









The Manufacturing Technology Deployment Group Inc. (MTDG) is committed to transforming the advanced manufacturing industrial base throughout the world for our sustainable future.

MTDG was established in 2020 as a 501(c)(3) not-for-profit holding company.





### **MTDG** family of companies





# Developing the "Additive Manufacturing Commons™": The Journey to Productionize Metal Additive Manufacturing





The proliferation of Metal Additive Manufacturing technology is currently outpacing the collective body of knowledge with respect to material properties and process reliability and repeatability.



#### Laser Powder Bed Fusion (LPBF)





A key issue in the application of metal additive manufacturing specifically is the variability in the *quality* and repeatability of metal parts (Tapia & Elwany, 2014).





- A number of factors drive the selection of process parameters in Laser Powder Bed Fusion (LPBF).
- The sensitivity of the process may drive application-specific parameter choices.

Saunders, M. (2018). How process parameters drive successful metal AM part production. Metal Additive Manufacturing, 4(2), 127-135.



Each parameter can be adjusted independently, making parameter selection a multivariable problem.

- Laser power: the total energy emitted by the laser per unit time
- Spot size: the diameter of the focused laser beam
- Scanning velocity: the speed at which the spot is moved across the powder bed along a scan vector
- Hatch distance: the spacing between neighboring scan vectors, which is designed to allow a certain degree of remelting of the previous weld track to ensure full coverage of the region to be melted
- Layer thickness: the depth of each new powder layer to be melted.

#### Finding the operating window





 Laser power vs scanning velocity graph – how process outcomes vary with parameter choices

Saunders, M. (2018). How process parameters drive successful metal AM part production. Metal Additive Manufacturing, 4(2), 127-135.

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#### Lack of fusion





 Insufficient penetration of the laser energy leaves unmelted material and weakness in the component

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Large corporations have many advantages over small and medium manufacturers (SMMs) as many have multiple plant locations with hundreds of similar machines performing similar operations providing a rich and robust data lake for analysis and benchmarking.





In order to provide the possibility for SMMs to have the same opportunities as larger enterprises in learning from a centralized performance monitoring system, an Additive Manufacturing Commons<sup>™</sup> is proposed as a multi-sided platform (MSP) for secure data sharing between SMMs, their customers, and researchers.



#### **The Problem Being Addressed**



The small medium manufacturing industrial base is not keeping pace with system prime contractors and their Tier 1 suppliers with respect to Advanced Manufacturing and Industry 4.0 technologies



#### **Low-Cost Non-Proprietary Solution**



Open standard based data acquisition and control system with no recurring licensing costs located at each SMM enabling the secure capture and digital delivery of standardized "in-situ" process data





- automated collection of critical manufacturing process data <u>removing human</u>
  <u>error</u>
  - automated ingestion of manufacturing process data into AI and Machine Learning tools
  - respond immediately to violation of limits by <u>automatically shutting down a</u> process or changing the process to keep it within limits
  - use the captured in-situ data to **<u>establish acceptance criteria</u>** for production parts
  - Part acceptance based upon receipt of a contracted data set delivered digitally
    - Can be used to reduce or eliminate costly non-destructive testing
    - <u>limit costly and time-consuming destructive testing</u>
    - <u>Capture additional statistical information</u> relative to specific SMM's performance and operational capabilities without violating their intellectual property or competitive sensitivities

Buyer

#### **Extremely Low Cost**



"If the system is too costly it likely won't scale into the industrial base"

- The LIMS is extremely low cost \$5k including software – one time only - (No recurring license fees!
- The LIMS device not required for each machine, it just needs to hang on the same network as the other machines
- The LIMS is completely extensible letting you add new code and functions without having to pay extra
- The LIMS hardware Bill of Material is made up of 100% commercial off the shelf parts that anyone can buy



### **One Attack Surface**



#### "If the system can't significantly overshoot cybersecurity requirements it can't be part of a trusted network"

- The LIMS has only one attack surface making it no different than any CNC machine on the production line
- The LIMS is fully functional in an air-gap configuration and does not need the Internet to do all its functions (an IIoT box without the Internet dependency)

#### Azure Government Cloud Services – enables the multi sided platform

- Independent Secure Zone system embedded within cloud service provider facility
- Strong authentication across systems, networks and data (cryptographic keys using FIDO protocols)
- Application-Level Encryption (including data at rest)
- · Platform designed to be portable to any cloud service

Banking Level Security – approaching zero-trust architecture as established by NIST

- · Data is valued and treated like currency
- Hardware level encryption and tokenization from origination to destination
- Transparent to the Authenticated Users



Hardware Encryption

Data Moving to and from the Cloud



Tokenization & TLS 1.3 Encryption

#### **Additive Manufacturing Commons**







- The Additive Manufacturing Commons<sup>™</sup> will offer SMMs a secure and controlled environment in which to share data with one another.
- A secondary—but still significant—benefit of this is allowing SMMs to securely share production data with their customers, providing customers with greater confidence and input with respect to the AM process going into the parts they have purchased.



## **MTDG Leadership Team**





### **Contact MTDG**

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