Advancing your
Aerospace and Airport Business

Webinar SIG 3DP

June 20th , 2024

Advancing your
Aerospace and Airport Business

Program:

- Welcome by Harry Kleijnen, chairman SIG 3DP
- “The Additive Manufacturing Business Case” by Onno Ponfoort, Senior Management Consultant at Berenschot.
- “Sharing experience and approach in on-boarding AM” by Daniel Hoogstraate, Account Manager Additive Manufacturing Services for the Netherlands at Materialise
- ‘’Strategic Insights into Additive Manufacturing: Gaining an Edge in Innovation” by Tonya Cole, Industry Solution Experience Senior Manager Dassault Systems
- Wrap-up, conclusion & question

Advancing your
Aerospace and Airport Business

NAG SIG 3D introduction

Vision:

Advancing the Dutch aerospace industry competitiveness through cutting edge additive technologies, fostering innovations and ensuring sustainable growth

Highlighting the opportunities of Additive Manufacturing:

Freedom of Design allowing complicated geometries without compromising structural integrity

- Potential of cost reduction by waste reduction, less energy intensive processes and light weight components
- Time to market reduction. AM enables fast design iterations, optimized fine tuning to meet stringent performance and safety requirements
- Supply chain efficiency, on-demand production and reducing the need for extensive warehousing and long lead times

Pushing Performance and Boundaries.

Traditional manufacturing constraints often hinder innovation. AM technology opens new opportunities to push performance and expanding iterative thinking

Industrialization of Additive Manufacturing.

AM has matured substantially, from prototyping, tooling to nowadays series production including quality, safety and certification of AM produced parts

Collaboration.

Emphasizing partnerships between the Dutch AM ecosystem, aerospace industry players, academia and regulatory bodies.

Additive Manufacturing and the Business Case

Webinar NAG

Onno Ponfoort, Berenschot

20 JUNI 2024

WEBINAR NAG – 20 JUNI 2024

Agenda

Additive Manufacturing and the Business Case

Introduction Berenschot

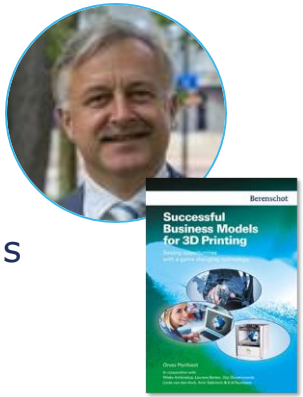
AM benefits

Some business cases

Onno Ponfoort - Berenschot

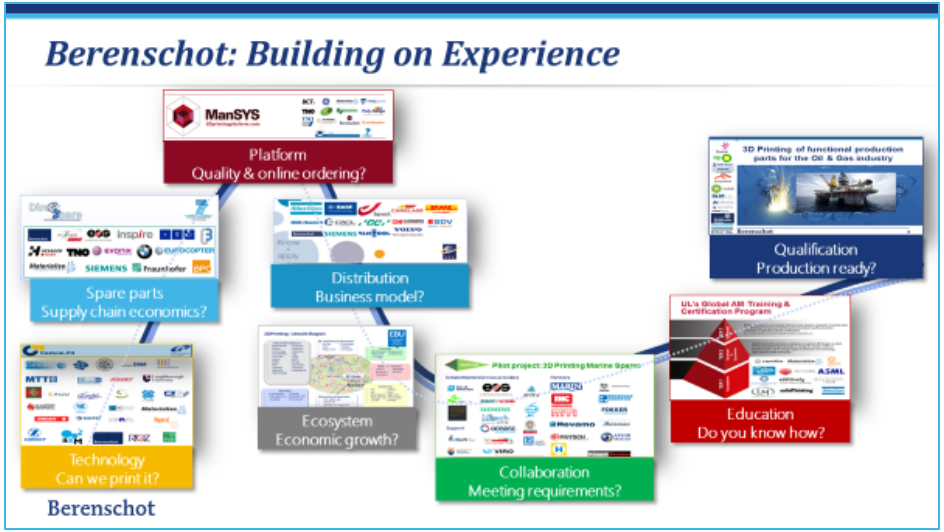
Berenschot

- General practice
- Founded 1938
- 450 staff
- HQ The Netherlands



Onno Ponfoort

- Practice Leader 3D Printing
- Active in 3D Printing since 2004
- Economic & organisational aspects



3D Printing/Additive manufacturing?

What it is, what you can use it for

- 3D printing/additive manufacturing: making three dimensional solid objects from a digital file.
- The object is created by laying down or hardening successive layers of material until the object is created..
- 3D printing enables you to produce complex shapes using less material than traditional manufacturing methods. It also allows you to print simple parts directly, without of using a mould.
- 3D printing technology is destined to transform almost every major industry.
- Most companies use 3D printing in the design process/prototyping: fast and relatively cheap.
- In many markets 3D Printing is also already used for end products: Automotive, Aviation, Construction, Consumer Products, Healthcare, Food, Oil & Gas.

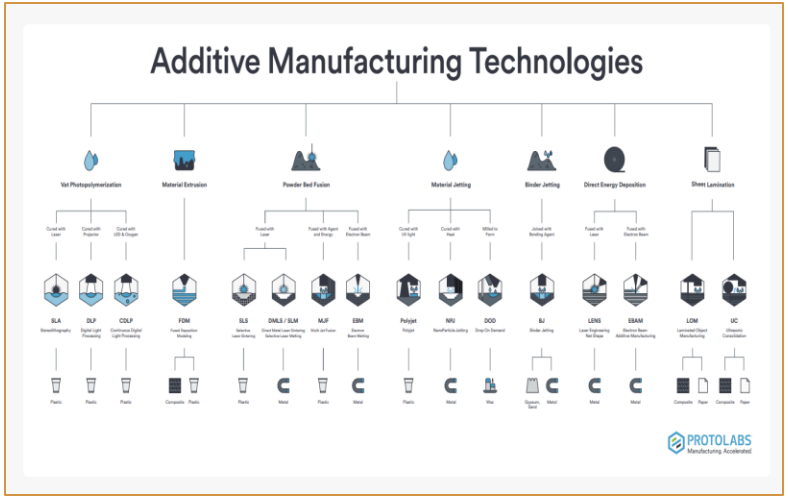
Desk top
€ 2.000

Industrial
€ 1.000.000+

AM/3D Printing Technologies

American Society for Testing and Materials (ASTM) classification

1. **Vat Photopolymerisation**
   Stereolithography (SLA)
   Digital Light Processing (DLP)
   Continuous Liquid Interface Production (CLIP)
2. **Material Jetting**
3. **Binder Jetting**
4. **Material Extrusion**
   Fused Deposition Modeling (FDM)
   Fused Filament Fabrication (FFF)
5. **Powder Bed Fusion**
   Multi Jet Fusion (MJF)
   Selective Laser Sintering (SLS)
   Direct Metal Laser Sintering (DMLS)
6. **Sheet Lamination**
7. **Directed Energy Deposition**
   Wire and Arc Additive manufacturing (WAAM)



Source: https://www.hubs.com/get/am-technologies/

3D Printing: Why and When

3D printing

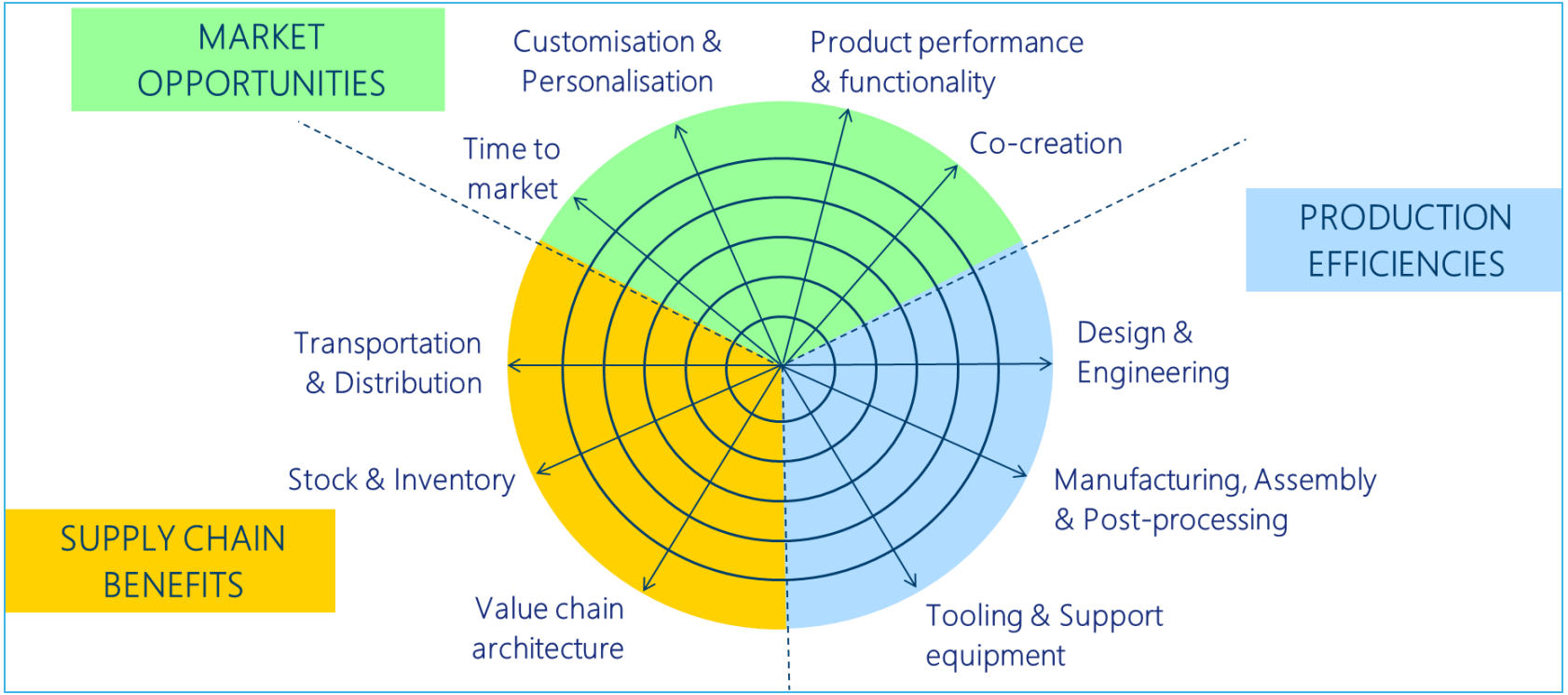
- Because it is available ➔ NO
- ***Because it delivers results***

➢ ***Cheaper***
- To produce (less material, less labor)
- To use (less energy, longevity)
- To distribute (production close to location)
- To store (fewer pieces on stock)

➢ ***More sustainable***
- Less waste after production
- Less energy (production, transport, use)
- Fewer parts to scrap

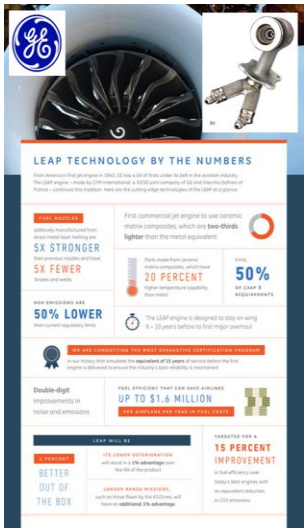
➢ ***Better quality or functionality***
- Functionally better design
- Improved ease of use
- Less maintenance or replacement

Typical benefits of AM



3D Printing business case: Examples (1)

GE: Nozzle for Leap engine



Series of parts

Fuel nozzle:

- 5* stronger
- 5* fewer parts
- 50% less emissions
- $ 1,6 mln lower fuel cost/airplane

Business

- 50+ customers in 20 countries
- 6000+ orders, $ 78 billion
- 25% + market share
- 2500 + jobs

BMW: Thumb protector

- 3D Printing used to reduce strain on employees' hands

- Lower number of working days lost due to illness

B

Joint Industry Projects

Developing standards for 3D printed (spare) parts in Oil, Gas & Maritime

JIP I

- equinor
- bp
- Shell
- TOTAL
- KONGSBERG
- ocas
- ivaldi
- TechnipFMC
- SIEMENS Ingenuity for life
- IMI Critical Engineering
- voestalpine
- SANDVIK
- aidro
- vallourec
- SLM SOLUTIONS
- Additive Industries
- IMMENSA TECHNOLOGY LABS
- Quintus
- HIPtec
- AFRC
- DNV·GL
- Berenschot

JIP II

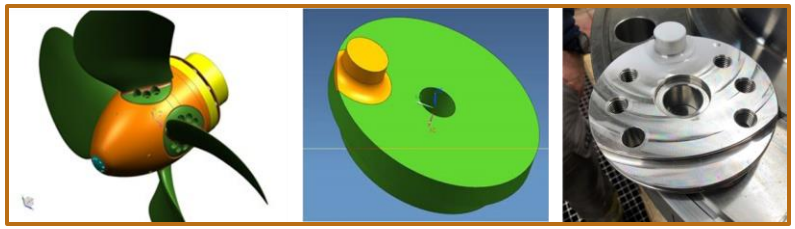
- equinor
- ارامكو السعودية saudi aramco
- voestalpine
- KONGSBERG
- SIEMENS
- Guaranteed
- FIT
- XDM 西帝摩
- ADDILAN
- SANDVIK
- intertek ImphyTek Powders
- IMI Critical Engineering
- Kongsberg Ferrotech
- ExOne
- HOWCO
- bmt aerospace
- NMIS National Manufacturing Institute Scotland
- DNV·GL
- Berenschot

JIP III

- equinor
- KONGSBERG
- slb OneSubsea
- PETRONAS TechnipFMC
- SULZER
- EUREKA
- Nikon SLM SOLUTIONS
- 3D SYSTEMS
- Guaranteed
- bmt aerospace
- Layerwise
- NMIS National Manufacturing Institute Scotland
- fenice
- imphytek. POWDERS
- ZEISS
- SIEMENS energy
- PELAGUS-3D
- cetim Mefrer
- effee induction
- IMMENSA TECHNOLOGY LABS
- vallourec
- Kongsberg Ferrotech
- DNV
- Berenschot

3D Printing business case: Examples (2)

Kongsberg case – Crank pin disc: repair and remanufacturing



Economic benefits

- Less material
- Reduced lead-times
- Less energy & fuel cost
- Lower distribution and Warehousing cost

Savings 20 – 70%

Sustainability benefits

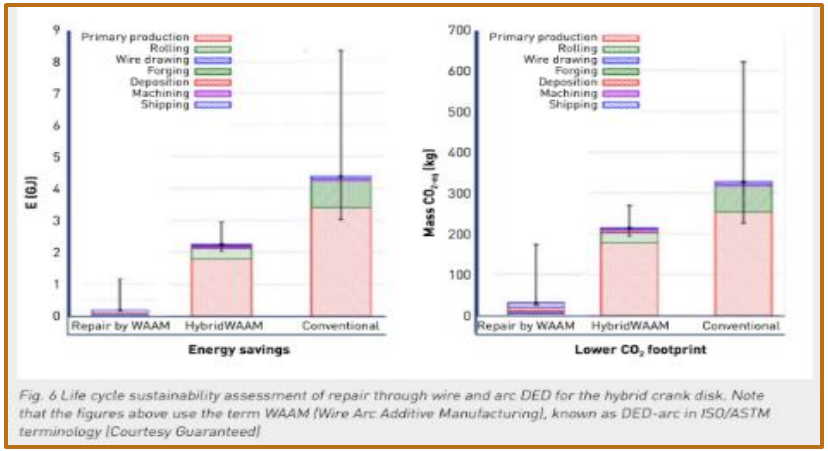


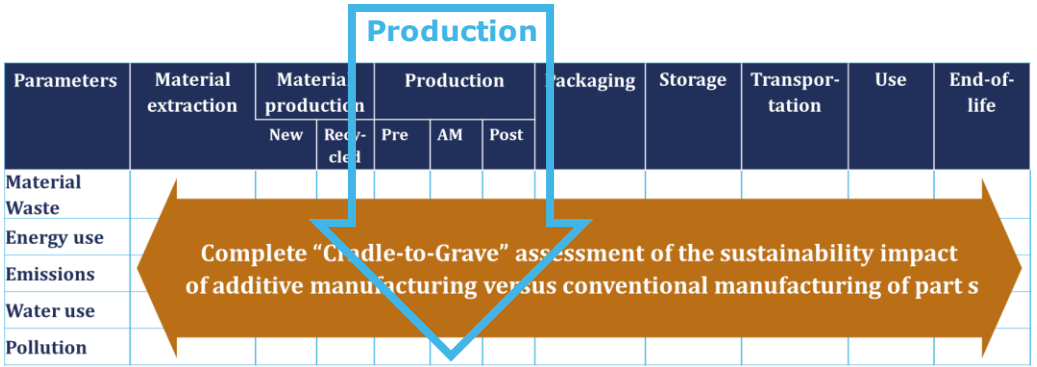
Fig. 6 Life cycle sustainability assessment of repair through wire and arc DED for the hybrid crank disk. Note that the figures above use the term WAAM (Wire Arc Additive Manufacturing), known as DED-arc in ISO/ASTM terminology (Courtesy Guaranteed)

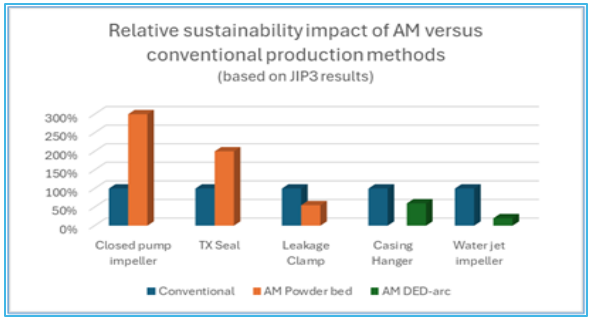
- Hybrid DED: - 50% energy, - 33% CO2
- Repair DED: - 95% energy, - 90% CO2

AM = Sustainability? Not always!

Findings during JIP Phase III

- 'On demand/on location' is more easily realized with AM ➔ AM likely to support production in countries with cleaner energy mix, close to the point of use to reduce logistic emissions.
- Powder-bed fusion for 'like-for-like' AM of casted parts, increases emissions during production ➔ To be analyzed if the design (e.g. light-weighting) offers energy benefits during the use phase
- WAAM likely to reduce CO2 emissions up to 40% vs. milling. because of less material use





Drivers for adoption of metal AM

Adopters Main reasons to adopt
Relative advantage
Organisational image
Pressure from competition
Supplier marketing activities

Non-adopters Main reasons not to adopt
Complexity
Financing costs
Business case
Reluctance at business partners

Visionary leaders

with room to manoeuvre are willing to step in, convince partners/stakeholders with

- The economics and benefits in operations
- Real life examples presented by end-users

Cautious managers

with investment guidelines and risk-assessments, can be convinced via:

- Real life examples including a business case
- Involving supply chain partners to share costs

UNIVERSITY OF TWENTE.
Luuk Nolet

3D Printing

A valid technology to produce fully functional parts in many materials

From Lab
- Prototype
- R&D, makerspace
- Manual
- Slow

To Fab
- **Validated end part**
- **Industrial setting**
- **Automated**
- **Quick**

- 3D Printing: increased functionality, certified (spare) parts, cost effective tooling
- Not only plastics: Large size metal printing is possible, composites, alloys, ceramics, etc.

- 3D printing is a means, not a goal:
  - Determine the benefits you want to achieve
  - For companies of all sizes, in every supply chain role
  - Be your visionary self and create the future for your company

Any Questions?

Onno Ponfoort
Practice Leader 3D Printing

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The VALUE of ADDITIVE MANUFACURING for Aerospace

Daniel Hoogstraate

Account Manager for The Netherlands

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About..

28 offices in 19 countries

Founded 1990
2013 Nasdaq listed

+ 2,400 Employees

Medical applications
AM-Software
AM-Production Services

+ 195 printers

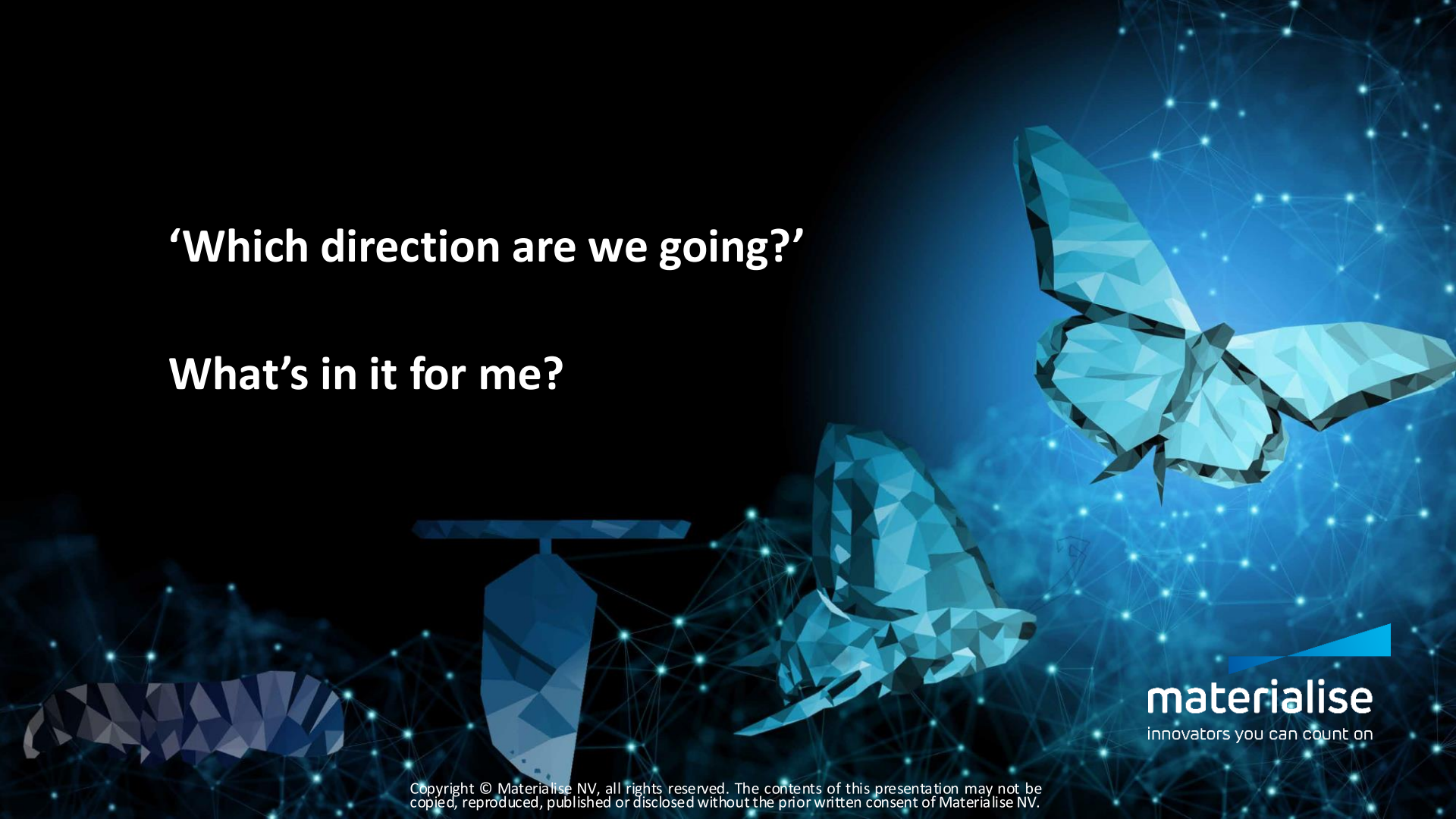
+ 6,000 parts produced per day

+ 485 patents granted
+ 185 pending

ISO 9001, 13485, 14001, 27001
EN 9100, EASA 21.G
Tisax, EcoVadis Bronze

‘Which direction are we going?’

What’s in it for me?



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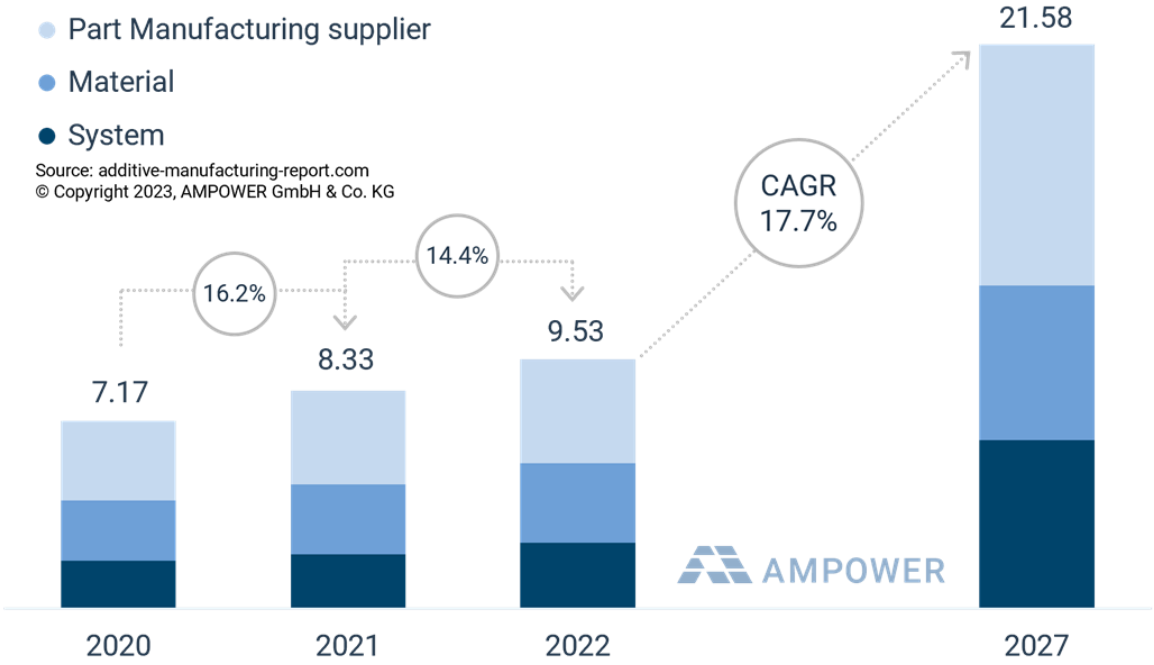
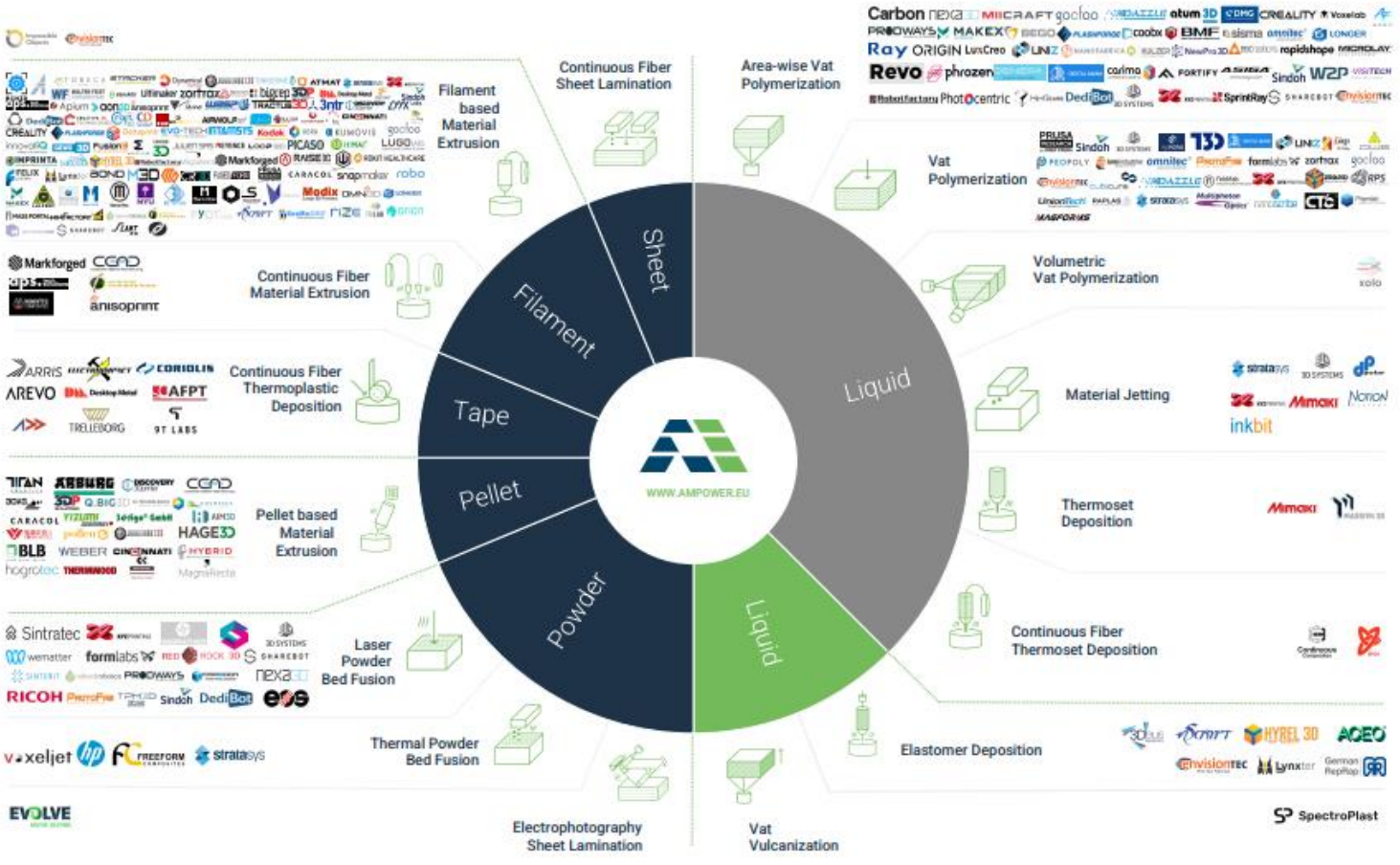
Global metal and polymer Additive Manufacturing market 2020 to 2022 and supplier forecast 2027 [EUR billion]





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AMPOWER Maturity Index 2024

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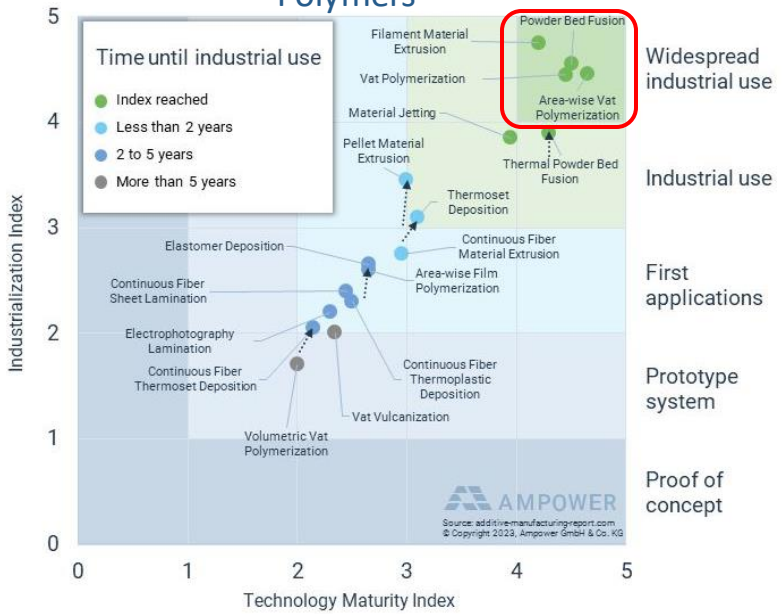
Polymers



Metals

Good and bad news about AM-adoption

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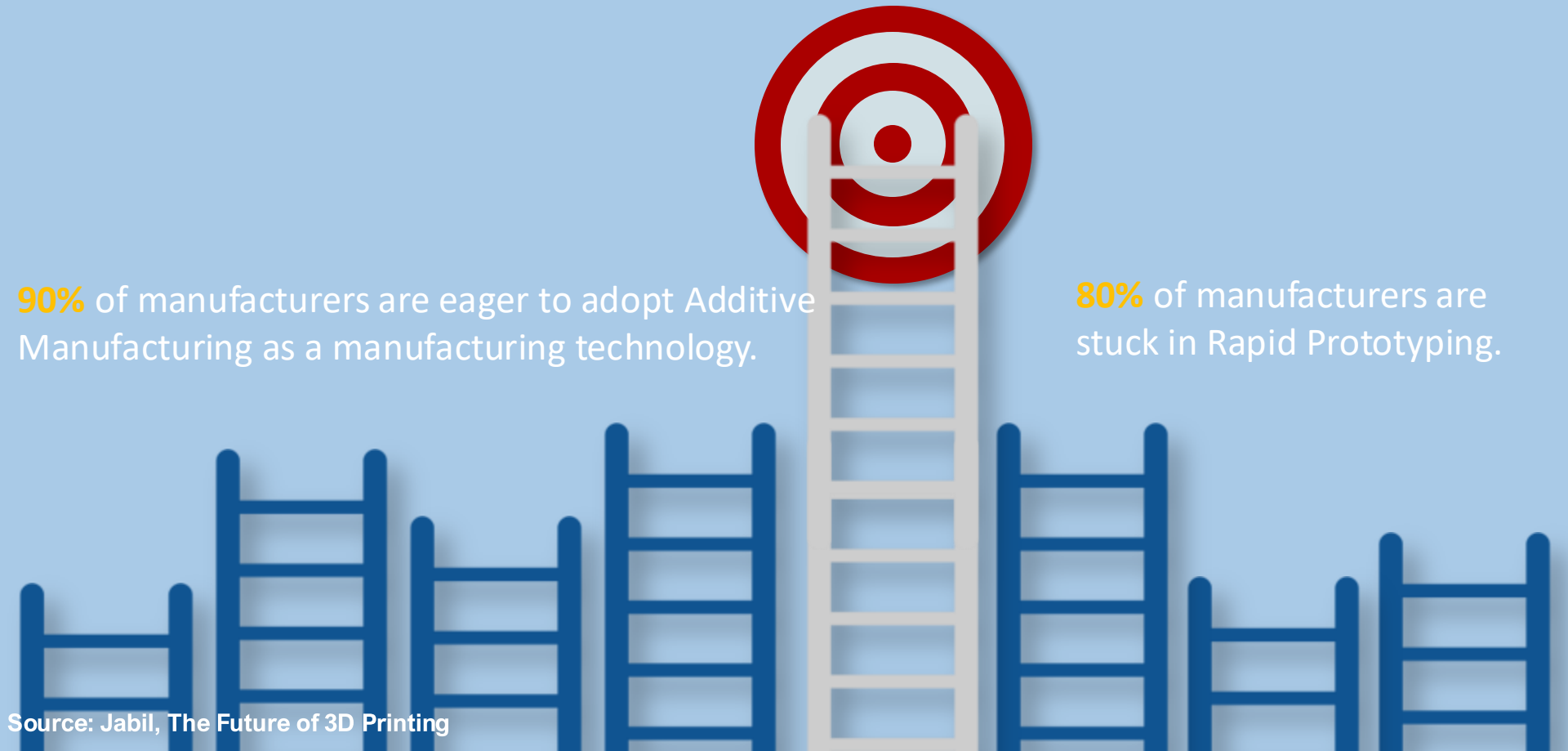
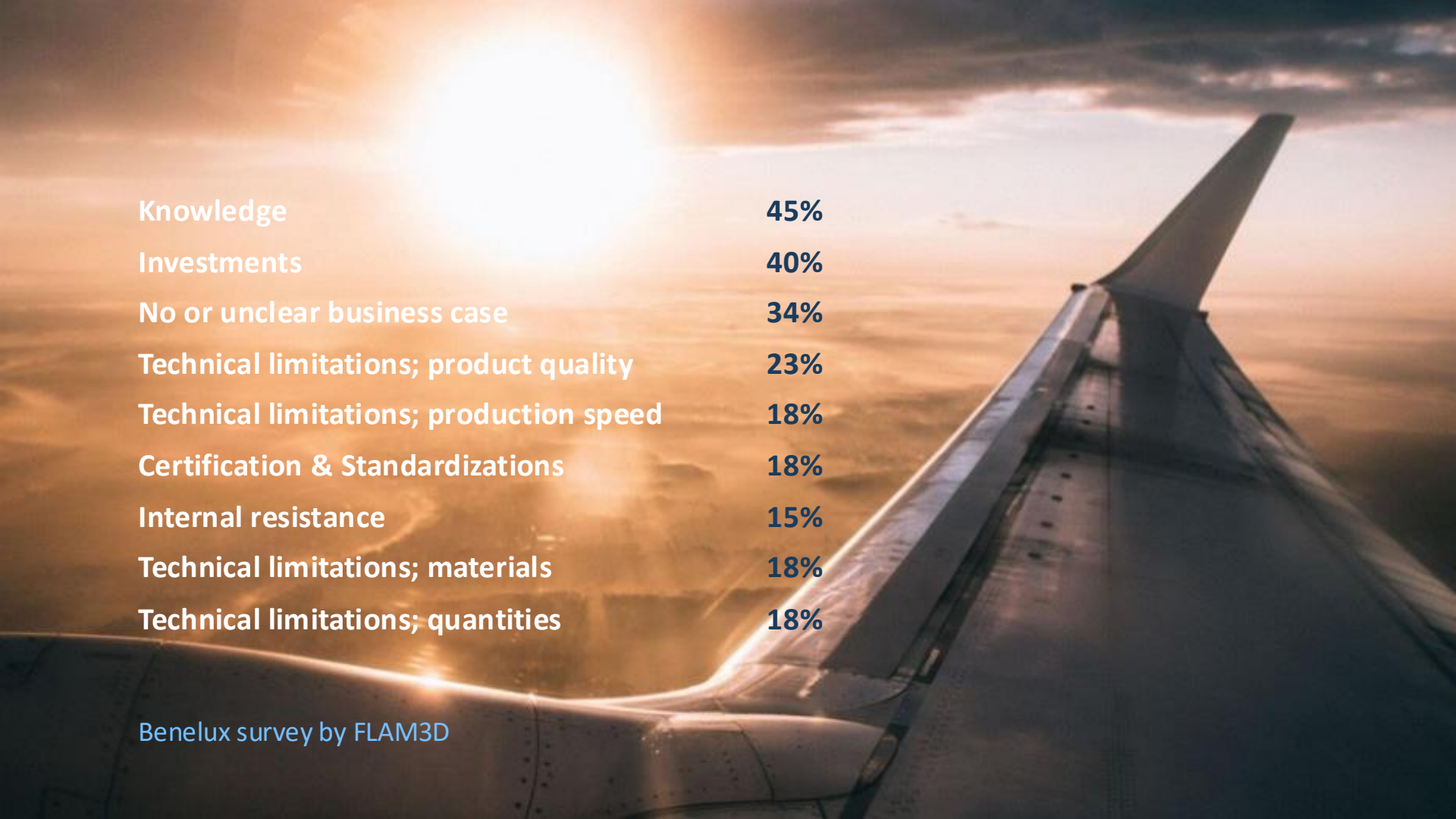
90% of manufacturers are eager to adopt Additive Manufacturing as a manufacturing technology.

80% of manufacturers are stuck in Rapid Prototyping.

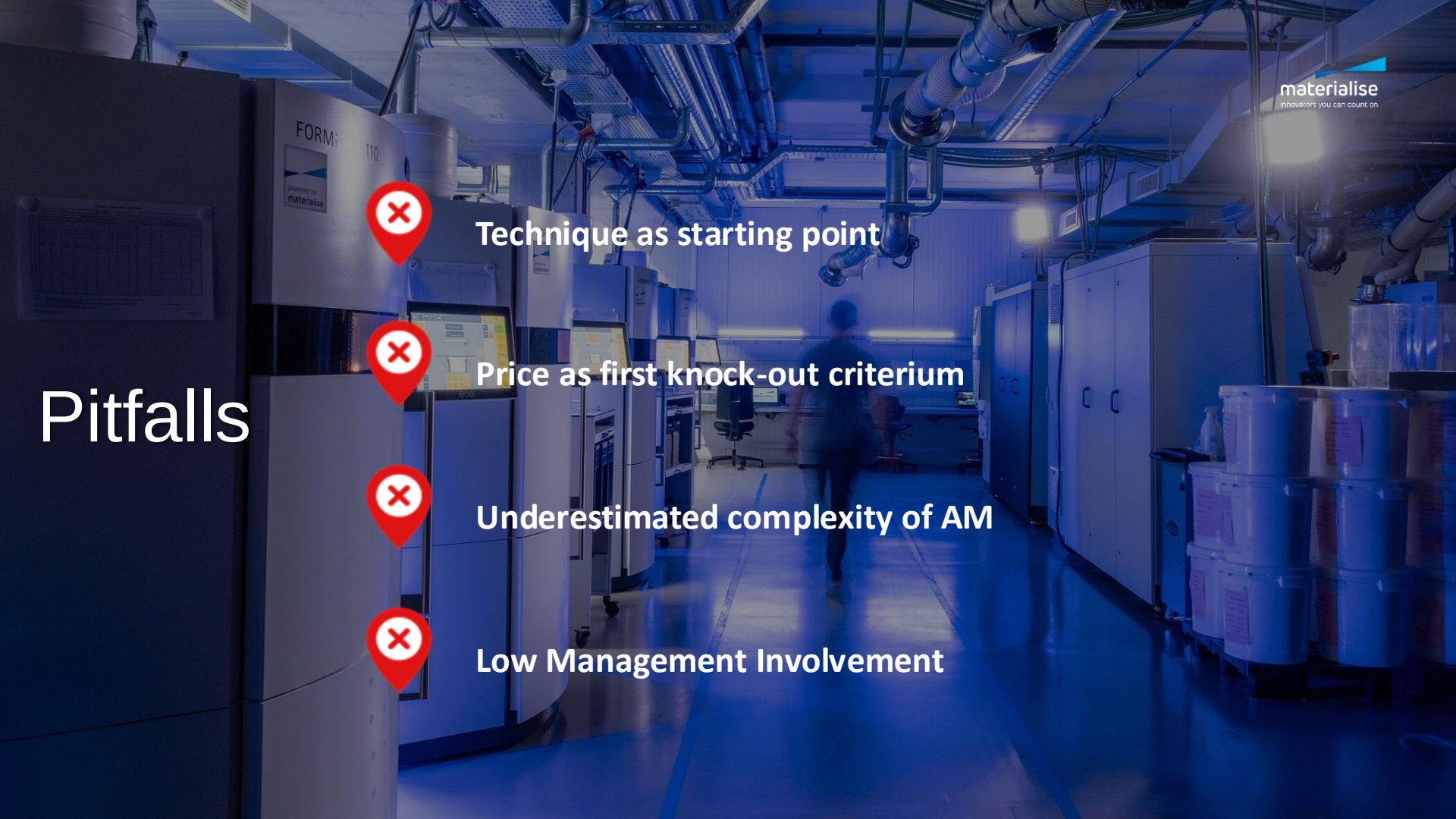


Source: Jabil, The Future of 3D Printing



Knowledge	45%
Investments	40%
No or unclear business case	34%
Technical limitations; product quality	23%
Technical limitations; production speed	18%
Certification & Standardizations	18%
Internal resistance	15%
Technical limitations; materials	18%
Technical limitations; quantities	18%

Benelux survey by FLAM3D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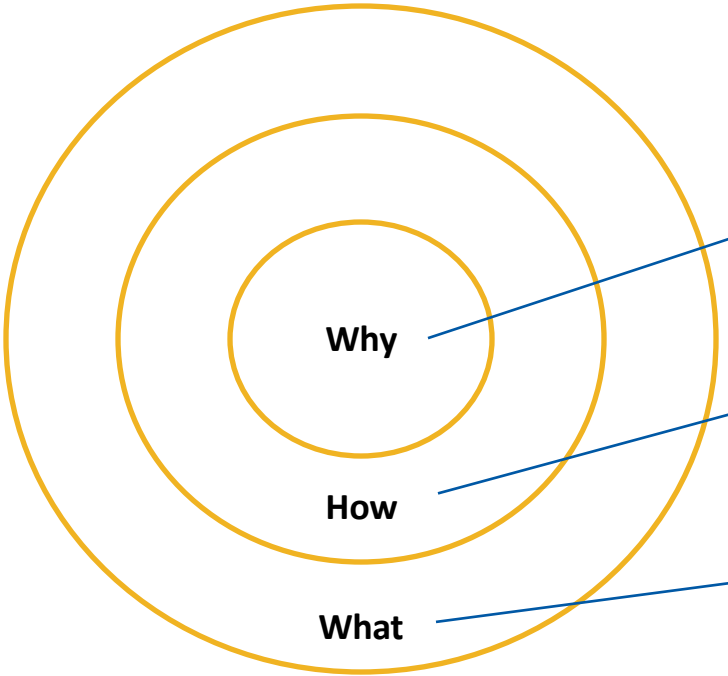
Pitfalls
Technique as starting point
Price as first knock-out criterium
Underestimated complexity of AM
Low Management Involvement



Drivers, Challenges, Pain..

Application, Strategy

Benefits of AM

Weight saving, less inventories, time-to-market, part reduction, mass customization, etc, etc.

Technique, Product

Process, materials, finish, pre- & post –processing, etc.

'Golden Circle by Simon Sinek ('Start with why')

Applications

Prototyping

MRO supplies

Cabin interiors

Tooling

Specials

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328 Support Services

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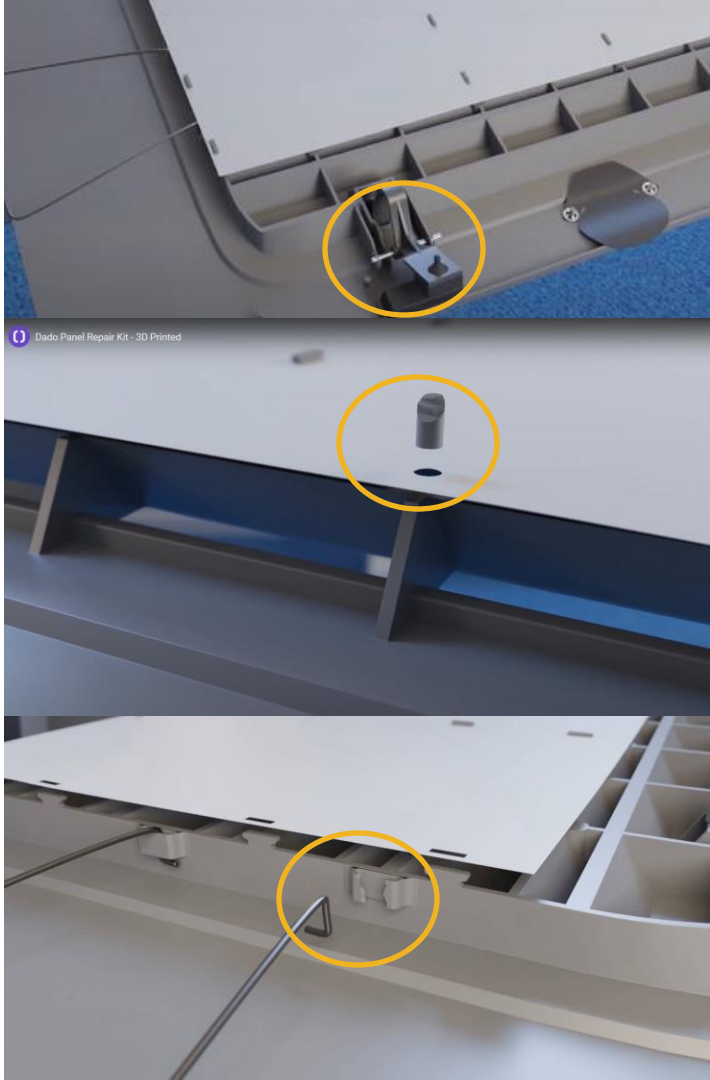
Fokker

GKN AEROSPACE

AIRBUS

relies on 3D Printing
for better production.

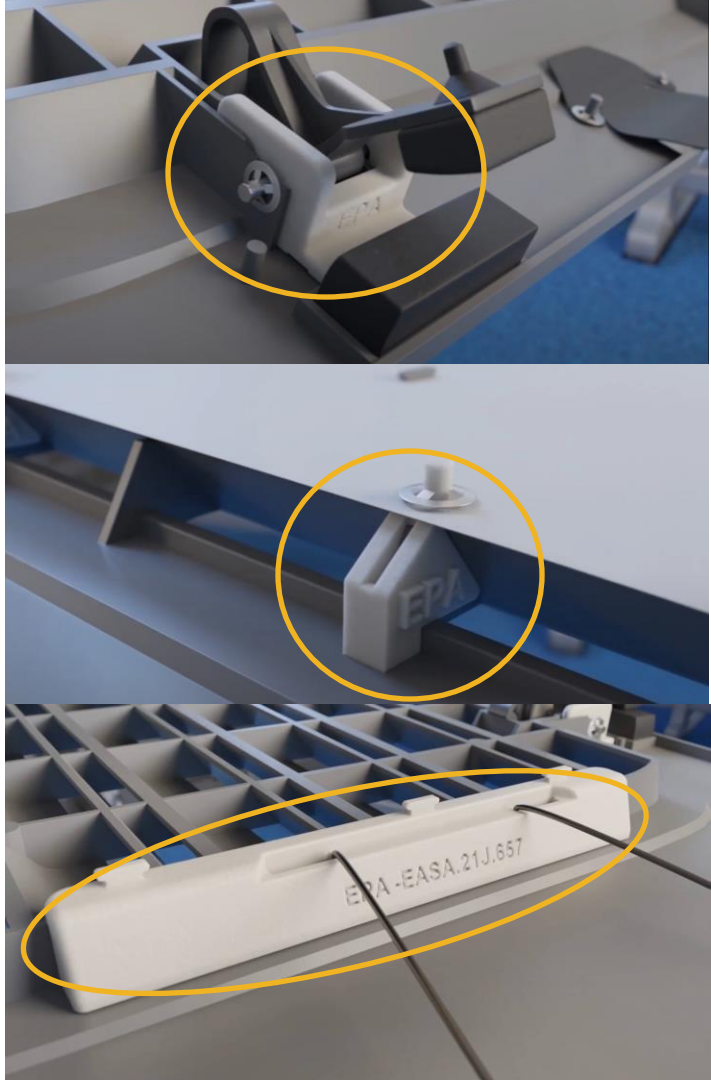

Dado Panel Repair Kit - 3D Printed

→ No replacement costs

→ Stronger

→ Minimizing AOG (Airplane On Ground)

STIRLING DYNAMICS
an expleo company



Soap Bottle holder

Quantity:
400 pcs

Technique:
Laser Sintering

Material:
PA 2241 FR

Curtain Slider

Quantity:
200 pcs

Technique:
Laser Sintering

Material:
PA 2241 FR

ATMOS UAV

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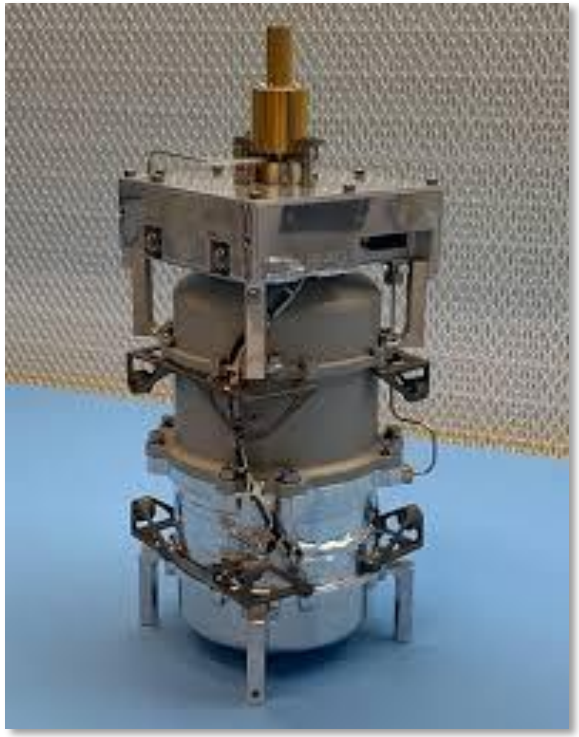
- ✓ Cable guides
- ✓ Brackets
- ✓ Housings
- ✓ End-plates
- ✓ ..

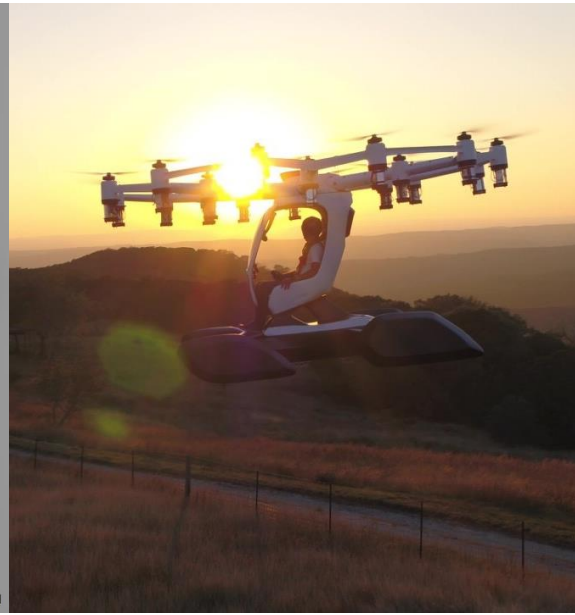
> 70 parts per vehicle

Non-disclosed

Non -disclosed

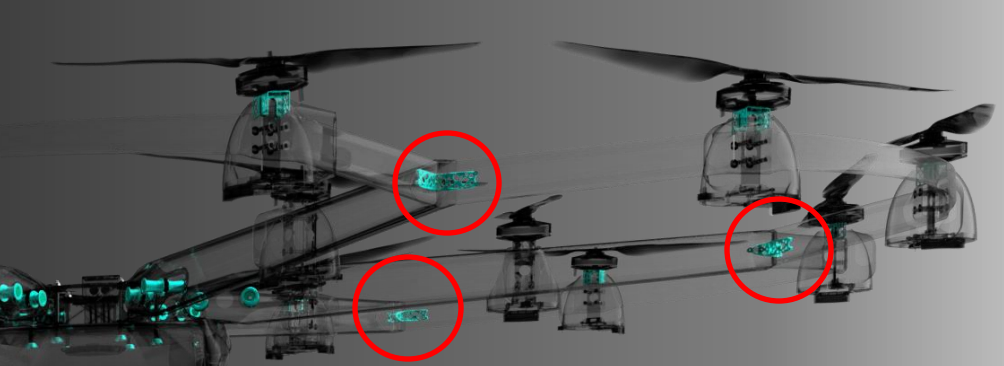
bradford space



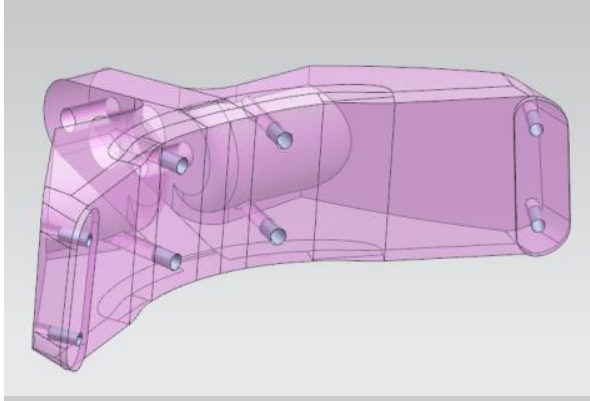


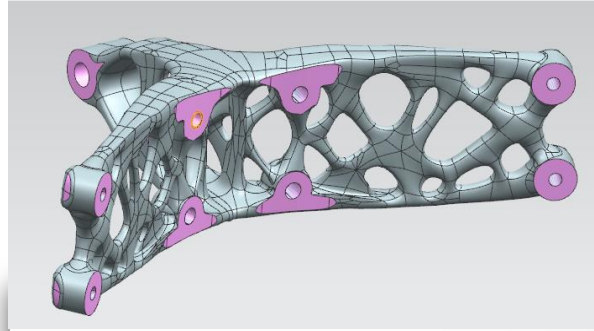
The first thing I started thinking about was how we can use new enabling technologies, new manufacturing technologies, to evolve designs really quickly. We got the Materialise team involved really early on for that reason."

- Balazs Kerulo, Chief Engineer at LIFT.



- Generative design optimized for AM
- 40% weight reduction (250g to 152g)

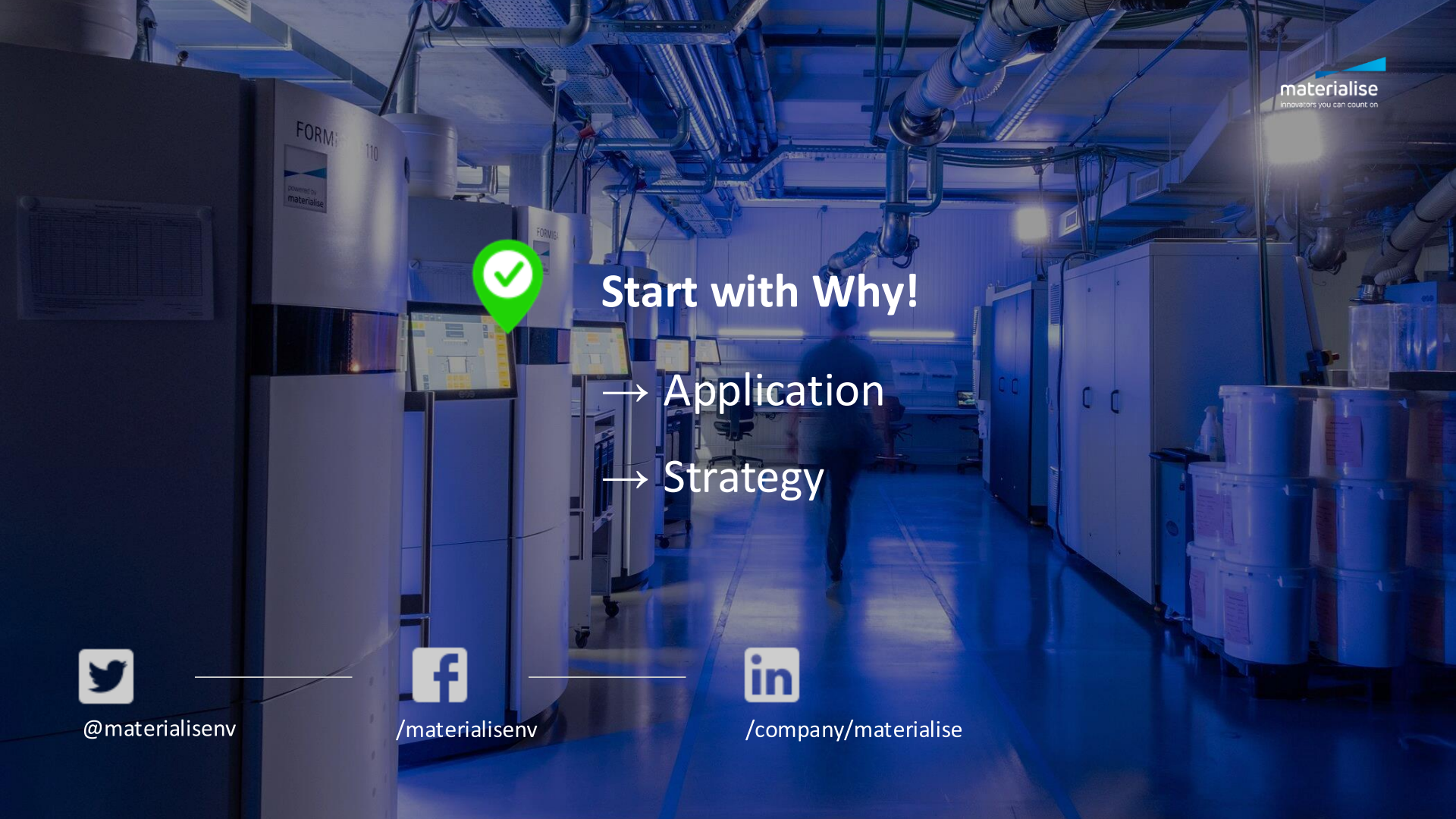




By using Additive Manufacturing:

- cc. 1.5M USD saving during development
- 10+ kgs of weight reduction per aircraft
- increased fly time through energy saving
- decreasing (months of) time on toolmaking

- maintaining equivalent level of safety!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Start with Why!
→ Application
→ Strategy
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