i3DMFG™
DISRUPTIVE METAL 3D PRINTING

A BTX PRECISION COMPANY



DFM VS DFAM: HOW DESIGN PRIORITIES CHANGE IN METAL ADDITIVE MANUFACTURING

Executive Summary

Design for Manufacturing (DFM) is a broad engineering discipline that connects product design with the realities of production. Design for Additive Manufacturing (DFAM) takes the philosophy behind DFM and applies it to additive processes. And one major objective of DFAM is to use additive capabilities to alter a design and improve the product itself.

In traditional manufacturing like machining or fabrication, manufacturability often improves when geometry is simplified or setups are reduced. In metal additive manufacturing, some of these traditional DFM constraints are relaxed, and that opens up new possibilities in part design.

Laser powder bed fusion can produce internal passages, organic load paths, lattices, and consolidated structures that may be difficult to create conventionally. However, it's important to remember that the process also introduces specific considerations involving build orientation, support structures, thermal distortion, powder removal, surface condition, post-processing, inspection, and qualification.

The amount of redesign required for additive manufacturing depends on the project goal. A supply-chain or lead-time application may justify printing a largely conventional geometry. A performance-driven application usually benefits from deeper redesign. The greatest success will come by reconsidering what the part could become when tool access, parting lines, and assembly-driven boundaries no longer define the design. This paper compares conventional DFM and DFAM, focusing primarily on the powder bed fusion processes used at i3D MFG. It explains the cost models behind DFM and DFAM, and highlights where additive manufacturing can create technical or economic value that may be overlooked when a part is judged only through a conventional manufacturing lens.

Key Takeaways

- **Manufacturing process:** DFM and DFAM both bring manufacturing knowledge into design, but they optimize around different process capabilities and constraints.
- **Two DFAM responsibilities:** Engineers must design for successful printing and use additive capabilities where they support the product requirements.
- **Opportunity lens:** The value of DFAM often appears when engineers stop trying to reproduce a legacy part and instead consider how geometry, material placement, and component integration can improve the product.
- **Purposeful complexity:** Additive can reduce the need for tools and setups for many complex features, allowing geometry to serve performance or integration goals. Build time, supports, risk, inspection, and finishing still affect cost.
- **Consolidation decisions:** Fewer parts and joints can improve reliability and simplify assembly, but serviceability, cleaning, inspection, and build risk must also be assessed.
- **Production planning:** Material choice, build strategy, post-processing, inspection, and qualification should be defined early.
- **Process selection:** The best manufacturing route depends on performance, total delivered cost, lead time, supply risk, production volume, and quality requirements.

Common Terminology

TERM	MEANING
Additive Manufacturing (AM)	A family of processes that build physical geometry through successive addition of material
Design for Manufacturing (DFM)	The broader practice of aligning design decisions with manufacturing capability

Design for Additive Manufacturing (DFAM)	The application of design and manufacturing knowledge to additive process constraints and opportunities
Laser-Based Powder Bed Fusion of Metals (PBF-LB/M)	The standardized process category used as the technical focus of this paper
Direct Metal Laser Sintering (DMLS)	A widely used commercial term for metal laser powder bed fusion
Hot Isostatic Pressing (HIP)	A post-process that may be used to reduce internal porosity and modify material performance
Nondestructive Evaluation (NDE)	Inspection methods that assess a part without damaging it

DFM and DFAM in Context

The Goal of Conventional DFM

DFM evaluates how design choices affect manufacturing in areas like cost and machining time. It applies across many traditional manufacturing processes. For clarity, this paper uses the term conventional DFM for design practices associated with machining, casting, molding, forming, and fabricated assemblies.

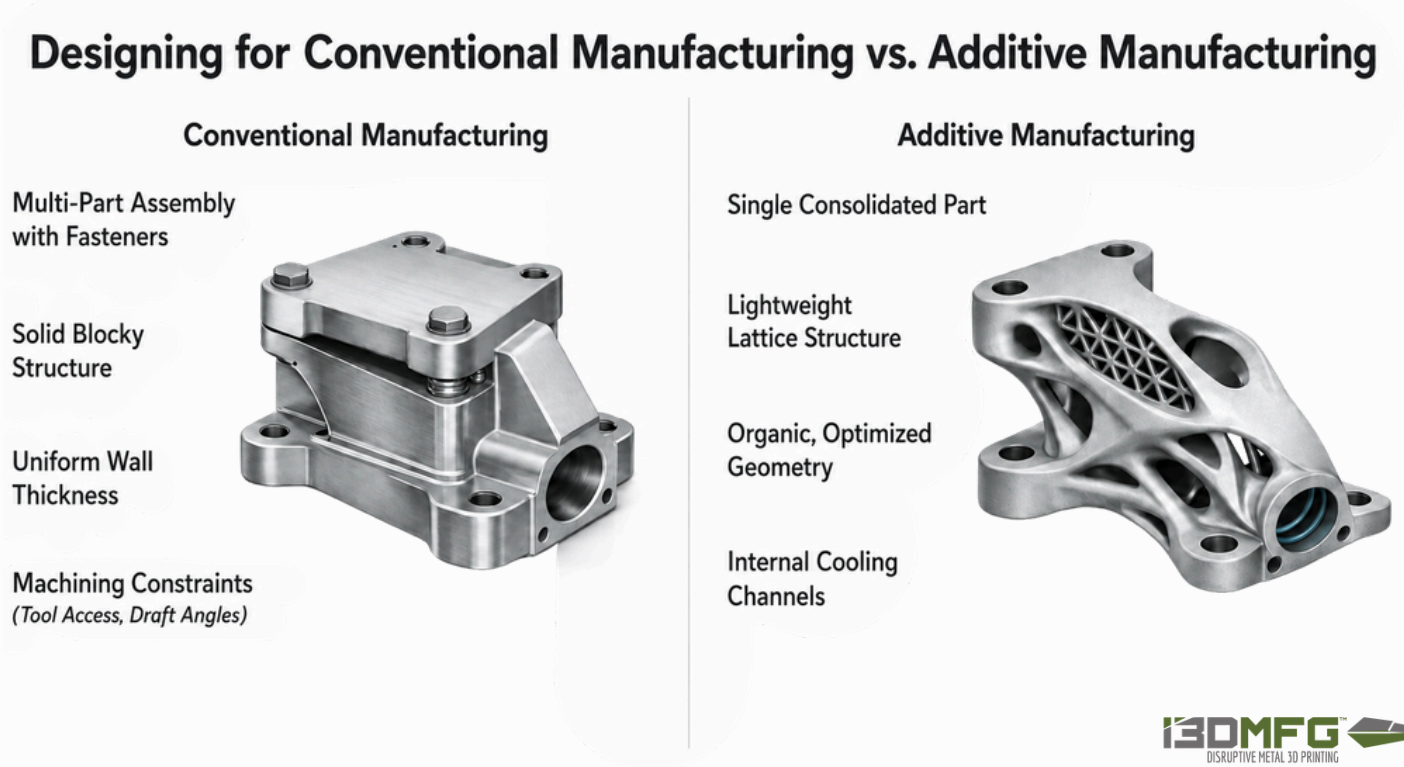
For instance, a conventional DFM review may address fixture locations or bend radii. These considerations are valuable because they reduce manufacturing difficulty and ultimately, for the customer, improve price per part.

DFAM Combines Manufacturability with Design Opportunity

DFAM applies the philosophy of DFM to additive processes. It has two closely related responsibilities. The first is to make the part producible within the intended additive process. The second is to evaluate whether a new design optimized for the capabilities of additive manufacturing could improve performance, integration, material use, lead time, or supply flexibility.

- Important factors in designing for successful production: Build orientation, support strategy, feature size, thermal behavior, powder removal, dimensional allowance, post-processing access, inspection, and process repeatability.
- Important factors in designing to use metal additive capabilities: Part consolidation, topology optimization, internal channels, conformal features, lattices, localized material placement, and product variation without dedicated tooling.

How Manufacturing Assumptions Shape a Design



Every manufacturing process shapes a part's geometry in ways that can be subtle or obvious. Conventional processes encourage features that match tools, stock, molds, fixtures, and assembly methods. Additive manufacturing changes many of those assumptions, while adding new constraints related to the build and the material response.

Constraint Inheritance in Legacy Parts

Existing parts that were previously manufactured by traditional manufacturing methods often contain features required by that prior manufacturing route. Common examples include:

- Straight drilled passages
- Access holes
- Thick machining stock
- Split housings
- Flanges
- Bosses
- Fasteners
- Weld joints
- Plugs
- Uniform wall sections

When the part moves to additive manufacturing without a design review, those features often remain. They may not affect the part's success, but reviewing them could present opportunities to reduce mass or simplify assembly through design tweaks.

Weld joints are a common example. In many legacy designs, the joint doesn't serve a function, but instead it exists because the geometry could not be produced as a single piece. In those cases, the joint and features supporting it can often be removed.

Some inherited features will remain necessary, of course. A flange may support service access. A split line may allow cleaning or inspection. A thick section may provide a machining datum or carry a bearing load. The design review should separate functional requirements from features created mainly for the previous process.

The Range of Redesign Effort

A direct process transfer can be appropriate when urgency is the driving priority; in these cases, only slight changes to account for factors like orientation or supports may be necessary.

However, applications pursuing mass reduction, thermal improvement, fluid performance, part consolidation, or material efficiency usually require broader architectural work. The designer may revise load paths, internal passages, interfaces, assembly boundaries, wall distribution, and inspection strategy. The result can look substantially different from the conventionally manufactured baseline.

Engineering Review Question

For each feature, identify the requirement it satisfies. Features with no current functional, inspection, service, or regulatory purpose are candidates for removal or redesign.

How Design Goals Change in DFAM

Geometry and Complexity

Conventional DFM often favors simple geometry because each additional feature may create more complexity, and that complexity can drive prices higher. Additive manufacturing can create many complex features directly from the digital model, making them practical design options instead of cost drivers.

In contrast to conventional manufacturing, in additive manufacturing, cost, risk, and manufacturability are often influenced by:

- Scan area
- Build height
- Supports
- Thermal risk
- Data preparation
- Inspection
- Cleaning
- Finishing

Complex geometry in additive manufacturing is certainly achievable when necessary, but it should have a defined purpose, such as mass reduction or component integration.

Assembly and Part Consolidation

Part consolidation is one of the most common DFAM opportunities. By consolidating welded assemblies into a single additively manufactured component, weld lines and associated heat-affected zones can be eliminated, improving structural continuity and reducing potential failure locations.

Eliminating the joint also removes requirements that go with it, such as joint preparation and access, weld fixturing, distortion correction, and more.
Combining components can also reduce fasteners and seals while decreasing the chance of tolerance stack-up; there are many other benefits, too, including a shorter bill of material.

However, consolidation also changes maintenance and quality planning in ways that should be carefully considered. A single integrated component may be harder to clean, inspect, repair, or replace.

A larger consolidated geometry may increase build duration and the financial impact of a failed build. Critical interfaces and failure modes should be reviewed before assembly boundaries are removed.

Performance-Driven Geometry

Without the constraints of conventional machining, DFAM can allow more freedom for designing around a part's performance priorities, such as structural or fluid requirements:

- Topology optimization can identify efficient load paths.
- Lattices can manage stiffness, energy absorption, heat transfer, or mass.
- Conformal channels can follow a surface or thermal source.

It's important to remember that optimized output still requires engineering interpretation. Validation is still critical, even when the geometry was generated through advanced simulation.

Material Strategy

Conventional material selection is often influenced by stock cost, availability, machinability, forming behavior, tooling wear, and scrap. Metal additive manufacturing adds powder availability, parameter maturity, layer thickness, thermal behavior, heat treatment, surface condition, fatigue performance, anisotropy, powder control, and qualification history to the decision.

In many cases, additive manufacturing opens the door to expensive materials becoming economical for a part design. Powder may cost more per unit mass than billet or bar stock, but near-net-shape production can still change a part's economics by improving material utilization. A complete cost comparison accounting for all necessary design factors is necessary to determine the best possible choice.

Iteration and Product Variation

Additive manufacturing can reduce the need for dedicated tooling when the geometry changes. This supports faster design iteration and product customization. Production controls still apply, and a design change may still require additional validation or qualification.

Side-by-Side Technical Comparison

DESIGN DOMAIN	CONVENTIONAL DFM	DFAM FOR METAL ADDITIVES
Primary design emphasis	Efficient, repeatable production within the selected conventional process	Successful additive production plus use of additive capabilities when they support product goals
Typical geometry	Accessible, prismatic, drafted, formed, or otherwise compatible with tools or process flow	Free-form geometry, internal passages, integrated features, lattices, and topology-informed structures within process limits
Internal features	Limited by cutter access, cores, joining methods, or secondary operations	Possible through layerwise construction, subject to support, powder removal, surface, and inspection requirements

Assembly strategy	Multiple parts may be used to provide access, create features, or fit available processes	Part consolidation may reduce joints and assembly, with serviceability and inspection reviewed in parallel
Material use	Stock or near-net blanks are cut, formed, or molded. Scrap and tooling can be significant	Powder is selectively fused. Material utilization can improve, while supports, refresh rules, and finishing remain cost factors
Process constraints	Tool reach, fixtures, draft, parting, bend radii, mold flow, setup sequences, and stock availability	Orientation, build height, supports, heat flow, distortion, minimum features, powder evacuation, and build volume
Tolerances and surfaces	Process capability and secondary finishing define achievable values	As-built capability is feature and orientation dependent. Critical interfaces often receive finish machining
Cost sensitivity	Complexity often increases operations, tooling, setups, and assembly effort	Cost is influenced by build time, supports, packing, risk, post-processing, inspection, and qualification

Production volume	Often strong for stable, higher-volume, simple or moderate-complexity parts	Often strong for high-value, complex, low-to-mid-volume, customized, or tooling-sensitive applications
Quality planning	Inspection is aligned with accessible features and established process capability	Internal features, process history, powder control, NDE, witness specimens, and qualifications may require added planning

Cost and Production Economics

The cost models for conventional and additive manufacturing are different, and both are sensitive to geometry, material, quality, and volume.

Conventional Manufacturing Cost Drivers

- **Raw material and scrap:** billet, plate, bar, casting, or forging cost, including the material removed during machining.
- **Tooling and setup:** molds, dies, fixtures, cutters, programming, changeover, and process development.
- **Cycle time and labor:** machining time, forming steps, tool changes, assembly, welding, and handling.
- **Scale:** tooling and setup can be distributed across larger production volumes, improving unit economics.
- **Supply chain:** long-lead tooling, specialty stock, outside processes, and multi-part sourcing can affect lead time and inventory.

Metal Additive Cost Drivers

- **Build time:** layer count, build height, scan area, parameter set, recoating time, and machine utilization.
- **Build preparation:** orientation, nesting, supports, simulation, data preparation, and process planning.
- **Material system:** powder cost, handling, sieving, refresh rules, reuse controls, witness specimens, and traceability.
- **Post-processing:** stress relief, HIP when required, support removal, EDM, machining, surface finishing, cleaning, and coating.
- **Quality and qualification:** dimensional inspection, NDE, material testing, process qualification, documentation, and change control.
- **Yield and risk:** build failure, distortion, cracking, support damage, or rejected features can have a larger impact on long or densely packed builds.

Complexity creates value when it has a purpose
Additive manufacturing can reduce the number of tools, setups, and joining operations needed for complex geometry. The opportunity is strongest when that complexity improves performance, integration, material use, or supply outcomes.

Strategic Takeaway

DFM *optimizes within constraints*
DFAM *removes many of those constraints, replacing them with opportunity*

Additive manufacturing does introduce its own constraints, but the difference is that it can open a new design space centered on performance.

Engineers will successfully transition to DFAM by breaking free from legacy constraints and fully leveraging material and geometric efficiency.

Conclusion

DFM asks: *"How do I make this more manufacturable?"*
DFAM asks: *"What is the best possible design, and how do I print it?"*

Additive manufacturing can reveal options that are difficult to see when the design is viewed only through the lens of traditional processes like machining. But strong results depend on candidate selection and early coordination.

Some parts will remain better suited to conventional manufacturing. Others will benefit from a hybrid route. The appropriate methodology is the one that meets the application requirements with a controlled and supportable production plan and, where AM fits, uses its design freedom to deliver a better product rather than merely a different process.

Discuss your project with i3D MFG

The i3D MFG engineering team can review your part to identify the best manufacturing route and discuss DFAM. Begin a technical discussion: www.i3dmfg.com/contact-us

About i3D MFG: i3D MFG provides design support, metal additive manufacturing, materials expertise, production, and finishing for high-performance metal components. Its team supports projects from concept evaluation and first articles through process refinement and repeatable production.

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