Are Metal LPBF Parts Overpriced? Cost Analysis of DED vs M-LPBF Parts Exceeding 300mm

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Presenter Profile

Tyson Gregory

Over the last 14 years, Tyson has worked within the AM industry with a focus on Metal LPBF and DED. One of his favorite activities during his career has been training new customers as they begin their additive journey. Having experience in both applications and sales has given him unique insight into the growth of the industry. When not working, Tyson enjoys spending time with his family and shuttling his children to their extracurriculars.

Current Cost Model Research for Metal AM

Background of Cost models for Metal AM

- Over 30 years of research into cost models for Additive Manufacturing beginning with cost models for Polymer processes
- Within the last 15 years, models based on previous research developed for LPBF
- Evidence shows that machine cost is largest influence on part cost alongside material consumption
- Smart part layout and utilization of machine time reduce cost of parts for LPBF (Piili et al. 2015)

Inexperience with cost model research for DED processes

- Sæterbø et. al.(2023), found that there had been over 18 research papers into cost models developed for LPBF and only 3 identified for DED. DED models also may split between Wire based processes and Powder based processes
- Cost models for DED can use basis of LPBF research as guidance, with many variables shared between platforms

Technology Comparison-Hardware

Metal Laser Powder-Bed Fusion

- Activities relating to build time:
- Recoater movement, Z-axis movement, Powder dispensing
- Laser scanning of parts, can focus or defocus beam spot size
- Optics move quickly across the plane, general layers of 20-60 microns with possibility of up to 120 microns in some materials
- Inert environment with gas flow thru filtration and across build plane

Laser Powder DED

- Activities relating to build time:
- Gas flows through nozzle, convergence of gas and laser beam to create weld pool
- Mechanical movements allow 3-5 axis rotation
- Optic mirrors do not move in same way as LPBF, laser movement follows nozzle and fixture movement
- Chamber may be inert or not inert; Shield gas over the melt pool

Activity Based Cost Models

Pre-Process Cost

- Part Design and setup within required software
- Machine setup; loading materials, build plates, other preparation relating to machine

Process Cost

- Machine operation
- Cost of running machine
- Amount of material consumed to build parts
- Labor needed during process
- Energy, gas, other operation and overhead

Post-Process Cost

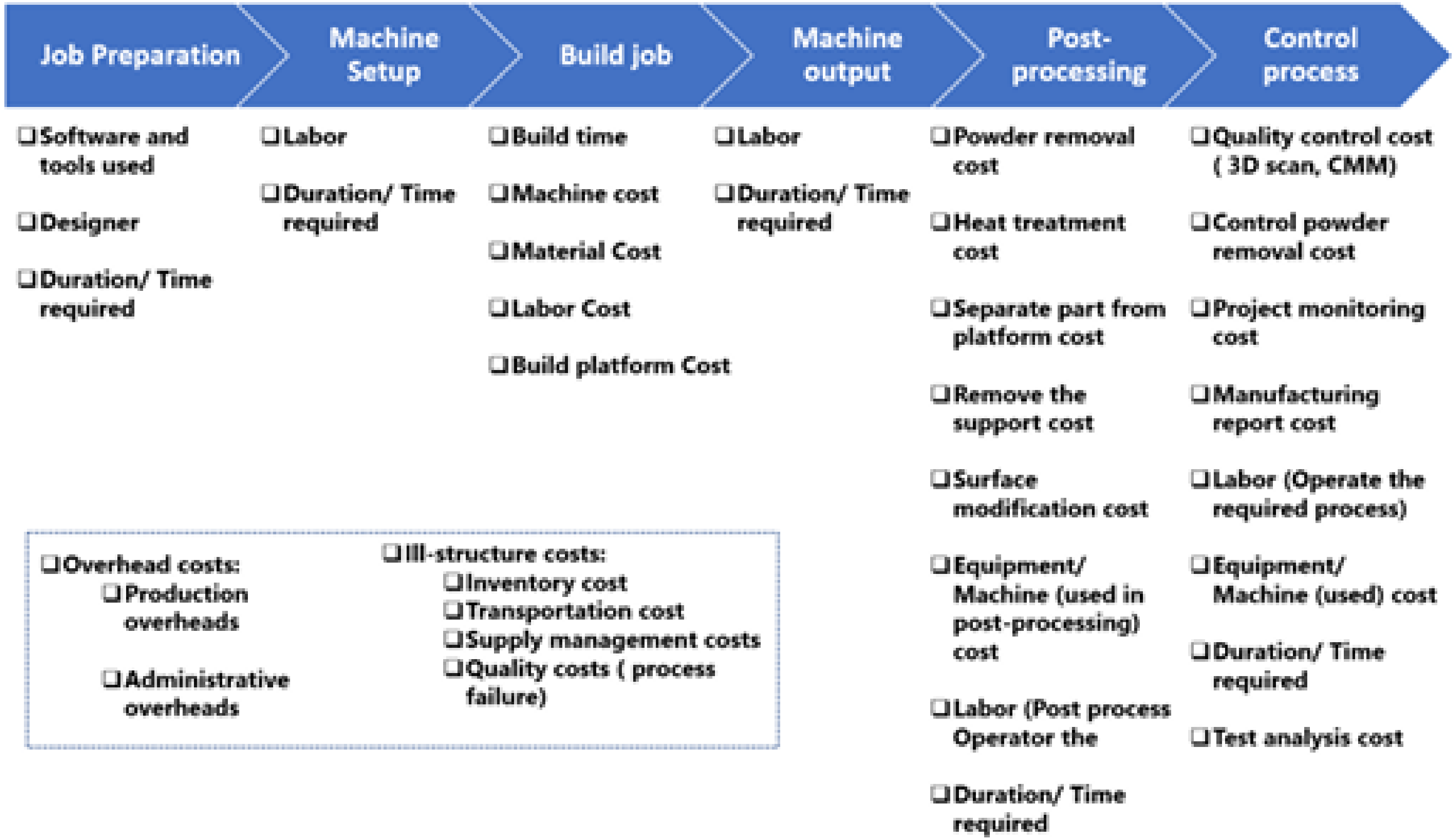
- Post machining
- Heat treat or stress relief
- Part removal
- Cleaning of machine chamber and post build activities

Assumptions for exercise

1. Machines are located in same facility and have same labor cost
2. Same Post Process requirements for Stress Relief and Surface Machining
3. Shared use of software licenses and tools where applicable

Cost models associated with ABC method generally follow the formula: Total Cost= Cost of all three activities added together.
Cost formula complexity is in each Process category

Activity Based Cost Models

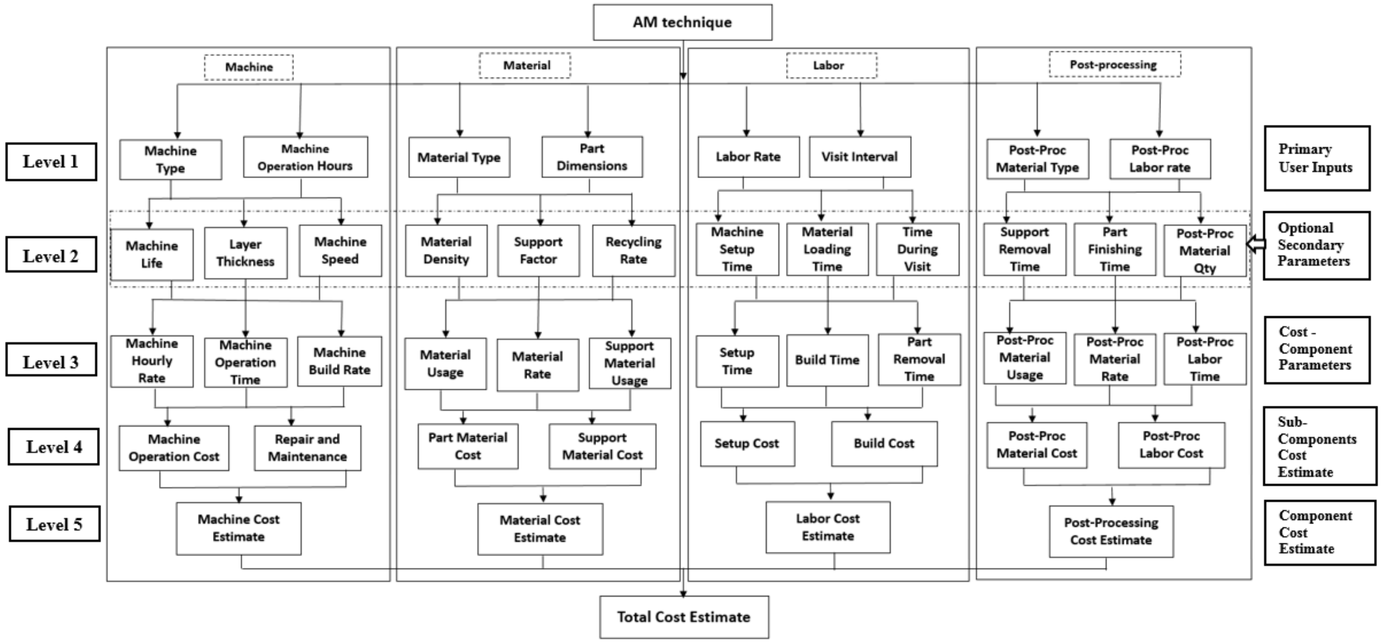


Source: Jarrar, Bernard, and Belkadi (2021)

Breakdown Approach

Overview of influences

- Uses build process of various AM platforms
- Divides Machine, Materials, and Labor into cost individual costs
- Sub-parameter can increase accuracy of cost categories



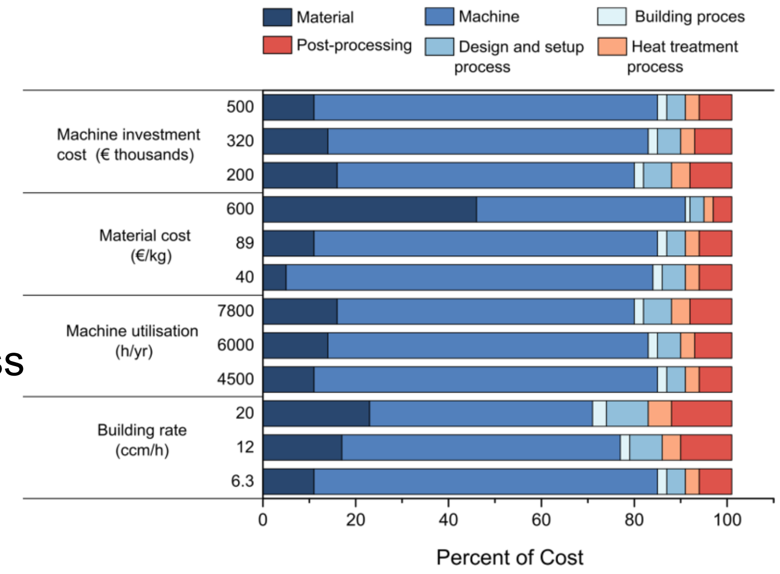
Source: Mahadik and Masel (2018)

Simplified Formula for Comparison

Focus of presentation will be on Process Cost Estimation

- Using a simplified formula for facilitating discussion of cost influences on AM process between LPBF and DED
- Part Cost= Machine Cost(Rate per hour) + Material Cost

- Reasoning: Majority of Cost Calculations point out that the two largest cost influences in Process cost are Machine investment and material cost



Source: Khanna, et al. 2024

Perceived flaws in part cost for single part example

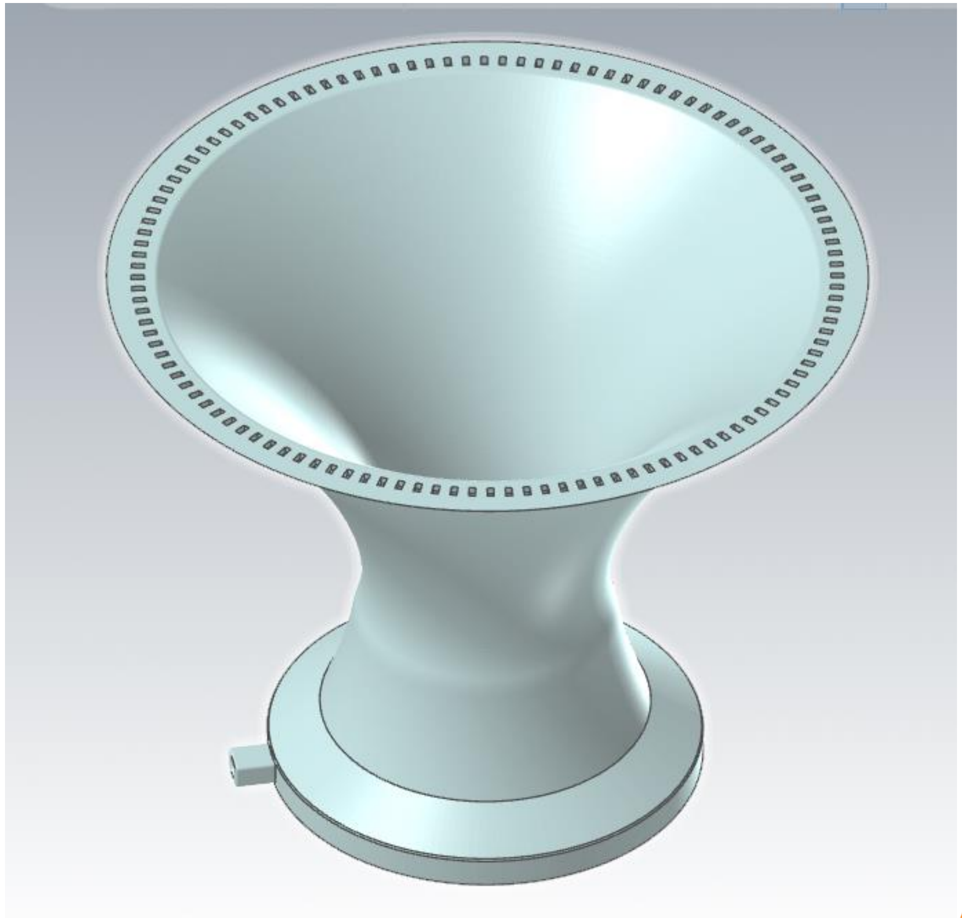
- LPBF excels at high mix of parts across build platform and utilization of Full Platform
- Even on large parts it may be optimal to also run test samples, or other parts to utilize platform space
- Platform comparison is based on only two machines
- Certain costs will not be revealed to respect OEMs
- Machine pricing may not be as accurate based on current information

Assumptions for exercise

1. Machines are located in same facility and have same labor cost and overhead
2. Same Post Process requirements for Stress Relief and Surface Machining
3. Shared use of software licenses and tools where applicable

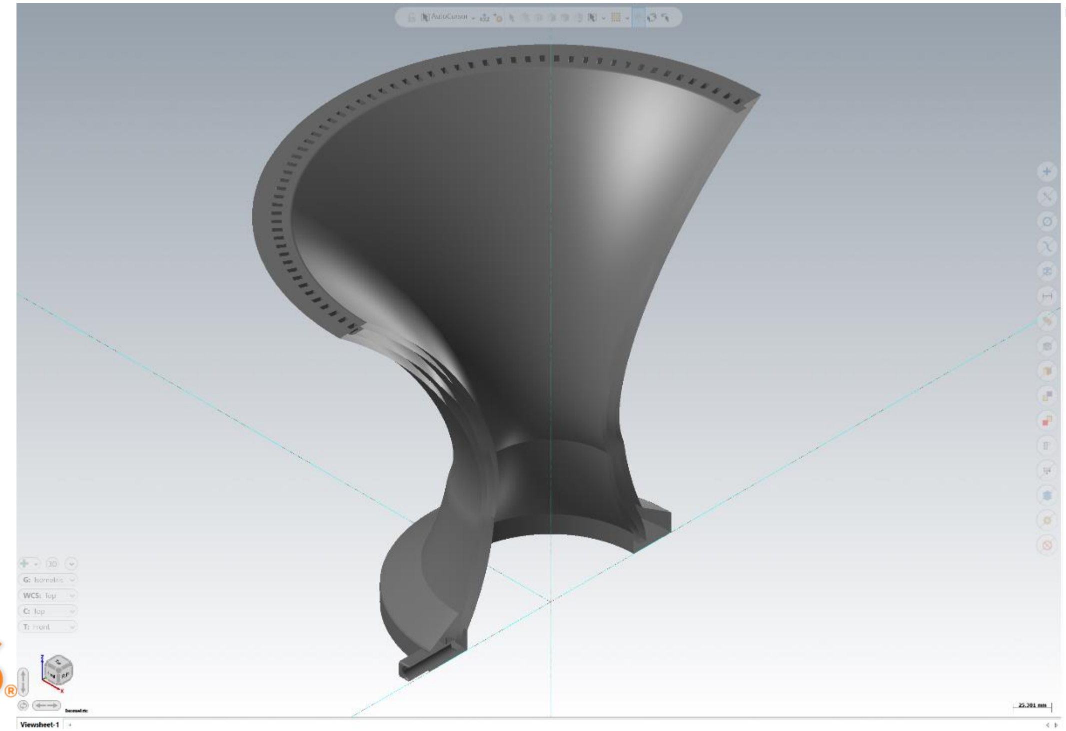
Part Design for Testing

Basic Part design based on familiar shapes



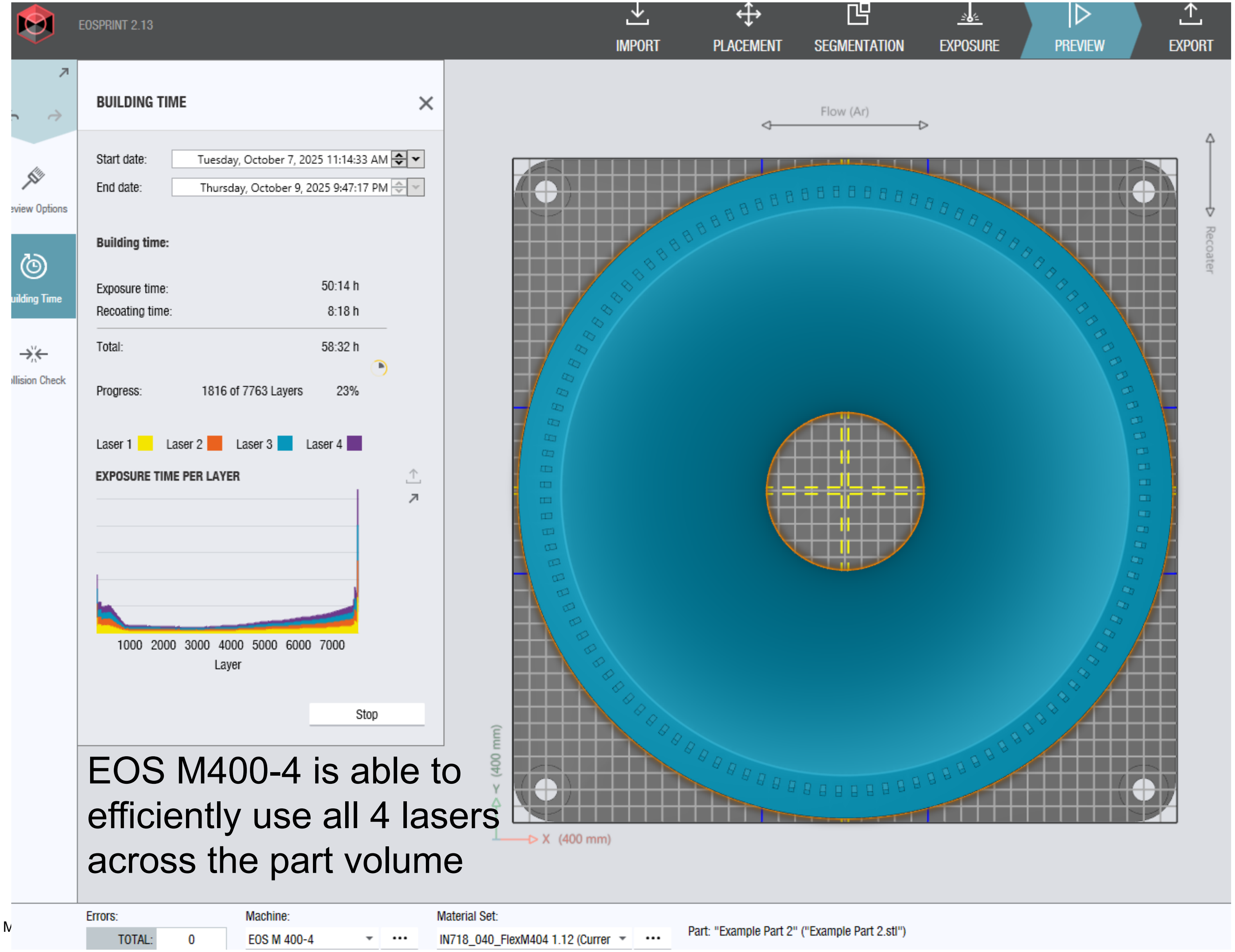
Overview of Part:

- Part Weight- Approximately 20kg. (IN625)
- Dimensions: 392mm diameter at largest section. Hollow cavity within part
- 321mm height



LPBF-Time Study

LPBF System: EOS M400-4
Total Build time: 58:32 hours
Default 40 micron IN718 parameters
Build Setup: 1 hour
Build Removal: 1 hour



EOS M400-4 is able to efficiently use all 4 lasers across the part volume

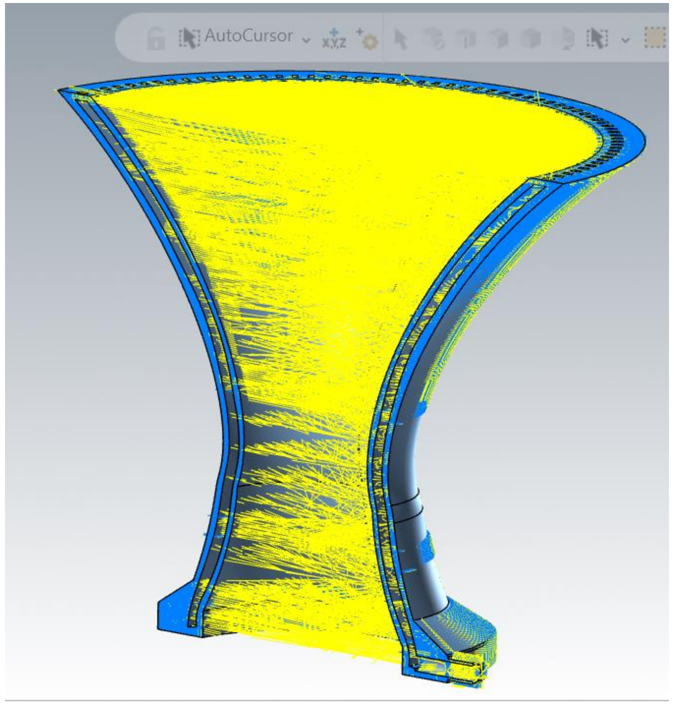
Data provided by :

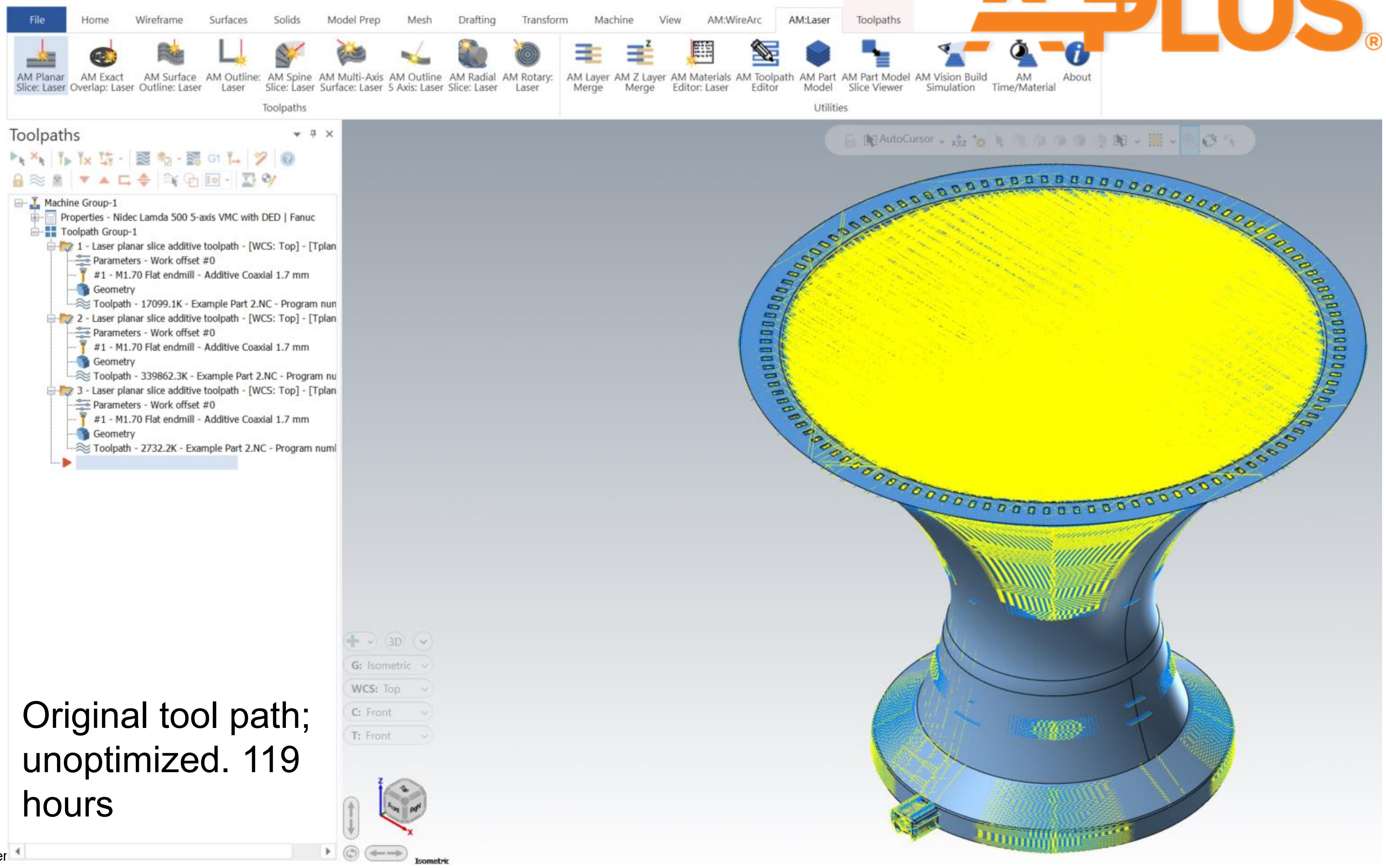
INCODEMA 3D ADDING TO THE FUTURE

DED-Time Study

Processing time may take longer to optimize tool paths. Engineer may need to prepare multiple tool groups based on part geometry.

Need to optimize movement of tool to minimize build time.

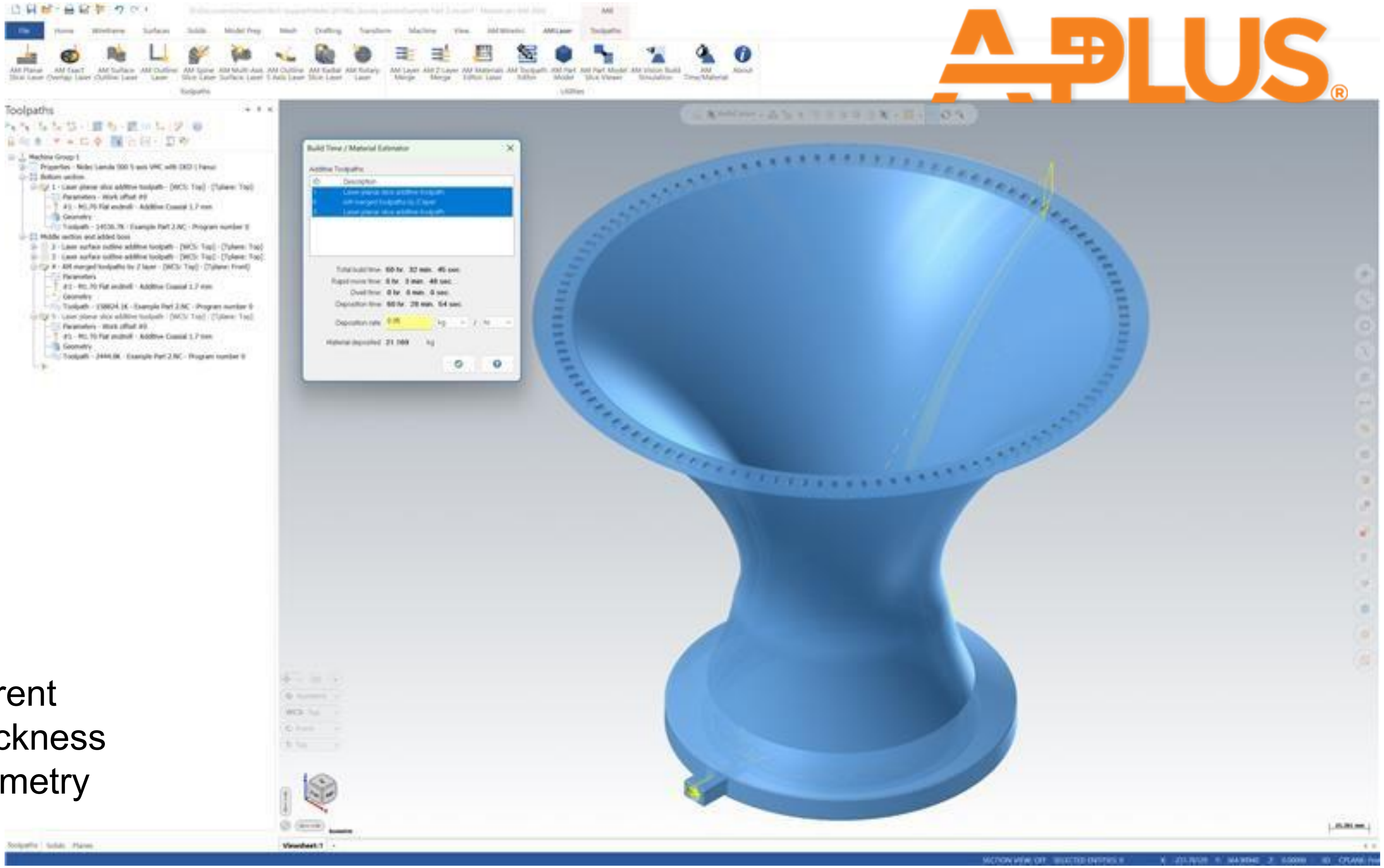


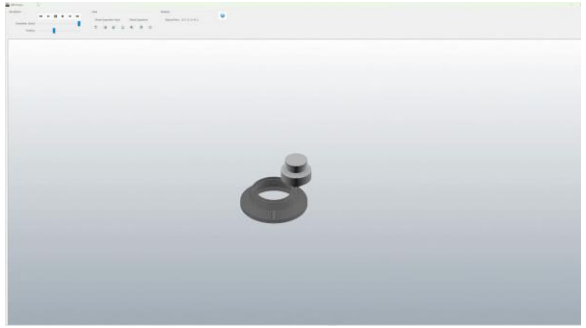


Original tool path; unoptimized. 119 hours

DED-Time Study

LP-DED System: NIDEC LAMDA500
Setup Time: 30mins
Total Build Time: 60hours 32mins
Removal time: 30mins





Three distinct tool paths for different sections of the part based on thickness and required parameters for geometry

Impactful Factors as Parts Scale

Material Costs

- Cost Calculation for Individual parts use the volume of powder used for the part
- Formulas have been developed to value powder reuse as it is recycled and refreshed.
- These calculations do not cover the cost of virgin powder supply purchased to fill the volume of the chamber in LPBF.
- Material recapture is lower in DED

Material Costs, cont.

- Initial Investment in IN625 material for example part:
- LP-DED: 50-60kg at low capture rate estimate
- LPBF: approximately 300kg needed to fill dispenser and provide coverage of 400mm platform

- LP-DED cost: $2,160; cost is consistent with virgin material once capture rate is determined
- LPBF cost: approximately $1,826 for individual part; Initial investment of virgin powder is $24,900. Powder can be reused in future builds

Gas Supply

- LPBF has a lower flow rate and recycling of Argon gas during the process
- LP-DED uses across platforms varies; some systems inert chamber, others that rely on shield gas have higher flow during process
- Gas flow for example DED includes shield gas, carrier gas. Non-inert chamber.

Simplified Cost Totals

LPBF

- Machine Rate($170) x Build Time(58.5) + Material Cost($1,826)=**<u>Part Cost($11,771)</u>**

- Notes: Material Cost based on 20kg part plus 2kg powder lost during removal and build.
- Not included: Virgin Material total investment; Labor for part removal and work needed to recycle powder and depreciated powder and refresh costs.

- Material Price for PSD 15-53 micron is $83 per kg

LP-DED

- Machine Rate($170) x Build Time(60.5) + Material Cost($2,160)=**<u>Part Cost($12,445)</u>**

- Notes: Material Cost based on 60kg; underestimating capture rate of 50%.
- Not Included; Argon Consumption as consumable cost; All powder usage is consistent virgin powder for repeat builds.

- Material Price for PSD 45-106 micron is $36 per kg

Notes:

- Machine costs are within $200,000 based on machines making the machine rate similar
- In this exercise machine rate is approximate and equalized to not reveal platform costs
- Machine estimate does not include accessories as these may be shared items based on assumptions
- Simplified costs modeled here need refined to more accurately provide cost

Notes:

- Machine Cost formula:

$$C_{Mach} = \frac{(C_I + M - S)}{T} * T_{bs}$$

- In this exercise machine rate is approximate and equalized to not reveal platform costs
- Machine estimate does not include accessories as these may be shared items based on assumptions
- Price examples are likely undervalued based on simplified exercise

Formula Source: Lamei, Z. 2014

Price Changes in Relation to Powder Cost

Ti64 Cost Increase

- Note: The build times would change based on parameters in both LPBF and DED so it is inaccurate to determine entire part cost

- Relationship of Material to costs:
- Dramatic increase in material cost when using Ti64 ($237.50/kg)
- Increase in LP-DED is lower($63/kg)

Cost to fill M400-4 chamber

- For builds using the entire chamber, approximately 175kg of Ti64 powder is necessary.
- Cost of material investment for virgin material: $41,475

- If size extended to same dimensions as larger format DED Systems price can be restrictive

Example:

- LAMDA2000 System build size:
- 2000mmx1,500mmx1,600 mm

- Ti64 powder necessary to build large parts utilizing the same footprint= Approximately 14,400kg

- Initial investment of material costs would potentially exceed 3million dollars.

Conclusions and Next Steps

Competitive Part Costs

- This exercise demonstrated a basic comparison of part pricing for 1 example part.
- Influencing factors to consider in future evaluations: Material costs of more expensive materials; Plan to use Ti64 next study
- Packing density of parts allowed based on part design; both LPBF and LP-DED
- Influence of part design on cost comparison

Future Steps to improve

- Use more in-depth method to improve cost accuracy
- Improve accuracy of machine pricing and include more OEM systems
- Partner with industry to compare cost methods they use for customers to academic models
- Different sized sample parts across platforms: limited by size of available systems
- Include Wire based processes

Acknowledgement and Citations

Special Thanks for Contributions:

- James Hockey and the team at Incodema3D
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Citations:

- Jarrar, Q., Bernard, A., & Belkadi, F. (2021). An Activity-Based Costing Model for Additive Manufacturing. In Product Lifecycle Management Enabling Smart X (pp. 492-507). Springer, Cham.
- Lamei, Z. (2014) A comprehensive cost estimation for additive manufacturing.
- Mahadik, Aditya & Masel, Dale. (2018). Implementation of Additive Manufacturing Cost Estimation Tool (AMCET) Using Break-down Approach. Procedia Manufacturing. 17. 70-77. 10.1016/j.promfg.2018.10.014.
- Khanna, N., Salvi, H., Karaş, B., Fairoz, I., & Shokrani, A. (2024). Cost Modelling for Powder Bed Fusion and Directed Energy Deposition Additive Manufacturing. *Journal of Manufacturing and Materials Processing*, *8*(4), 142. https://doi.org/10.3390/jmmp8040142
- Sæterbø M, Arnarson H, Yu H, Solvang W D, Expanding the horizons of metal additive manufacturing: A comprehensive multi-objective optimization model incorporating sustainability for SMEs, Journal of Manufacturing Systems,Volume 77, 2024, Pages 62-77, ISSN 0278-6125, https://doi.org/10.1016/j.jmsy.2024.08.026.

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Thank you.

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