PrintKinetic RESOURCE

Fits, Holes, and Moving Assemblies

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A hole modeled at 10.00mm in CAD does not print at exactly 10.00mm, and the direction and size of that error is consistent enough to plan for. Extrusion width, cooling contraction, and seam behavior around curved features tend to shrink internal circular features and can push external dimensions outward slightly, and the size of that error scales with nozzle diameter, material, and machine calibration. This guide connects five decisions that all depend on knowing that gap between nominal and actual size: clearance, press fits, hole compensation, threads, and clearance for moving parts.

Clearance is the starting concept everything else builds on. Two parts that need to slide or rotate against each other need a deliberate gap, and that gap has to survive both parts' dimensional error in the worst-case direction, not just the nominal difference between their modeled sizes. The Clearance Allowance Planner sets that gap based on the fit type (sliding, running, loose) and the printer's expected accuracy, rather than a single one-size-fits-all clearance value that works for some fits and binds on others.

Press fits go the opposite direction: instead of guaranteeing a gap, they guarantee interference, a small amount of intentional overlap that creates a friction hold once two parts are pressed together. Getting a press fit wrong in either direction fails differently: too little interference and the fit is loose and unreliable; too much and the part cracks during assembly or the mating part cannot be pressed in at all. The Press-Fit Allowance Planner calculates a safe interference range for a specific material's flexibility and expected accuracy, rather than reusing a rule of thumb from an unrelated material.

Hole compensation applies the same shrinkage-direction logic specifically to fastener and pin holes, where a hole even 0.2mm undersized can mean a bolt that will not thread through or a pin that will not seat. The Hole Compensation Planner works from the same printer-and-material accuracy assumptions as the clearance and press-fit planners so all three stay consistent, rather than treating hole sizing as an isolated guess made separately from every other fit decision on the same part.

Threads and moving assemblies push the accuracy question further, into features that see repeated stress or motion. Printed internal threads carry more risk than an inserted threaded fastener because they combine the dimensional-accuracy problem above with the layer-adhesion weakness that concentrates stress at the thread root; the Thread Strategy Planner weighs printed threads, tapped threads, and heat-set inserts against the assembly's actual reuse and load requirements. The Moving-Part Clearance Planner then applies the same accuracy assumptions to a hinge, slide, or rotating joint, where a clearance too tight binds or seizes and a clearance too loose introduces play the mechanism was not designed for.

Consider a hinge pin modeled to fit a 5.00mm hole with a 4.90mm pin, a clearance that looks generous on paper. On the printer that produced the part, internal circular features print roughly 0.2mm undersized due to seam and cooling behavior around curves, so the actual hole comes out closer to 4.80mm, smaller than the pin itself. The hinge binds completely on first assembly, not because the design was careless but because the nominal CAD dimension was never checked against this printer's actual circular-feature accuracy. Running the same geometry through the Clearance Allowance Planner with that printer's known accuracy would have surfaced the conflict before a wasted print, not after a binding hinge revealed it.

It is also worth separating a one-time fit from a fit that needs to survive repeated assembly and disassembly. A press fit that seats once and stays assembled permanently can use a tighter interference range than one meant to be taken apart and reassembled multiple times, because repeated insertion gradually wears the interference surface and loosens the fit. The Press-Fit Allowance Planner and Moving-Part Clearance Planner both ask for the assembly's expected reuse pattern specifically because a fit sized correctly for a one-time assembly can become loose or unreliable well before a design meant for repeated use would have been sized for in the first place.

A common mistake is trusting a calculated clearance or interference value without a test print on the specific printer that will produce the final part. These calculations use a reasonable estimate of typical FDM accuracy, but calibration, nozzle wear, and even ambient humidity shift the real number on any given machine. Treat a calculated fit as a well-informed starting point for one small test print, then adjust from what that test actually measures, not as a value guaranteed to work on the first attempt.

FAQ

Why do printed holes come out smaller than modeled?

Extrusion width, seam behavior, and thermal contraction around a circular hole tend to shrink it below the nominal CAD diameter. This is consistent enough to compensate for, but it is not zero.

Is a press fit that works on one printer safe to reuse on another?

Not without a check. Clearance and interference are sensitive to nozzle diameter, calibration, and material, so a tuned fit on one machine is a starting point, not a guarantee, on another.