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DIGITAL MANUFACTURING. REIMAGINED.™

DFM Red Flag Diagnostic

For sUAS Drone Components

A process-by-process checklist of common manufacturability issues that add cost, extend lead times, and put Gauntlet delivery schedules at risk — and how to fix them before production begins.

Certifications: AS9100D · ISO 9001:2015 · ITAR · NIST 800-171
Made in the USA: 7 U.S. Facilities 25+ Manufacturing Processes

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How To Use This Checklist

Review each section that applies to your drone component design. Check off items you've already addressed. Flag items that need attention. Share flagged items with your manufacturing partner catching these issues before production begins is always faster and cheaper than fixing them on the shop floor.

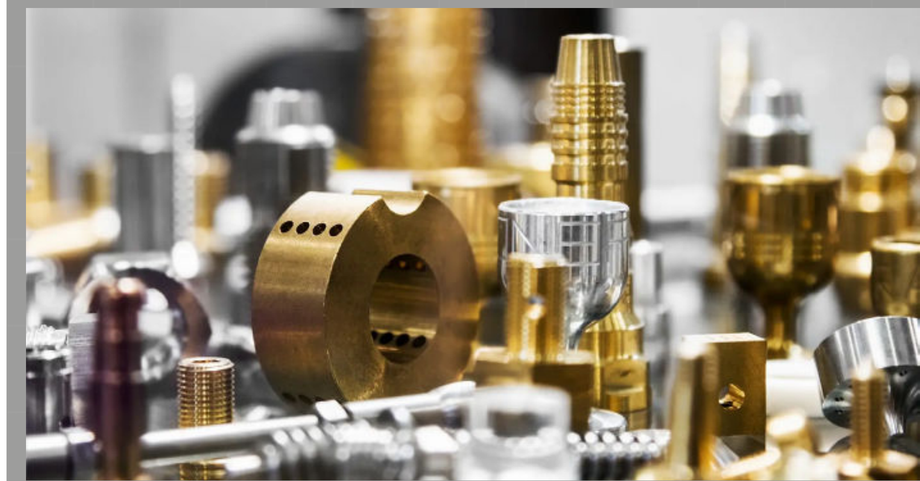
This diagnostic covers all major manufacturing processes used in sUAS production: CNC machining, additive manufacturing, sheet metal fabrication, photochemical machining, injection molding, cast urethane, die casting, extrusion, EDM, and assembly/ finishing/inspection.

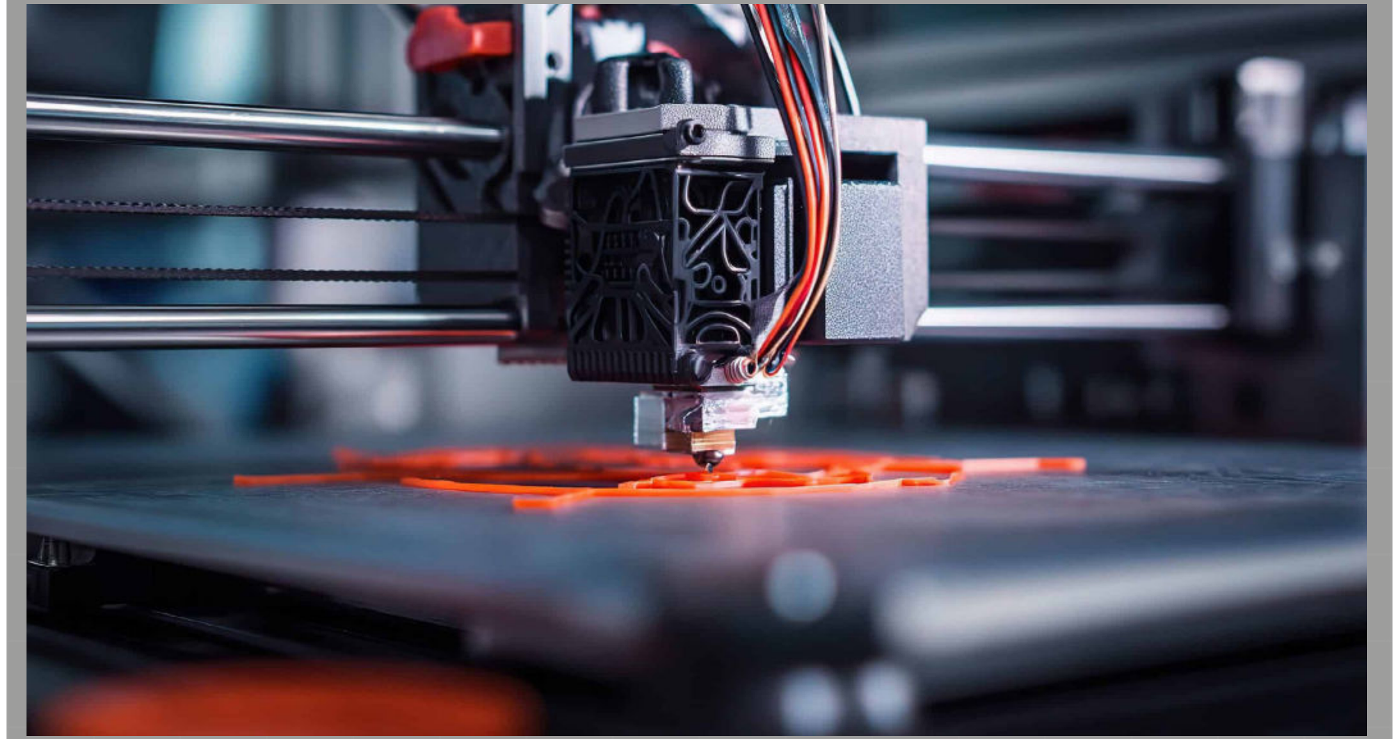
CNC Machining

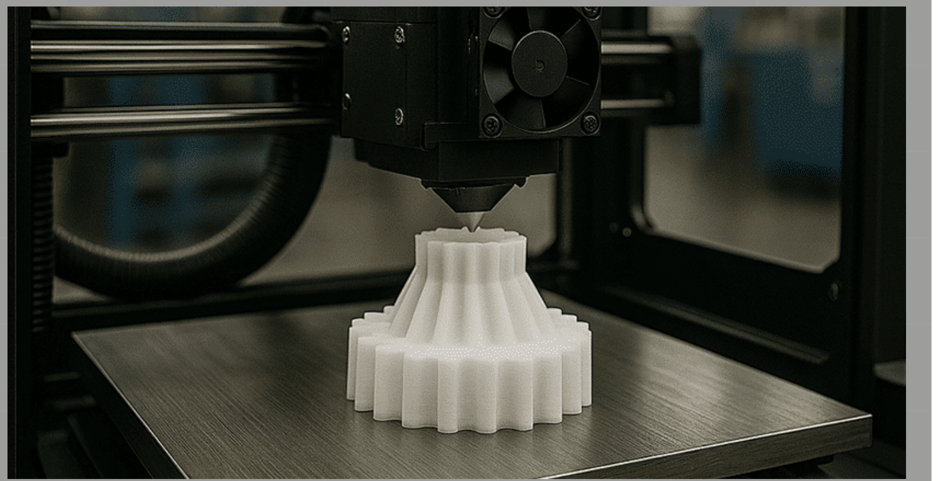
(3-, 4-, 5-Axis Milling & Turning)

Common drone components: Motor mounts, gimbal housings, structural bulkheads, payload brackets, rotor hubs, machined airframe sections.

DFM Red Flags	Why It Matters For sUAS
Sharp internal corners (zero radius) CNC end mills are cylindrical and physically cannot produce a true sharp internal corner. Specifying zero-radius corners forces EDM or multiple finishing passes.	Adds secondary operations, increases cost 30–50%, and extends lead time. Specify internal corner radii of at least 0.030" (0.76 mm) or larger.
Unnecessarily tight tolerances on non-critical features Blanket ±0.001" tolerances across the entire part when only mating surfaces and bearing bores actually require them.	Tight tolerances demand slower feeds, more inspection, and may require grinding or lapping. Apply tight callouts only where function demands it; use standard ±0.005" elsewhere.
Deep pockets or cavities with high depth-to-width ratio Pockets deeper than 4× the tool diameter require progressively smaller, more fragile cutters and slower material removal rates.	Increases cycle time dramatically, risks tool deflection and chatter marks, and compromises surface finish. Redesign to reduce pocket depth or widen the opening.
Thin, unsupported walls Walls thinner than 0.8 mm (metals) or 1.5 mm (plastics) are prone to vibration and deflection under cutting forces, especially in aluminum drone parts.	Causes chatter, dimensional inaccuracy, and scrap. If thin walls are functionally necessary, add ribs or gussets for rigidity or consider sheet metal instead.
Features that require multiple setups or 5-axis when 3-axis would suffice Undercuts, angled holes, or features on multiple faces that force extra fixturing setups or expensive 5-axis time.	5-axis machining can cost 3–6× more than 3-axis. Align features to X/Y/Z planes whenever possible to reduce setup count and machine cost.
Specifying exotic materials without functional justification Choosing titanium or Inconel for a bracket that could be made from 7075 aluminum at a fraction of the cost and machining time.	Exotic alloys wear tooling 5–10× faster and require specialized cutters. Confirm that the operating environment truly demands the material before specifying it.
Text, logos, or cosmetic engraving on machined surfaces Engraving adds dedicated tool paths and cycle time with no structural benefit.	Increases cost for a non-functional feature. Use laser marking after machining or apply labels as a post-process step.
No consideration for workholding / fixturing Parts with no flat reference surface, thin flanges, or flexible geometries that are difficult to clamp securely.	Requires custom fixturing (cost and lead time) or risks part movement during cutting. Design at least one flat datum surface for secure clamping.







Additive Manufacturing

(DMLS, SLS, MJF, FDM, SLA)

Common drone components: Lightweight structural nodes, airframe shells, battery enclosures, sensor housings, lattice structures, jigs and fixtures.

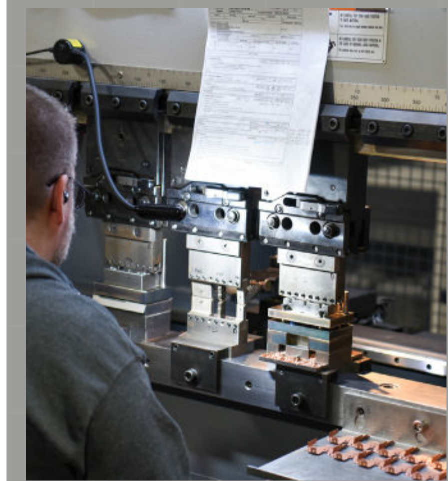
	DFM Red Flags	Why It Matters For sUAS
+	**Unsupported overhangs exceeding 45° (metal DMLS)** Metal additive builds layer by layer; overhangs beyond 45° from vertical require support structures that must be manually removed.	Support removal adds labor, damages surfaces, and may be impossible in internal channels. Orient the build or redesign overhangs to self-support.
+	**Insufficient wall thickness for the chosen process** SLS/MJF minimum ~0.7 mm, FDM ~1.0 mm, DMLS ~0.4 mm. Below these limits, walls won't form properly or will be too fragile to handle.	Parts fail during depowdering, handling, or in service. Check minimum feature sizes for the specific additive process before finalizing the design.
+	**Large flat surfaces without stiffening features** Flat spans warp during the thermal cycling inherent in all additive processes, especially in metal DMLS and FDM.	Causes bowing, curling, and dimensional inaccuracy. Add ribs, corrugation, or slight curvature to large flat areas to resist warpage.
+	**Trapped powder in internal cavities (SLS/MJF/DMLS)** Enclosed internal voids with no escape holes will trap unsintered powder that cannot be removed after the build.	Trapped powder adds weight (critical for sUAS), rattles during flight, and can damage components over time. Add drain holes ≥3 mm diameter to all enclosed volumes.
+	**Designing for additive when volume demands injection molding** Using SLS or MJF for 30,000+ identical parts when the geometry is moldable.	Additive per-unit cost at high volume can be 5–20× higher than injection molding. Use additive for prototypes and bridge production, then transition to molding for Gauntlet-scale volumes.
+	**Ignoring build orientation effects on strength** Additive parts are anisotropic & significantly weaker in the Z (build) direction than in X/Y.	A drone bracket loaded in the Z direction may fail at 40–60% of its X/Y strength. Orient critical load paths in the X/Y plane or redesign for multi-directional loading.
+	**Over-specifying surface finish on non-mating surfaces** Requiring machined-quality surface finish (Ra <1.6 µm) on surfaces that don't interface with other parts.	Post-machining or polishing of additive parts adds cost and lead time. Accept as-printed finish where function allows; specify finishing only on mating and sealing surfaces.

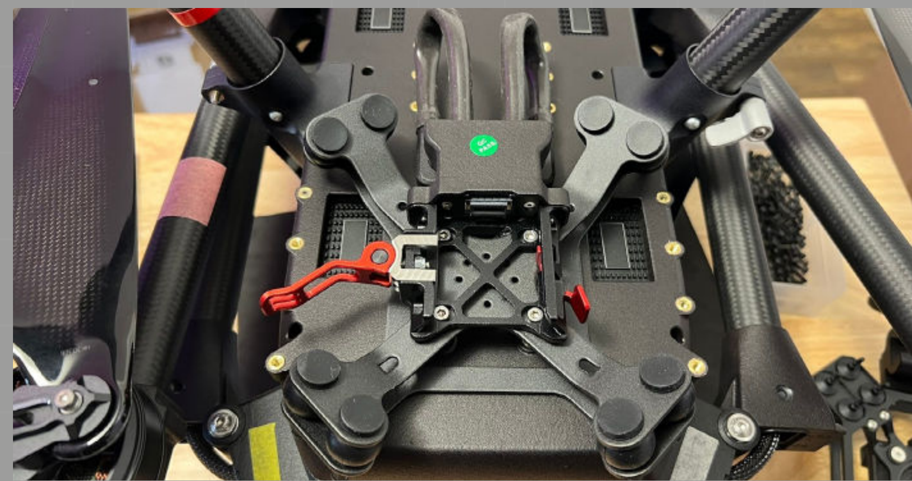
Sheet Metal Fabrication

(Laser Cutting, Forming, Welding)

Common drone components: Chassis panels, battery trays, mounting plates, brackets, shields, covers, ground-station enclosures.

DFM Red Flags	Why It Matters For sUAS
Bend relief notches missing near corners When a bend line runs into a perpendicular edge without a relief cut, the material tears or deforms unpredictably.	Causes cracking and scrap. Add bend relief notches (width ≥ material thickness) at every intersection of a bend line and an edge or adjacent feature.
Features too close to bend lines Holes, slots, or tabs placed within 2× material thickness of a bend line will distort during forming.	Hole shapes become oval, slots shift, and dimensional accuracy is lost. Maintain a minimum clearance of 2.5–3× material thickness from all bend lines.
Bends that exceed the material's minimum bend radius Specifying a bend radius tighter than the material and thickness allow (e.g., sharp bends in 6061-T6 aluminum).	Causes cracking on the outer surface of the bend. Use a bend radius of at least 1× material thickness for aluminum, 0.5× for mild steel.
Inconsistent bend directions requiring part flipping Bends in multiple directions that force the brake operator to flip and reposition the part repeatedly.	Each reorientation adds setup time and increases the risk of dimensional error. Design bends in a consistent direction where possible.
Designing sheet metal parts that should be machined (or vice versa) Using sheet metal for a part that requires 3D contoured surfaces, or CNC machining a simple bracket that could be laser-cut and bent.	Wrong process choice inflates cost. Flat profiles with bends = sheet metal. Complex 3D surfaces and thick cross-sections = CNC. Consult your manufacturer early.
Specifying weld quality beyond functional requirements Calling out cosmetic full-penetration welds on internal structural joints that will never be visible.	Cosmetic welds require grinding and finishing, adding labor. Specify structural weld requirements only; reserve cosmetic callouts for visible exterior joints.





Photochemical Machining/Etching

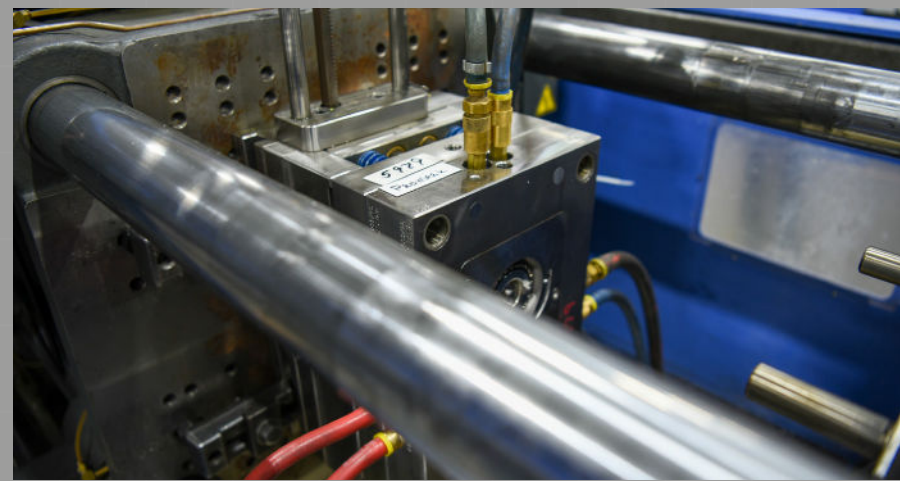
EMI/RFI shields, flex circuit stiffeners, battery contacts, thin gaskets, screens, filters, encoder discs, spring features.

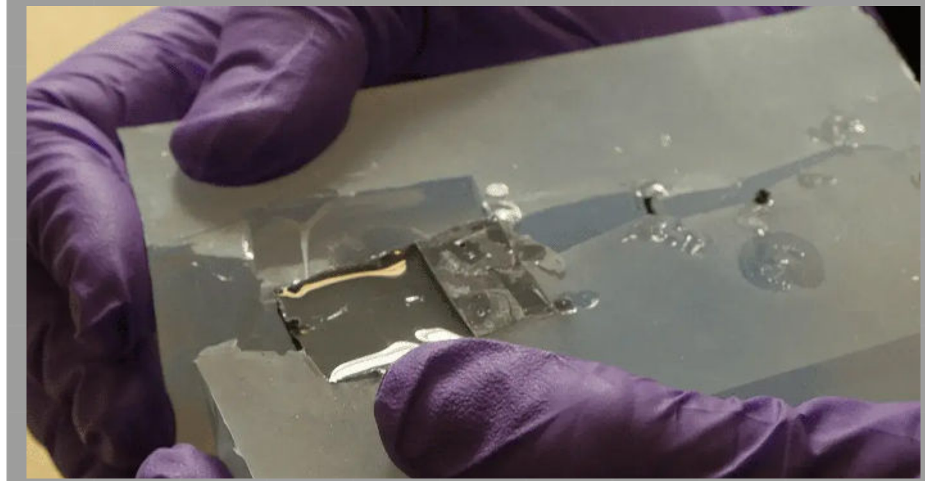
DFM Red Flags	Why It Matters For sUAS
Material thickness outside the sweet spot Photochemical machining works best on metals from 0.001" to 0.060" thick. Thicker materials etch slowly and lose edge definition.	Edge profiles become increasingly tapered above 0.040". For thicker parts, CNC machining or laser cutting is more economical and precise.
Feature sizes smaller than the material thickness Minimum feature width and spacing should be ≥1× material thickness for reliable etching.	Features narrower than material thickness risk under-etching or incomplete formation. Adjust geometry or select a thinner gauge.
Assuming stamping-like tolerances on etched features Etching typically holds ±0.001" per side or ±15% of material thickness, whichever is greater and not the ±0.0005" of precision stamping.	Over-specifying tolerance adds cost through tighter process controls or rejects parts unnecessarily. Align tolerances with what the process can hold.
Not leveraging the tooling advantage for design iteration Unlike stamping (which requires a new die for each design change), photochemical machining uses a photo mask that costs a fraction as much to revise.	If your sUAS design is still iterating between Gauntlet phases, photochemical machining lets you change part geometry for the cost of a new mask and not a new die.

Injection Molding

Common drone components: Airframe shells (at volume), propeller hubs, connector housings, control-surface linkages, lens bezels, switch housings.

DFM Red Flags	Why It Matters For sUAS
Non-uniform wall thickness Thick-to-thin transitions cause differential cooling rates, leading to sink marks on the outside and internal voids.	Warped, visually defective, and dimensionally unstable parts. Design uniform nominal wall thickness (typically 1.5–3.0 mm for drone-scale parts) and use coring to remove thick sections.
Insufficient or missing draft angles Vertical walls with 0° draft cannot release from the mold without scuffing, sticking, or requiring excessive ejection force.	Causes surface damage, ejection marks, and mold wear. Apply a minimum of 1° draft per side on all surfaces parallel to the pull direction; 2°+ for textured surfaces.
Undercuts that require side actions or lifters Internal hooks, snap-fits, lateral holes, or recesses that prevent straight mold pull require complex, costly tooling mechanisms.	Each side action adds $3,000–15,000+ to mold cost and introduces a maintenance point. Redesign undercuts as post-molded snap assemblies or through-holes accessible from the parting line.
Ribs thicker than 60% of the adjoining wall Freestanding bosses for screws or heat-staked inserts that lack gussets, have walls too thick, or trap air during fill.	Sink marks weaken and mar cosmetic surfaces. Size ribs at 50–60% of nominal wall thickness and taper them with 0.5–1° draft.
Boss design without adequate support or venting 100% CMM inspection of all dimensions on 30,000 units is neither practical nor affordable.	Bosses crack under fastener torque or develop voids. Connect bosses to nearby walls with ribs, keep boss wall thickness at 60% of nominal, and ensure venting.
Committing to steel tooling before design is frozen Cutting a production mold while the sUAS design is still changing between Gauntlet phases.	Mold modifications (steel-safe cuts only) are limited and expensive; non-safe changes require a new mold. Use cast urethane or 3D printing for bridge production until the design stabilizes, then commit to steel tooling.
Ignoring gate and parting-line location on cosmetic surfaces Gate vestiges and mold parting lines left on visible surfaces of the drone.	Requires secondary finishing (sanding, painting) and adds cost. Work with your molder early to locate gates and parting lines on non-cosmetic faces.





Cast Urethane Molding

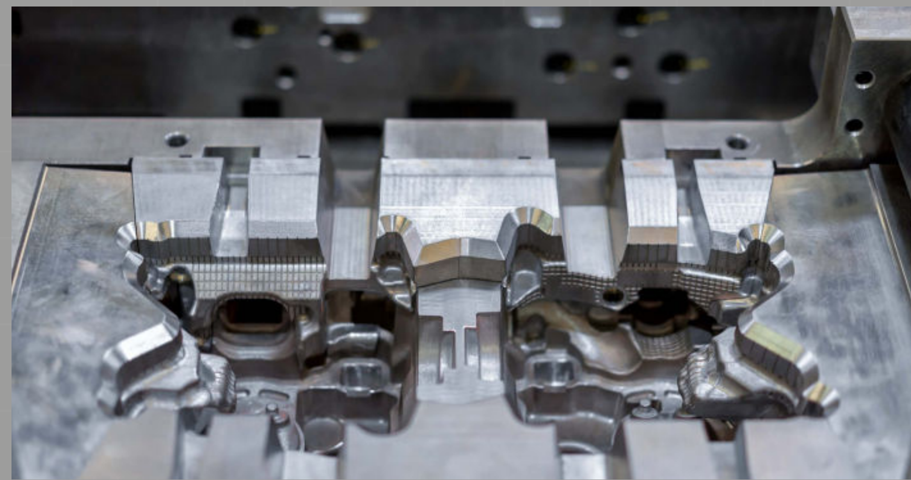
Common drone components: Bridge-production housings, vibration-dampening mounts, bumpers, overmolded grips, sealing components, prototype enclosures.

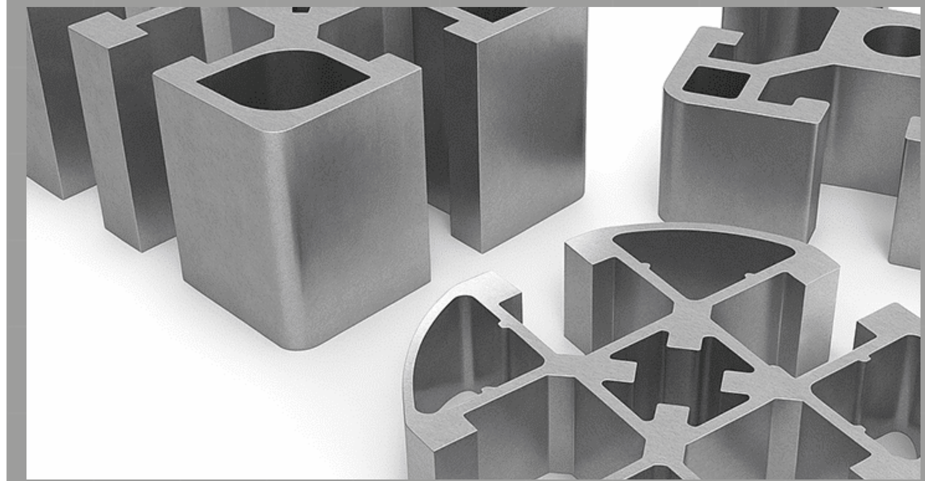
DFM Red Flags	Why It Matters For sUAS
Designing for urethane as if it were injection molding Urethane casting uses silicone molds with a limited life (~25 shots per mold) and cannot hold injection-mold tolerances.	Expect ±0.005"/inch vs. ±0.002" for injection. Design for the process; save tight-tolerance features for secondary machining if needed.
Planning for high volumes on urethane tooling Silicone molds degrade; producing 1,000+ parts requires multiple molds and becomes cost-prohibitive vs. injection molding.	Urethane is ideal for 10–500 unit bridge runs. For Gauntlet-scale volumes (30,000+), plan the transition to injection molding from the start.
Thin walls or deep cores that flex in a silicone mold Silicone tooling is flexible; tall thin cores can shift during pour, causing wall thickness variation.	Inconsistent wall thickness and potential leaks in sealed components. Keep core aspect ratios below 3:1 or add locating features to the mold design.

Die Casting

Common drone components: Motor housings, structural hubs, gimbal frames, gearbox enclosures, wing-to-fuselage interface fittings

DFM Red Flags	Why It Matters For sUAS
Insufficient draft on die cavity walls Die casting requires more draft than injection molding typically 1–3° minimum, depending on depth and alloy.	Insufficient draft causes die sticking, galling, and short die life. Apply generous draft early in the design.
Sharp corners and abrupt section transitions Sharp internal corners concentrate stress in both the part and the die, and create turbulent metal flow during fill.	Leads to hot spots, porosity, cracks, and premature die failure. Use generous fillets (minimum 1 mm radius) at all intersections.
Porosity-sensitive features in as-cast condition Standard die casting entraps air; critical sealing surfaces or high-fatigue zones may contain subsurface porosity.	For flight-critical drone components, specify vacuum die casting to minimize porosity, or plan for impregnation treatment on sealing surfaces.
Designing die-cast parts for low volumes Die casting tooling is expensive ($15,000–100,000+). At low volumes, per-unit amortization makes it cost-prohibitive.	Die casting becomes cost-effective above ~5,000–10,000 units. For lower volumes, consider CNC machining or investment casting and transition to die casting at Gauntlet production scale.





Extrusion (Metal & Plastic)

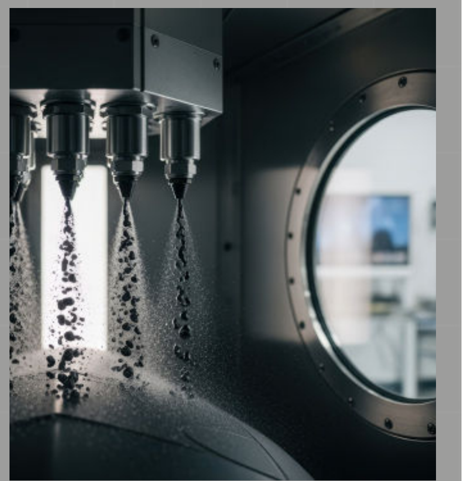
Common drone components: Structural rails, frame members, heat-sink profiles, antenna mast sections, cable conduit, wire harness channels, edge protection.

	DFM Red Flags	Why It Matters For sUAS
+	**Wall thickness variation beyond process capability** Extrusion requires relatively uniform wall thickness. Large thick-to-thin transitions cause uneven material flow and cooling distortion.	Bowing, twisting, and dimensional inconsistency in the extruded profile. Keep wall thickness as uniform as possible; use a max 3:1 ratio between thickest and thinnest sections.
+	**Asymmetric profiles without balancing geometry** Highly asymmetric cross-sections pull and twist as they cool because one side shrinks faster than the other.	Requires costly straightening operations. Where possible, add symmetry or counterbalancing geometry to the profile cross-section.
+	**Specifying extrusion for parts that need 3D geometry** Extrusion produces constant cross-section profiles only. If the part requires varying cross-sections along its length, it's not an extrusion candidate.	Choose CNC machining or die casting for parts with 3D geometry. Use extrusion for rails, channels, and structural members with consistent profiles, then machine features as secondary operations.
+	**Over-specifying surface finish on concealed profiles** Calling out anodize-quality finish on structural rails hidden inside the airframe.	Adds cost with no functional benefit. Specify finish requirements only where the profile is visible or where corrosion protection is needed.

Wire EDM / Sinker EDM

Common drone components: Precision slots, locking features, keyways, tight-tolerance connector housings, injection mold cavities for drone components.

DFM Red Flags	Why It Matters For sUAS
Specifying EDM when conventional machining can achieve the same result EDM is slow and expensive per hour. Using it for features that a standard end mill could cut wastes budget.	Reserve EDM for truly hardened materials (>45 HRC), ultra-tight tolerances (±0.0002"), or geometries impossible for rotary cutters (sharp internal corners, deep narrow slots).
No start-hole consideration for wire EDM Wire EDM requires a starting hole for the wire to thread through. If the start hole location isn't designed in, it must be drilled — adding a setup.	Pre-drill start holes in a prior CNC operation to eliminate an extra handling step and reduce total lead time.
Excessive part thickness for wire EDM Wire EDM can cut thick stock, but cutting speed drops significantly as thickness increases. A 4"-thick block cuts at a fraction of the speed of a 0.5" piece.	Cost scales roughly linearly with thickness. If possible, rough-machine the part closer to final dimensions first, then use EDM only for the precision features.



Assembly, Finishing & Inspection

Common drone components: Subsystem integration, surface treatments, coatings, heat treatment, testing and documentation for all drone components.

DFM Red Flags	Why It Matters For sUAS
Designing assemblies with no alignment or self-locating features Parts that require an assembler to visually align and hold components in position during fastening.	Increases labor time, introduces assembly variability, and complicates automated inspection. Design pilot holes, locating pins, chamfer guides, or keyed features so parts can only go together one way.
Specifying finishes before understanding the full assembly sequence Anodizing a part before it's welded (anodize must be applied after welding) or painting before press-fitting inserts.	Requires masking, stripping, or re-finishing — all adding cost and delay. Map the full assembly and finishing sequence before specifying surface treatments.
Calling out MIL-spec finishes without confirming the specific spec Saying "anodize per MIL-A-8625" without specifying type (I, II, III), class, or color leaves interpretation to the finisher.	Ambiguous specs cause rework, rejects, and disputes. Specify the exact MIL-spec type, class, thickness, and color to ensure the right corrosion/wear protection for the operating environment.
No inspection datum scheme designed into the part Parts with no clear primary, secondary, and tertiary datum surfaces for CMM or fixture-based inspection.	Inspectors must improvise fixturing, introducing measurement uncertainty. Design GD&T datum features from the start so parts can be consistently and repeatably inspected.
Requiring full dimensional inspection on every part at volume 100% CMM inspection of all dimensions on 30,000 units is neither practical nor affordable.	Define a sampling plan (e.g., AQL-based) and identify critical-to-quality dimensions for 100% inspection vs. statistical sampling on the rest. Your manufacturer can help you design an efficient inspection protocol.

Ready To Put This Checklist To Work?

Fathom's applications engineers perform comprehensive DFM reviews on every project, identifying these red flags and dozens more that are specific to your part geometry, material, and production volume. It's part of our white-glove approach to manufacturing.

Whether you're preparing for a Drone Dominance Gauntlet or scaling an existing sUAS program, we can help you catch manufacturability issues early before they become production delays.

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