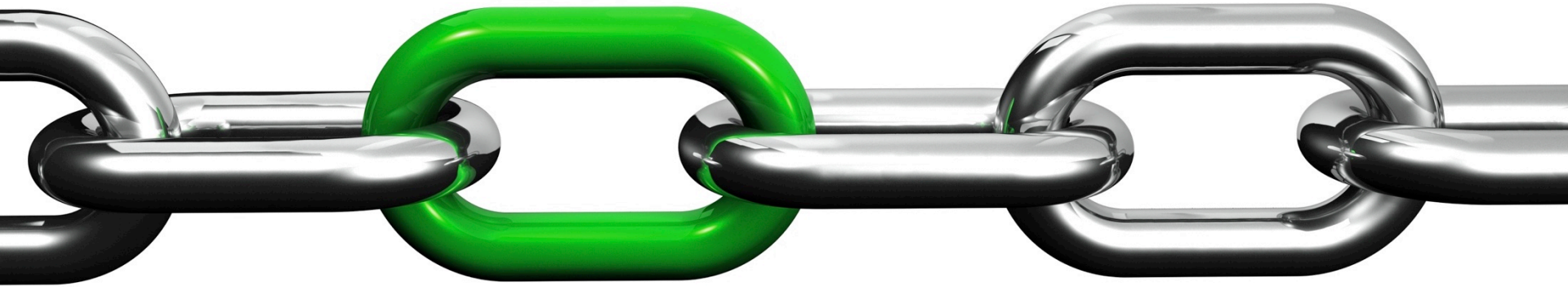
X1 ThermoForm | On-Demand Supply Chain Solution

Infiltrated sand 3D printed tooling helps manufacturers solve supply chain issues

- Start production faster
  - Digital manufacturing workflow of 3D printing enables rapid turnarounds
  - Produced in the United States without the uncertainty of international shipping logistics
- Cost-effective product improvement
  - Innovate with unique geometries
  - Iterate quickly without high tooling investments
  - Test functional prototypes



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X1 ThermoForm | Where Does 3D Sand Fit?

Considerations for infiltrated sand tooling for plastics

1

Performance

- Tool coatings designed to withstand the temperatures of pressure forming processes
- Service temperatures vary by coating, but typically allow for operation up to 350°F
- Development partnerships to tailor coatings to specific customer application requirements

2

Precision

- Tolerances of +/- 0.030" with standard finishing
- Tools can be machined to achieve tighter tolerances when necessary
- CTE value (12 ppm/°F) comparable to aluminum and stainless steel

3

Durability

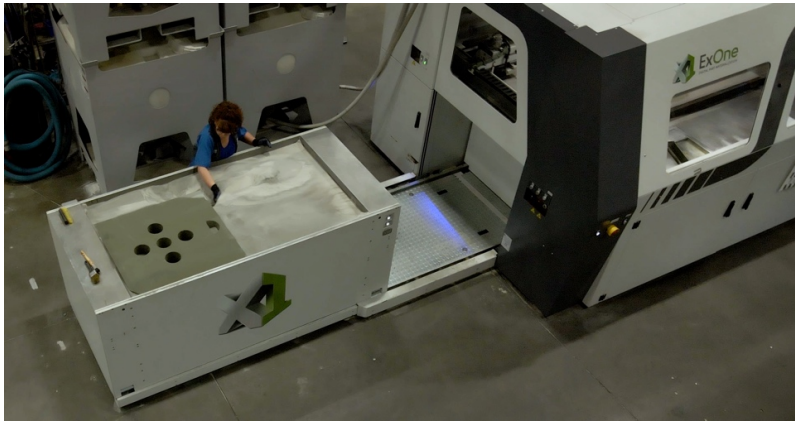
- Fully dense tools with isotropic properties
- Continued success on development projects and results from thermoforming customers provide confidence

ExOne

Large Tool Production on the S-Max®

Utilizing the world's most popular sand 3D printing system

- S-Max Pro
  - 70.9 x 39.4 x 27.6 in / 1800 x 1000 x 700 mm
  - 332 gallon build capacity
  - One job box prints in under 24 hours
  - Multiple segments can be bonded together for even larger tools



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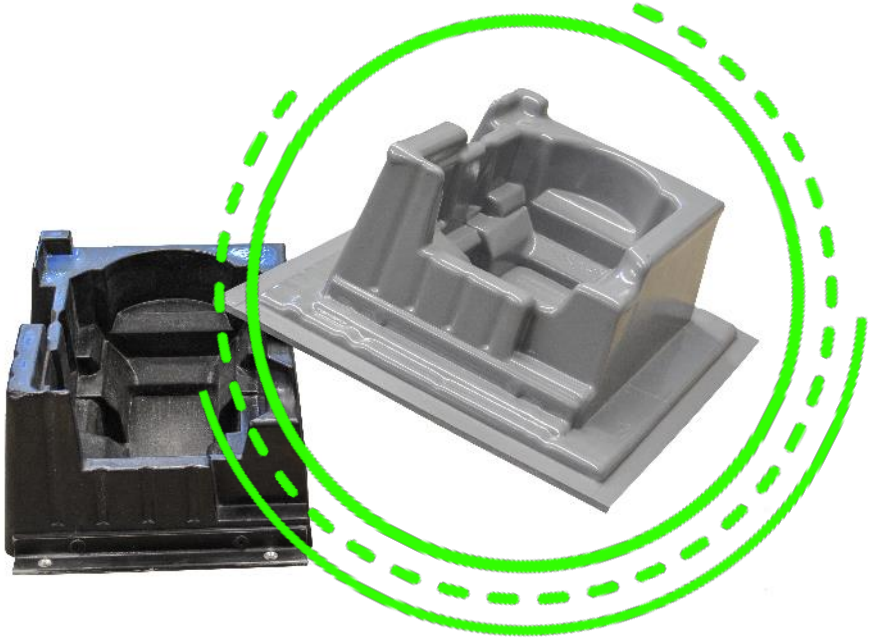
X1 ThermoForm | Vacuum Form Tooling

Delivered in under 2 weeks to meet the demands of short-run production

INDUSTRY Tooling & Fixtures
APPLICATION Deep draw vented vacuum form tool
LOCATION Beaver Falls, Pennsylvania
CHALLENGE A durable, low-cost tool was needed for short-run production with a fast turnaround.

SOLUTION
3D PRINTING ExOne S-Max®
MATERIAL Silica sand infiltrated with epoxy for a 0.3" HDPE part
BENEFITS The short-run tool was produced in under two weeks and ran 57 cycles over 24 hours without failure while forming at 350°F (177°C).



On-demand tooling enables more efficient production without high tooling costs and long lead times.

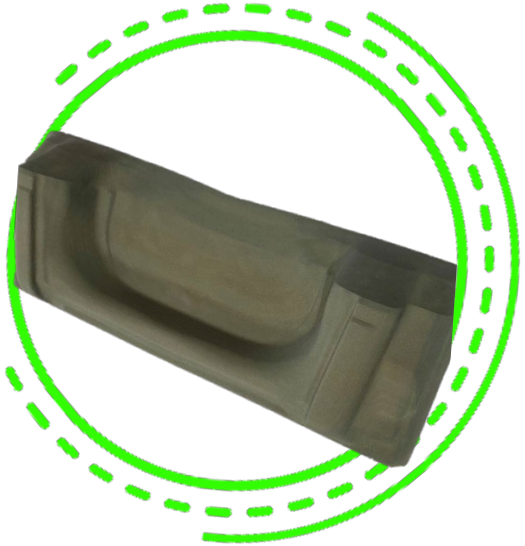
X1 ThermoForm | Fast Tooling Changes the Game

OAM original appearance manufacturing

Durable tooling 3D printed in sand opens new business opportunities

INDUSTRY Automotive
APPLICATION Exterior panels
LOCATION Ames, Iowa
CHALLENGE More durable and flexible tooling was needed as steel, composite, or wood tools required constant maintenance. OAM often struggled to place vacuum holes in precise locations due to material and design constraints. The cost and lead times of aluminum tooling were prohibitive for OAM's business model.

SOLUTION
3D PRINTING ExOne S-Max®
MATERIAL Silica sand infiltrated epoxy for 0.060" ABS formed parts formed at 290-305°F
BENEFITS X1 ThermoForm greatly accelerated OAM's product launch timelines with a tool delivered in 2 weeks, compared to 3+ months for cast aluminum, but at half the cost. Product volumes not previously profitable are now viable and product variations previously unaffordable are now opportunities for expansion.



"X1 ThermoForm is a gamechanger for the industry. When we discovered 3D printed tooling we felt like we struck gold – here was something that could finally meet our needs and fill the gap in the tooling market. Our product launch timelines are an order of magnitude faster than we could have ever dreamed of before."
Zach Kowalik, CEO Original Appearance Manufacturing

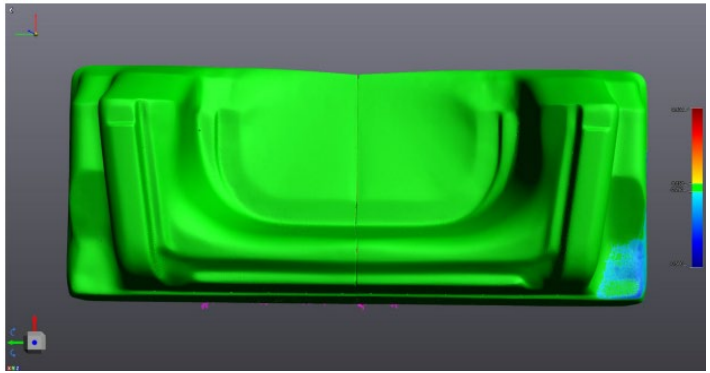
ExOne

X1 ThermoForm | Durability

OAM original appearance manufacturing

Testing shows little to no signs of degradation after initial production run

- Initial 3D scan of tool before use with 0.5mm initial tolerance
- 100 pulls of 0.060" ABS with an average cycle time of 3:50-4:05 minutes
  - Forming temperature between 290°-305°F (143-151°C)
  - Tooling surface temperature never exceeded 180°F (82°C)
- Follow up 3D scan of tool overlaid on top of initial scan
  - Safety range set to 0.5mm, equal to the maximum accuracy of the scanner
  - Results show only one area of the X1 ThermoForm tool deviating less than 0.25mm beyond the safety range
- Testing to continue after 200, 500, 1000+ pulls



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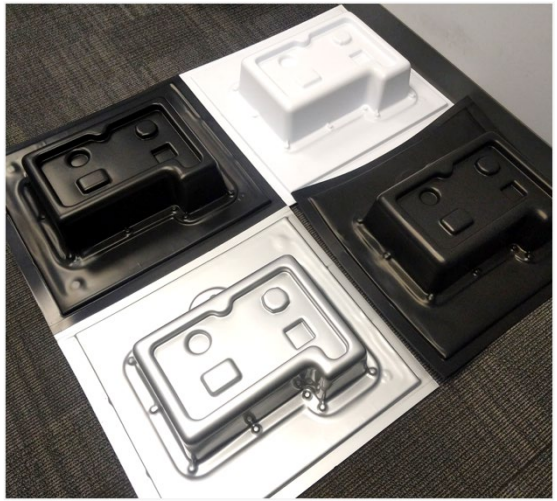
X1 ThermoForm | 3D Tooling Workflow

Understand your requirements

Understanding the Part Requirements → **Designing the Tool for X1 ThermoForm** → **Material Considerations**

- Conventional Tooling vs Additive Manufacturing
  - Service temperature
  - Low volume applications
  - Accuracy limitations
  - Surface finishing techniques
  - Design for Additive Manufacturing (DfAM)
- Increased benefits with Binder Jetting
  - No supports needed on overhangs
  - True production speeds
  - Large format printers and ability to print multiple sections with designed connections for even larger tools



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X1 ThermoForm | 3D Tooling Workflow

Considerations and workflow for optimized 3D printed tooling

- Reduce weight
- Reduce thermal load
- Design lattice structural reinforcement for critical areas
  - Level of support varies based on application
  - Adequate spacing is needed to accommodate for the infiltration process
  - Wall thickness of 0.5" recommended for most applications, speeds up processing
- Integrate mounting features
- Add venting or cooling channels

X1 ThermoForm | 3D Tooling Workflow

Specifications on materials and processing capabilities

Understanding the Part Requirements → Designing the Tool for X1 ThermoForm → Material Considerations

Density	1.8 g/cm³	112 lbs/ft³
Max Service Temperature	180°C	356°F
CTE	21 ppm/°C	12 ppm/°F
Compressive Strength	151 Mpa	21,850 psi
Tolerance	+/- 0.762mm or better with machining	+/- 0.030 in or better with machining
Coating Options	Durable coatings matched to your application needs	
Flexure Strength	47 MPa	6,819 psi
Ultimate Tensile Strength	36 Mpa	5,200 psi

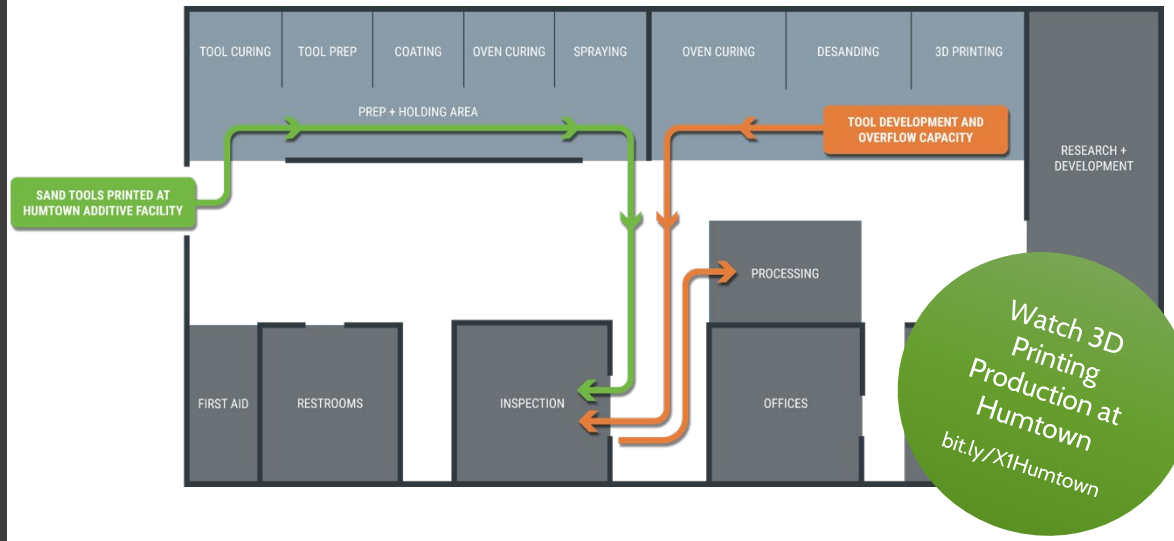
ExOne

X1 ThermoForm | The Future of Tooling

Capacity to scale with a roadmap to offer development and rapid production tools

We're working on the future of tooling while already supplying OEMs and innovative companies with infiltrated sand tooling today.

- Domestic production in Leetonia, Ohio
  - Co-located with Humtown Additive, operators of the largest collection of sand 3D printers in the country
  - All tools inspected in-house before shipping
- Facility expansion mapped for development projects and production expansion
  - Roadmap to optimize for future tool delivery in 1.5 weeks or faster



Co-located partnership with production capacity on fleet of ExOne sand 3D printers

ExOne

Q&A

STAY TUNED: The next Session on X1 Tooling for Composites begins at 2 p.m. ET