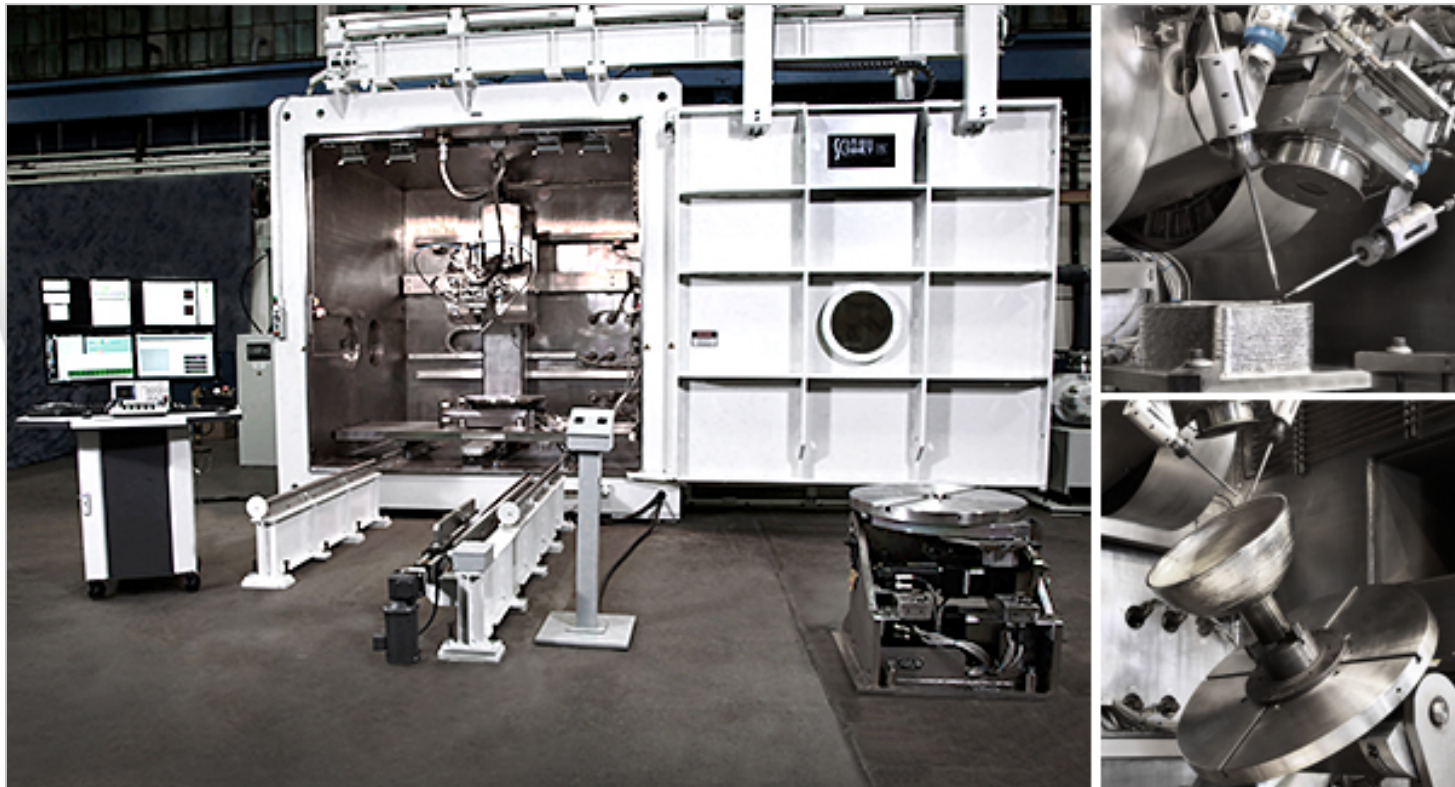


## eBook

# How to Capitalize on Industrial Metal 3D Printing with Sciaky's Electron Beam Additive Manufacturing (EBAM®) Technology



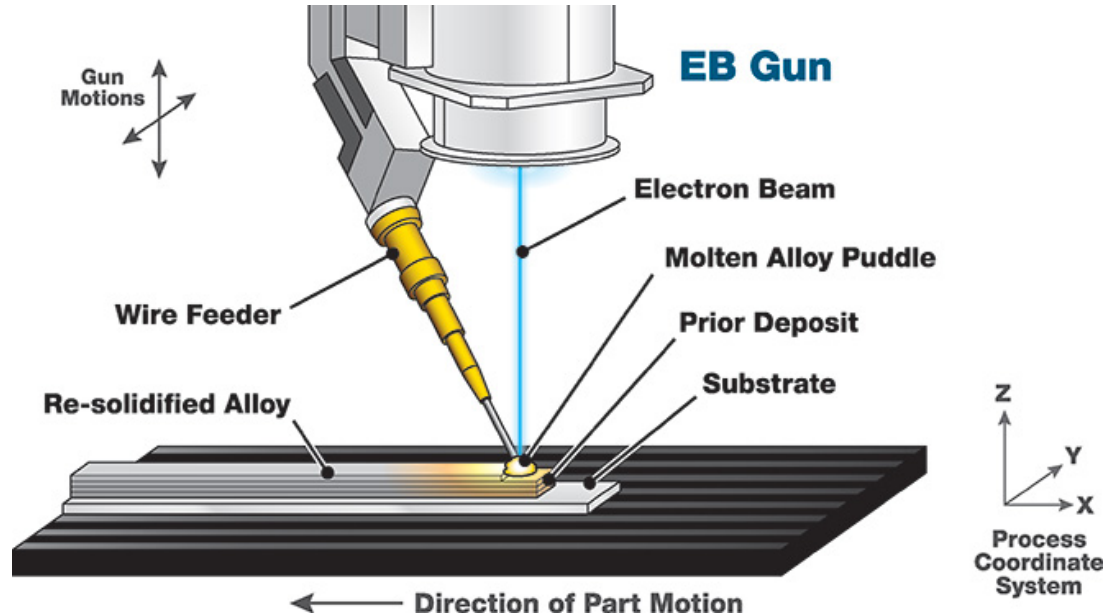
# Contents

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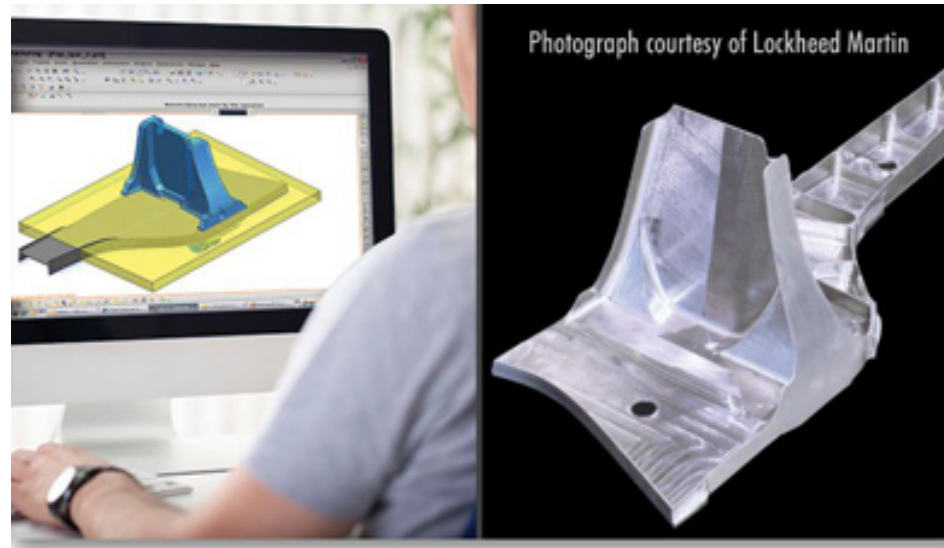
# EBAM<sup>®</sup>: How It Works

The EBAM process utilizes wire feedstock and an electron beam heat source to produce a near-net shape part inside a vacuum chamber.



# EBAM<sup>®</sup>: How It Works

Starting with a 3D model from a CAD program, Sciaky's electron beam (EB) gun deposits metal, via the wire feedstock, layer by layer, until the part reaches near-net shape.



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# EBAM<sup>®</sup>: How It Works



Once the part reaches near-net shape, it undergoes finish heat treating, machining and inspection.



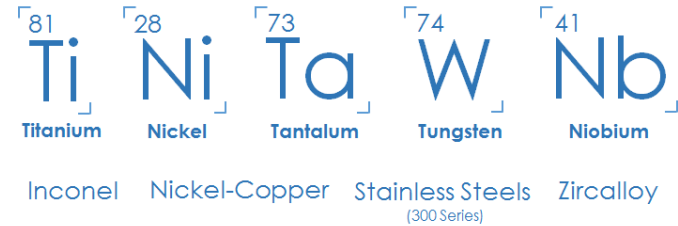
# EBAM®: Part Candidates

## Examples of EBAM Parts:

As a rule of thumb, EBAM parts should be at least 8 inches in length



## Autogenously welded metals:



## Parts not suited for EBAM:

Tiny, lightweight parts that fit in your hand.



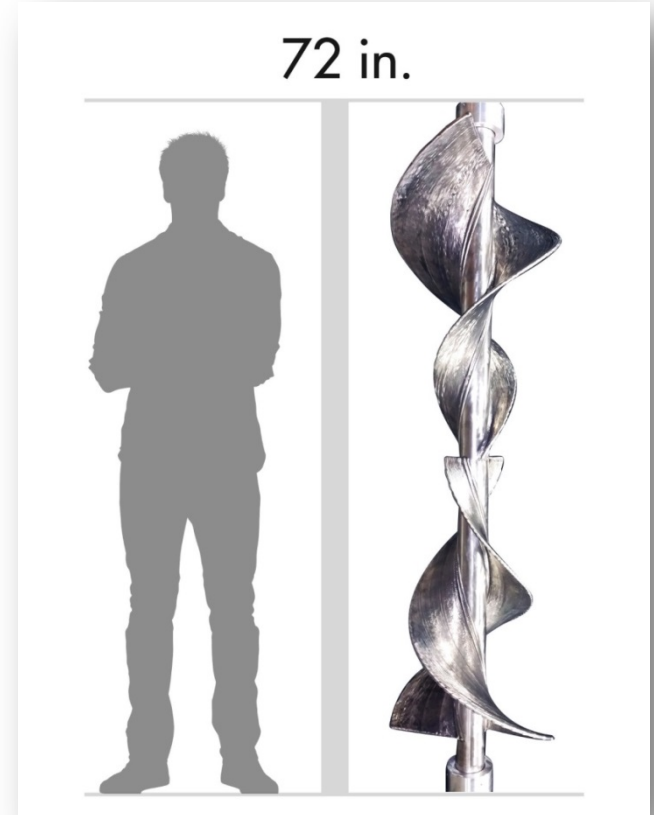
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# EBAM<sup>®</sup>: Part Scalability

EBAM can produce high quality, large-scale metal structures, up to 19 feet in length, with very little material waste.



Courtesy Lockheed Martin



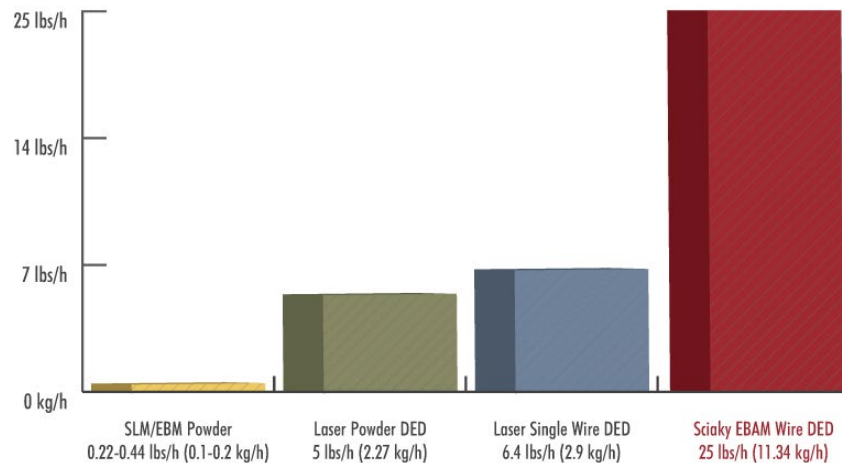
Titanium Screw Structure  
Printed in 20 Hours



# EBAM<sup>®</sup>: Deposition Rates

Gross deposition rates range from 7 to 25 lbs. (3.18 to 11.34 kg) of metal per hour, depending upon the selected material and part features.

Metal Additive Manufacturing Deposition Rates





# EBAM<sup>®</sup>: Materials

Autogenously weldable metals are the best material candidates for EBAM. They include Titanium, Tantalum, Tungsten, Niobium, Stainless Steels, Aluminum, Nickel/Super Alloys and many other weldable metals available in wire feedstock.

Titanium 22 <b>Ti</b>	Tantalum 73 <b>Ta</b>	Tungsten 74 <b>W</b>	Niobium 41 <b>Nb</b>	Aluminum 27 <b>Al</b>	Nickel 28 <b>Ni</b>
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# IRISS<sup>®</sup>: Interlayer Realtime Imaging & Sensing System

Adaptive Thermal Control by way of real time molten pool measurements

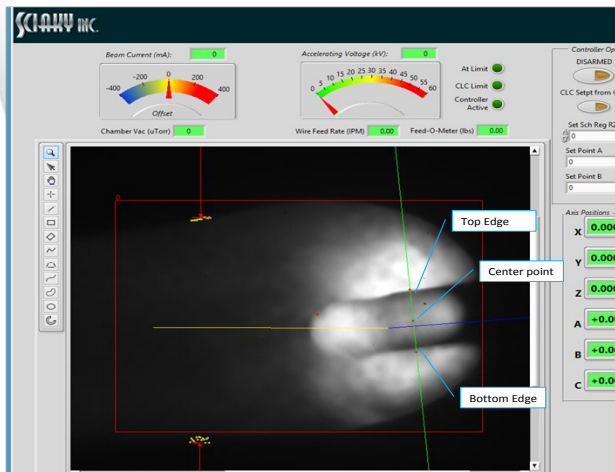
Process Benefits with IRISS Closed-Loop Control:

- Bead Geometry Uniformity
- Consistent Microstructure
- Consistent Mechanical Properties
- Consistent Chemistry
- Automated and adaptive Real-Time Process Controls
- Automatic Process Variable Acquisition and Recording



Without CLC

With CLC



**IRISS<sup>®</sup>**  
Interlayer Realtime  
Imaging & Sensing System

**SCIAPY INC.**

# IRISS<sup>®</sup>: Same part, time after time.

*“Manufacturers will be able to monitor and manage, in real-time, every single step of the metal deposition process to ensure the final product will meet their — and their client’s — highest standards.”*

- 3DPrintingIndustry.com



*“We know more about the creation of each additive part than we can reasonably know about parts created other ways... In the future, the data could be marshaled to streamline the process to a degree that goes well beyond just replacing one metalworking operation with another.”*

- **Slade Gardner**, Ph.D. and Former LM Fellow  
at Lockheed Martin Space Systems  
(AdditiveManufacturing.Media)



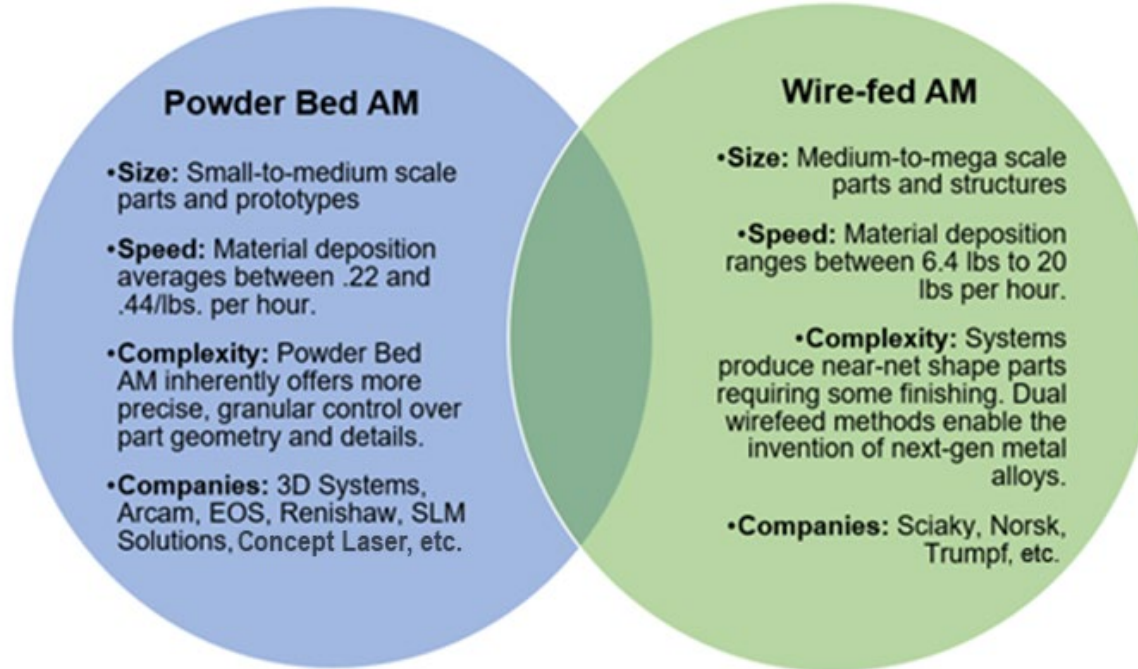
# Ti 6Al 4V Static Properties

High Level Comparison (Z-Direction)				
Method	Group	UTS (ksi)	.2% YS (ksi)	% Elong
EBAM (2017)	Stress Relief HT (Custom Wire)	137	128	12.0
EBAM (2017)	Water Quench HT (Custom Wire)	150	134	9.2
EBAM (2016)	High Temp HT (Custom Wire)	131	112	18.1
EBAM (2016)	Stress Relief HT (Standard Wire)	135	122	14.7
Forging	Handbook Value Ti64 AMS 4928 (Forging, minimum)	130	120	10.0
Mil-5 (Plate)	Handbook Value Ti64 AMS 4911 (Plate, minimum)	130	120	10.0
SAE Aerospace	Handbook Value Ti64 AMS 4999 (Additive Mfg. Ti-6Al-4V)	124	111	5.0

EBAM values based on average measurements available to date, and do not represent a full allowable basis study. Measurements are z-axis values.



# EBAM®: Powder vs. Wire



*"EBAM may not have the same advantages when it comes to small complex geometries that powderbed systems offer, but this is made up for in terms of size, speed, and flexibility, making it an important technology for industries like aerospace, where large-scale, 3D printed parts may play a role in the future of aircraft production." - 3DPrintingIndustry.com*

*"Sciaky use[s] a wire-feed electron-beam process that is similar to welding layers of metal in a vacuum. The welding approach prevents the formation of slag and corrosion, allowing for better part density and strength." – Machine Design*



# SCIANKY INC.

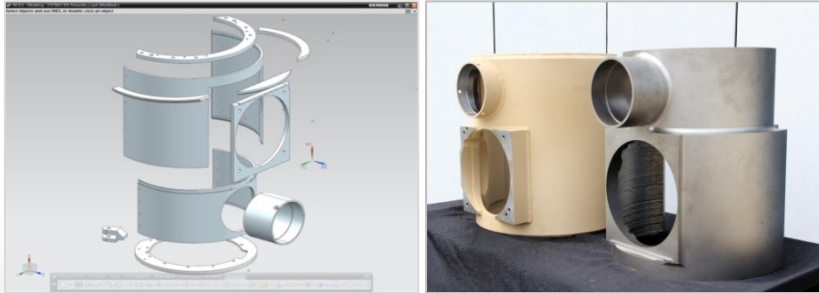
The only large-scale metal AM machine producer in the world  
with parts in use for land, sea, air, and space.



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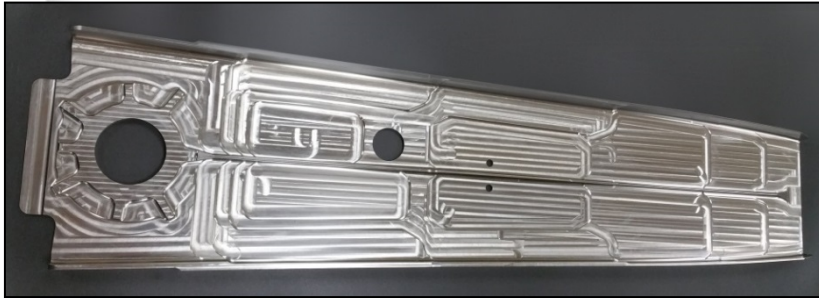
## Land Combat Vehicles



## Sub Sea Vessels



## Airframe Components



## Satellite Propulsion Systems



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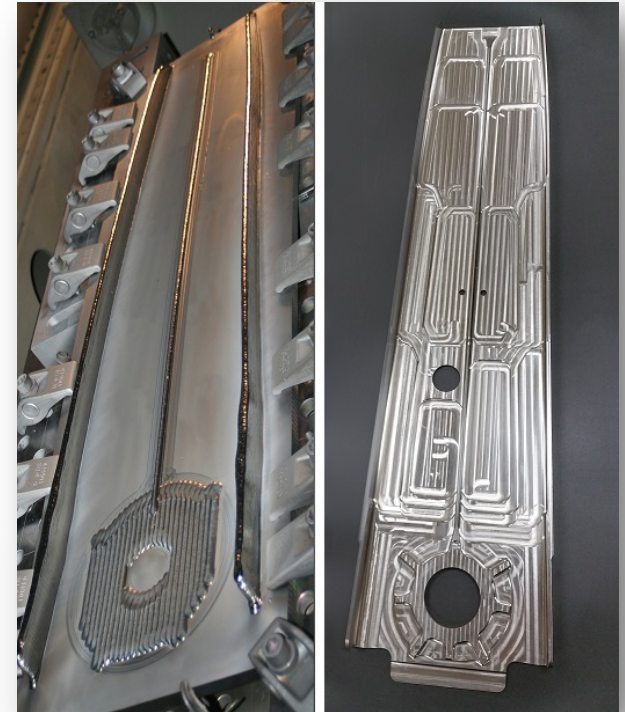
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[sciaky.com](http://sciaky.com)

# Case Study

- Business case: Reduce cost of Titanium Airframe structures. 30%-40% typical
- Qualification program is underway
- Material studies and demonstration parts are in production and test
- EBAM<sup>®</sup> equipment is located at Customer
- Currently working with Customer's Suppliers



## Commercial Aircraft Manufacturer



Titanium Airframe Structure  
1500mm x 400mm





# Case Study

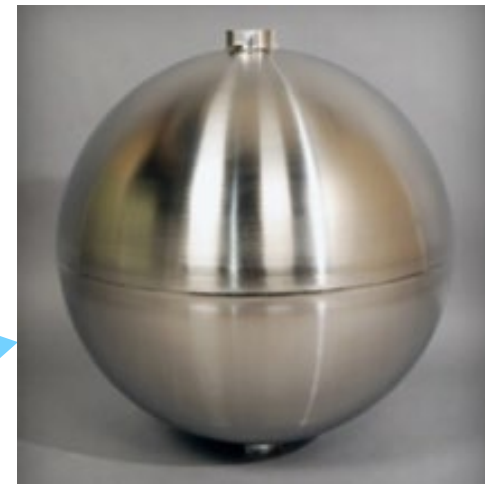


Traditional Manufactured Tank:

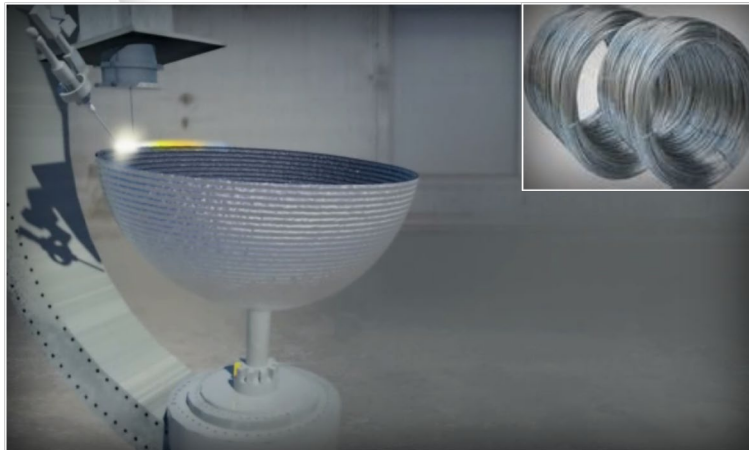
18-21 months / \$330-375k



32-46" Tank  
\*5 tanks per vehicle



Future AM Tank: 5-6 months / \$170k



Per Vehicle*	Cost	Time
Traditional Mfg	\$1.875M	21 months
Additive Mfg	\$850K	6 months
Savings	\$1.025M / 55%	15 months / 66%

# Case Study

**LOCKHEED MARTIN**  
SPACE SYSTEMS







Lockheed Martin  
Test Lab


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# Case Study



CHALLENGE	SOLUTION	RESULTS
 maintain repeatability, accuracy & reliability	 R&D material studies	80% time reduction to manufacture a tank
 cut lead time	<b>EBAM</b> Electron Beam Additive Manufacturing	55% less cost
	<b>IRISS</b> Interlayer Real-time Imaging & Sensitive System	75% reduction in waste



# Case Study



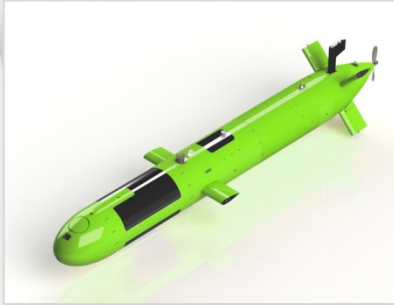
## Aircraft Part Manufacturer

### New Hybrid Forging Process

- Use traditional forging process on AM produced metal preforms
- Reduces forging tooling cost and lead time
- Reduce Press utilization
- Produce near-forging metal properties and microstructure



# Case Study



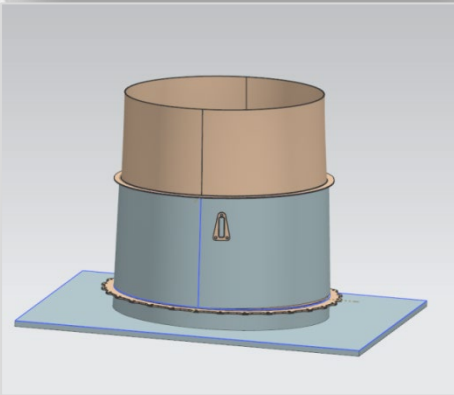
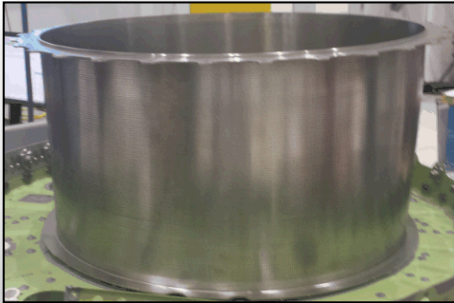
## Titanium Variable Ballast (VB) Tank

- Previous supplier (forging service) abruptly closed
- ISE researched options and discovered that Sciaky did similar work for Lockheed Martin Space Systems with its EBAM® 3D printing process
- Sciaky reduced production time from 16 weeks to 8 weeks
- EBAM part passed the same vigorous qualification tests as the previously forged part
- Subsequent parts can be produced and shipped inside of one week, at roughly half the cost of the original forging



# Case Study

## Small Business Jet Manufacturer



20 in. diameter | 28 in. length

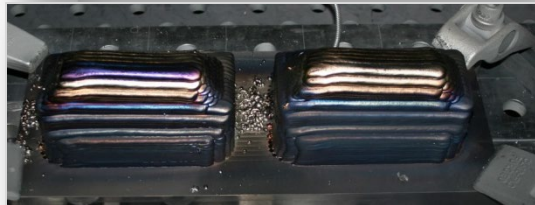
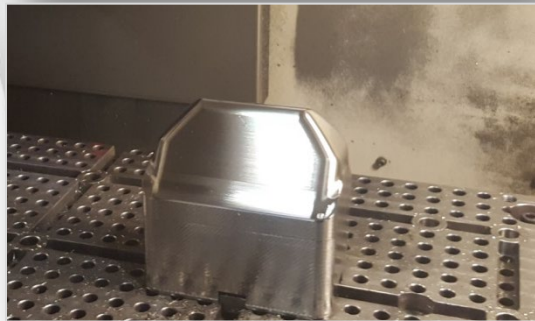
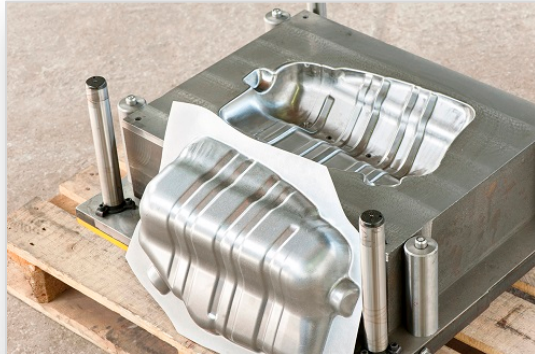
### Engine Inlet Structure

- The function of the part was proven in multiple flight tests
- New Product Development required one ship-set in 3 weeks – EBAM® Delivered!
- Traditional means included 6-parts fastened together
- The functional performance of the part improves with a one-piece construction



# Case Study

## Electric Vehicle Manufacturer



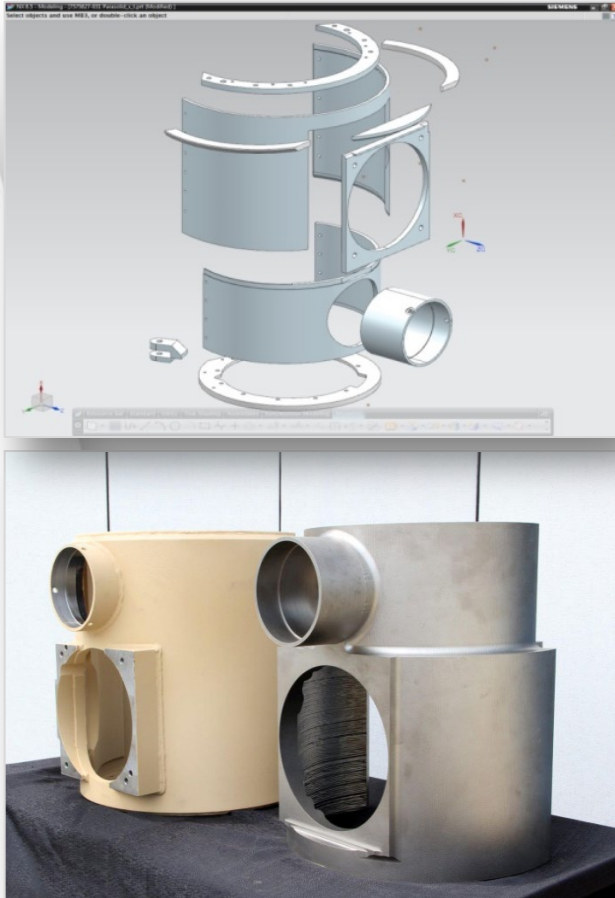
### Tooling Solutions

- Lead time for tooling production represents a big challenge for auto manufacturers
- Sciaky showed this manufacturer how EBAM® could help dramatically reduce tooling production lead time
- Sciaky also demonstrated how EBAM could be leveraged for tooling repair and repurpose operations
- EBAM printed tool was put into production



# Case Study

**GENERAL DYNAMICS**  
Land Systems



## Gun Turret for Combat Vehicle

- Previous part was manufactured in 11 separate pieces
- EBAM® produced the part in a single piece, saving significant time and cost
- The cost and labor-savings justified the use of titanium, which resulted in significant light-weighting of the assembly

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**For more information,  
call the EBAM<sup>®</sup> today at  
877-450-2518.**

**Or visit us online at [www.sciaky.com](http://www.sciaky.com)**

**Thank You!**

