

Small Business Data Management Pain Points

Empowering Small and Medium Size Enterprises Through Effective
Additive Manufacturing Data Management

NIST Workshop

NIST National Cybersecurity Center of Excellence

Rockville, MD

June 7, 2023

Slade Gardner, PhD

Big Metal Additive, Denver CO



Introduction

Slade Gardner, President, Big Metal Additive

- Industrial AM since 2000
- Equipment, Materials, Process, Methods and Priorities
- 2022 SME Additive Manufacturing Industry Achievement Award

Big Metal Additive, Denver, CO

- We make parts
- Products: Prototypes, First Articles, Low-Rate Production, Full-Rate Production
- Factory of 100 Machines
- Aerospace, Space, Maritime, and Oil & Gas
- + Value added engineering





Large Metal Parts from Additive Manufacturing

Insufficient availability of castings, forgings and billet

Replacements produced with wire-arc DED

- Up to 95% reduction in schedule
- Up to 63% reduction in cost
- Designs integrate multiple pieces into single components
- Higher evolution of multifunctional design
- Digital inventory ALWAYS ready to respond

Adoption has been slow, but people are moving faster

- Technology Readiness Level (TRL) has been popular focus
- Manufacturing Readiness Level (MRL) is the key





Additive Manufacturing is Not a Hobby

Additive Manufacturing is more difficult than people think

- Making a shape is easy
- Making a part is difficult

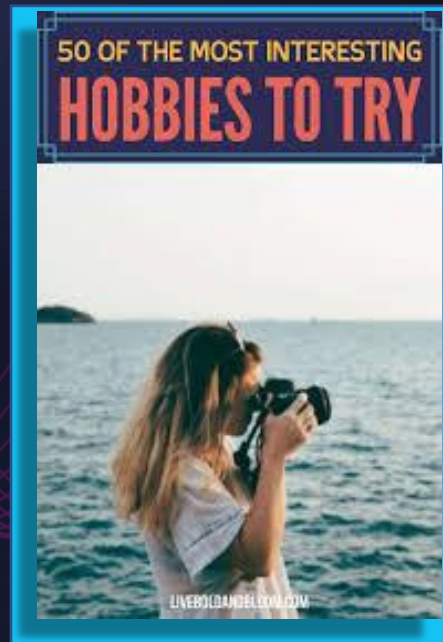
AM does not replace the machine shop

AM replaces the foundry

- Plate, bar, casting, forging
- Material certs

Material creation

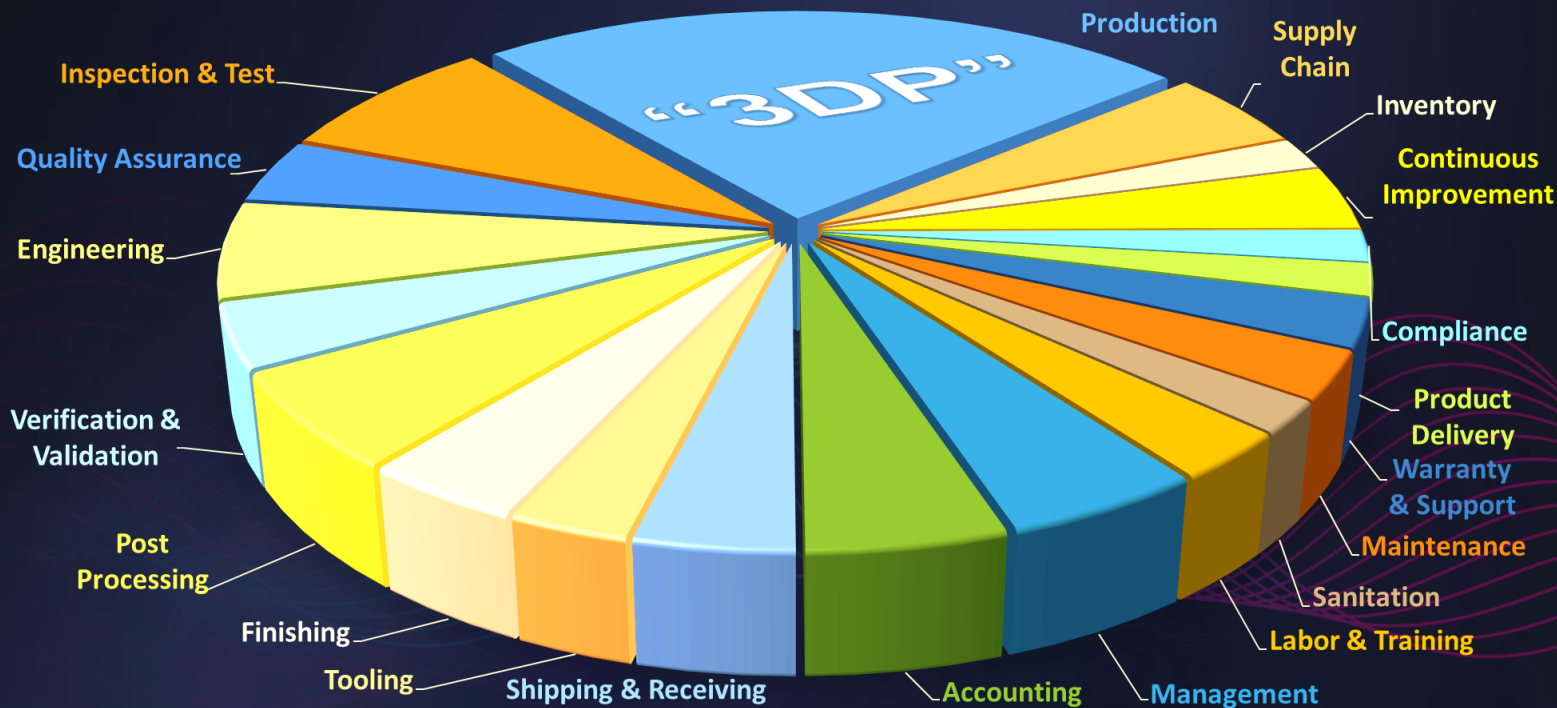
- Process specification driven
- 100% focus and purpose required





Manufacturing is a Key Word

Manufacturing goes way beyond just "3D Printing"





Manufacturing Requires Acceptance

Qualification – Does it satisfy requirements?

- Facility – control plan (specification)
- Equipment – control plan (specification)
- Personnel – employee training and education (records and certificates)
- Materials (feedstock) – origination, composition, repeatability (specification)
- Process – fixed controllable process (specification)
- Materials (product) – properties, statistical control
- Product – 1st article qualification & lot acceptance criteria

- Inspection – NDE is always required – what is the standard?
- Testing – witness coupons often required

Certification – Does the authority agree?



Quality Management System

Without a QMS, you are irrelevant in the manufacturing world

- ISO 9001:2015
- AS9100 D (2016)
- API Spec Q1

QMS provides a documented plan for:

- Customer focus
- Leadership
- Engagement of People
- Process Approach
- Improvement
- Evidence-based decision making
- Relationship management



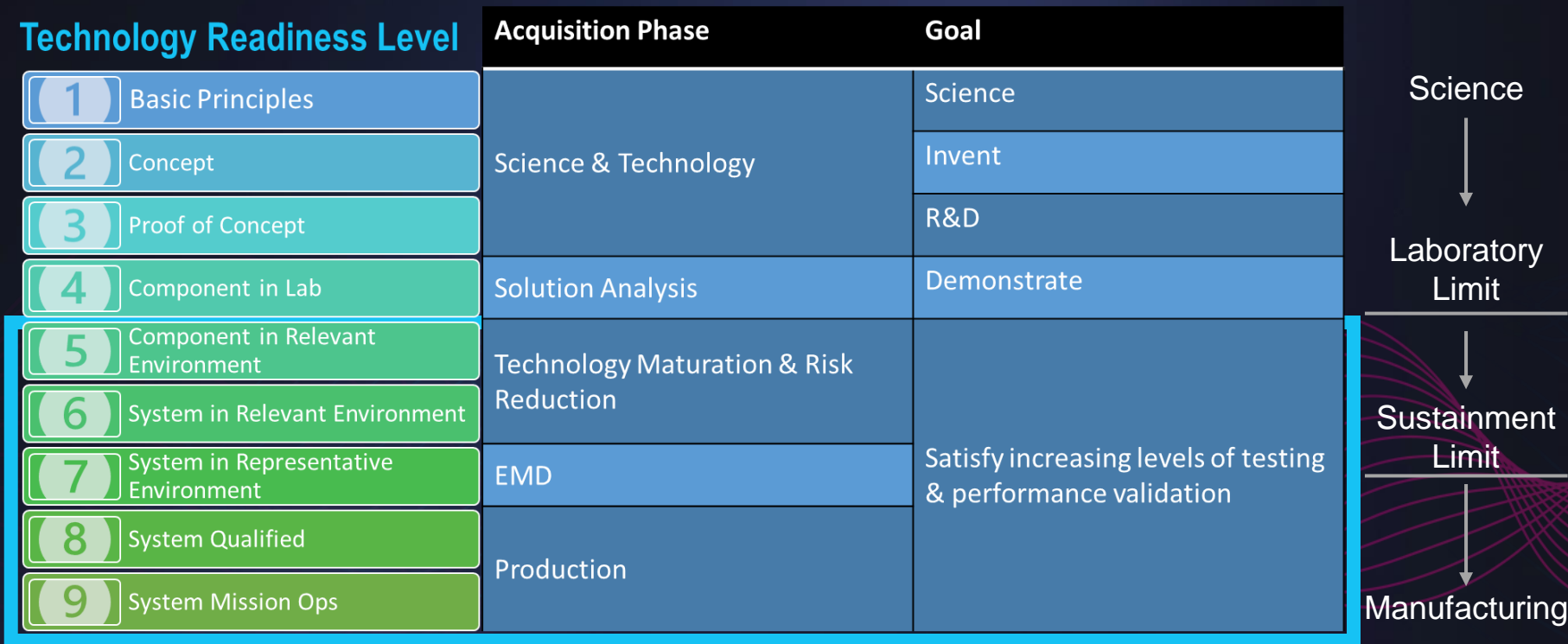
Manufacturing Myths

- ❌ Expeditionary Manufacturing
 - How do you pass a QMS audit (?)
 - Where is the facility control plan (?)
- ✅ Depot Sustainment / Battle Damage Repair (maybe)
- ❌ Laboratory Manufacturing
 - Specifications and procedures (?)
 - Purpose of a lab is to experiment (not QMS)
- ❌ Casual Part Time Manufacturing
 - How do you certify workforce (?)
 - Quality assurance / Inspection & test (?)





Technology Development has been good for AM



Plea to DoD: Don't stop at Sustainment – Finish the development to Manufacturing!



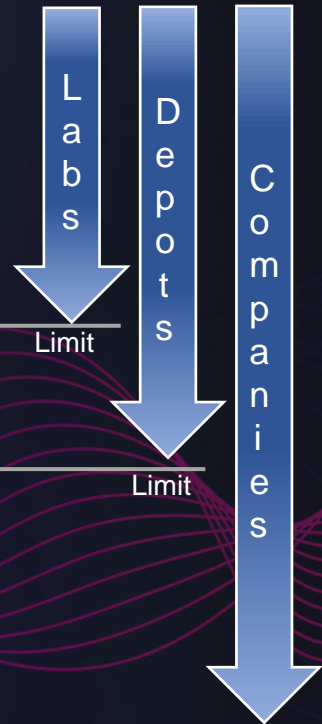
It's Time to Focus on Manufacturing

Technology Readiness Level

- 1 Basic Principles
- 2 Concept
- 3 Proof of Concept
- 4 Component in Lab
- 5 Component in Relevant Environment
- 6 System in Relevant Environment
- 7 System in Representative Environment
- 8 System Qualified
- 9 System Mission Ops

Manufacturing Readiness Level

- 1 MFG Implications
- 2 MFG Concepts
- 3 MFG Proof of Concept
- 4 MFG in a Lab Environment
- 5 MFG Prototype
- 6 MFG Prototype in Production Relevant Environment
- 7 Produce System in a Production Environment
- 8 Pilot Line
- 9 Low-Rate Initial Production (LRIP)
- 10 Full-Rate Production (FRP)





It's Time to Focus on Manufacturing

Technology Readiness Level

1	Basic Principles
2	Concept
Published papers and technology.	
4	Component in Relevant Environment
Transferable from one group to another.	
5	System in Relevant Environment
6	System Representative Environment
7	System Qualified
8	System Mission Ops
9	System Mission Ops

Manufacturing Readiness Level

1	MFG Implications
Products and the people who make them.	
4	MFG Prototype
Nontransferable.	
5	Relevant Environment
Every milestone from investment.	
6	Produce System in a Production Environment
7	Pilot Line
8	Low-Rate Initial Production (LRIP)
9	Low-Rate Initial Production (LRIP)
10	Full-Rate Production (FRP)



People are the Key to Manufacturing

Expertise, skill and training

- Years and decades of dedication are necessary
- Procedures, knowledge and certifications
- Practice makes perfect – and perfect is required

Essential Professional Manufacturing Roles

- Quality Manager / Inspection Lead
- Project Manager / Team Manager
- Business Development / Customer Support
- Finance / Accounting
- Vendor Supply Chain Manager / Maintenance / Shipping & Receiving
- Manufacturing Personnel / Support Personnel



People Feel Pain

SP 800-171 Rev. 2

Protecting Controlled Unclassified Information in Nonfederal Systems and Organizations

- Personnel to execute all requirements
- Cost associated with implementation
- Our contracts don't cover hardware / software
- Infrastructure investments required to comply
 - Capital
 - Staffing
- Many, many websites to navigate just to understand



More Pain

Cybersecurity Maturity Model Certification (CMMC) 2.0 Program

- Hygiene aspects
- Implementation aspects
- CUI isn't firmly defined
 - Customers don't portion mark
 - The 'over classification' conundrum
 - Cost?
- Some requirements of CMMC are not applicable to SME



Pain in the ...

Small Company working for a large corporation or government entity

- Comply with all contractual items
- Flow down of universal Ts & Cs
- Referenced by code or FAR/DFAR
- Documents reference documents, layer upon layer...
- Due diligence takes forever
- Getting paid can take way too long

Small innovative company

- We have latest software, our customers do not
- We can pivot at a customers request but then they break their payment system



Standards vs Branding

ISO/ASTM 52900:2021

- Additive Manufacturing
- DED-arc
 - Arc –DED
 - Wire arc DED

US Patent and Trademark Office

- WAAM - Branded Mark
 - Marketing
 - Advertising
 - Serial Number 79336338
 - International Registration Number 1651331

A screenshot of the ASTM website. At the top, it says "CELEBRATING 125 YEARS". Below that, there are navigation links for "Products & Services", "Get Involved", "About", and "News". The main content area shows the title "ASTM ISO/ASTM52900-21" and the subtitle "Additive manufacturing — General principles — Fundamentals and vocabulary". There is a "Scope" section with text describing the standard's purpose and application.

A screenshot of the United States Patent and Trademark Office (USPTO) Trademark Electronic Search System (TESS). The page displays the trademark "WAAM" for "WAAM" (Wires of common metal). The search results show the trademark number "IC 006, US 002 012 013 014 023 025 050, G & S: Metal and metal alloys; Wires of common section; Non-electric wires of common metal having a non-circular cross section; Multistrand of common metal alloys for further manufacturing; Hollow corded wires of common metal; He- metallic filaments for use in 3D printing and additive manufacturing; feedstock in the form of welding; feedstock in the form of metallic filaments containing metal powder for use in 3D printing; electrical cables and wires of common metal; welding and soldering materials, namely, wire".



THANK YOU!

Follow us on Linked In:

www.linkedin.com/company/big-metal-additive

Sign up for our newsletter:

info@bigmetaladditive.com