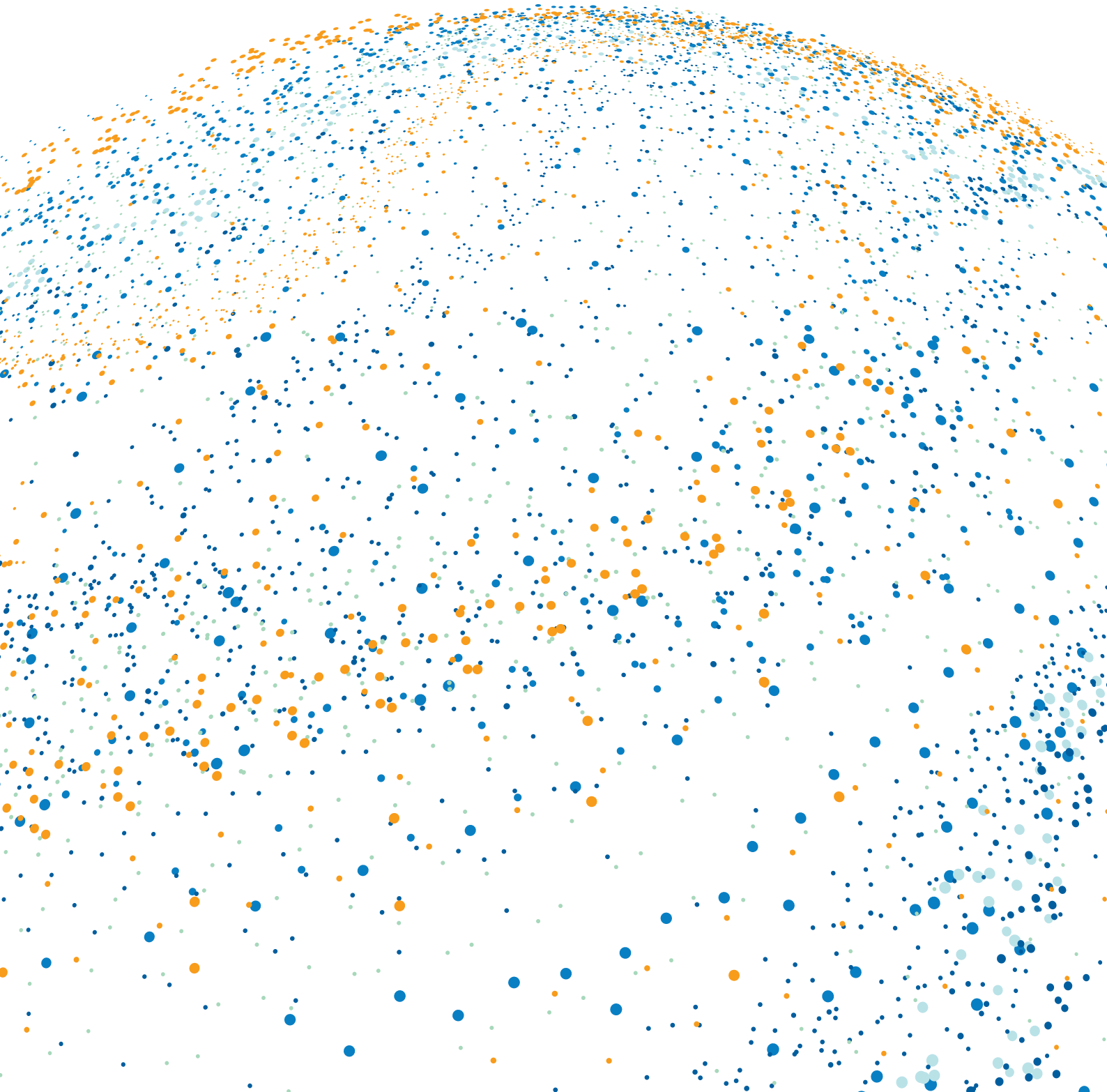
Wilhelmsen | ivaldi

Bringing 3D printing to the maritime industry



3D printing @ Wilhelmsen

From parts to files: Wilhelmsen ventures into 3D printing with Ivaldi Group

Wilhelmsen and Ivaldi Group are collaborating to explore in-port 3D printing opportunities for marine products and spare parts.

Making print-on-demand a reality, 3D printing services revolutionise the availability and delivery of marine spare parts.

Rapid design changes and the ability to quickly bring new solutions to our customers makes 3D printing an attractive option and the technology opens up several new possibilities:

- Reduced costs associated with minimum order quantities and storage
- Shorter transportation and delivery time
- Minimised delays – no more prolonged importing procedures that could result in machine downtime
- Typical parts procurement takes up to months but 3D printing could take just days
- Personalised parts according to customer needs

"Rapid design changes and the ability to quickly bring new solutions to our customers makes 3D printing an attractive option and the technology opens up several new possibilities."

Speak with us to find out how 3D printing can help bring sustainable, competitive savings and advantages for you; or if you'd like to understand the full potential of 3D printing spare parts.

About Wilhelmsen Ships Service
Wilhelmsen Ships Service offers a standardised portfolio of tailor-made maritime solutions, specifically designed to ensure your fleet is always sailing as efficient, safe and smart as possible. Our innovative solutions are available in each and every port you do business. The company's worldwide maritime service network also provides ships agency services and handles maritime logistics.

About Ivaldi
Ivaldi Group leverages cutting edge additive manufacturing and metal fabrication solutions to provide in-port parts on demand services for the maritime and offshore industries. Drawing on a breadth of additive manufacturing industry experience, Ivaldi Group works across a range of stakeholders to digitize product portfolios and improve cost, risk and delivery for all parties.

1 3D Printing Technologies

1.1 FDM:

One of the additive manufacturing technologies that we are currently using is **FDM (Fused Deposition Modeling)**, which fuses the material layer by layer. This allows us to create parts with internal structures, cavities, shapes and geometries that are sometimes not feasible using a traditional manufacturing process.

Specifications for FDM technology:

Build dimensions: 305x305x305mm or 1 cubic foot

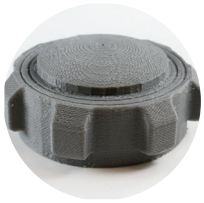
Resolution height: Highest tested resolution is .1 mm

Machine name: **Type A Machines Series 1 Pro** print pod - each print pod has 6 printers that allow us to print in parallel

Materials for FDM:

Nylon is an impact and chemical resistant material

Copolyester is a combination of different polyesters that are chemical resistant and durable



Polylactic Acid (PLA) is a strong, hard plastic

Elastomeric is a rubber-like material that creates flexible parts

Future material: conductive material.

1.2 SLA:

Another additive manufacturing technology we use is **SLA (stereolithography)**, which uses a laser to trace out the printing path layer by layer. Using heat and UV light, the parts are post cured to achieve full mechanical properties. We are currently using Formlabs Form 2 machine.

Specifications for SLA technology:

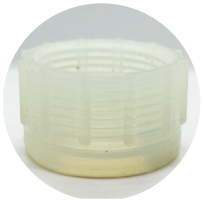
Build dimensions: 145mm x 145mm x 145mm

Resolution height: .025mm

Name of machine: **Form 2** from Formlabs

Materials for SLA:

Elastomeric



Engineering

High Temperature

Casting

Future Materials: **Water, gas, oil resistant rubber and extreme heat resistant tough polymer.**

2 Casting Capabilities

Using 3D printed patterns, we are able to investment **cast metal parts**. There are various advantages to using additive manufacturing for casting such as:

A final part can be manufactured in only 2 days.

With the use of an induction furnace, we have more control of the melting process, and we are able to melt metal in a fraction of the time.

We are able to melt metals with higher melting points like stainless steel.

We are able to create metal parts with complex geometries.

Specifications for cast metal parts:

Current Technology: investment casting.

Future Technology: **ceramic shell casting** for ferrous and non-ferrous metals as well as larger parts.

- Dimensions: 3.5 inches in diameter by 6 inches in height or 5 inch^3
- 3% error from CAD to finishing

Materials for cast metal parts:

Aluminum

Bronze

Brass

Future Material: Stainless Steel.

3 Pattern Making

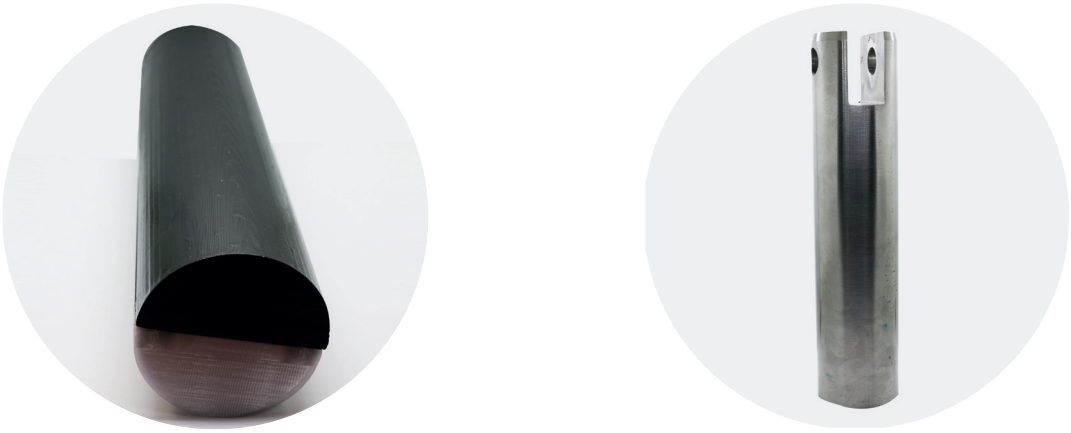
We are able to create a 3D printed pattern for sand casting, which could be used for very large metal parts.

What are our size capabilities? We can print a **pattern** in multiple pieces and weld them together. This allows our size limit to be extensive.

$$

What costs are associated? These patterns can be made at a fraction of what traditional wooden patterns would cost. For example, a part to be cast with a diameter of 500mm will cost 2/5 of what a wooden pattern costs.

Bushing, 3D printed pattern cost: $60.42, wooden pattern cost: $555.00, our production cost: $1,225.00, our lead time: 4 weeks, traditional lead time: 12+ weeks



Guide Bar, 3D printed pattern cost: $22.74, wooden pattern cost: $575.00, our production cost: $1,225.00, our lead time: 4 weeks, traditional lead time: 12+ weeks

4 Design Capabilities

To achieve "**ship files - not parts,**" we have photogrammetry and scanners to create 3D models from images and broken and worn out parts.

One of the benefits of **additive manufacturing** is that complex patterns or textures can be added to parts for **advanced performance**. There are various benefits with adding texture to maritime spare parts:

- Improve perceived value of a part.
- Increase grip and functionality.
- Obscure common visual imperfections.
- Create unique or personalized objects.

We optimize our design parts to decrease print time and **reduce cost** per part using additive manufacturing so that the **maritime industry** can obtain spare parts within 24 hours. At Ivaldi, we meet customer needs by making changes and adjustments to customize parts. Compare this to injection molding, where you have to commit to a mold once it's created because the mold is expensive.

We rely on **revolutionary technology** (photogrammetry and scanning), experience and tools to create a 3D model. We are able to bring down the cost per part using low cost printers, parallel production and other process improvements. Instead of printing one part per printer, we are able to print multiple parts at the same time - making it time and cost efficient.

5 Secondary Operations and Assemblies

We are capable of performing secondary operations and/or assemblies of multiple parts.

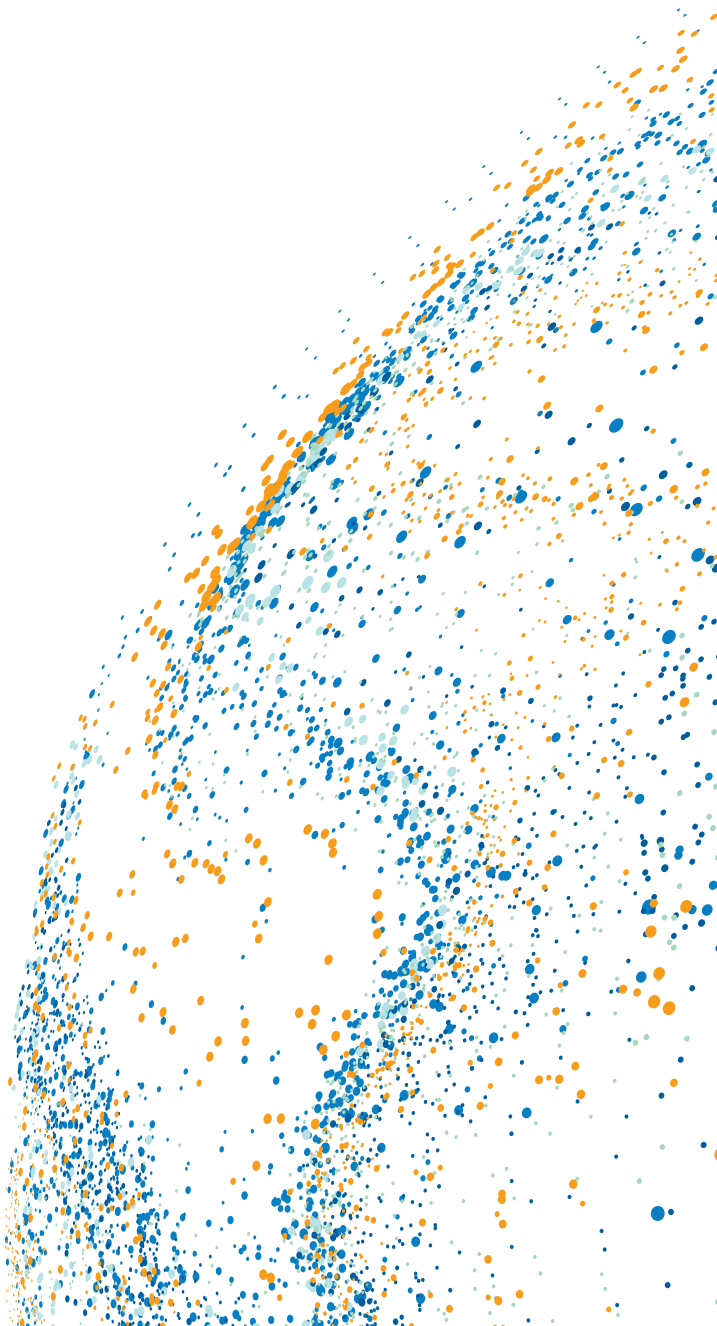
Secondary Operations:

- Polishing
- Sanding
- Coating
- Thread cutting

Assemblies:

- Gluing
- Drilling Operations
- Plastic Welding
- Lathe Operations
- Insert Installation
- Milling Operations

wilhelmsen.com



Wilhelmsen Ships Service
Phone: (+47) 67 58 40 00
Fax: (+47) 67 58 40 80

Postal Address:
PO Box 33, NO-1324
Lysaker, Norway