PROTOTYPING CHECKLIST

A Technical White Paper for Rapid Prototyping Professionals

Complete Fabrication Ltd

2026 Edition, revised October 2026

This checklist contains a lot of detail. The quickest way to the best prototype is to talk to us: call 01223 836837 or email info@compfab.co.uk, and we will give you advice based on 40 years of making prototypes.

© 2026 Complete Fabrication Ltd. All rights reserved.

Executive Summary

This white paper is a technical reference for the key decision points in a rapid prototyping job, from getting the CAD file ready through to final finishing. Each item gives practical guidance, with figures from our own workshop where we have them and typical industry values elsewhere.

Rapid prototyping covers a range of additive and subtractive processes (FDM, SLA, DLP, Carbon DLS, SLS, MJF, PolyJet and CNC machining), and each has its own limits on geometry, resolution, material and finish. In our Whittlesford workshop we run SLA, Carbon DLS, DLP, FDM, CNC machining and vacuum casting, with painting and finishing in-house; SLS and MJF parts are sourced through partners. Mistakes at any stage of preparation can lead to failed builds, inaccurate parts, extra finishing cost or a complete rework.

Most of those problems start before the build, in the CAD file or the brief. Checking the points in this document before you send a job is the cheapest way to avoid them, and we check every file for printability before it goes to print and flag anything that could cause a problem.

1. CAD File Preparation

1.1 CAD Resolution and Triangle Count

All major prototyping processes use tessellated mesh formats (most commonly STL or OBJ) in which curved surfaces are approximated by triangular facets. The quality of that approximation is governed by two output parameters: chord height (sometimes called sag or deviation tolerance) and angular deviation.

A chord height of 0.01 mm to 0.05 mm is appropriate for most industrial prototypes. Tighter values produce smoother curved surfaces but generate exponentially larger file sizes and slower slice times. Angular deviation should typically be set between 0.5° and 1.0°.

Application	Recommended Chord Height	Typical Triangle Count	Approx. File Size
Consumer product (visual)	0.02 mm	200k – 800k triangles	10 – 40 MB
Mechanical fit part	0.05 mm	50k – 200k triangles	3 – 10 MB
Jewellery / fine detail	0.005 mm	1M – 5M triangles	50 – 250 MB
Large structural component	0.1 mm	20k – 100k triangles	1 – 5 MB

Very high triangle counts slow file handling without improving the part. Below about 0.02 mm chord height, extra facets rarely show on FDM or SLA parts.

1.2 Closed Surfaces (Watertight Geometry)

A valid printable mesh has to be topologically closed: every edge has to be shared by exactly two faces, and the mesh has to enclose a definable interior volume. Open shells, non-manifold edges, reversed normals, and intersecting bodies are the four most common geometry faults picked up during pre-processing.

© 2026 Complete Fabrication Ltd. All rights reserved.

Mesh errors are common in raw CAD exports. Repair tools such as Materialise Magics, Netfabb and Meshmixer fix most of them automatically, but complex faults such as overlapping shells or inverted volumes need manual work.

- Reversed normals cause the slicer to misidentify inside and outside surfaces, leading to hollow walls or inverted features.
- Non-manifold edges (three or more faces meeting at one edge) create ambiguous geometry that most slicers cannot resolve.
- Internal voids left from boolean operations can trap uncured resin (SLA/DLS) or unsintered powder (SLS). For hollow SLA parts, add at least two drain holes of 3 mm or more.

1.3 Fit Tolerance

Fit tolerance is the clearance between mating parts. Each process shrinks, warps or prints holes undersize in its own way, so fit allowances must be designed in. On our SLA parts, allow 0.1 to 0.2 mm clearance between mating parts; holes print about 0.05 mm undersize, and the smallest reliable hole is 0.4 mm. Minimum walls are 0.4 mm where supported and 0.8 mm unsupported, and text needs 0.4 mm if embossed or 0.6 mm if engraved. For most jobs a 0.1 mm offset is enough, but fits depend on many factors, so talk to us about critical ones.

Process	Typical Dimensional Accuracy	Recommended Clearance (slip fit)	Recommended Clearance (press fit)	
FDM	±0.4 mm (our guide)	0.2 – 0.3 mm per side (test it)	Test on a sample	
SLA / DLP	±0.15 mm (our SLA)	0.1 – 0.2 mm	Test on a sample	
SLS (Nylon PA12)	±0.1 – 0.3 mm	0.2 – 0.4 mm per side	0.0 – 0.1 mm per side	
PolyJet	±0.025 – 0.05 mm	0.05 – 0.15 mm per side	−0.025 – 0.0 mm per side	
CNC Machined	±0.10 mm (our standard)	0.02 – 0.05 mm per side	−0.01 – 0.02 mm per side	
Carbon DLS	Discuss at quote	Discuss at quote	Discuss at quote	

1.4 Boss Sizes

Bosses (cylindrical protrusions used to take screws, heat-set inserts, or snap-fit features) need process-specific sizing. Printed bosses behave differently from injection-moulded equivalents because of anisotropic strength and layer adhesion mechanics.

General design rules for printed bosses:

- Minimum boss outer diameter: 2.0× the fastener nominal diameter (e.g., M3 screw = 6 mm OD minimum).
- Wall thickness of boss: 0.8× the inner diameter minimum to prevent splitting under torque.
- Boss height: no more than 3× its outer diameter without gusset reinforcement.

© 2026 Complete Fabrication Ltd. All rights reserved.

- Heat-set insert bosses: size the bore to the insert maker's recommendation for the material and process.
- Carbon DLS bosses: ask us for bore sizes for press-fit inserts. Carbon describes DLS parts as having consistent properties in every direction, so pull-out strength depends less on build orientation.

On SLA parts we usually bond threaded inserts in place. For a printed thread, model it in the CAD and we clean it up with a tap; cast parts always take inserts.

1.5 Paint Tolerance

Any surface that will be painted needs an allowance for paint thickness, especially mating faces, snap fits and boss bores. These figures are from our paint shop for small, high-fidelity models; larger parts take more paint, but it matters less at that scale.

Coating Type	Typical System	Typical Total Build	Design Allowance
High-gloss finish	Primer, colour and gloss lacquer	About 0.2 mm	Allow 0.2 mm on mating faces
Satin, matt or spark finish	Primer and colour	0.1 – 0.15 mm	Allow 0.1 – 0.15 mm on mating faces

2. Build Parameters

2.1 Build Envelope Size and Part Positioning

The build envelope sets the largest part a machine can make in one piece, and where a part sits in it affects supports, surface quality and accuracy. These are the largest parts we make in one piece. Bigger parts can be made in sections and joined; our largest sculptures were made this way.

Technology	Largest Part (mm)	Notes	
SLA	450 × 450 × 450	In MPC12 on our largest machine; large parts need planning	
FDM (open frame)	800 × 800 × 1,000	PLA, PETG and TPU	
FDM (enclosed)	340 × 320 × 340	Engineering materials, depending on the part	
CNC machining	762 × 406 × 508 travel	Haas VF-2SS 4-axis mills	
Vacuum casting	800 × 550 × 550	Single casting, up to a 3.5 kg shot	
Paint shop	1,000 × 2,000 panels; 1,000 × 1,000 × 600 parts	Largest parts we can spray	

Nesting many parts in one build is common in SLS and MJF because the powder supports every part. In SLA, FDM and Carbon DLS, each extra part needs its own supports, so batch layouts are planned to keep supports off show faces.

© 2026 Complete Fabrication Ltd. All rights reserved.

2.2 Build Orientation (Horizontal vs. Vertical)

Part orientation during the build is one of the highest-impact decisions in rapid prototyping. It directly affects mechanical strength, surface quality on critical faces, support volume, build time, and the risk of delamination or warping.

- Vertical build (tall in Z): saves bed space, but FDM parts are weaker between layers, and Z-direction strength in FDM can be much lower than in-plane strength.
- Horizontal build (part laid flat): usually gives stronger parts and a better surface finish on top and bottom faces, but takes up more build plate area and often needs more supports for overhangs.
- 45° orientation: a common compromise that keeps support volume down and runs layer lines away from critical stress directions.
- Carbon DLS: Carbon describes DLS parts as having consistent properties in every direction, so orientation is driven mainly by supports and show-face quality rather than strength.

For functional FDM parts, orient so the main load runs along the layers (in the XY plane), not across them. This matters much less for Carbon DLS parts.

Orientation	Surface Quality (A-face)	Strength (Z-axis load)	Support Volume	Typical Use Case
Flat / Horizontal	Excellent	High (XY plane load)	High	Visual show models, flat panels
Vertical / Upright	Good (sides), Poor (top)	Low	Low	Tall thin features, cylinders
45° diagonal	Good	Medium	Medium	Functional brackets, clips
Custom (per feature)	Excellent on target face	Variable	Variable	Precision mating surfaces

2.3 Material Choice

Material choice affects every downstream decision. It determines post-processing options, surface finish, mechanical properties, chemical resistance, and regulatory compliance. The main things to weigh up are: mechanical requirements, thermal environment, aesthetic requirements, and any end-use testing requirements.

Material	Process	Tensile Strength	Heat Deflection Temp.	Best Use Case
PLA	FDM	37 – 60 MPa	52 – 65°C	Visual models, low-stress parts
ABS	FDM	30 – 45 MPa	80 – 100°C	Functional housings, snap fits
ASA	FDM	33 – 48 MPa	95 – 108°C	Outdoor / UV-resistant models
PA12 (Nylon)	SLS (via partners) / FDM	45 – 55 MPa	150 – 175°C	Functional mechanical parts

© 2026 Complete Fabrication Ltd. All rights reserved.

Accura Xtreme	SLA	38 – 44 MPa	62 °C	Tough functional prototypes, snap fits
MPC12	SLA	50 – 56 MPa	49 °C	Clear functional parts, master patterns
PETG	FDM	48 – 53 MPa	70 – 80°C	Transparent parts, food-contact
TPU / TPE	FDM / SLS	25 – 50 MPa	60 – 90°C	Gaskets, grips, flexible parts
PC (Polycarbonate)	FDM	55 – 72 MPa	110 – 130°C	High-temp enclosures, optics
Glass-filled PA12	SLS (via partners)	70 – 85 MPa	180 – 200°C	Structural, under-bonnet parts
Carbon EPX 82	Carbon DLS	80 MPa	130 °C	Rigid functional and end-use parts
Carbon EPU Pro 50 / 90	Carbon DLS	14 / 22 MPa	n/a	Seals, grips and flexible parts
Carbon MPU 100	Carbon DLS	35 MPa	50 °C	Biocompatible, sterilisable functional parts

SLA and Carbon DLS figures are from the resin makers' data sheets for materials we run. Our Carbon resins are EPX 82, RPU 70, EPX 86FR (flame-retardant), FPU 50, EPU 40, EPU 45, EPU Pro 50 and 90, MPU 100 and SIL 30. MPU 100 and SIL 30 are biocompatible; see our Biocompatible Resins and Medical-Grade Polymers white paper for their test data.

2.4 Surface Finish

Surface finish is usually specified as Ra (average roughness, in µm). As printed, PolyJet, SLA and Carbon DLS parts are the smoothest, powder-bed SLS and MJF parts are grainy, and FDM parts show visible layer lines. Our SLA parts are bead blasted as standard for a uniform matte finish, and any process can be sanded, primed and painted to a show finish.

A Class-A, high-gloss show finish needs sanding, primer surfacer, wet flatting and polishing, whatever the process. Starting from a smoother process such as SLA or Carbon DLS cuts the hand-finishing time.

2.5 Support Positions

Support structures are necessary for any overhanging geometry below the self-supporting angle of the process (typically 45° for FDM, 25–30° for SLA and Carbon DLS). Poorly planned supports cause surface damage on contact faces, increase post-processing time, and can introduce distortion when removed.

- Tree supports (FDM/SLA/DLS): touch the model at minimal points, which cuts witness marks and removal time.
- Block/lattice supports (FDM): stronger but leave larger contact scars; suitable for non-visible faces.
- Soluble supports (PVA/HIPS in FDM, wax-jet in PolyJet): allow complex internal channels and eliminate removal damage.

© 2026 Complete Fabrication Ltd. All rights reserved.

- SLS/MJF: powder acts as self-support; no dedicated support structures required for most geometries.
- Carbon DLS: supports are generated by Carbon's print-preparation software and removed by hand after washing. Flag critical show faces in your brief so supports can avoid them.

When specifying support positions, identify the A-surfaces (see Section 2.6) so supports can be kept off them.

2.6 A-Surface Identification

A-surfaces are the primary visible or functional surfaces of a prototype: the faces that will be seen, touched, or measured by the end client. Identifying A-surfaces at the CAD stage lets the print team optimise orientation (placing A-surfaces on the underside or towards the best-resolution axis), keep supports off those faces, and concentrate post-processing effort where it counts.

- Mark A-surfaces in the CAD model using a distinct colour, material designation, or annotation layer before exporting.
- Communicate A-surfaces explicitly in the job brief, with photographs or annotated renders if possible.
- For multi-part assemblies, identify primary, secondary and tertiary A-surfaces. Primary: seen in normal use. Secondary: visible on close inspection. Tertiary: internal or structural.

2.7 Build Layer Thickness / Resolution

Layer thickness directly controls vertical resolution, as-printed surface roughness on angled faces, and build speed. Thinner layers produce smoother results but increase build time and can reduce mechanical stability of very tall features.

Process	Minimum Layer Thickness	Standard Layer Thickness	Maximum Layer Thickness	Time Impact (0.1→0.2 mm)	
FDM	0.05 mm	0.12 – 0.28 mm	0.4 mm	~50% faster	
SLA	0.025 mm	0.05 mm (our standard)	0.2 mm	~50% faster	
DLP	0.025 mm	0.05 – 0.1 mm	0.15 mm	~40% faster	
SLS	0.08 mm (fixed)	0.1 mm (fixed)	0.12 mm	Fixed, not adjustable	
PolyJet	0.014 mm	0.027 – 0.032 mm	0.032 mm	Minimal variation	
MJF	0.08 mm (fixed)	0.08 mm	0.08 mm	Fixed	
Carbon DLS	Continuous process	n/a	n/a	Not layer-based	

2.8 File Type

© 2026 Complete Fabrication Ltd. All rights reserved.

File format affects geometry fidelity, colour information and how easily the file moves between software. We accept STL, STEP, IGES and native CAD files, and for Carbon DLS, STL or STEP is all we need.

File Format	Primary Use	Supports Colour	Supports Multi-material	Notes	
STL (Binary)	Universal prototyping	No	No	Most common for printing	
STL (ASCII)	Debugging only	No	No	Use binary instead	
OBJ + MTL	Colour models, visual review	Yes (texture map)	Partial	Colour texture models	
3MF	FDM (Bambu, Prusa, MakerBot)	Yes	Yes	Can carry print settings	
AMF	Multi-material, colour	Yes	Yes	Rarely used	
STEP / STP	CNC machining, hybrid workflows	No	No	Best for CNC and editing	
VRML / WRL	Full-colour PolyJet	Yes	Yes	Full-colour PolyJet	

STL binary format remains the most universally supported export. 3MF is rapidly becoming the preferred standard for FDM workflows due to its compact size and ability to carry print settings alongside geometry.

2.9 Build Speed

Build speed depends on layer count, layer area and curing steps. Carbon DLS cures continuously rather than layer by layer, so it is quick for small, complex parts. In practice the schedule matters more than machine speed: our SLA jobs usually print overnight, CAD received by 5:30 pm is usually delivered the next day when capacity allows, and painting or polishing adds at least a day.

For time-critical projects, tell us the deadline at quote so we can plan the build, finishing and delivery together.

3. Painting and Surface Finishing

3.1 Paint-on-Paint Finish

Achieving a high-quality painted finish on rapid prototypes requires systematic layering: substrate preparation, primer, colour coats, and clear lacquer. Each stage must be allowed to cure fully before the next is applied, as premature recoating causes solvent trapping, blistering, and adhesion failure.

Recommended paint system for prototype models:

© 2026 Complete Fabrication Ltd. All rights reserved.

- Step 1 - Substrate preparation: sand printed surface to 240–400 grit, then degrease with isopropanol or acetone (use IPA only on SLA, resin, and DLS parts).
- Step 2 - Adhesion promoter (optional but recommended for PP-like or waxy surfaces): apply 1 thin coat, allow 10 minutes flash-off.
- Step 3 - Primer surfacer (2K or high-build): 1–2 coats, with flash-off between coats and a full cure before sanding.
- Step 4 - Wet flat primer with 800 grit. Re-prime any sanded-through areas.
- Step 5 - Colour coat (2K polyurethane or automotive base coat): 2–3 medium coats, 10–15 minutes flash between coats.
- Step 6 - Clear lacquer / top coat: 2 coats, fully cured before handling.

Two-pack (2K) systems are harder and more chemical-resistant than single-pack paints. 2K lacquer is the most durable finish we apply, and we recommend it for any prototype that will be handled or tested.

SLA and Carbon DLS parts start smoother than FDM parts, so they usually need less sanding before primer.

3.2 Paint Thickness and Its Dimensional Implications

Paint adds thickness that has to be treated as part of the design. On display models it rarely matters, but on any part that assembles with another, even 0.1 mm can cause interference. Our paint shop allows about 0.2 mm for high gloss and 0.1 to 0.15 mm for satin, matt and spark finishes on small, high-fidelity models. As a guide to time, one high-gloss part takes 2 to 3 days, 20 parts 5 to 6 days and 100 parts 20 to 25 days.

For assemblies that will be painted, increase nominal clearances by the paint allowance on each painted mating face. Mask threads, bores and snap-fit features before painting, or clean them up afterwards.

4. Medical Grade Requirements

4.1 Regulatory Framework

Prototypes intended for use in medical contexts (handled by clinical staff, in contact with patients, used in surgical simulation, or submitted as part of a regulatory filing) have to meet a more demanding set of material and process requirements than general-purpose prototypes.

The principal regulatory frameworks governing medical device prototypes are:

- ISO 10993 (Biocompatibility): defines a series of tests for cytotoxicity, sensitisation, irritation, and systemic toxicity for materials intended for patient contact.
- ISO 13485: the quality management system standard for medical device manufacturing. Prototyping facilities supplying to regulated customers may need certification.
- US FDA Quality Management System Regulation (21 CFR Part 820): in force from February 2026, it incorporates ISO 13485 by reference.
- EU MDR 2017/745: the Medical Device Regulation governing devices placed on the European market, including rules on materials and testing evidence for regulatory submissions.

Not all rapid prototyping materials are biocompatible. Verification of ISO 10993 compliance has to come from the material manufacturer; it can't be assumed based on material type alone.

© 2026 Complete Fabrication Ltd. All rights reserved.

4.2 Biocompatible Materials for Prototyping

Only a small subset of prototyping materials carry validated biocompatibility testing. The choice should be made together with the client's regulatory team, as the right testing tier depends on the type and duration of patient contact.

Material	Process	ISO 10993 Status	Contact Type Supported	Notes
MED610 (PolyJet)	PolyJet	ISO 10993-3, -5, -10, -18; USP Class VI	Permanent skin; short-term mucosal	Stratasys data sheet
BioMed Clear (SLA)	SLA	ISO 10993 and ISO 7405 evaluated	Skin and mucosal (see data sheet)	EtO, gamma, e-beam, autoclave
BioMed Durable (SLA)	SLA	USP Class VI; ISO 10993 evaluated	Long-term skin contact	Formlabs data sheet
MPU 100 (Carbon DLS)	Carbon DLS	ISO 10993-4, -5, -10, -23; USP <88>	Skin contact, single-use instruments	We run this in-house; EtO, e-beam, gamma; autoclave only if unloaded
SIL 30 (Carbon DLS)	Carbon DLS	Biocompatible (Carbon data)	Skin contact	We run this in-house; soft, Shore A 35
PEEK (FDM/CNC)	CNC machining / FDM	Implant grades have a long clinical history	Implant-grade applications	We machine prototypes from solid stock

Carbon MPU 100 is the main biocompatible material we print. Carbon's test data cover ISO 10993-4, -5, -10 and -23 and USP <88>, and parts can be sterilised by EtO, e-beam or gamma, or autoclaved if under no load. For full details, see our Biocompatible Resins and Medical-Grade Polymers white paper.

4.3 Post-Processing and Sterilisation

Medical prototype post-processing must consider sterilisation compatibility. Not all materials survive common sterilisation methods, and sterilisation can alter dimensional accuracy and mechanical properties.

Sterilisation Method	Max Temperature	Compatible Materials	Effect on Printed Parts
Autoclave (steam, 134°C)	134°C	PEEK, metal SLM, glass-filled PA	Most polymers warp; check the maker's data, as some medical resins are autoclavable
EtO (ethylene oxide gas)	< 60°C	Most polymers, Carbon MPU 100	Residual EtO must outgas; cycle adds 24–48 hrs
Gamma radiation	Ambient	PA12, PEEK, PC, metals, Carbon MPU 100	Can cause yellowing or embrittlement in some resins; MPU 100 compatible

© 2026 Complete Fabrication Ltd. All rights reserved.

VHP (vaporised H_2O_2)	< 40°C	Most polymers	Minimal dimensional impact; preferred for SLA/PolyJet
UV / plasma	Ambient (surface only)	All	Surface decontamination only, not terminal sterilisation

4.4 Traceability and Documentation Requirements

Medical projects typically require a higher level of build traceability than standard prototyping. The following documentation should be generated and retained for all medical-grade builds:

- Material batch/lot number and supplier certificate of conformity.
- Machine calibration records at time of build.
- Build log (start/end time, layer count, ambient conditions).
- Post-processing log (cleaning agent, duration, operator, date).
- Dimensional inspection report (CMM or calliper with measurement positions defined).
- Biocompatibility data sheets from material supplier.

If the prototype supports a regulatory filing (for example an FDA 510(k) or an EU MDR technical file), keep the fabrication record for the period the regulation sets, with a clear description of any deviations from the approved process.

5. Rapid Reference Checklist Summary

Use this consolidated checklist at each project stage to confirm all critical parameters have been reviewed before submitting a build job.

#	Checklist Item	Key Action	Status	
1	CAD resolution & triangle count	Set chord height 0.01–0.05 mm; verify file size is manageable	☐	
2	Closed / watertight surfaces	Run mesh repair; zero open edges, no non-manifold geometry	☐	
3	Fit tolerance	Apply process-specific clearance per fit type (see table)	☐	
4	Boss sizes	OD ≥ 2× fastener dia.; wall ≥ 0.8× bore; height ≤ 3× OD	☐	
5	Paint tolerance	Allow 0.1–0.2 mm on painted mating faces (see 1.5)	☐	
6	Build envelope & position	Part fits our largest sizes (see 2.1) or is split for joining	☐	
7	Build orientation	A-surface faces down or towards highest resolution axis	☐	
8	Material choice	Verified against mechanical, thermal & regulatory needs	☐	
9	Surface finish spec	Ra target defined; post-processing steps agreed	☐	

© 2026 Complete Fabrication Ltd. All rights reserved.

10	Support positions	Supports excluded from A-surfaces; soluble supports if required	☐	
11	A-surface identification	Annotated in CAD and communicated to build team	☐	
12	Layer thickness / resolution	Selected to balance quality and build time for application	☐	
13	File type	STL, STEP or native CAD; file checked before build	☐	
14	Build speed / schedule	Estimated build time reviewed against project deadline	☐	
15	Paint-on-paint system	Process and product system agreed; mating faces masked	☐	
16	Paint thickness	Dimensional compensation applied to relevant features	☐	
17	Medical grade requirements	ISO 10993 data confirmed; sterilisation method compatible	☐	
18	Carbon DLS process check	Confirm part compatible with DLS continuous print process; no trapped volumes; drain holes for hollow sections	☐	

References and Further Reading

- ISO 10993 Series, Biological evaluation of medical devices (ISO, Geneva).
- ISO 13485:2016, Medical devices: Quality management systems.
- Materialise, Magics User Guide and STL Repair Reference.
- Stratasys, PolyJet Technology Overview and MED610 Material Data Sheet.
- Formlabs, BioMed Resin Technical Documentation and ISO 10993 Reports.
- Carbon, Inc., MPU 100 Technical Data Sheet, Doc 108269-01 Rev F (June 2026).
- Carbon, Inc., resin technical data sheets (current editions).

© 2026 Complete Fabrication Ltd. All rights reserved.