Knowledge Sharing Centre

Manufacturing Technology Conference 2024

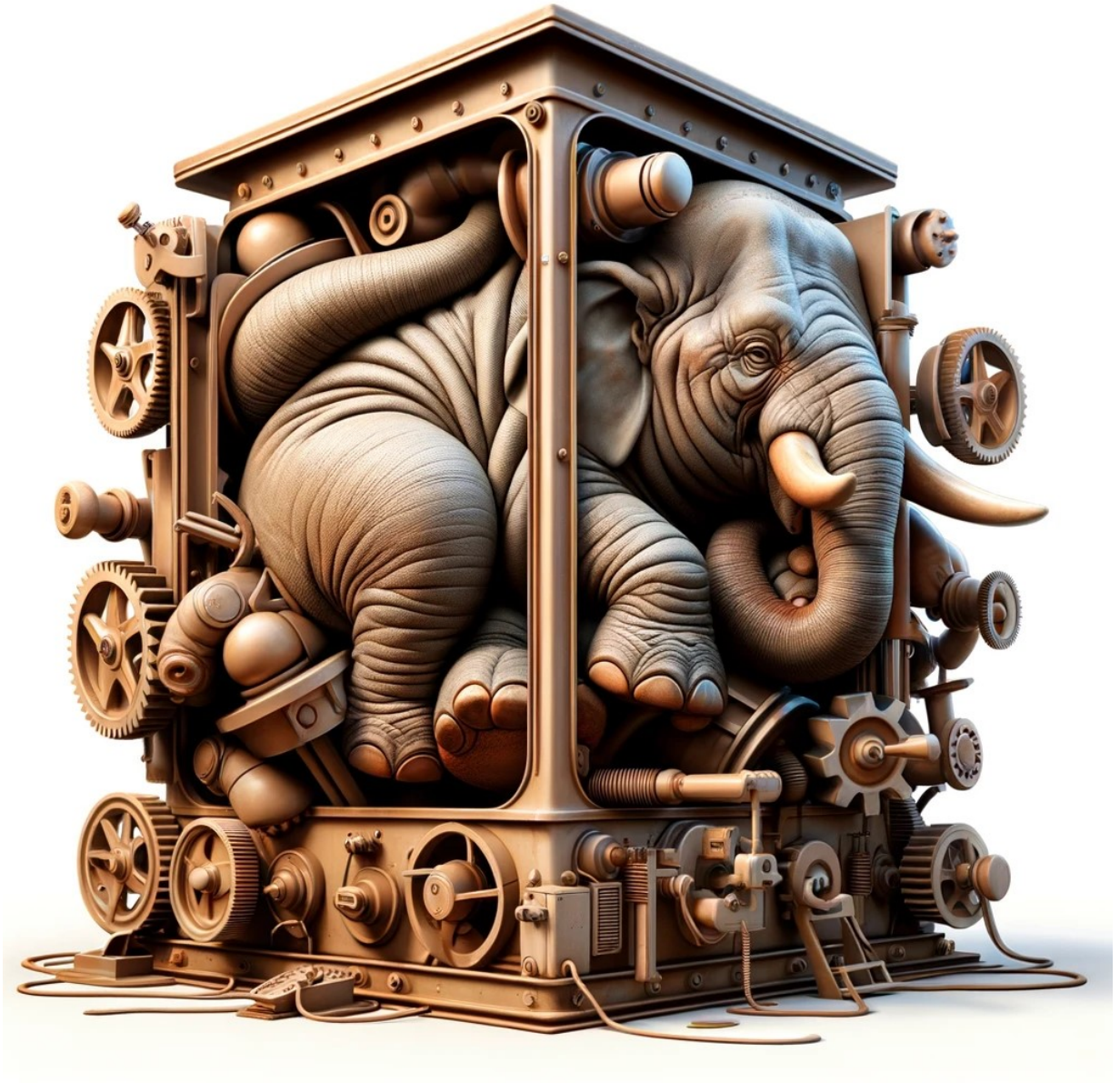
ASML / Additive Industries / Additive Center / Hexagon / NTS

Masterclass SPC for AM

How to serial manufacture high tech complex metal 3D printed parts?

But let's start with why.

Future of ASML



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Collaboration in the full chain

Design for 3D printing

ASML

3D printing Production

NTS

Excellence in equipment

Organising SPC in production

Additive Center

SPC tools

HEXAGON

Shared learning platform

Amify

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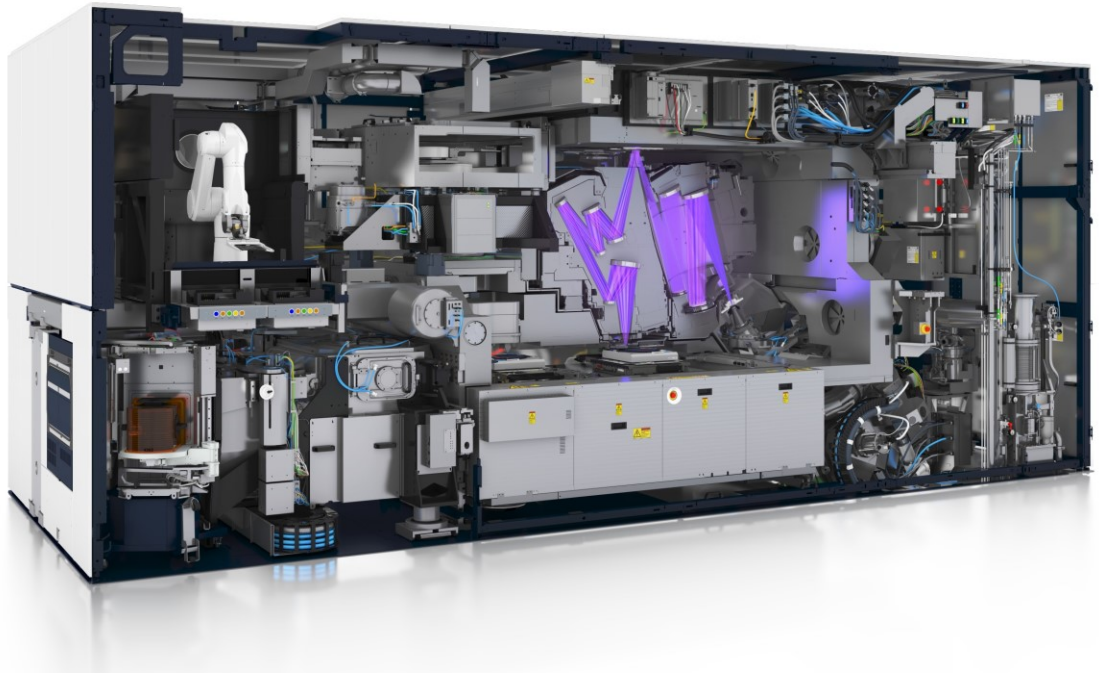
Why AM and what is needed to push the boundaries together?

ASML is changing the world one nanometer at a time

- ASML creates the critical tool to make chips
- We must exploit many manufacturing technologies including additive manufacturing to push our technology further
- ASML systems contain **>200 AM parts**



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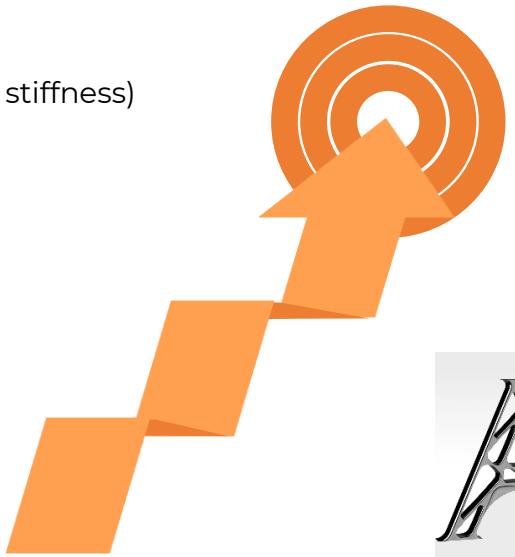
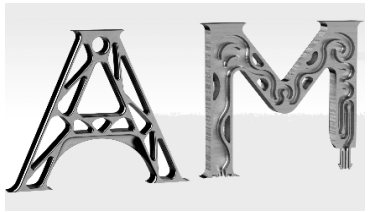
Why AM at ASML?

Performance improvement
Dynamics (mass reduction, increased functional stiffness)
Thermal optimization
Flow optimization

Integration of different functions
Enables functionality
Fit in constrained volumes
Integration of different parts into one

Design Freedom
Enables Innovation
Easier to iterate





We have to use AM mostly to design high tech complex parts

High complexity designs are so complex and/or critical that just controlling the production circumstances alone does not guarantee performance. Performance must therefore be validated on a part specific base.

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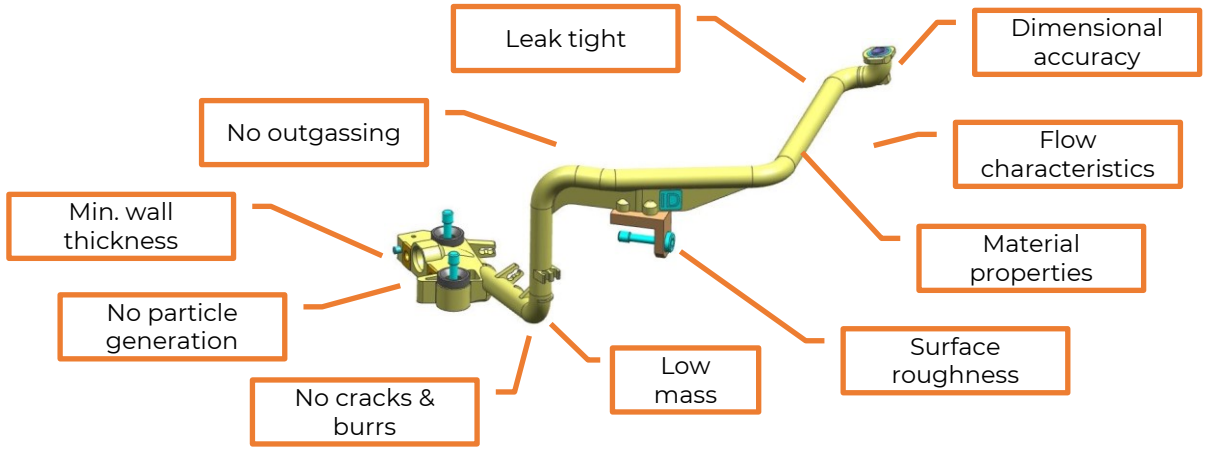
Requirements on high complexity AM designs and part quality

Most common requirement categories:

- Functional
- Mechanical
- Material
- Geometric



“The degree to which a part satisfies the specified set of attributes or requirements”

100% part qualification Inspect every part	**Statistical Process Control** Use statistical methods to assess part quality
High cost	Lower cost after initial set up
Time consuming	Less time intensive
Difficult to scale in volume production	More effective in large scale operations
Immediate detection of defects	Predictive and preventive insights

Proper implementation of SPC requires a good understanding of not only the statistical methods but also the AM process itself

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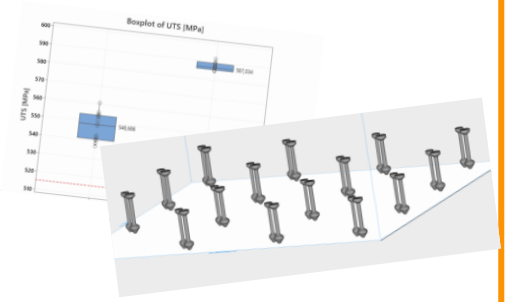
How to serial manufacture demanding High Tech metal 3D printed parts ?

Quality assurance

AM process

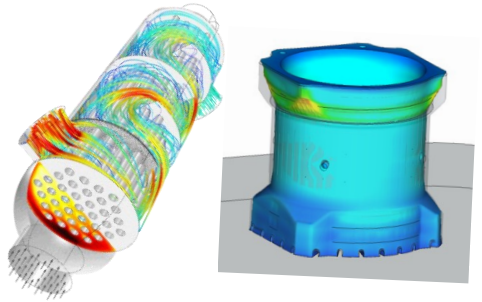
ISO 52920 Qualification principles for Additive Manufacturing

Parameter qualification



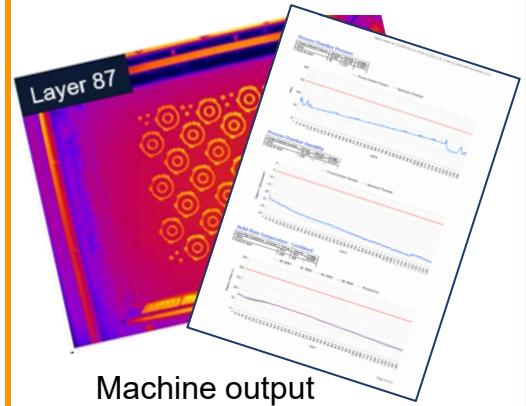
Mechanical properties, leak tests, roughness

Design Verification



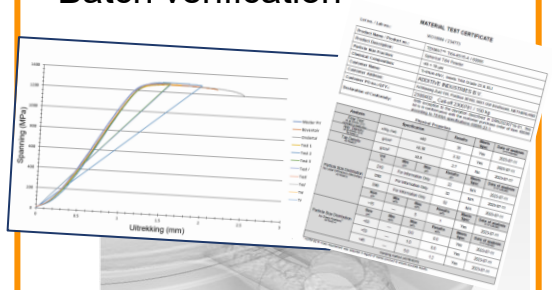
Design guidelines
Simulation

Process validation



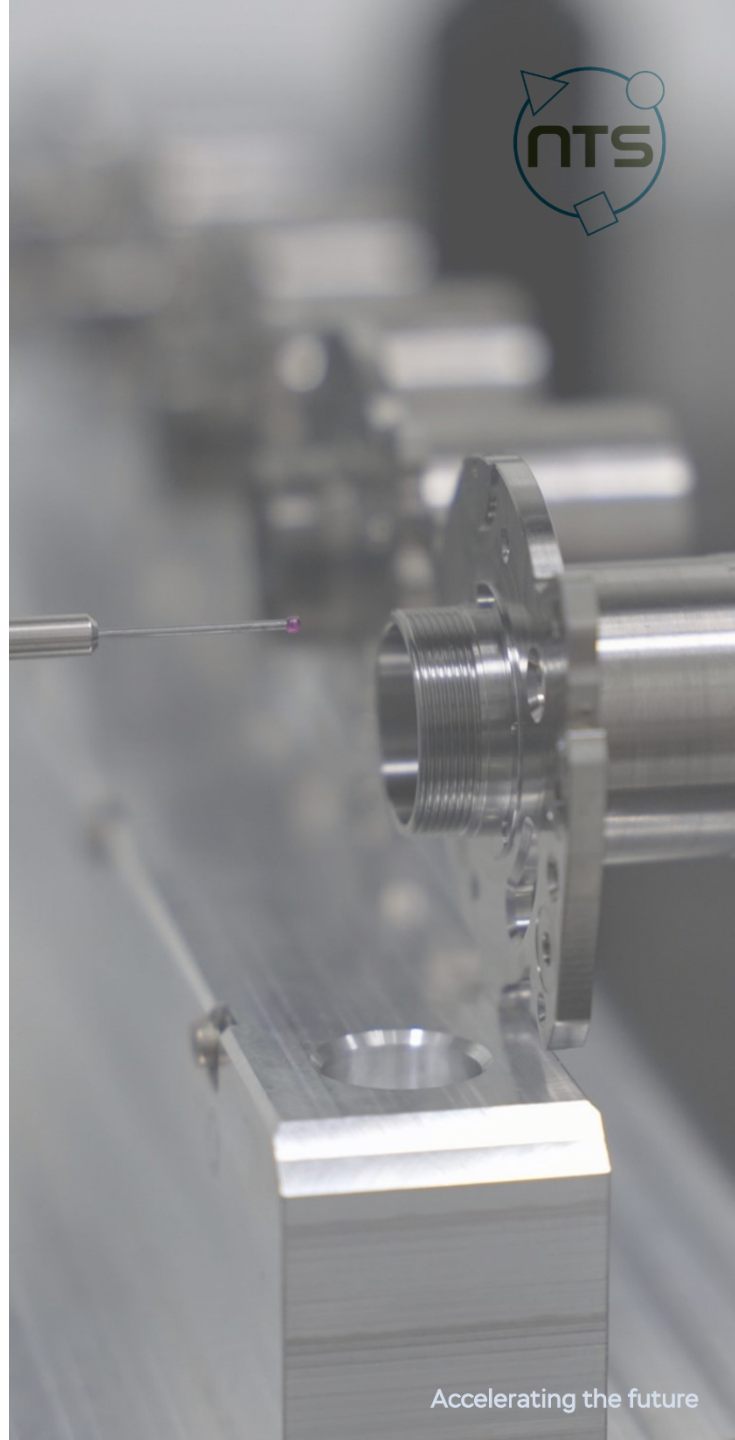
Machine output
Job report

Batch verification



Witness samples
Powder certificates

Part Verification



Quality assurance

Simple parts
"simple" part verification
and process control

Complex part
Extensive part verifications
Increasing batch verification tests
Stringent process control

How to ensure quality for increasing part complexity and requirements

- Complex production process with a lot of parameters which can influence the quality
- Geometry related influence
- Periodic controls

The process generates a large amount of data.
The combination of the different data helps to improve the predictability of the part quality
Increasing process control will decrease the required part verifications and thereby cost

Push the boundaries by increasing the process capabilities without the cost

How to serial manufacture demanding High Tech metal 3D printed parts ?

Adopting Metal AM

"The" success factors one has to take together with the initial investment

Application Development

Identify the right applications for you and your customers

Process Development

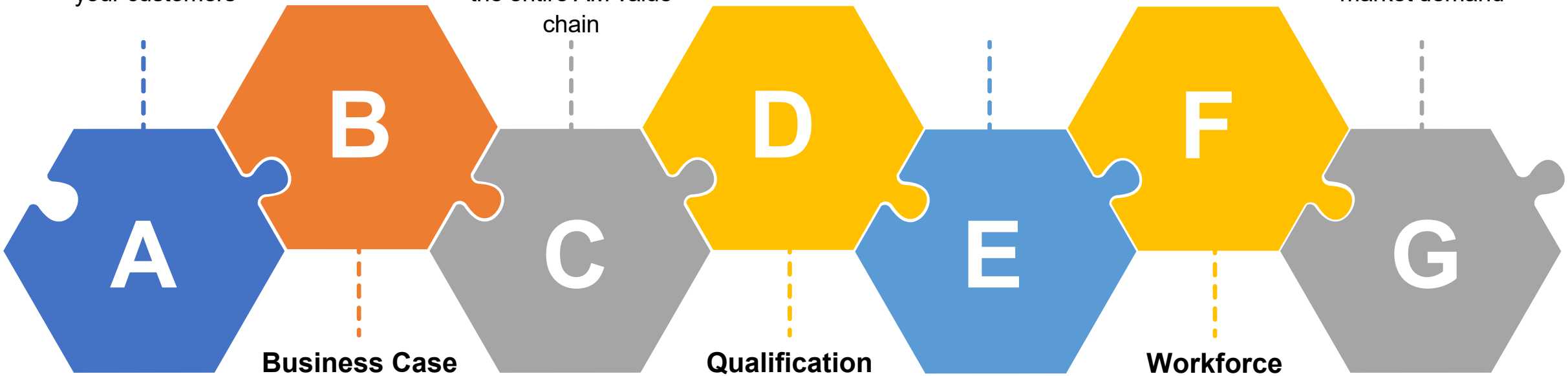
Refine the print parameters and define the entire AM value chain

Facility Design

Consider the overall facility and its operation

Production

Scale-up and calibrate the investment to the market demand



Business Case

Iterate and test the business case

Qualification

Understand the qualification steps for the part and the process

Workforce

Re-train or upskill the workforce

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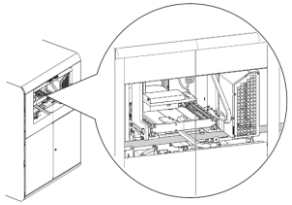
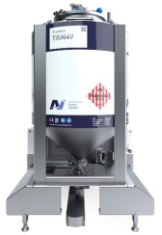
continuous automated production in metal AM is a prerequisite for Enhanced SPC

1. Manual machine set-up
2. manual powder handling

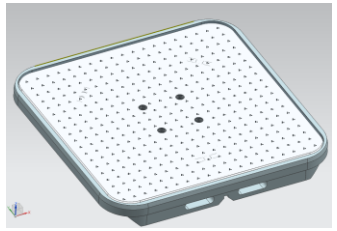
3. Scaling with standalone printers and FTEs
4. missing flexibility



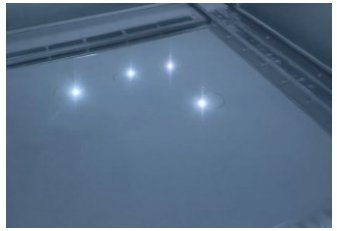
1. Automated Build Changeovers



2. Automated Powder Handling



3. Automated Calibration & Laser alignment



4. Full-Field-Laser & 420mm square build plate

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How to implement SPC in the manufacturing process?

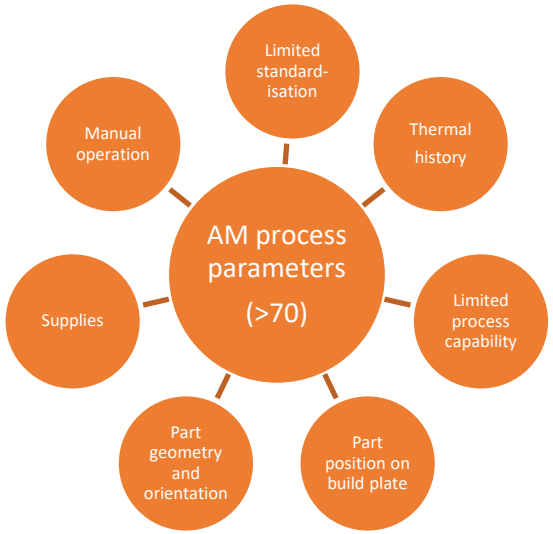
Getting AM in control, the journey to SPC

The AM in control chasm

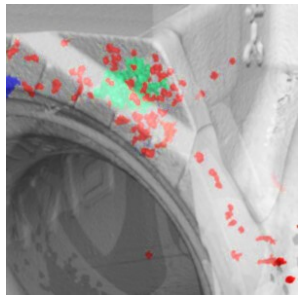
- No real time process and part quality data
- Data collection is limited
- Data is fragmented and stored on different locations

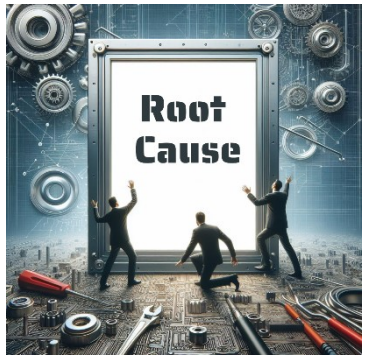
AM is a complex process

AM is a data rich process



Root-cause analysis is complex and time consuming





How to bridge the gap ?

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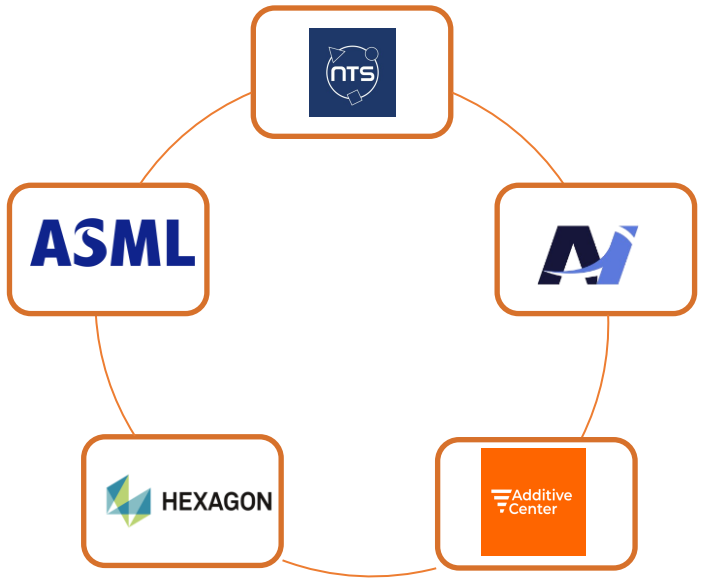
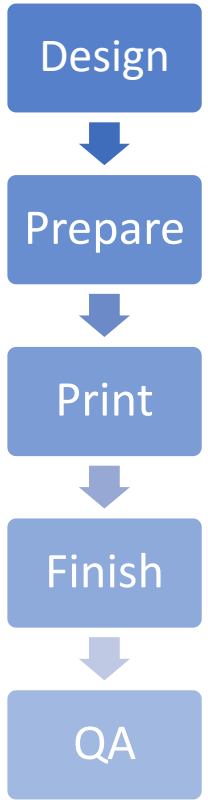
Enhanced SPC, enabling real time quality prediction

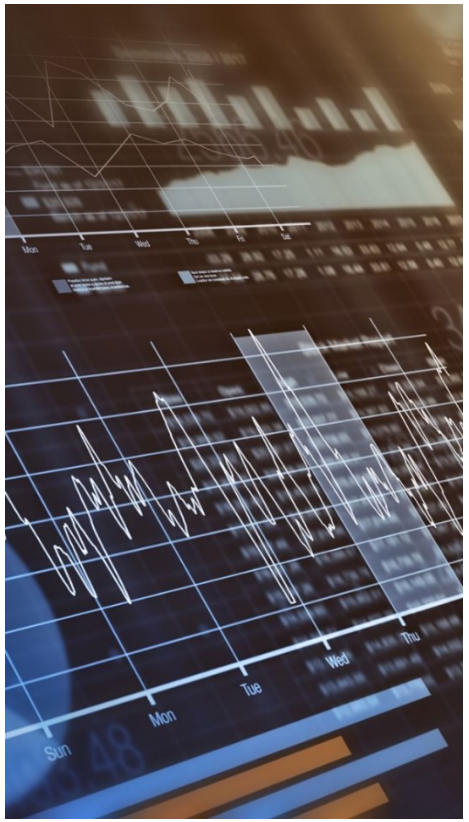
Collaboration is key



Ingredients for success

- Involve all stakeholders
- Include the overall value chain
- Facilitate representative data collection
- Data intelligence to learn, understand and improve





The road to enhanced SPC

Clear objectives → Representative data collection → Process mapping and understanding → Statistical tools and Techniques → Transition to SPC

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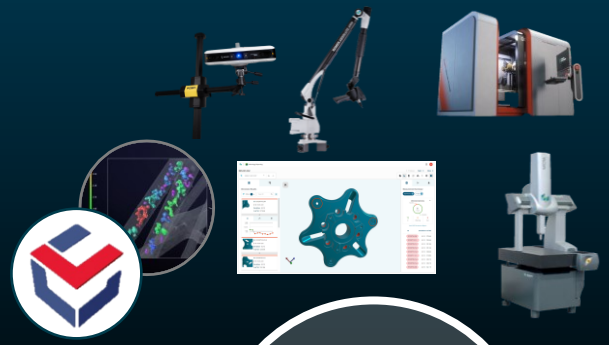
How to go from *conventional to enhanced SPC*

Conventional SPC

How SPC is usually deployed

Product



Measure

Predict

Part inspection

- Dimensional inspection
- NDT / CT

Conventional SPC

- Monitor quality measurement and analyze quality deviation
- Adapt measure frequency
- Anticipate quality issues

Challenges

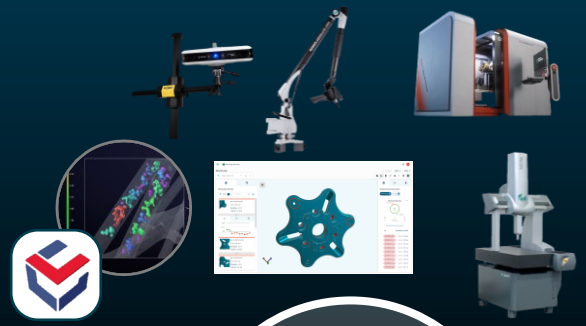
- Identification of quality issues arrives late
- Impact of process variations on part quality not measured

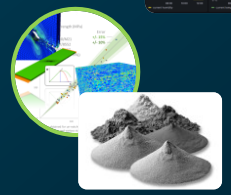
* process parameters + material + environment

Enhanced SPC

Combine product & process analytics to control and enhance quality

Product + Process





Measure

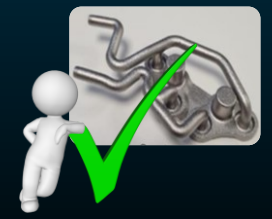
Quality Data

Auto ML

Production Data

Derive insight

Predict



Part AND process inspection

- Dimensional inspection & NDT
- Machine data
- Material data
- Environmental data
- …

Digital root cause analysis

- Correlate impactful process & environment parameters with part quality
- Identify and quantify process & environment parameters that impact part quality

Enhanced SPC

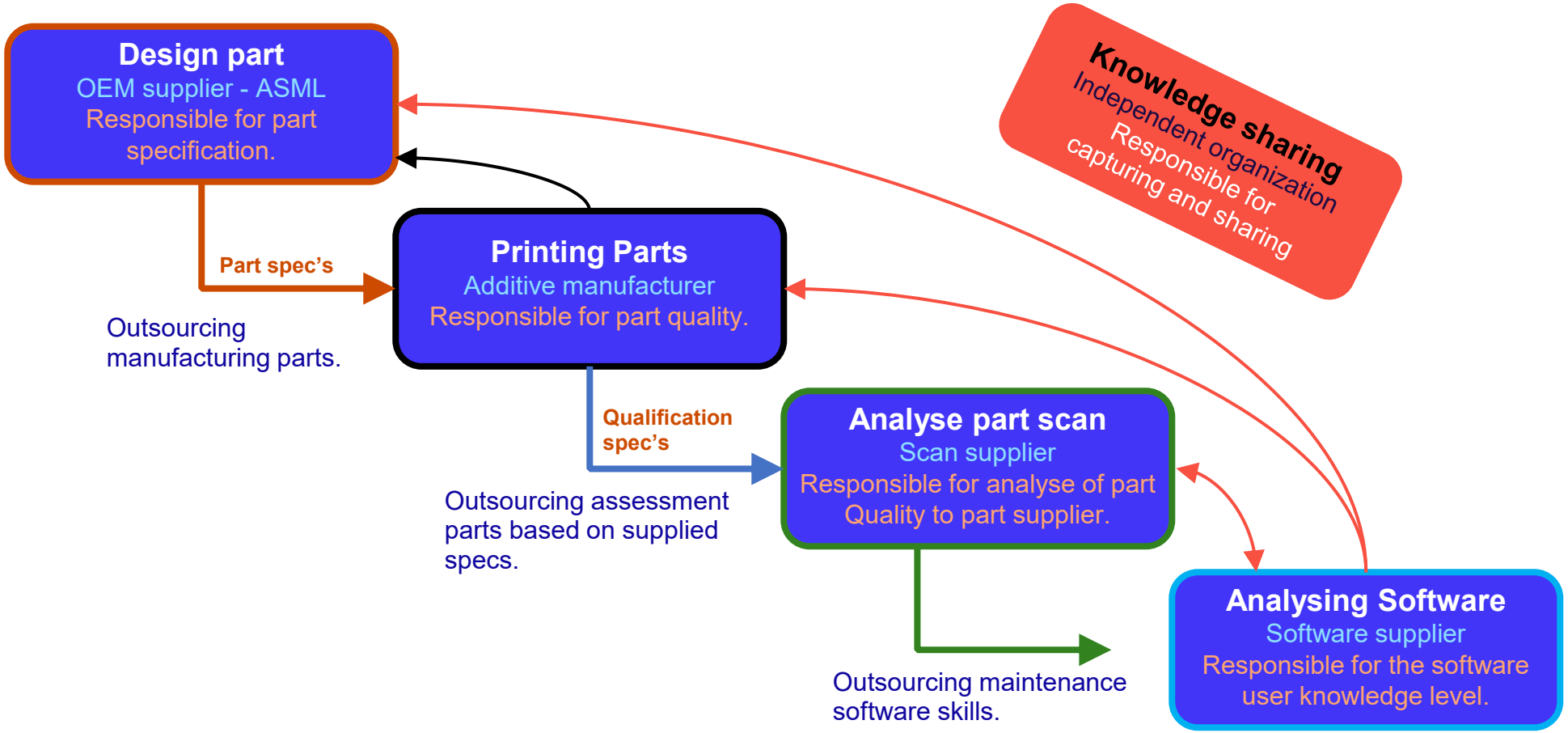
- Further reduce part inspection
- Adapt process & env. measure frequency
- Anticipate quality deviation early on
- **Improve part quality by improving process robustness**

* process parameters + material + environment

HEXAGON


Amify
How to learn together
accros the full value chain

Collaboration in the supply chain



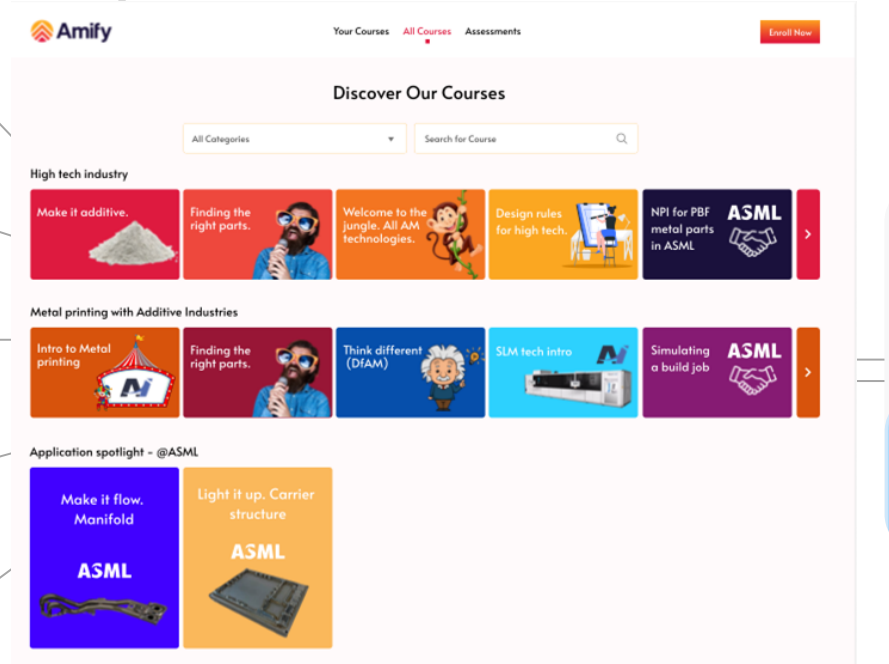
Platform to accelerate collaboration

Amify
An Additive Center brand

Fast evolving Industry knowledge

Content partner benefits:
Industry adoption insights, Brand awareness and revenue sharing, Educate thousands of engineers, not tens

Additive Industries
SLM SOLUTIONS
Nikon
HEXAGON
FESTO
3D SYSTEMS
RÖSLER
finding a better way ...
Etteplan
eos
RENISHAW
apply innovation™
hp
DMG MORI
SIEMENS
KMNE
stratasys
NANODIMENSION

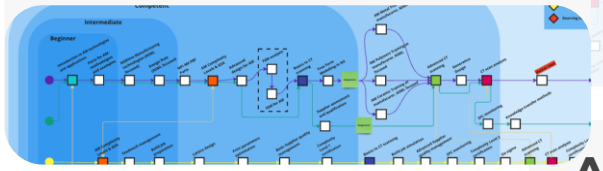


Continuously updated and maintained

Tetrapak

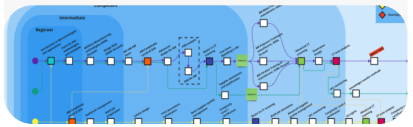
Hyundai

ASML Amify area learning tracks to improve quality



Developed with ASML AM competence and L&D. Maintained through Stay Competent system.

ASML Supply chain



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The KSC is the connector between companies from the design and manufacturing industry, which bundles knowledge in an accessible way to achieve joint growth and collaborations on a trusted basis.

Thanks for your attention

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Open platform for knowledge sharing with first members:

ASML · ThermoFisher Scientific · holland innovative · Mikro Centrum at the heart of hightech · Brainport Industries