Engineering with a difference

Feasibility study of additive manufacturing (AM) center of excellence in Finland

Etteplan AMO Team 20.11.2019



AM in Finland

- Currently, there are none AM service bureau with needed equipment and competence to provide manufacturing services for critical applications in Finland.
- Finland is missing innovation center similar to AMEXI in Sweden
- There is an opportunity for a new 3D printing service bureau or consortion with credibility in Finland

HX program Industrial value

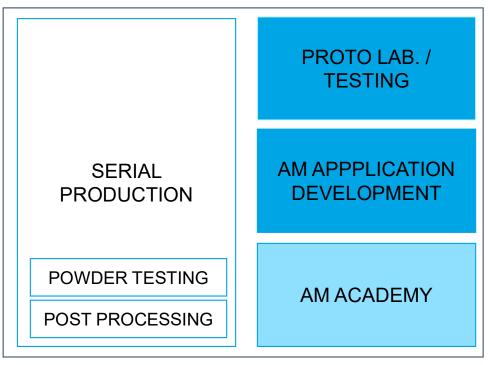
- Finland will replace its Hornet fighters in 2021, and the bidding process for the program is now ongoing.
- The primary objective of industrial participation is to ensure the military security of supply of defense industry products from Finnish and foreign manufacturers and the availability of critical technology in any circumstances. The secondary objective is to ensure the development of Finnish technology and competence in the future as well.
- The total value of the Industrial participation (IP), is approximately EUR
 2-3 billion.



Overview

- HX-program opens an opportunity to create industrial-scale additive manufacturing expertise in Finland, which serves and develops Finnish defense and security industry expertise, and also brings technical expertise to the use for other industries
- The AM Center of Excellence can accelerate the industrial adoption of additive manufacturing and help bring a new generation of innovative engineers and products to the market. The excellence center will fill the gaps in additive manufacturing knowledge and this is what Finnish manufacturing needs to take full advantage of the new technology.
- Companies in HX AM Consortium need to commit to do what it takes to reach the highest level in AM, production of critical aerospace components in collaboration with others and with whole Finnish AM ecosystem.

Additive Manufacturing Center of Excellence (AMCE)





Necessary steps in creation of a qualified component created by LPBF

full understanding 4. Post 1. Design 2. Build prep processing Visual · Build volume limitations Radiography or CT Self-supporting design File formats Metallurgical Design for · Powder & support removal Model Raw part · Support integration Dimensional **LPBF** Surface finishing inspection processing Platform layout Analyzing build data requirements Part orientation Part & lot acceptance · Lot acceptance articles · Material properties & Stress relief Structural Thermal requirements • HIP assessment processing · FEM, CFD, etc. Manufacturing Solution treat or anneal Precipitation age Consequence of failure Machining Build complexity · Quality system Part Finishing · Bead/grit blast Service classification · Structural safety Qualification operation Peening bureaus margins Honing/polishing Quality control specs Etching · Certification & analysis Cleaning Environmental control · Integrity of solid Model quality · Model checking Chemistry Materials Version control Mixing 5. Certification Reuse limitations Planning for all Dimensional · Platform selection Component operations from concept Surface texture · Recoater selection development to part **Build lot** Final part PT, ET, UT, CT Build parameters Final Written prior to plan execution · Lot acceptance test & result · Build data collection inspection & proceeding to build · Process certification records Chamber environment acceptance Proof testing Restart policies Packaging · Post-build powder removal



Levels of AM Quality - LAMQ

Extremely critical component (aerospace,nuclear)

Critical component – needs classification / certification (PED/oil & gas etc.)

Critical component with dynamic loads – Fatigue!

Data sheet values should be met

Part needs to be made out of metal material

Finnish AM service bureaus



Typical industry needs

Military needs

Research and Machine Base in Finnish Research Centers

- Large number of good research on-going
- Metal AM machinery in academia is distributed well geographically and still increasing
- Level of AM education varies in academia
- More education needed to universities and technical colleges for national spreading of AM
 - Design rules
 - AM techniques
 - Hands-on experience
 - Exercises & operating the machines

Research Center	Location	Machine	
Aalto University	Otaniemi	EOS M290	
EOS Finland Oy	Turku	Too many to list	
LUT	Lappeenranta	EOS M270, EOS M290	
University of Oulu in cooperation with Nivalan Teollisuuskylä	Nivala	SLM 280HL	
JAMK University of Applied Sciences	Jyväskylä	LPBF (planned for 2020)	
Savonia University of Applied Sciences	Kuopio	Metal X (2019), LPBF & DED (planned for 2020)	
SASKY	Sastamala	SLM 125HL	
Turku University of Applied Sciences	Turku	LPBF (planned for 2020)	
TUT	Tampere	DED (wire-feed)	
University of Vaasa	Vaasa	LPBF (planned for 2020)	
VTT	Otaniemi	SLM 125HL	



Commercial Metal AM in Finland

- Top level quality print service not available
- Laser Powder Bed Fusion (LPBF) only
- Limited production capacity
 - 5 medium sized metal AM machines in whole of Finland
- Advanced post processing not existing in Finland
 - Hot Isostatic Pressure (HIP)
 - Automatic support removal (Hirtisation)
 - Improved surface finishing (Hirtisation, MMP, abrasive honing..)
- So far three Finnish companies publicly announced metal AM machine acquiring

Service Bureau	Location	Machine	
3D Formtech	Jyväskylä	EOS M290	
3D Step	Tampere	SL 280HL Twin (400 W)	
Delva	Hämeenlinna	EOS M270, EOS M290	
HT Laser	Keuruu	SLM 280 2.0 Twin (700 W)	
Materflow	Lahti	Concept Laser M1, SLM 280HL	

Company	Location	Machine	
Lillback Powerco	Härmä	3D Systems	
Valmet Oyj	Sundsvall, Sweden	EOS?	
V.A.V. Group	li	SLM Solutions	



Service bureaus annual theoretical volume



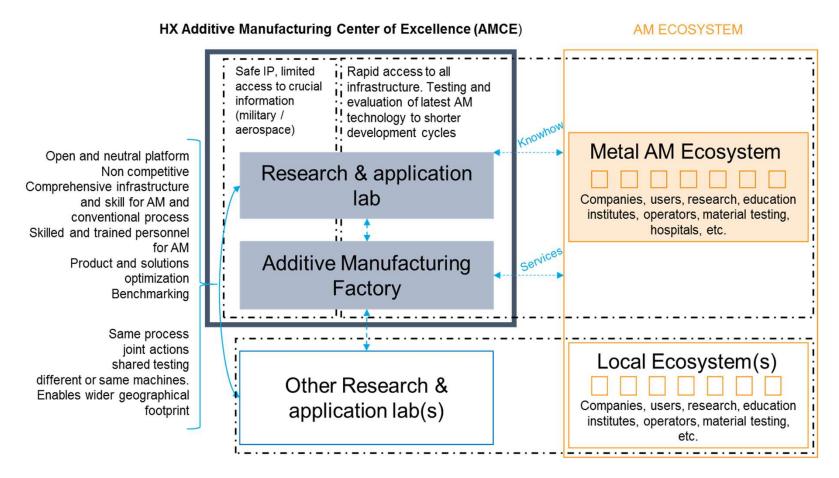




Example components with detailed information on their size, volume and print time.				
Component	Bracket	Piston	Block	
Size	140 x 120 x 85 mm	Ø50 x 56 mm	Ø185 x 170 mm	
Volume	115 cm ³	57 cm ³	2180 cm ³	
Components per one build	6	13	1	
Estimated print time per piece	13 h	4,5 h	180 h	
Potential annual volume	420 pcs	1220 pcs	30 pcs	
combined theoretical production volume that Finnish metal AM service bureaus	3336 pcs.	7500pcs.	258 pcs.	

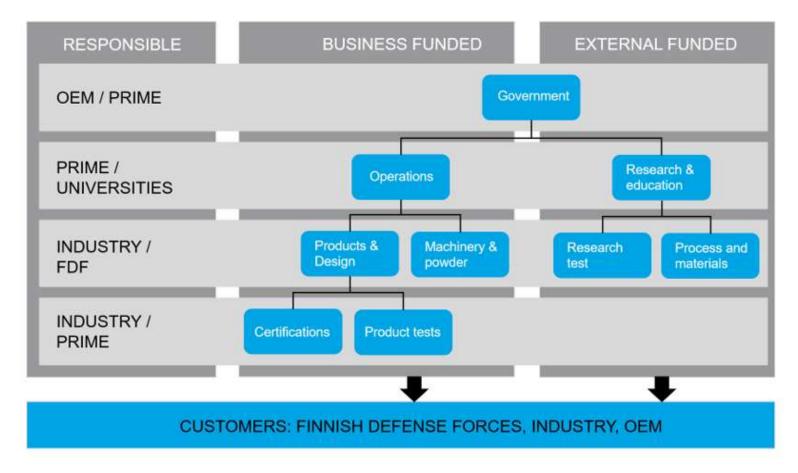


Consortium role





Overview of roles



Overview of roles in HX AMCE consortium.(Patria Aviation Oy, 2019)



Benefits for Finland

- Increases competitiveness of Finnish companies
 - Increased AM know-how leads to new innovations
 - Better and more cost-competitive products
 - Increased creation of added value
- Creates foundation for completely new industry in Finland
 - Opportunity for Finland to be an early adopter of AM
 - High-technology manufacturing increased creation of added value
 - Huge export opportunity due to the nature of AM
 - Lost traditional factory jobs can be replaced by new AM factory jobs
- New high-paying jobs created
- Provides excellent facilities for high level research work
- Crucial contribution to security of supply



