Welcome to the

THE NEXT LEVEL

of Additive Manufacturing.

Positioning Metal Additive as a Second Source for National Security Needs

April 10, 2025

Abstract

As geopolitical instability increases worldwide, the US and our allies are expending inventories while building stockpiles as risk reduction for future conflicts. The DoD supply base is increasing production rates to meet the warfighter demands. However, capital equipment choke points in the casting and forging supply chains are preventing OEMs from meeting the forecasted demands. AM suppliers with existing machine capacity and material specifications can be a second source to critical forging and casting suppliers who cannot meet increased demands. Presentation discussion will focus on what key technical capabilities AM suppliers must have in place to rapidly support the OEM supply chain as a second source.

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Nicholas Mayer is the Vice President, Product Management of Norsk Titanium. Prior to joining the Company in 2016, Nick held management positions within the advanced development divisions of Northrop Grumman, Aerojet Rocketdyne, and Lockheed Martin. His background focuses on program management of developmental systems and capture of advanced aerostructure programs.

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Geopolitical Environment is Volatile

- Multiple regional conflicts have endured, draining US and allied munition stockpiles - $17B appropriated for replacement
- Near-peer threats continually influence national strategy
- Recent munition usage exceeds annual production rates
- Expect the DoD to signal a demand increase to industry with multiyear contracts and resulting cash infusion
- Defense industrial base will shift long-term planning and investment to replenish its depleted munitions stockpiles and prepare for the challenges ahead

How Is Industry Preparing For an Increase In Production Rates?

- Defense contractors are expanding their production facilities, hiring and training workers, and modernizing their processes
  - LMT opened a new missile production facility in June 2022 with a fully robotic paint line and other automated processes to accelerate missile production and increase output
  - RTX expanded its internal test capacity, with new facilities near its Tucson, Arizona, production line and at the Redstone Arsenal test facility
- Castings & Forgings have been identified as a critical choke point in the supply chain, creating a national security need
- Significant capital investment to increase legacy capacity and reduce lead times
- Concurrently, additive is being explored as an alternative

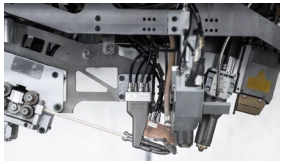
Metal Additive 'Toolbox' Can Produce Across the Part Spectrum

Small & Intricate → **Large Structural Components**

Laser Powder Bed Fusion / DMLS

Binder Jetting

Blown Powder



Electron Beam Melting / Directed Energy Deposition

Low Deposition Rate → **High Deposition Rate**

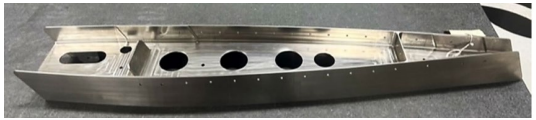
What Is Required to Act As A Second Source?

- Capacity Constrained Component
  - There must be an urgent need to warrant implementation costs
- Material Specifications
  - Sufficient material properties for a 1:1 replacement
  - Repeatable Process
- Industrial Capability
  - Cannot create a ‘new’ bottleneck
  - Multiple machines at multiple locations

First DED Additive DoD Prime Specifications in Place

- Northrop Grumman Has Approved Multiple Suppliers
  - Multi-year allowables effort
  - PA-DED Specification published
  - Norsk Titanium approved and on ASL
- General Atomics procuring large DED structural applications
- Additional primes implementing MMPDS based specifications
- Inconel 625 development with US Navy
  - Characterized initial material properties
  - Continuing to refine process for nickel superalloys
  - Moving into more complex shapes
- Other alloys in development

General Atomics Primary Structure



Northrop Grumman RPD® Component

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What Was Required For Norsk To Enter the Defense Supply Chain?

Regulatory

- FAA
- EASA
- AFRL
- NAVAIR
- BATTELLE

Commercial Aerospace

- BOEING
- RTX
- SAFRAN
- AIRBUS

Industrial

- hitech
- ASML
- equinor

Defense Primes

- GENERAL ATOMICS AERONAUTICAL
- RTX
- NORTHROP GRUMMAN
- BOEING

Industry Committees

- SAE INTERNATIONAL
- Nadcap
- AIAA SHAPING THE FUTURE OF AEROSPACE
- MMPDS
- ASTM INTERNATIONAL

Leveraging Production In Commercial Aerospace

7 RPD® printed parts on every Boeing 787 Dreamliner:

GKN LEONARDO SPIRIT AEROSYSTEMS

Norsk Titanium sells parts to Boeing through tier-1 suppliers

Direct replacement for forged titanium parts on Airbus programs

AIRBUS

- First Parts qualified December 2023
- Recurring production underway

Additive Capacity Must Be at Industrial Scale

- Primes must invest to move additive from the technology development and prototype environment into industrial scale production
  - Frozen manufacturing process compliant with DoD requirements
- Significant capacity is needed to provide a viable alternative to legacy manufacturing processes
- US sourced raw materials is an imperative
- Must minimize (or eliminate) post processing tailored to the additive process

Implementing Additive As A Second Source

- Prime contractor specifications must maximize additive applications, the additive supply chain must be able to insert products into the existing manufacturing flows
- Additive industrial base can market products as ‘alternative raw materials’
  - Prime contractor drawings call out ‘make from’ casting, forging, or RPD® material
  - Supply chain can then source from multiple suppliers optimizing lead time and overall costs
  - Removes the sole source additive risk
- 10-20% of the overall demand in enough to prove additive capability and fund a viable alterative supply base

THANK YOU!

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