IVS INDUSTRIALVALVESUMMIT | VALVE campus THE VALVE INDUSTRY THINK TANK

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How will AM influence valve design and manufacturing?

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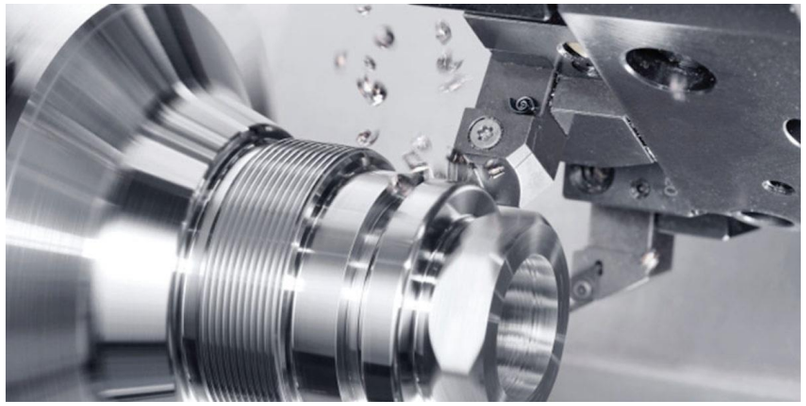
How will AM influence valve design and manufacturing?

Manufacturing principles

Casting

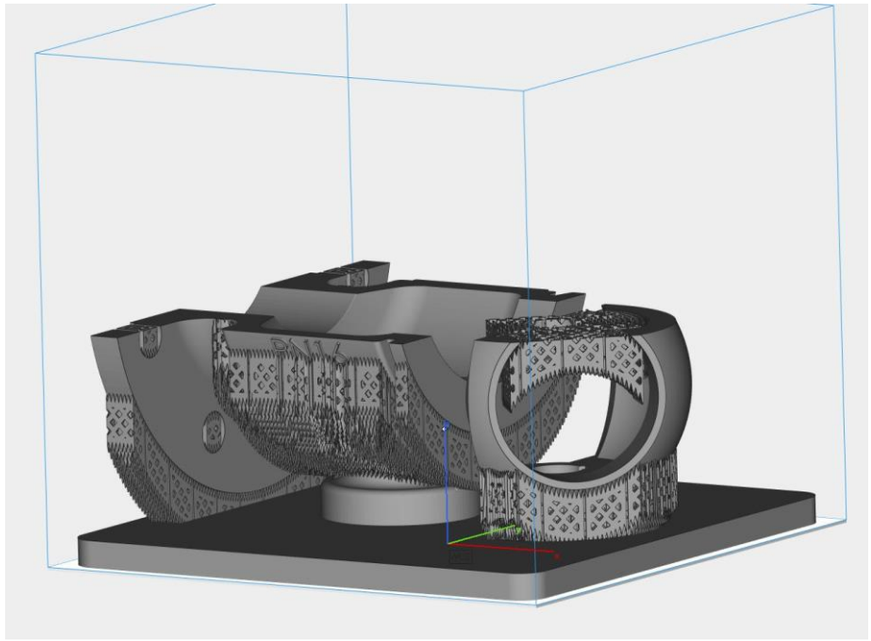
Subtractive manufacturing

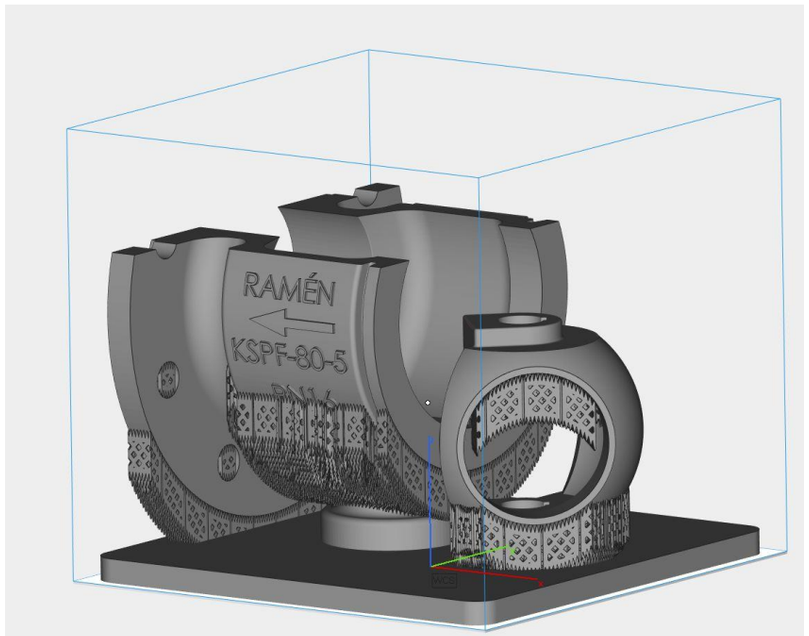


How will AM influence valve design and manufacturing?

Additive Manufacturing = 3D printing

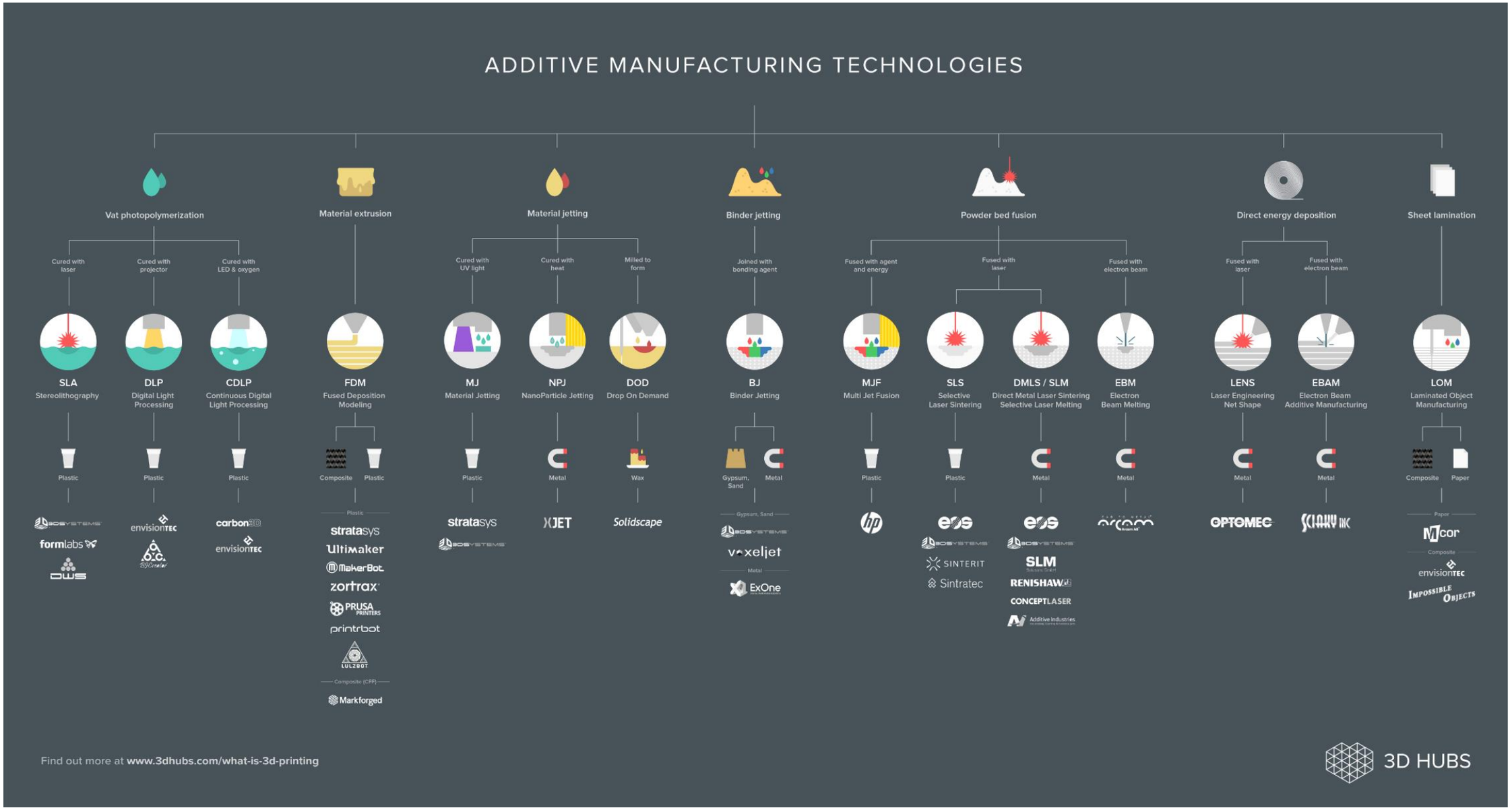
The process of producing parts by successive melting of layers of material rather than removing material. Each layer is melted to the exact geometry defined by a 3D computer model





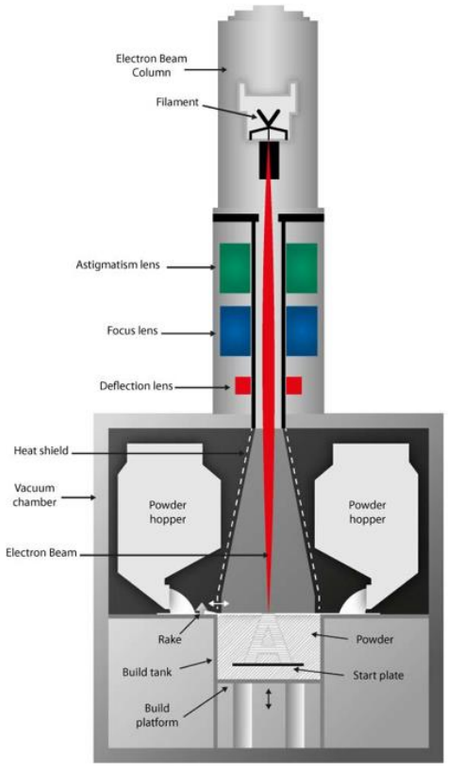
How will AM influence valve design and manufacturing?

3D Printing – A wide range of AM technologies



How will AM influence valve design and manufacturing?

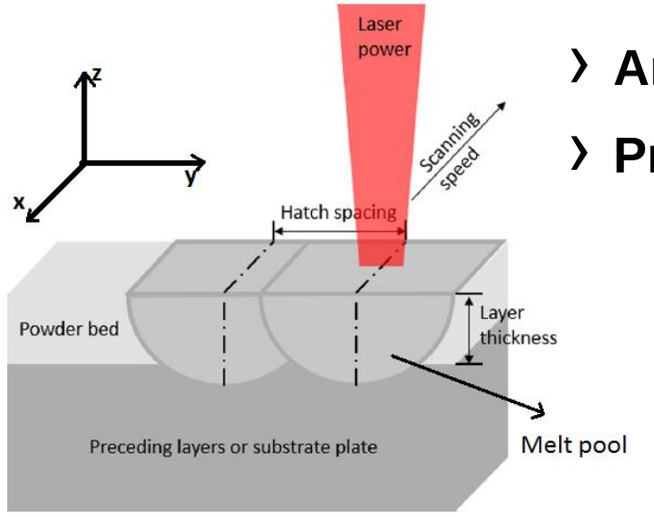
Electron Beam Melting (EBM)
- Titanium gr 2
- GE ARCAM



› **Vacuum process**

› **Hot process (650ºC)**

Selective Laser Melting (SLM)
- Stainless steel 316L
- SLM SOLUTIONS

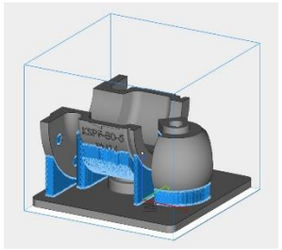


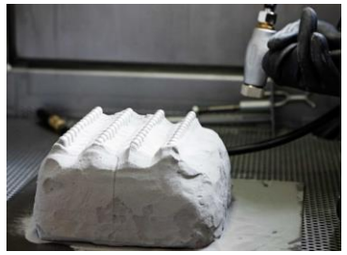
› **Ambient process**

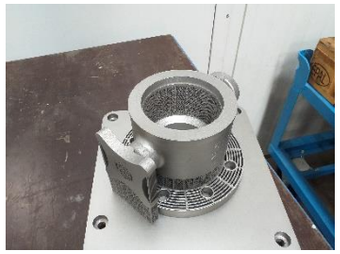
› **Protective gas**

How will AM influence valve design and manufacturing?

Process Time







3-5 days depending on geometry and height

How will AM influence valve design and manufacturing?

Commercially available metals for AM

- **Titanium gr. 2**
  Commercial Pure Titanium
- **Titanium gr. 5**
  Ti 6Al-4V
- **Titanium gr. 23**
  Ti 6AL-4V ELI
- **Cobalt Chrome**
  CoCr
- **Inconel 718**
  EN 2.4668
- **Stainless Steel 316L**

How will AM influence valve design and manufacturing?

Material Strength for AM produced titanium parts

	Arcam Ti6Al4V, Typical	Ti6Al4V, Required**	Ti6Al4V, Required***
Yield Strength (Rp 0,2)	950 MPa	758 MPa	860 MPa
Ultimate Tensile Strength (Rm)	1020 MPa	860 MPa	930 MPa
Elongation	14%	>8%	>10%
Reduction of Area	40%	>14%	>25%
Fatigue strength* @ 600 MPa	>10,000,000 cycles		
Rockwell Hardness	33 HRC		
Modulus of Elasticity	120 GPa		

*After Hot Isostatic Pressing **ASTM F1108 (cast material) ***ASTM F1472 (wrought material)

The mechanical properties of materials produced in the EBM process are comparable to wrought annealed materials and are better than cast materials.

How will AM influence valve design and manufacturing?

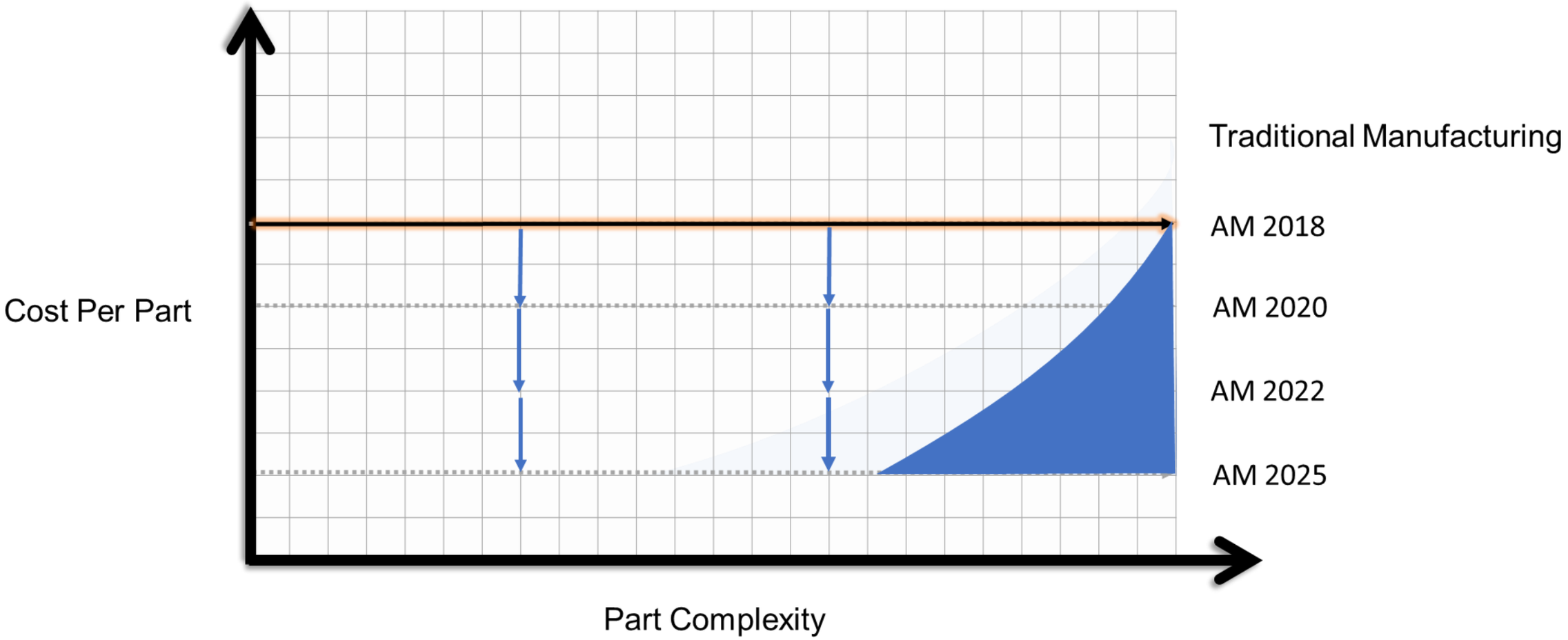
Mechanical properties of selective laser melted stainless steel 316L

Condition	Build direction	Yield Strength [MPa]	Ultimate Tensile Strength [MPa]	Elongation [%]	Charpy Impact Energy [J]
ENGIE Selective Laser Melted 316L (As-built)	Vertical	508 ✓	634 ✓	39 ✓	94 ✓ SD=7
	45°	513 ✓			100 SD=8
	Horizontal	451 ✓			105 SD=11
ENGIE Selective Laser Melted 316L (Annealed)	Vertical	348 ✓			121 ✓ SD=6
	45°	355 ✓			133 ✓ SD=13
	Horizontal	343 ✓			127 ✓ SD=9
ASTM F2184-16 Stress relieved or vacuum annealed	/				Not mentioned in the ASTM F2184-16
EN 10088-3:2015* Semi-finished products, bars, rods, wire, sections and bright products – 1.4404 (316L)	/				Min. 100
EN 10216-5:2013* Seamless steel tubes for pressure purposes – 1.4404 (316L)	/				Min. 100 (Longitudinal) Min. 60 (Transversal)
ISO 22068:2012 Sintered metal injection-moulded materials – MIM-316L-140	/				Not mentioned in the ISO 22068:2012
NF A 32-060:2001* Foundry products - Cast steel and nickel alloy castings for pumps, valves and fittings - GX2CrNiMo19-11-2 (1.4409)	/	Min. 195	440 - 640	Min. 30	Min. 80

Vertical 508 ✓ SD = 10
45° 513 ✓ SD = 7
Horizontal 451 ✓ SD =15
Vertical 348 ✓ SD=8
45° 355 ✓ SD=2
Horizontal 343 ✓ SD=5
206

How will AM influence valve design and manufacturing?

Cost vs. complexity



How will AM influence valve design and manufacturing?

Opportunities with adapting to AM technology

Design freedom

Short lead times

Functional surface

Customization

Cost-efficient production

QA

Environmental footprint

Cost of capital

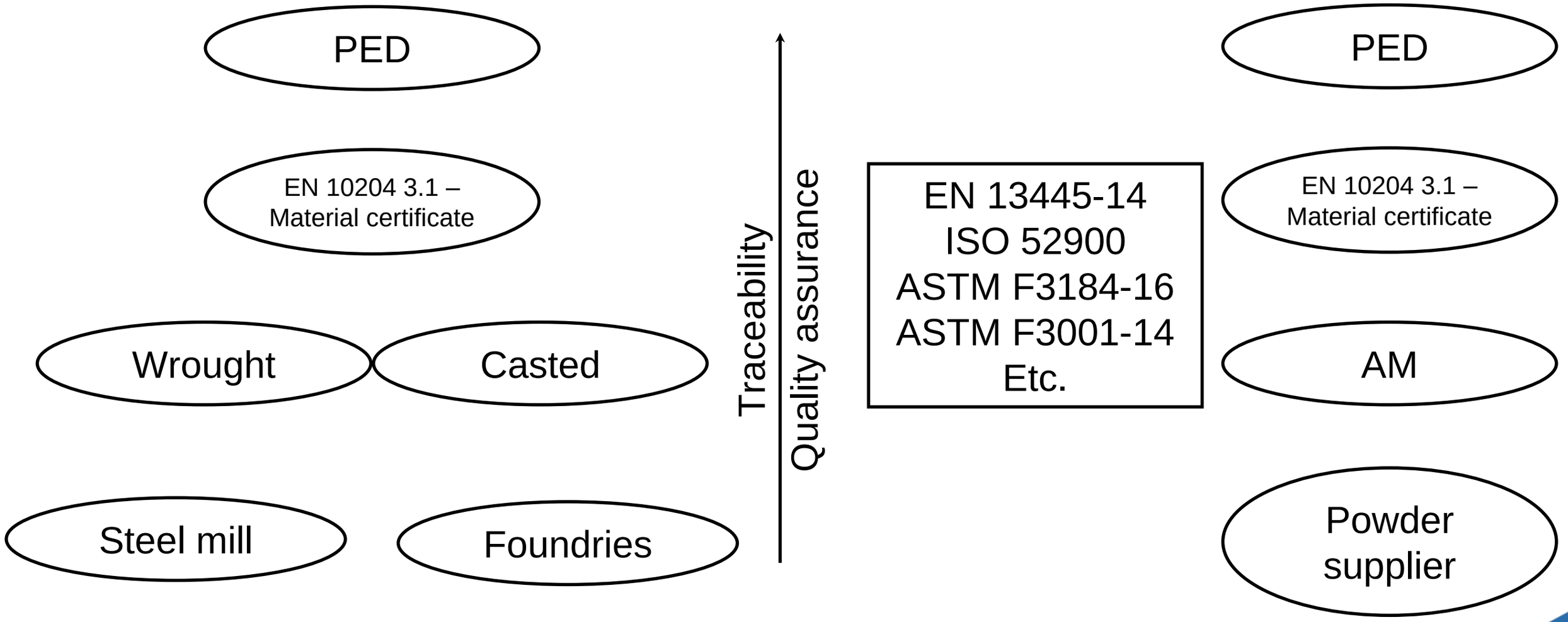
How will AM influence valve design and manufacturing?

Speed of optimized design

- **Customization based on unique application data**
- **CFD for optimized flow paths**
- **Material strength requirements**
- **Print on demand**
- **Optimised for machining, assembly and QA**
- **Spare parts printing**
- **Minimized material usage**
- **Optimized logistics**
- **Optimized lead time**

How will AM influence valve design and manufacturing?

Challenges for the AM technology in the valve industry
- **Pressure Directive, PED 2017/68/EU**



How will AM influence valve design and manufacturing?

Challenges for the AM technology in the valve industry
- **Where are we heading?**

- **Where to Print**
  Invest in 3D printer and qualified staff
  Using local sub suppliers with AM
  Local Print houses with machining capability
  Print on site with the customer
- **Spare parts supply and demand**
  Spare part printing anywhere
  IP protection
  Quality assurance
- **Open up for disruptive business models**
  Can we have a Uber or Spotify for industrial Valves?

Thank you!

Do you have questions?

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Ramén Valves
We know the flow