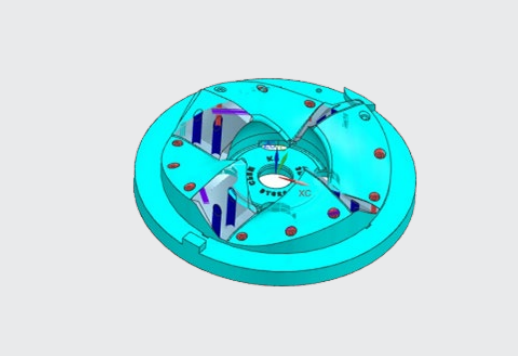
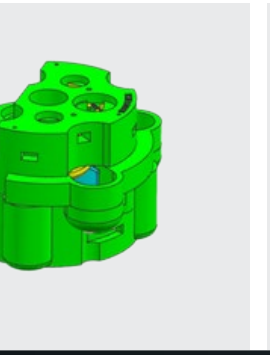



CASE STUDY

Indian Steel Foundry Solved Complex Castings with Sand Binder Jetting

Digital casting with ExOne S-Max® 3D printer enables KSB in India to drastically reduce lead times, improve part quality, and lower production costs

KSB

ExOne™

Pumps, valves, and services are the core of KSB's business. The company delivers standard, custom-made, and special solutions for transporting, controlling, or shutting off fluids for the mining, energy, water, petrochemicals/ chemicals, building services, and general industry. As part of the renowned global KSB Group, a German company with 102 branches worldwide, KSB Limited in India strives for excellence in its region. KSB Foundry has been integrating additive manufacturing in its day-to-day operation to enable it to develop the highest-quality and customized pumps and valves for numerous applications, even the most complex and challenging ones.

CUSTOMER
KSB Limited – Foundry Division

HEADQUARTERS
Maharashtra, India

INDUSTRY
Steel foundry

APPLICATIONS
Pumps, industrial valves, services for applications

3D PRINTER
ExOne S-Max®

PRINT MEDIA
Sand: Silica
Binder: Furan

WEBSITES
www.ksb.com
www.ksb.co.in

Before adopting 3D printing, KSB foundry in India produced castings just like any other in the country. The foundry relied on pattern-based molds, hence it had very long lead times and high costs, as well as often experienced casting defects and produced inaccurate parts. As times changed, the customer requirements for faster delivery, lower prices, complex geometries, and better quality pumps and valves became more and more demanding, which could hardly be fulfilled by conventional casting methods.

To address these challenges and be one step ahead of its competitors, the foundry decided to tap into digital casting in 2022 and acquire ExOne's binder jet sand 3D printing technology, the S-Max® 3D printer.

The foundry utilizes the 3D printer to create complex molds and cores directly from CAD data for a variety of industries with a dimensional accuracy of ± 0.5 mm. The simple binder jetting process of ExOne enables the foundry to achieve geometric complexity without the need for a physical pattern, which is impossible to fulfill with conventional casting techniques. The 3D printing technology from ExOne produces accurate and uniform cores and molds in a record time.

The foundry shared that it could complete many complex casting projects successfully with the aid of the S-Max® 3D printer. Four of the foundry's complex casting projects are briefly discussed in this case study.

ExOne S-Max®

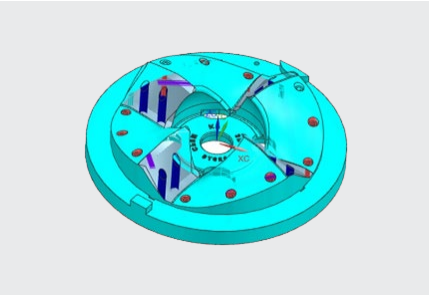
CHALLENGE 1

Develop propeller impellers with high dimensional accuracy and high-quality

An open impeller is a kind of impeller used in centrifugal pumps and agitators. Its blades are not enclosed by a shroud or casing to allow for the easy flow of liquids with high levels of solids or suspended articles through the impeller. The casting of open impellers is critical in ensuring the performance, reliability, and efficiency of the pump or agitator system in which the impellers are used.

With the regular sand casting methods, producing defect-free, open impeller castings, and delivering the parts on time to its customers were tough challenges for KSB. These castings have a reduced thickness, especially in the area of the blades. This leads to cold running, deformation, and unfilled casting areas.

KSB was certain that the solution to these problems was the simple and flexible sand binder jetting process. By printing the molds with the necessary foundry planning methods such as vent channels, support ribs, risers, and the integration of the ingate system in one design, KSB could eliminate the defects. Thanks to digital casting, KSB could deliver the propeller impellers much faster and the production costs could be reduced by 50 % as the cost of hard tooling was eliminated.



CAD 3D model

Mold and core package

Part

Characteristics

WORKPIECE
Propeller impeller

SIZE OF THE WORKPIECE
Diameter: 625 mm
Height: 159 mm
Weight: 61.5 kg

CASTING MATERIAL
Steel CA6NM

Traditional procedure

Casting using pattern-based mold

MANUFACTURING TIME
8 – 10 weeks
(pattern making & casting)

ESTIMATED COST
Rs. 350,000

ExOne sand 3D printing procedure

The mold and core were printed on the ExOne S-Max® 3D printer

LAYER THICKNESS
0.28 mm

MANUFACTURING TIME
4 weeks
(printing & casting)

ESTIMATED COST
Rs. 175,000

Characteristics

WORKPIECE
Suction impeller

SIZE OF THE WORKPIECE
Diameter: 313 mm
Height: 136 mm
Weight: 14.7 kg

CASTING MATERIAL
Bronze

Traditional procedure

Casting using pattern-based mold

MANUFACTURING TIME
8 weeks
(pattern making & casting)

ExOne sand 3D printing procedure

The mold and core were printed on the ExOne S-Max® 3D printer

LAYER THICKNESS
0.28 mm

MANUFACTURING TIME
3 days (printing & casting)

"ExOne's binder jet sand 3D printer has revolutionized KSB's capabilities to deliver the components in record time and positioned us at the forefront of meeting customer needs."

Bhagwan Bagal,
Head of Plant at KSB Limited

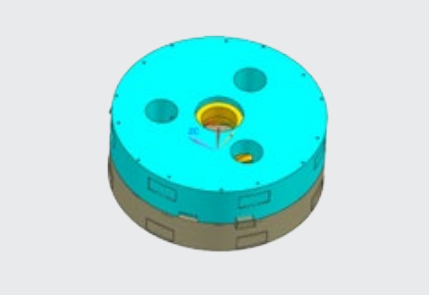
CHALLENGE 2

Produce an urgently required suction impeller within three days

A suction impeller is often used in centrifugal pumps, specifically in the pump's suction stage, to draw fluid into the pump and impart kinetic energy to it. The traditional casting of suction impellers requires a pattern creation which is used to create a mold. With this method, KSB usually needed ca. eight weeks in total to deliver the final part.

A customer urgently required a suction impeller. They needed the part in three days after ordering it which would be impossible for KSB to fulfill with the conventional mold and core making method.

The digital casting enabled KSB to design the mold and core rapidly and to print them directly with the ExOne S-Max® 3D printer – all took place on day 1. On day 2, the cast part was poured and dispatched with fettling. The shot blasting was carried out on day 3.



CAD 3D model

Mold and core package

Part

CHALLENGE 3

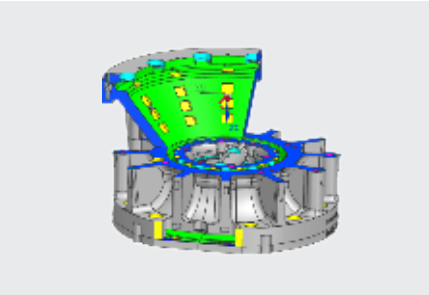
Develop a casting larger than the build area of the printer's job box

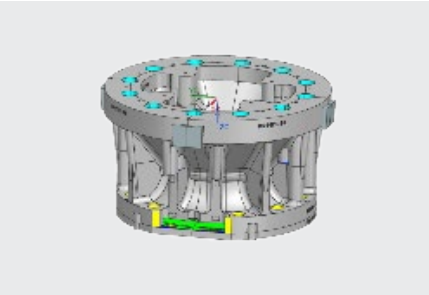
Bell mouths are commonly found in pipes, ducts, and certain types of containers. They have a specific shape that is often associated with the flared opening or entrance of a cylindrical or conical structure.

In India, the estimated lead time for sandcasting huge parts like a bell mouth is usually around 14 weeks. One of KSB's customers urgently required a bell mouth within six weeks. This was a huge challenge for KSB not only due to the extremely fast lead time but also because of the huge size of the bell mouth which was larger than the build area of KSB's 3D printer.

Nevertheless, KSB was able to deliver the product on time. The complex and big molds were printed in seven days on the ExOne S-Max® 3D printer. The large molds were split into 12 pieces and assembled with male-female dowels. KSB also split the drag mold, the core, and the cope mold – each into four pieces. A single piece filled the build area of one job box.

If KSB made traditional complex tooling to create the molds and cores, it would have needed around eight to ten weeks just to complete this process. Thanks to the ExOne 3D printer, the molds and cores were ready in seven days and the product could be delivered within the agreed six-week time.





CAD 3D model

Mold and core package

Bell mouth

Characteristics

WORKPIECE
Bell mouth

SIZE OF THE WORKPIECE
Diameter: 1,950 mm
Height: 1,173 mm
Weight: 2,400 kg

CASTING MATERIAL
Steel (A743 GR CF8M)

Traditional procedure

Casting using pattern-based mold

MANUFACTURING TIME
14 weeks

ESTIMATED COST
Rs. 3,400,000

ExOne sand 3D printing procedure

All molds and cores were printed on the ExOne S-Max® 3D printer

LAYER THICKNESS
0.28 mm

MANUFACTURING TIME
6 weeks

ESTIMATED COST
Rs. 2,250,000

Characteristics

WORKPIECE
NDE and DE covers

SIZE OF THE WORKPIECE
Diameter: 430 mm
Height: 357 mm
Weight: 110 kg

CASTING MATERIAL
Steel WCB

Traditional procedure

Casting using pattern-based mold

MANUFACTURING TIME
Approximately 16 weeks

ESTIMATED COST
Rs. 450,000

ExOne sand 3D printing procedure

All molds and cores were printed on the ExOne S-Max® 3D printer

LAYER THICKNESS
0.28 mm

MANUFACTURING TIME
4 weeks

ESTIMATED COST
Rs. 145,000

The ExOne Company
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europe@exone.com
asia@exone.com

www.exone.com

X1_KSB_CaseStudy_EN_2024-02

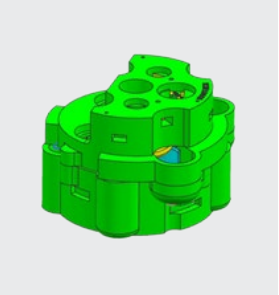
CHALLENGE 4

Reproduce old, damaged parts rapidly with reverse engineering and sand 3D printing

Non-Destructive Examination (NDE) and Destructive Examination (DE) covers are designed to protect critical components of pumps, valves, and other industrial equipment during inspection processes. The covers have a complicated geometry, hence it usually takes about 16 weeks to produce them with a traditional sandcasting method.

The NDE and DE covers of a customer were already old and damaged. The customer needed new castings within four weeks but no tooling was available. However, KSB could solve this problem easily and rapidly with reverse engineering and digital casting.

KSB scanned the damaged parts, prepared a 3D model, and delivered a drawing within four weeks. The foundry designed the complex molds and cores in three days and printed them in one day using the S-Max® 3D printer. If KSB had to create a traditional wood pattern first to make this complex mold, the foundry would have needed around 12 weeks just for these processes. Thanks to the ExOne binder jet sand 3D printing technology, the mold package was ready to pour in about one week and the new parts could be delivered to the customer three weeks after that.



CAD 3D model

Mold and core package

Part