# 3-D PRINTING METALS MAP

## Because of research from the **NextManufacturing Center**,

3-D printing with metals will change drastically over the next five years. The center is developing an entirely new approach to metals 3-D printing—merging data from all parts of the process to create a fully integrated understanding of the technology.

## A **HOLISTIC** APPROACH

**MATERIALS**
- microstructure control
- defect structure/porosity
- material recycling
- new alloy development

**PRINTING PROCESS**
- powder spreading
- melt pool geometry
- process modeling and process mapping
- laser powder bed, electron beam, and binder jetting processes


**PART INSPECTION AND QUALIFICATION**
- machine learning and computer vision
- nondestructive evaluation
- mechanical testing

**INDUSTRY APPLICATIONS**
- innovative component fabrication
- 3-D printing equipment training

**DESIGN**
- geometric design
- topology optimization
- design optimization

**COST**
- manufacturing feasibility
- technology commercialization modeling

## **END TO END:** 3-D PRINTING METAL PARTS

**PRINTING STRATEGY**

Using modeling software, engineers sketch a blueprint to plan the most efficient way to fit the part inside the printer. How a part is oriented inside the printer affects volume, mechanical properties, printing time, and what type of powder can be used.

**POWDERS**

Engineers choose metal powder based on a number of factors including alloy type, particle size, strength, and required surface finish.

**POWDER SPREADING**

Inside the printer, metal powder is spread in a thin layer. Adjusting the mechanics of this step can increase the speed and strength of 3-D printed parts.

**PARTICLE SINTERING AND FUSION**

After the powder is spread, a high temperature laser or electron beam draws the design into the powder, melting and fusing the metal powder to create a solid layer.

**FINAL PART**

Thin layers are built up until an intricately printed part is complete.

**MICROSTRUCTURE AND PROPERTIES**

After the part is printed, it may require post-processing including heat treatment or shop painting. Post-build finishing optimizes the mechanics of the part and gives more control over aesthetics.

**INSPECTION AND QUALIFICATION**

Finally, a part must go through a final inspection and qualification process to certify its performance for demanding applications.

Read more about how the NextManufacturing Center is defining the future of additive manufacturing from metals to bio-printing at **www.engineering.cmu.edu/next**

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