

ADDITIVE BY SANDVIK

PLAN IT – PRINT IT – PERFECT IT



Mikael Schuisky, PhD
Manager AM Services
Sandvik Additive Manufacturing

SAFETY FIRST

Sandvik's objective is zero harm to our people, the environment we work in, our customers and our suppliers.



PROTECTIVE
EQUIPMENT



FIRST AID
KIT



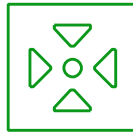
ALARM



EMERGENCY
NUMBER



EMERGENCY
EXIT



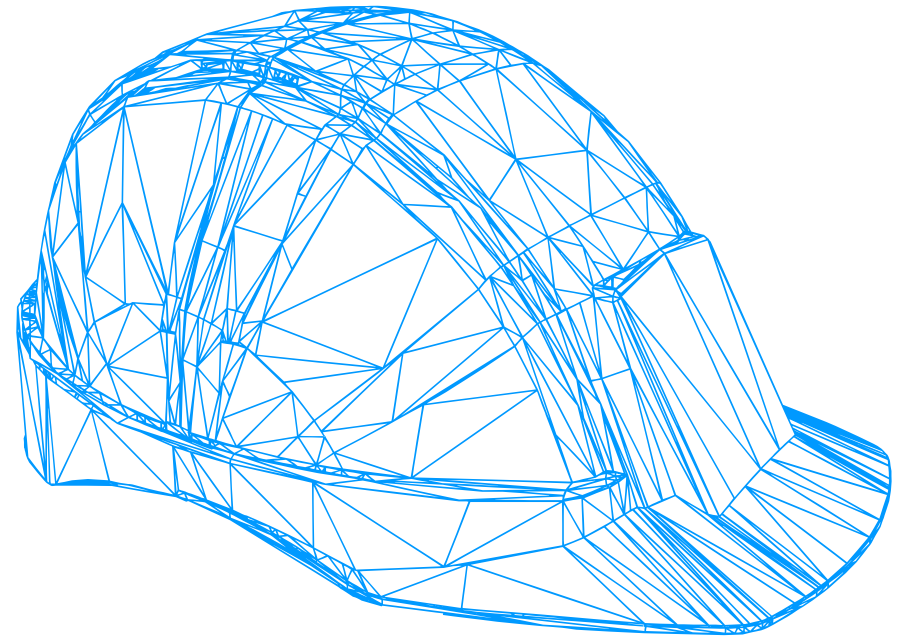
ASSEMBLY
POINT



PSYCHOLOGICAL
SAFETY



HEALTH &
WELL-BEING



ADDITIVE MANUFACTURING AN ENABLING TECHNOLOGY

WHAT IS AM / 3D PRINTING FOR YOU?



FASHION



3D PRINTED SHOES



3D PRINTED FOOD



3D printed Vegan beef



3D printed Wagyu beef



3D printed pizza



3D printed chocolate



3D printed meals



FOOD INK
first 3D printing restaurant



UK PATIENT RECEIVES WORLD'S FIRST 3D PRINTED EYE PROSTHETIC



3D PRINTED HOUSES

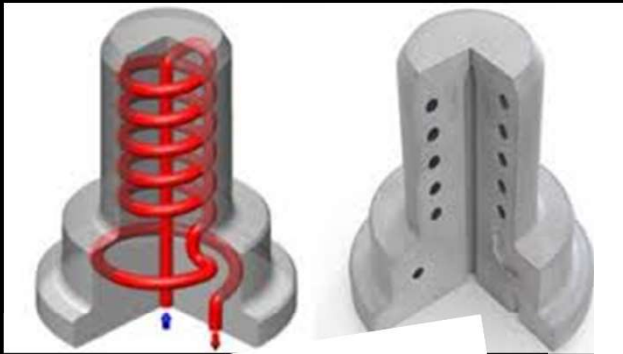


<https://www.svt.se/nyheter/inrikes/se-sverige-forsta-forsta-3d-printade-hus-ta-form>

TRANSPORT - BIKES AND MOTORCYCLES



INDUSTRIAL EXAMPLES



Sample metal 3D printed water connectors for the Audi W12 engine. Photo via Volkswagen AG



HP Metal Jet 3D printed gear shift for Volkswagen. Photo via HP

"HP's new Metal Jet 3D printing platform unlocks the speed, quality, and economics to enable our customers to completely rethink the way they design, manufacture, and deliver new solutions in the digital age."



LIGHTER
COMPONENTS

DESIGN
FREEDOM

MASS
CUSTOMIZATION



CUSTOMER VALUE

INCREASED
PERFORMANCE

FASTER
REPAIRS

REDUCTIONS IN
INVENTORY



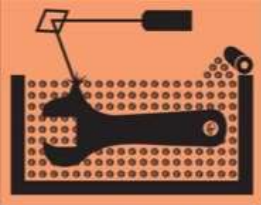
DIFFERENT AM TECHNOLOGIES



THE SEVEN FAMILIES OF ADDITIVE MANUFACTURING



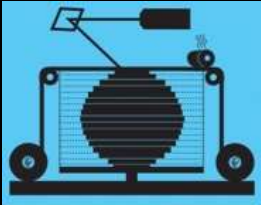
VAT
PHOTOPOLYMERIZATION



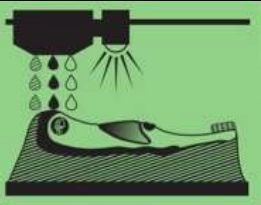
POWDER BED
FUSION (PBF)



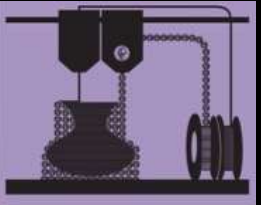
BINDER
JETTING



SHEET
LAMINATION



MATERIAL
JETTING

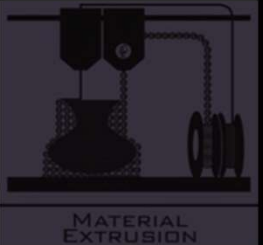
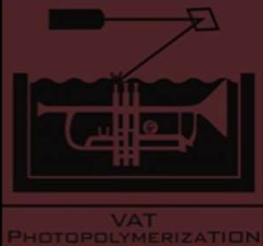


MATERIAL
EXTRUSION



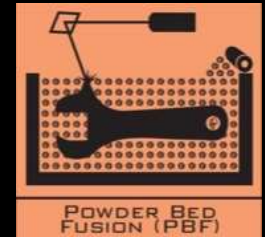
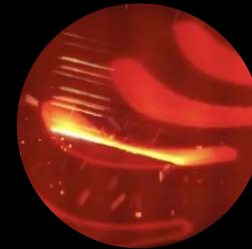
DIRECTED ENERGY
DEPOSITION (DED)

THE SEVEN FAMILIES OF ADDITIVE MANUFACTURING

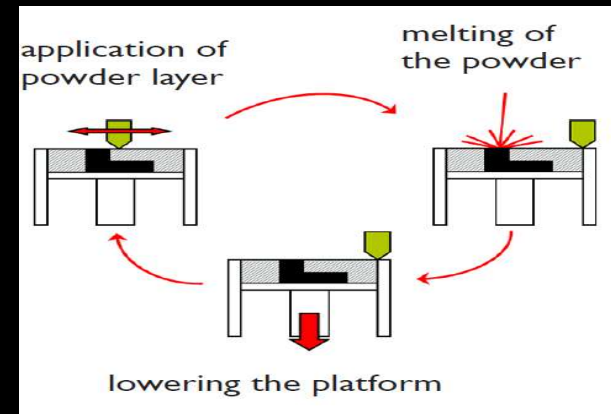


POWDER BED FUSION

METALS



- Melting technology
- Laser or E-beam
- Powder bed
- Protective atmosphere or vacuum
- Build speeds <math>< 1000 \text{ cm}^3/\text{hr}</math>
- Support structures most often needed



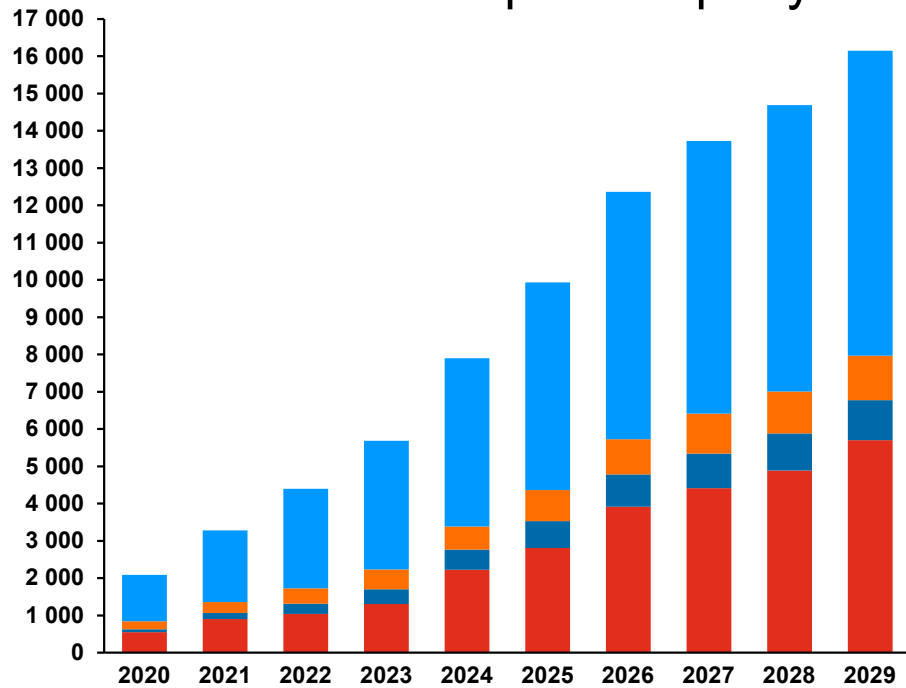
DMLS = Direct Metal Laser Sintering
SLM = Selective Laser Melting
EBM=Electron beam melting
LaserCUSING (used by GE / Concept Laser)



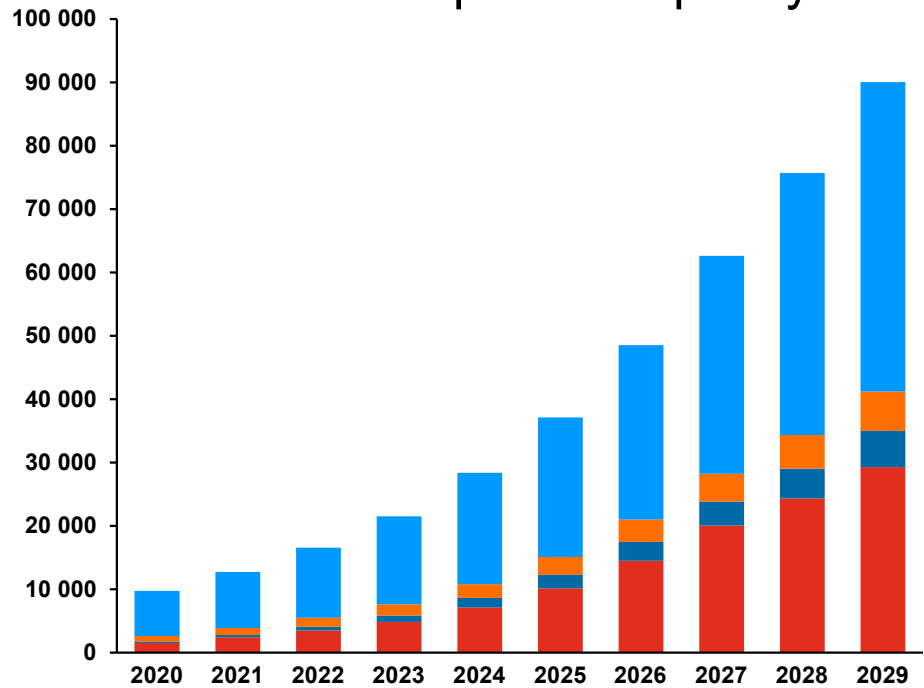
METAL PRINTING MARKET

- Powder Bed Fusion
- Directed Energy Deposition
- Metal Binder Jetting
- Bound Metal Deposition

New installed printers per year



Installed printer capacity



POWDER BED FUSION

TRENDS

- More machine producers
- Multiple laser systems – up to 12 lasers
- Larger build volumes
- Higher level of automation
- Increased availability of materials
- Increased build speeds
- Various build speeds
- Solutions for multi materials

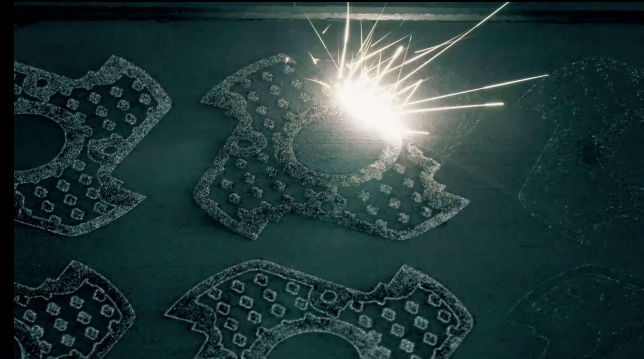
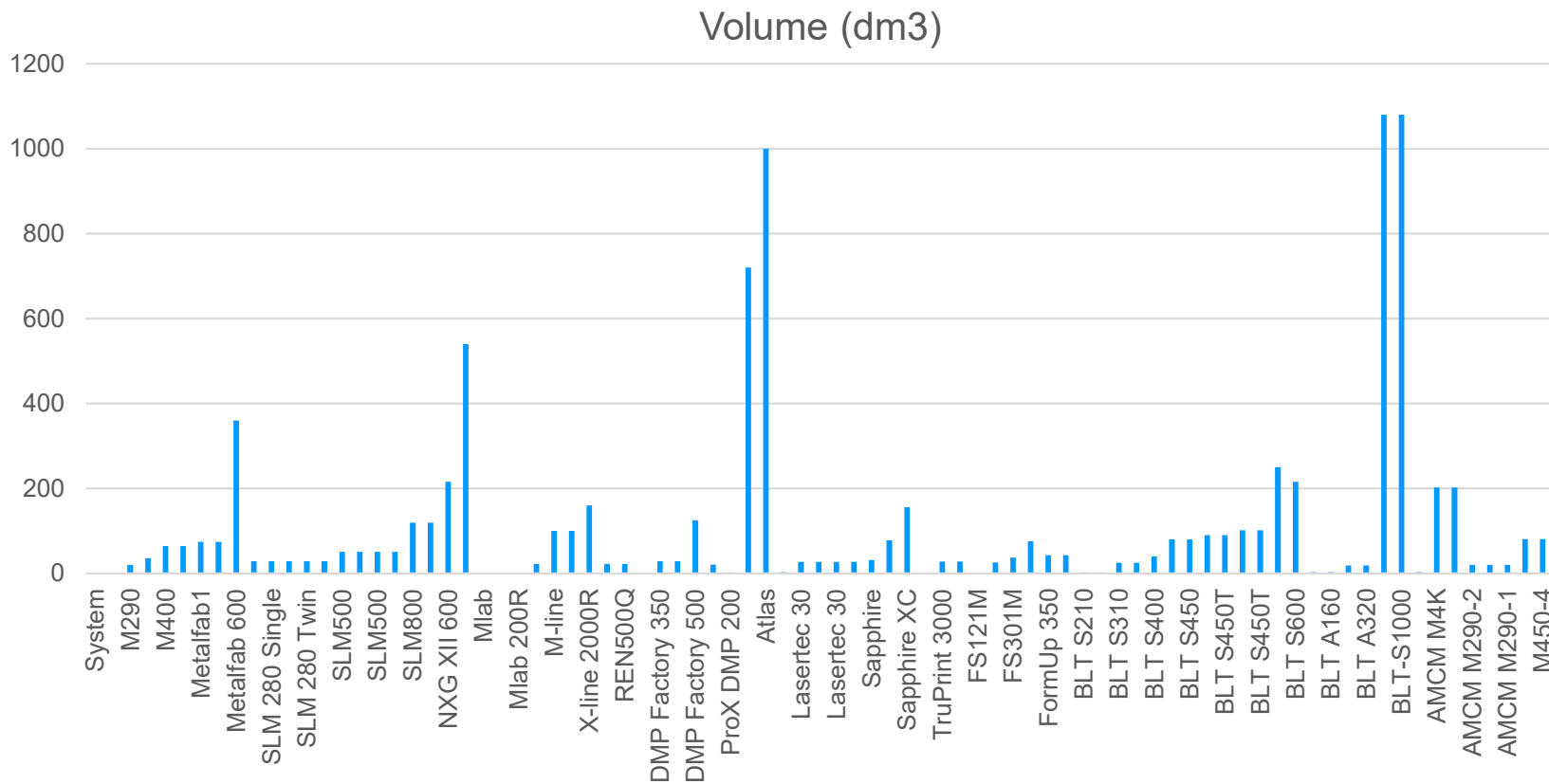


Image courtesy of SLM

BUILD VOLUME / LASER MODELS

POWDER BED FUSION LASER

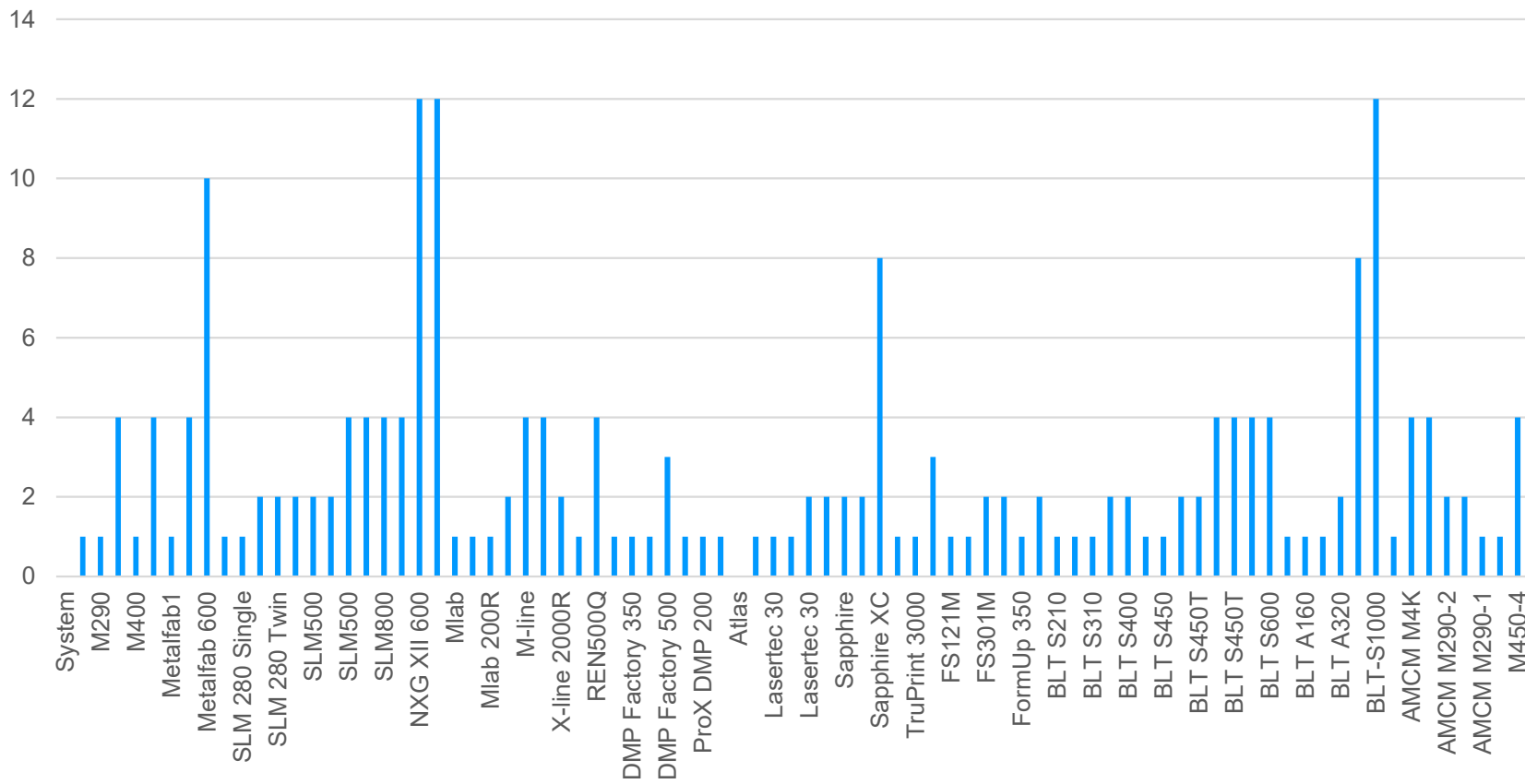
Most common: 20-30 L
 Standard large: 50-100 L
 Large: 200- "1000" L



NUMBER OF LASERS

POWDER BED FUSION LASER

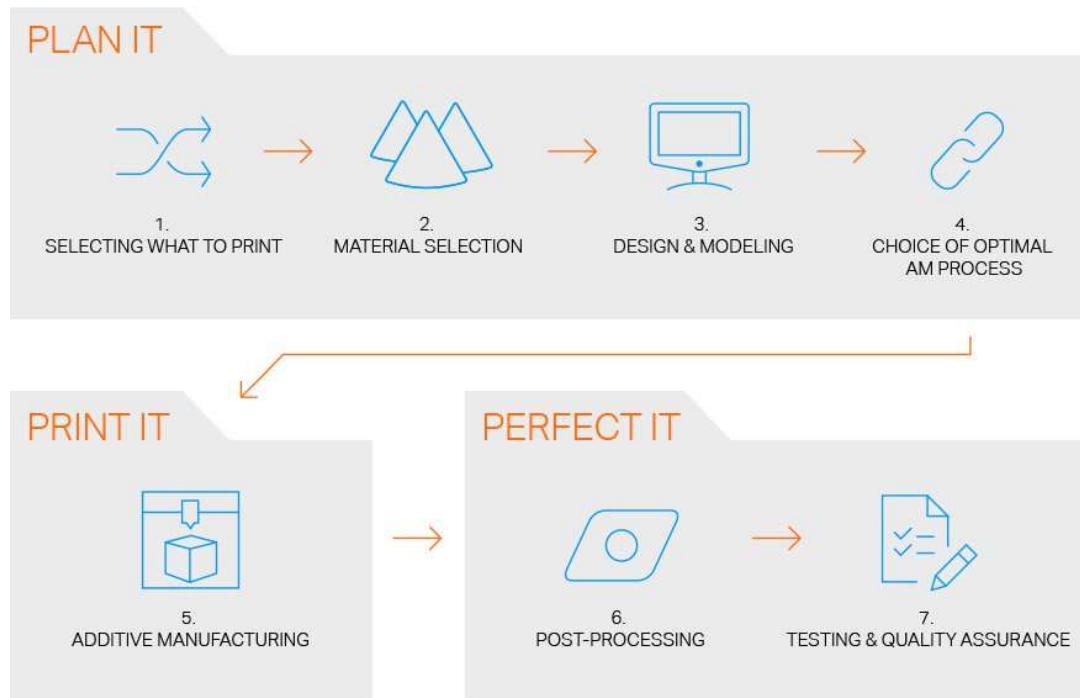
Few: >4 lasers
Standard: 4 lasers



SANDVIK ADDITIVE MANUFACTURING

ADDITIVE BY SANDVIK

PLAN IT – PRINT IT – PERFECT IT



OUR OFFERING:



Advisory services

We take you from idea to prototype – or serial production.



Manufacturing services

From rapid prototyping to serial production, we offer full service production of your component.



Metal powder

We offer the widest range of powder alloys for additive manufacturing around and can even customize materials.





PLAN IT

PLAN IT



1. SELECTING WHAT TO PRINT

- Identification of which components that are suitable to print.
- Using the Sandvik AM-selection checklist.
- As leading experts in subtractive manufacturing, we will also tell you when not to use AM.



2. MATERIAL SELECTION

- In what environment does your component exist?
- Based on 160-year material knowledge, and with in-house AM-powder production, we are expert at matching material properties to application.
- Offering the widest range of AM-alloys and can even customize materials.



3. DESIGN AND MODELING

- Metallurgical knowledge is key to know how thinly a component can be printed and still hold up.
- Deep applications design- and metalworking know-how, backed by state-of-the-art AM design software and optimization methods.



4. CHOICE OF OPTIMAL AM PROCESS

- With all major printing technologies for metals in-house, we will always choose the optimal process for your component.
- We know how to define the most optimal printer parameter setting and processing combinations matched to a specific material and AM-application .



THE AM CHECKLIST

SELECTION CRITERIA

- ✓ Complex shapes
- ✓ Expensive materials
- ✓ Smaller series
- ✓ Low weight
- ✓ Revolutionary designs
- ✓ Individual variations – tailored
- ✓ Shorter lead times and reduced NWC (spare parts)
- ✓ Merging sub parts into one component
- ✓ Increased productivity by reducing assembly time



WORLD LEADER IN METAL POWDERS

OSPREY® METAL POWDERS

MORE THAN
2000
GRADES

FIRST YEAR OF
POWDER SALES
1979

OUR PROGRAM OF OSPREY® METAL POWDER INCLUDES:

- Maraging steels; 18NI300 & MAR-60HRC
- Tool steels; M2 & H13
- Stainless steels; 17-4PH & 316L
- Nickel free SS; X15 CrMnMoN 17-11-3
- Low alloy steels
- Duplex steels
- Cobalt alloys
- Copper alloys
- Soft magnetic alloys
- Binary alloys
- High temperature materials
- Nickel-based superalloys
- Aluminium alloys
- Titanium alloys

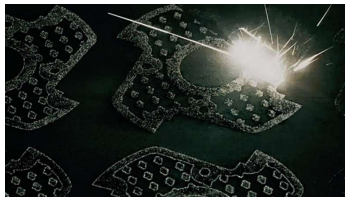




PRINT IT

PRINT IT

POWDER BED FUSION

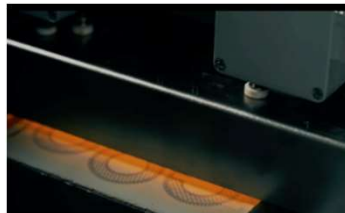


LASER

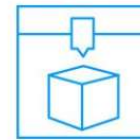
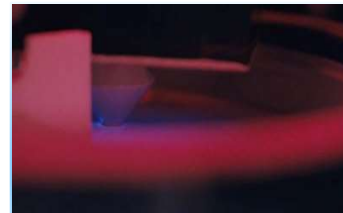


ELECTRON BEAM (EBM)

BINDER JETTING

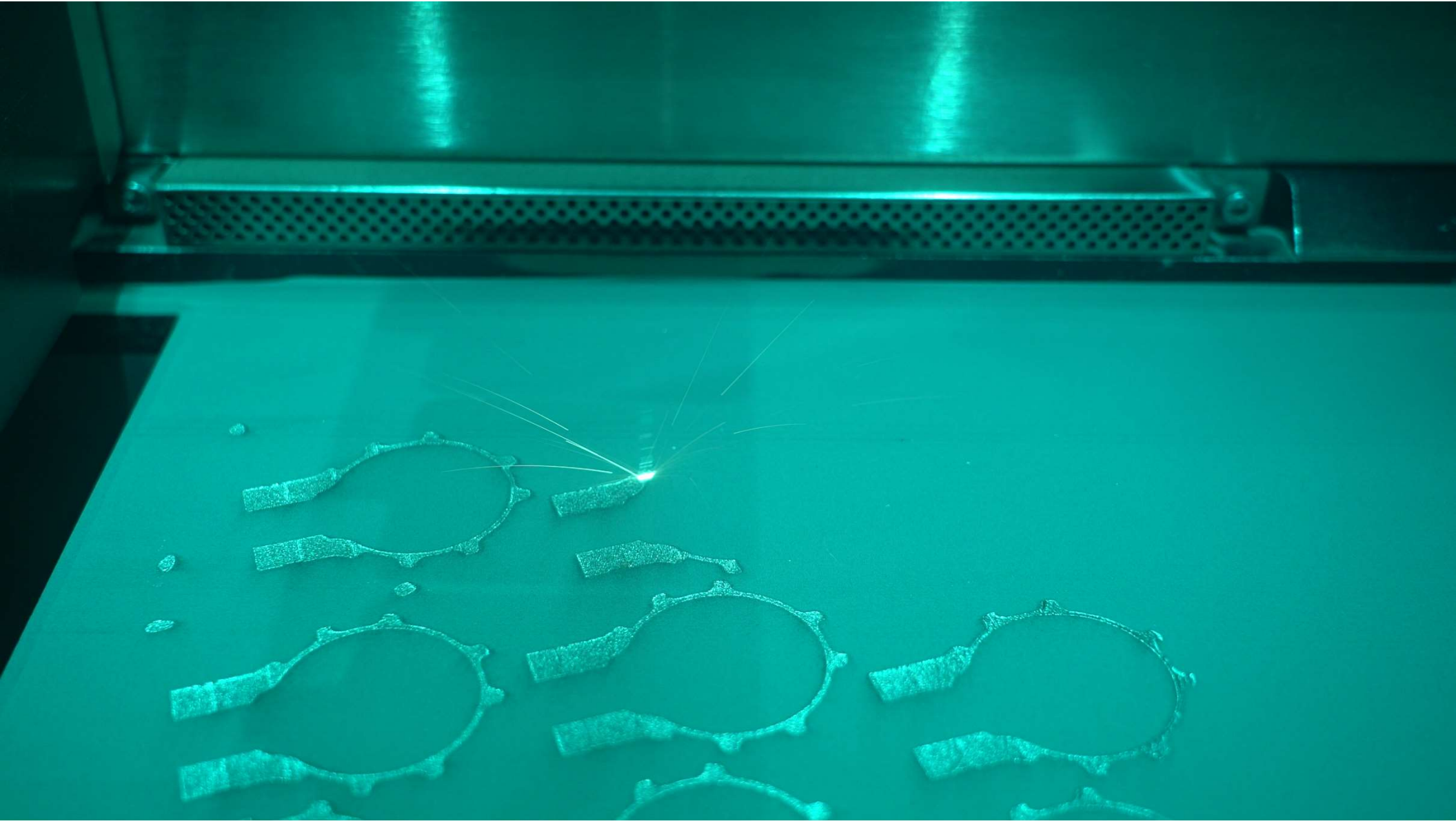


STEREOLITHOGRAPHY



5. ADDITIVE MANUFACTURING

- From rapid prototyping to serial production.
- We always develop the right printing parameters so that the components get the optimum properties.
- All additive manufacturing processes feature layer-by-layer fabrication of three-dimensional objects, but production techniques vary.
- In Sandvik we offer AM of unique materials like Osprey 2507, FeCrAl, Cemented Carbide and Diamond Composite but also standard materials like Ti64 and 316L.





PERFECT IT

PERFECT IT

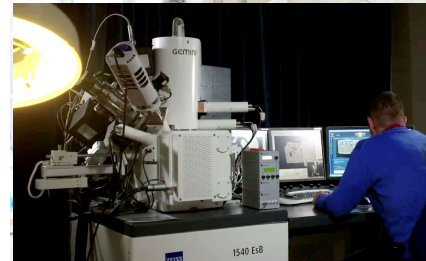


6. POST PROCESSING



7. TESTING AND QUALITY ASSURANCE

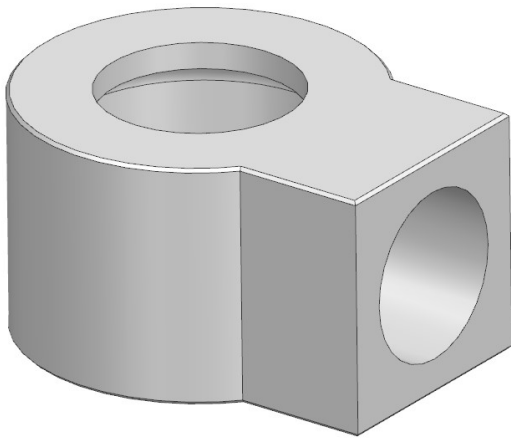
- In order to achieve required properties, it is almost always necessary to post-process components produced with AM.
 - Sandvik has more than 75 years of leading expertise in post-processing methods, such as machining, sintering or Hot Isostatic Pressing (HIP).
- Traceability, testing and documentation. Building on Sandvik's long experience in quality assurance, we have made it our mission to build a solid quality assurance system within AM as well.
 - To support this, Sandvik has northern Europe's largest R&D Center for advanced metallic materials, with the most sophisticated testing equipment.



DESIGN FOR ADDITIVE MANUFACTURING

EXAMPLE OF SPARE PART

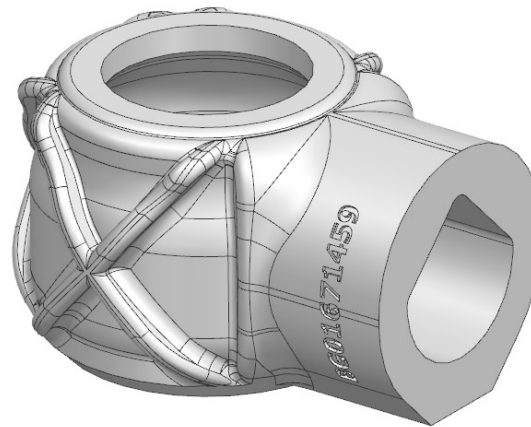
Existing Design



Weight = 0.35 Kg
Material: Raex384 (S003 equivalent material)
S355K2+N

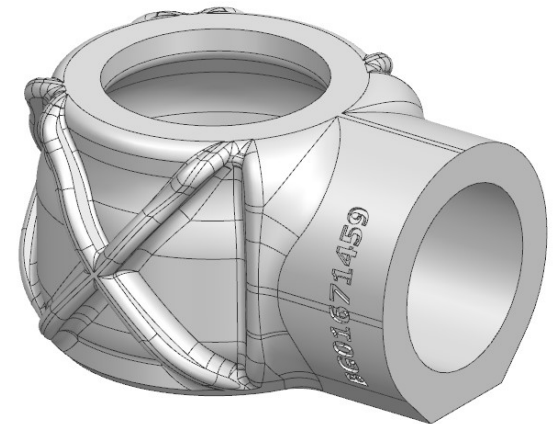
DfAM Design

Printing = BG01671458



Weight = 0.22 Kg
Material: AISI 316L As Built

Machining = BG01671459

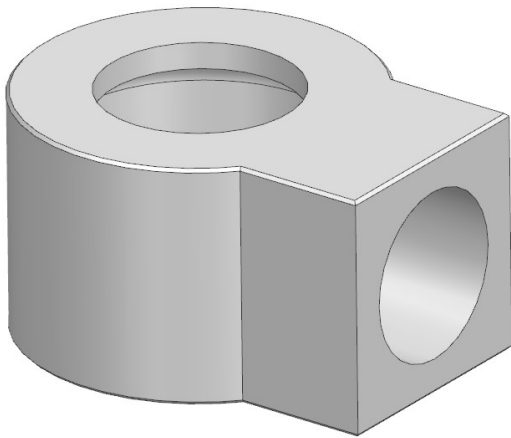


Total weight reduction is 37%

DESIGN FOR ADDITIVE MANUFACTURING

EXAMPLE OF SPARE PART

Existing Design



Weight = 0.35 Kg
Material: Raex384 (S003 equivalent material)
S355K2+N

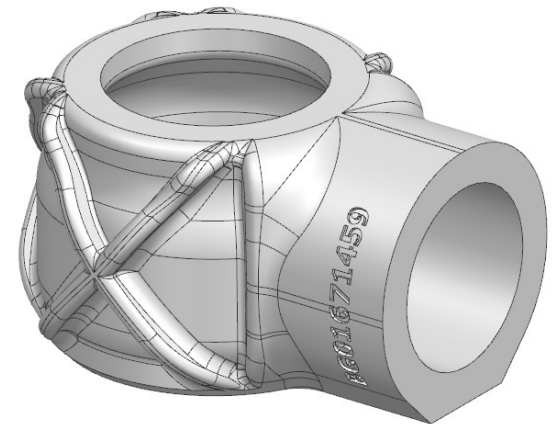
DfAM Design

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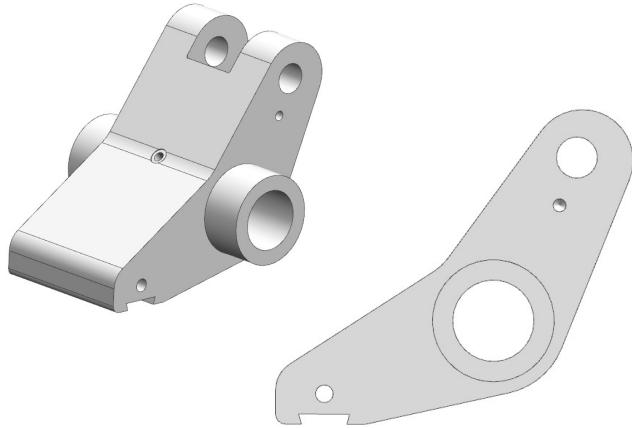


Total weight reduction is 37%

DESIGN FOR ADDITIVE MANUFACTURING

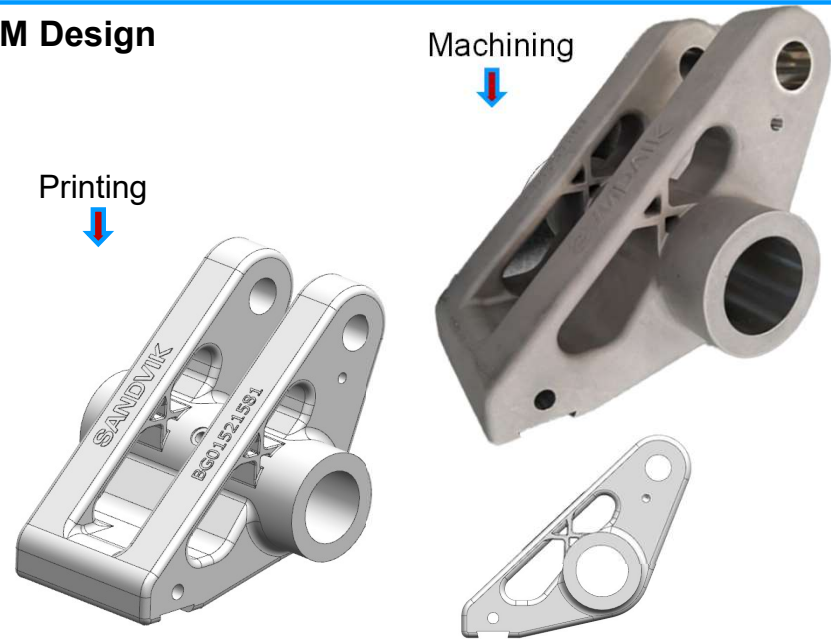
EXAMPLE OF SPARE PART

Existing Design



Weight = 16.55 Kg (36.5 lbf)
Material: ASTM A36

DfAM Design



Weight = 13.76 Kg (30.35 lbf)
Material: AISI 316L



Total weight reduction is 16.8%

CUSTOMER CASE

LKAB WASSARA



Simplified assembly and optimized design
Increased life-time and rate of penetration



DESIGNERS: Per Viklund, Maria Bengtsson

MATERIAL: Osprey™ 18Ni300

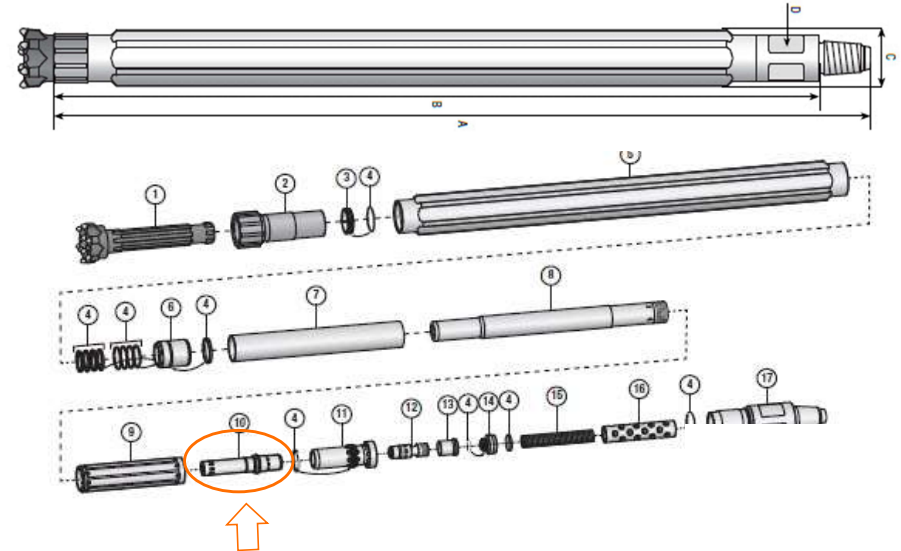
AM TECHNOLOGY: Powder Bed Fusion Laser

POST PROCESSING: Hardening and machining

SIMPLIFIED ASSEMBLY, OPTIMIZED DESIGN FOR IMPROVED PRODUCTIVITY

“Additive manufacturing gives us the possibility to optimize the design of our hammers with fewer components and streamlined water channels. Initial tests in production environment made with W70 sliding case from Sandvik AM show very promising results, indicating improved life time and increased rate of penetration.”

MARIA BENGTSSON
SENIOR ENGINEER, LKAB WASSARA



CUSTOMER CASE

VAREL NOZZLES



Customization
50-70%
shorter lead times
Reduced inventory

DESIGNERS: Magnus Boström, Bruno Cuillier

MATERIAL: Cemented Carbide, WC12Co

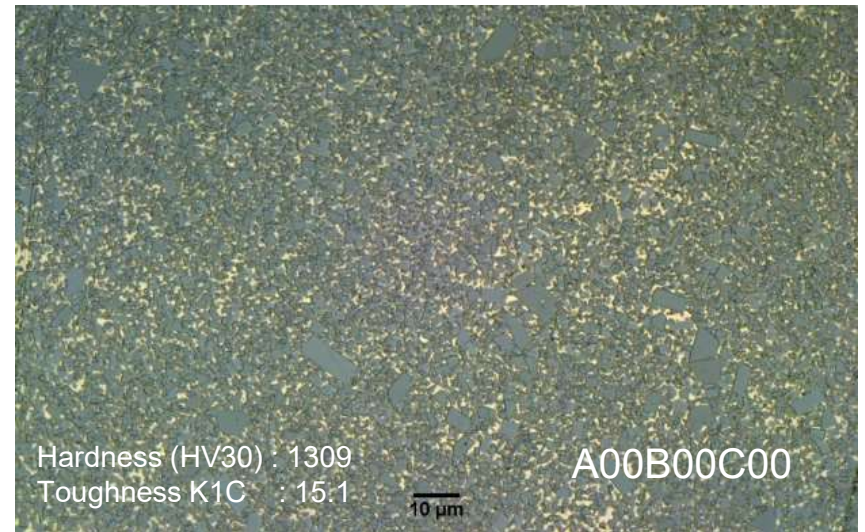
AM TECHNOLOGY: Binder Jetting

POST PROCESSING: Sintering and sand blasting

JUST-IN-TIME AM DELIVERY FLEXIBLE CUSTOMIZATION

“Today the nozzles are manufactured with traditional methods, which is a long process with long lead times. For Varel it means that we need to keep a large inventory to be able to serve our customers in the oil and gas-industry. With AM we can receive parts faster and can reduce our inventory significantly.”

BRUNO CUILIER
GLOBAL PRODUCT ENGINEERING DIRECTOR, VAREL



CUSTOMER CASE

COROMILL® 390



More than...

80%

REDUCED WEIGHT
compared to conventional 390

Up to...

200%

INCREASED
PRODUCTIVITY

DESIGNERS: Per Wiklund, Johan Lindström, Anna Nordstrand

MATERIAL: Titanium alloy, Ti6Al4V

AM TECHNOLOGY: Powder Bed Fusion Laser

POST PROCESSING: Heat treatment and machining



DESIGN THE UNSEEN
OPTIMIZE PERFORMANCE



“With the new light-weight CoroMill® 390, produced with AM, the weight of the cutter body is reduced by >80%. Combined with new Silent Tools™ milling adaptors, this is an exceptional tooling combination for slender tooling. The solution limits the vibration tendencies and enables high productivity and good process security in demanding applications.”

THOMAS WIKGREN

PRODUCT MANAGER SHOULDER MILLING, SANDVIK COROMANT



[Link to Coromill® 390 film](#)

CUSTOMER CASE WITH OSPREY MATERIAL

COOLANT CLAMPS



DRILLING A CURVED HOLE IS HARD PRINTING IT ISN'T

“The AM-version of the cooling clamps of the Seco JET GL Turning Heads offers many advantages. Quick and easy insert indexing reduces down-time and improves productivity. It also makes it possible to apply the high-pressure coolant straight to the cutting edge, which improves both tool life and chip control. We see many more opportunities with the unique AM-technology for other parts of our product program.”

JONAS THURESSON
SENIOR R&D ENGINEER - TURNING PRODUCTS, SECO TOOLS

Concept was
launched 2017
Increased productivity
Improved tool life
and chip control

DESIGNERS: Per Wiklund, Jonas Thuresson, Andreas Larsson

MATERIAL: Osprey™ 18Ni300

AM TECHNOLOGY: Powder Bed Fusion Laser

POST PROCESSING: Tumbling and blast finishing

STEADYLINE®
& JET GL-TURNING HEADS



CUSTOMER CASE

MOTOR NODES FOR E-BIKES



Reduced cost
Improved quality
and performance
Sustainability
advantages

DESIGNERS: Zach Krapfl, GSD Global

MATERIAL: Titanium alloy, Osprey® Ti6Al4V

AM TECHNOLOGY: Powder Bed Fusion Laser

POST PROCESSING: Heat treatment and sand blasting

HOW 3D PRINTED TITANIUM MOTOR NODES BECAME A GAME-CHANGER IN E-BIKES

“We wanted to add the material advantages of titanium to our high-end e-bikes, but titanium parts are very difficult to machine using CNC – and costly at that. But with Sandvik Additive Manufacturing we got a solution that didn’t just prove to be financially feasible – but enabled substantial improvement in terms of quality and energy efficiency as well.

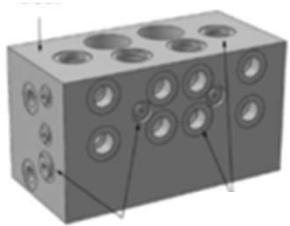
ZACH KRAPFL
GSD GLOBAL



CUSTOMER CASE

HYDRAULIC MANIFOLD

SANDVIK MINING AND ROCK TECHNOLOGY



TRADITIONAL
MANIFOLD FROM
SOLID BLO
34.5 kg
Machined and drilled,
from solid block,
with plugged holes



ADDITIVE
VERSION OF
MANIFOLD
6.6 kg



More than...

80%

REDUCED WEIGHT
compared to conventional manifold

Tested under

250 BAR

in test mine

Shorter
leadtimes
and reduced
inventory

DESIGNERS: Shrikant Hallur, Thanujakshi GS, Ravi B

MATERIAL: Osprey™ 316 stainless steel

AM TECHNOLOGY: Powder Bed Fusion Laser

POST PROCESSING: Heat treatment, blasting and machining



HYDRAULIC MANIFOLD FOR SANDVIK MINING AND ROCK TECHNOLOGY

“The additive version of our hydraulic manifold has led to a weight reduction of more than 80 percent, enabling a quick and easy exchange during service: the additive manufacturing process also results in much shorter lead-times. During inhouse testing the manifold has delivered very good results at 250 bar, which we expect to be able to repeat within a real environment.”

ABHIJIT BHALGAT

DEPUTY GENERAL MANAGER - INDIA PARTS SOURCING





THANK
YOU!

FOR FURTHER INFORMATION, VISIT

WWW.ADDITIVE.SANDVIK

OR

WWW.METALPOWDER.SANDVIK

We drive the **SH/FT**
towards more **efficient** and
sustainable manufacturing

