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

PART INSPECTION AND QUALIFICATION

- machine learning and computer vision
- nondestructive evaluation
- mechanical testing

DESIGN

- geometric design
- topology optimization
- design optimization



PRINTING PROCESS

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

INDUSTRY APPLICATIONS

- innovative component fabrication
- 3-D printing equipment training

COST

- manufacturing feasibility
- technology commercialization modeling

END TO END: 3-D PRINTING METAL PARTS

PRINTING STRATEGY

POWDERS

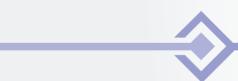
POWDER SPREADING

PARTICLE SINTERING AND FUSION

FINAL PART

MICROSTRUCTURE AND PROPERTIES

INSPECTION AND QUALIFICATION



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.

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

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.

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

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.

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

Carnegie Mellon University
College of Engineering