Ultimaker white paper

3D printing: The total cost of ownership

Ultimaker

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Behind the price tag

At Ultimaker, we believe there should be no hidden costs behind a 3D printer's price tag. After all, 'leap of faith' can't be an expense in your department's budget.

That's why our 3D printing experts, with years of experience in testing, fixing, and printing parts on Ultimaker machines, have created this white paper. In it, we list the costs that can crop up when running a fused filament fabrication (FFF) 3D printing solution.

To make things easier, this document uses the Ultimaker S5 as an example.

Read on for a full cost breakdown of the 3D printing workflow. Our aim is to help you:

- Avoid getting locked into a 3D printing platform that drains your budget with hidden costs
- Feel confident to choose the most cost-effective 3D printing workflow for your business

Warranty and service

A warranty protects you against any mechanical hardware problems. If something goes wrong that wasn't your fault, the reseller or manufacturer should fix or replace your 3D printer at no cost — although you may be charged shipping costs. Manufacturers' warranties vary in duration and coverage, with some lasting six months, and others up to two years.

Regardless of duration, before signing a warranty, you should find out what is included in the manufacturer's definition of 'consumables'. These are the parts of the printer that will wear over time. Consumables should be listed in your warranty and will always fall outside of the warranty terms.

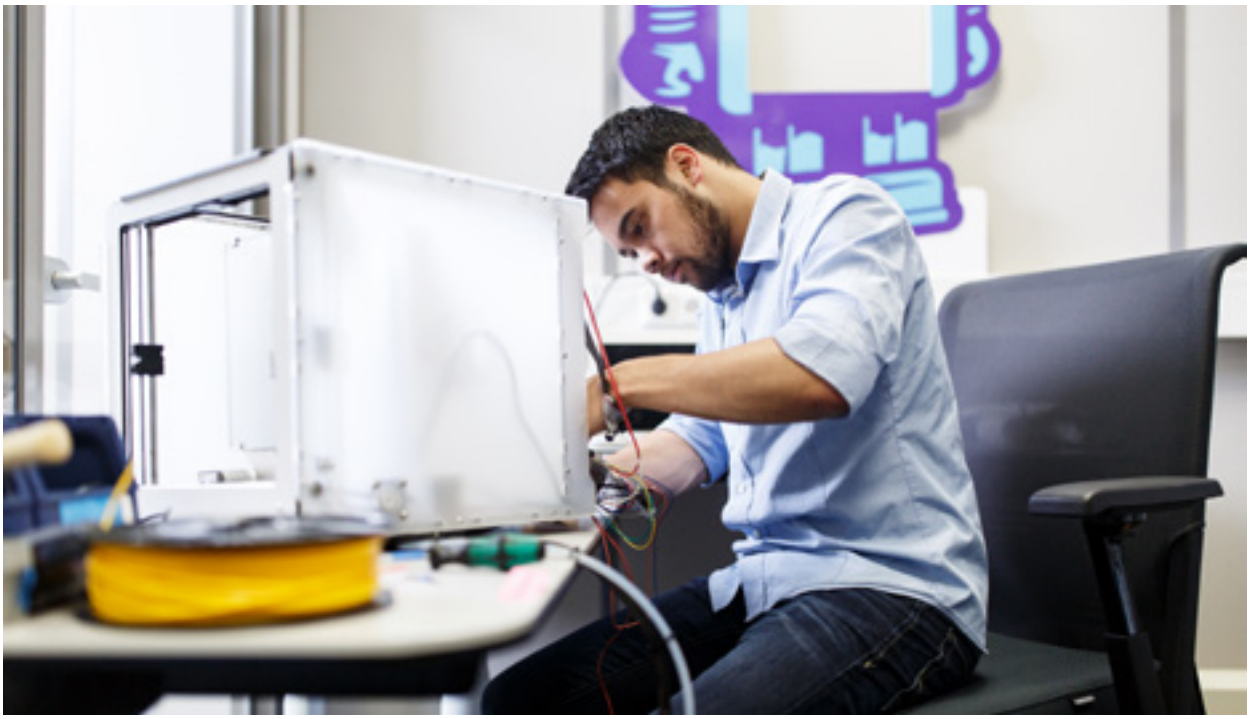
Ultimaker's factory warranty lasts for 12 months. If any of your printer's consumables break within this time, you will need to buy a replacement part. These include:

- Glass build plate
- Print cores (but not the print head)
- Silicone nozzle covers
- Bowden tubes

Some 3D printers use only their manufacturer's materials, and their warranty is made void by printing with third-party materials. But as part of Ultimaker's open filament system, we encourage 3D printing with third-party materials. Doing so will not void the manufacturer's warranty, but any parts damaged by the use of third-party filaments are excluded from the warranty.

Warranty extension

Some manufacturers will extend your warranty if you do so within a certain number of days from purchase. This provides greater security, but may result in slightly different terms and conditions. For example, you might only be allowed to extend your warranty as part of an annual service agreement.



Ultimaker hardware is designed so that regular maintenance can be performed by users

Service agreements

For an additional cost, some 3D printer manufacturers offer ongoing service agreements. Many follow a subscription model and include preventative maintenance performed by a certified technician. For some industrial 3D printers, these service agreements are mandatory. You can expect to pay between 15% and 20% of your 3D printer's purchase price annually for a service agreement.

Ultimaker 3D printers require little regular maintenance, and our hardware is designed so this can be performed by our users. Some Ultimaker distributors offer additional paid service plans. These technicians are trained and certified by Ultimaker, and offer expert support in your time zone and language.

Hardware costs

Reliability

Reliability can affect the cost of owning a 3D printer in two ways.

1. **Print reliability:** If your 3D printer is unreliable, you are more likely to reprint parts. This increases your running costs, material waste, and time spent troubleshooting. Conversely, a reliable printer can reduce costs and waste, while streamlining processes. And a higher print success rate means higher productivity.
2. **Hardware reliability:** With proper maintenance, your 3D printer should cope with your workload. This is critical, as repairs result in printer downtime. And when problems can't be fixed locally, the unit may be shipped to a service partner, meaning more lost time.

   Ultimaker 3D printers are highly reliable machines with a low repair rate. Our printers are also easy to fix, with our global network of trained Service Partners able to perform most repairs. So depending on your location, downtime for repairs is minimized.

Annual cost of maintenance

3D printers require regular maintenance to ensure optimal performance. While routine maintenance on some 3D printers can only be performed by a certified technician, you are able to maintain Ultimaker 3D printers yourself.

Based on a 3D printing activity range of 1,500 hours per year (one four-hour print per day, or a 29-hour print per week), we recommend performing the following maintenance tasks:

Monthly	Quarterly	Annually
Clean printer	Clean print cores	Lubricate feeder gear
Lubricate axles	Check tension of short belts	Replace Bowden tubes
	Check for play on axles	Clean system fans
	Check quality of nozzle cover	Lubricate hinges
	Lubricate lead screw Z motor	
	Clean feeders	
	Check for debris in front fan of print head	

These tasks can be performed in an hour or less, and require minimal resources: a microfiber cleaning cloth, household detergent, lubricant (included in the box), and two Bowden tubes (consumables).

Power consumption

The Ultimaker S5 features a 500 W power supply, but uses an average of 300 W (0.3 kWh) when printing. This calculation is based on printing a carbon-filled filament, with a nozzle temperature of 270 °C and a build plate temperature of 65 °C. While idle, the printer draws 25 W. Based on printing activity of 1,500 hours, you can expect to pay for roughly 450 kWh of electricity when running an Ultimaker S5.

Every Ultimaker S5 has an integrated power supply that is hipot tested before leaving our factory

Consumables

Consumables are those parts not covered by the warranty, and differ between manufacturers. How often you'll need to replace consumables depends on how often you use your 3D printer.

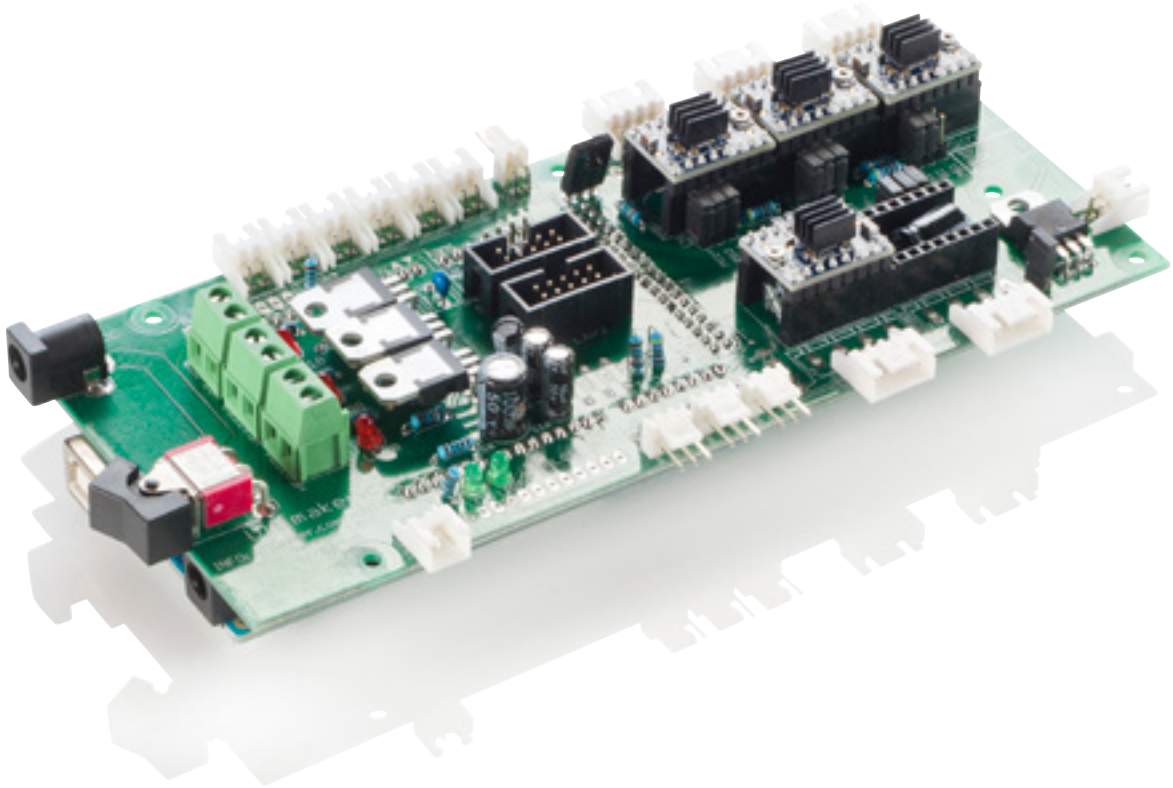
For example, depending on your usage of the Ultimaker S5, you may need to replace the following consumables:

- Silicon nozzle cover – €1.00 ($1.20)
- Glass build plate – €28 ($31.20)
- Print core – €99.95 ($114.95)
- Bowden tube – €23 ($27.60)

Spare parts

If any part of your 3D printer breaks after the warranty has expired, you will need to buy the spare parts to fix it. For this reason, legacy support and spare part availability are important considerations. If a 3D printer is discontinued, will the manufacturer continue to produce and stock spare parts, and for how long? You may find that some manufacturers do not, forcing you to buy a new machine.

For the few printers that Ultimaker has discontinued, we provide spare part support for up to three years beyond the discontinuation date.



Ultimaker will stock spare parts – like this circuit board – for up to three years after any product is discontinued

Material costs

FFF 3D printers use thermoplastic and composite materials to fabricate parts. The materials you choose will depend on your printed parts' property requirements. The average cost of material therefore differs, based on a number of variables.

Here are some questions that will guide you in forecasting your annual material costs:

- What is the average weight of your 3D printed parts (before post-processing)?
- What is the cost per gram of the required material?
- How many parts will you print per year?
- Does the material have a limited shelf life?
- Does your printed part need support material?
- Are any consumables required to ensure good first-layer adhesion (glue stick, adhesion sheets, adhesive spray, etc.)?
- What are the costs of post-processing? (See section 6)

Remember that prints can be optimized to use less material during the design and slicing phases, by:

- Using a reduced or gradual infill percentage
- Using a lightweight build plate adhesion structure (e.g. a brim rather than a raft)
- Changing the orientation to require less support material
- Optimizing the design to use less material
- Using a generative algorithm to reduce material usage, while maintaining strength (although such CAD software often carries a cost)

Waste

One of the advantages of additive manufacturing methods is that they generate less waste, with FFF generating the least of all.

Waste reduction methods include printing a prime tower for switching between dual extrusion print nozzles, cutting off a small amount of filament for proper extrusion, or simply cleaning the nozzle of an unwanted material or color.

Technologies such as selective laser sintering (SLS) and stereolithography (SLA) generate more waste. These machines use a container of thermoplastic powder or resin, which cannot be easily reused and must therefore be periodically disposed of.

Using economical material

Ultimaker 3D printers feature an open filament system, so a huge range of third-party 2.85 mm filaments can be used on our machines.

It might be tempting to reduce material costs by choosing the cheapest filament available. However, cheaper third-party filament may:

- Consist of lower grades of polymer, with different performance levels
- Contain lower-quality stabilizers or plasticizers
- Contain low-quality pigment, meaning more color has been used – effectively diluting the polymer
- Suffer from diameter variation, creating nozzle pressure changes that result in visible 3D printed artifacts
- Be poorly wound on the spool, resulting in tangled filament and disrupted prints

If you choose a 3D printer with a closed material system, the use of any third-party material will void your hardware warranty. If your part requires a material unsupported by your 3D printer, you risk needing to buy a different machine.

Software costs

Print preparation and slicing

Slicing software ‘slices’ your CAD design into 3D printable layers. In it, you can specify additional settings for your print, such as infill percentage, wall thickness, and scaling.

Some manufacturers charge extra for offline versions of this software, which can create a hidden cost. Freeware versions exist, but are unsuitable for those with IP theft concerns.

Ultimaker Cura is free to download for offline use, and designed to work seamlessly with Ultimaker 3D printers. Trusted by over 2,000,000 users worldwide, it is the leading print preparation software for FFF 3D printing. Ultimaker Cura can predict the print time and required material weight before starting a print, so you can use it to calculate the cost of a part before ever buying a 3D printer.

The Ultimaker S-line and Ultimaker Cura is a powerful combination trusted by leading manufacturers

Material profiles

Within Ultimaker Cura, optimized print profiles automatically adjust the software's slicing settings, based on the material selected. This eliminates a trial-and-error approach.

Ultimaker Cura users can download preconfigured print profiles, developed by the material's manufacturers. These include profiles for advanced engineering materials, and carbon- and glass-fiber reinforced composites, from leading materials companies such as:

- Arkema
- Clariant
- DSM
- Dupont
- LEHVOSS Group
- BASF
- Owens Corning
- Eastman
- Ensinger
- Igus
- Jabil
- Murtfeldt
- Solvay
- More being added regularly

3D printer management

Most 3D printers are network-enabled, allowing you to remotely manage print jobs. You can scale your output and increase efficiency by purchasing multiple 3D printers and centralizing print management via a network. This option is considered an enterprise feature by some manufacturers, and therefore a paid extra. If you wish to implement a scalable 3D printing workflow, this becomes a hidden cost.

Ultimaker's network-enabled S-line 3D printers feature free, pre-installed printer management software: Ultimaker Digital Factory. It allows you to manage print jobs from your desk or via a free smartphone app for Android and iOS.

Multiple print jobs can be queued and will start printing when a machine matching the required material setup becomes available. If you own different models within the S-line, the software is smart enough to know if a print job exceeds an S3's build volume, and wait for an available Ultimaker S5. Ultimaker Digital Factory also features analytics that show your print success rate, material usage, and uptime. These metrics help you forecast your annual 3D printing costs and improve your print group efficiency.

Post-processing

Post-processing can range from something as simple as snapping off a small brim, to an eight-hour sintering process using a dedicated post-processing unit. It can therefore take different amounts of time, and use a range of consumables, and generic or specialized tools. These include:

- Wet or dry sanding (requires sandpaper)
- Polishing (requires plastic polish compound)
- Gluing modular parts (requires a modeling or industrial adhesive)
- Painting (requires a layer of primer and a top coat)
- Screw threading (requires an off-the-shelf tool)
- Removing support material (requires pliers or a water bucket for soluble filament)
- Curing (requires isopropyl alcohol, a curing bath, and disposable hand protection)
- Sintering (requires a sintering oven)

FFF 3D printing is known as the most user-friendly of the three main 3D printing technologies. With the right design and material, minimal post-processing is required.

Different post-processing techniques demand a range of simple or specialized tools

Facility requirements

To varying degrees, 3D printers will:

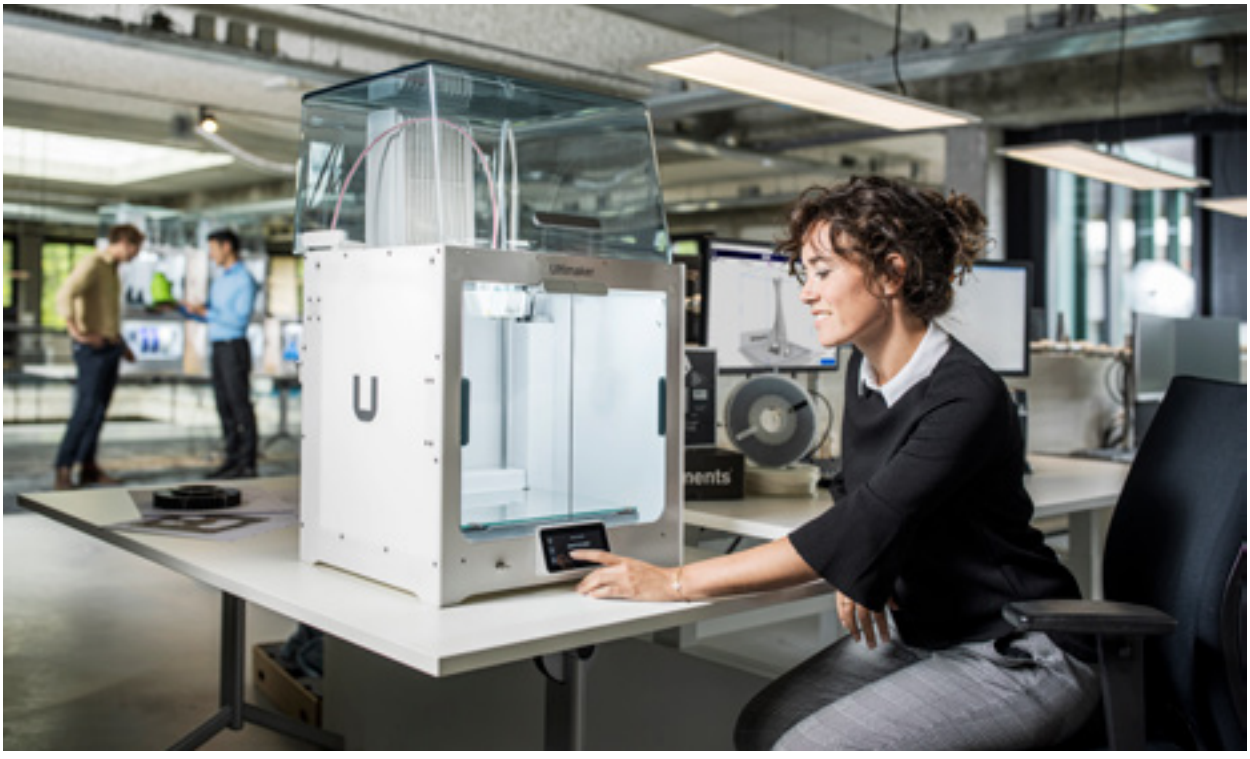
- Require space
- Use electricity
- Emit sound
- Produce an odor, depending on the material used

It is wise to consider these factors before installing a 3D printer. Check the printer's dimensions before purchase to ensure that sufficient space is available, and that it is close to a fused power outlet.

Desktop 3D printers require only a small space, while larger industrial machines may require an entire section of your workshop. Depending on the material printed, and the number of 3D printers, HVAC-certified venting may be required. For optimal air quality when using desktop printers, you may also need an air filtration solution such as the Ultimaker S5 Air Manager, which removes up to 95% of all ultrafine particles (UFPs).

If post-processing forms a significant part of your workflow, a dedicated station is recommended. Where necessary, this should provide access to waste disposal for hazardous chemicals like isopropyl alcohol.

Despite having the largest build volume of our range, the Ultimaker S5 fits easily on a standard desk, and has a maximum noise output of 50 dB. Post-processing is simple and, when using PVA support material, requires only a sink or drain.



Labor and training

Some 3D printer manufacturers require that at least one user receive training before using the machine, or the warranty becomes void. Other manufacturers offer training bundled with higher-tier annual service plans, or at an extra cost.

Once this skill-level requirement is met, only the trained employee can conduct 3D printing tasks. This leaves you with a number of choices that present additional training and employment costs, and that you should consider before investing in a 3D printing solution:

- Increase the responsibilities of a current staff member
- Employ a full or part-time 3D printing operator
- Employ a contractor

No warranty is voided if an Ultimaker printer is used without training, and our products require no specific level of expertise. Our customers have found that a typical employee induction takes around 30 minutes, and a productive workflow knowledge can be gained in as little as three hours. Beyond this minimal time investment, no further training or labor costs are required.

Ultimaker's product range is built to be as easy to use as possible. In the case of the Ultimaker S5, the touchscreen display provides intuitive instructions at every step. This 'plug and play' experience means that, using Ultimaker Cura's preconfigured material settings, anyone can start printing in seconds and achieve first-time-right results.

For the best 3D printing experience, we encourage users to familiarize themselves with the product manual and our free online resources.

The 3D printing workflow consists of a number of tasks. Some of these are listed below to help you identify whether your staff could perform them without further recruitment or training:

- Preparing and loading digital files (STLs and G-code)
- Selecting and purchasing material
- Loading material
- Cleaning (once a month)
- Post-processing
- Occasional maintenance (ordering spare parts)
- Occasional troubleshooting (with local access to the Ultimaker support network)

Total cost of ownership breakdown

In summary, here is a list of the ownership costs that will apply to any 3D printer. These will vary between manufacturers. As a guide, we have listed the costs of owning an Ultimaker S5 for a year, based on an estimated activity range of 1,500 hours per annum.

Hardware	Ultimaker S5 costs example	Price in Euros	Price in USD	Your chosen printer's costs
3D printer bundle	Ultimaker S5, Air Manager, and Material Station	€8,495	$9,100	
Included extras	Accessory kit*	€0	$0	
Warranty	12 months	€0	$0	
Annual service plan	Ultimaker requires no preventative maintenance plan	€0	$0	
** This Accessory kit includes: Ultimaker Tough PLA, Ultimaker PVA (both 750 g), Glue stick, Oil, Grease, Screwdriver (2 mm), USB stick, and an Ethernet cable.*				
Consumables				
Bowden tubes	Consumable listed in warranty	€23 per tube	$27.60 per tube	
Print cores	Consumable listed in warranty	€99.95	$114.95	
Glass build plate	Consumable listed in warranty	€28	$31.20	
Silicone nozzle covers	Consumable listed in warranty	€1.00 per cover	$1.20 per cover	
Software				
Print preparation software	Ultimaker Cura	€0	$0	
Print profiles	Preconfigured materials settings	€0	$0	
Management software	Cura Connect	€0	$0	
Power consumption	0.3 kWh x €0.094* ($0.108**) x 1,500 hours	€42.30	$48.60	
* *source* ** *source*				
Labor and training				
Labor	Minimal additional labor needed using Ultimaker products	€0	$0	
Training	Minimal additional training needed using Ultimaker products	€0	$0	
Materials				
Average material cost per gram	Average cost of Ultimaker material: €47.44 or $57.91 ÷ 750 gram	€0.06 per gram	$0.08 per gram	
Average weight of printed part	Insert your printed part weight here (100 grams used as an example)	100 grams	100 grams	
Number of printed parts per year	Insert your number of parts here (100 parts used as an example)	100	100	
Estimated yearly material cost	Average cost per gram x number of printed parts	€600	$800	
Total cost of ownership	**Covering 12 months of running costs***	**€9,289.25**	**$10,123.55**	Based on the purchase of an Ultimaker S5 Pro Bundle

**Please note: All prices accurate at the time of publication and are subject to change*

Take the next step toward affordable 3D printing

Request a quote from Ultimaker

Read more 3D printing resources

About Ultimaker

Since 2011, Ultimaker has built an open and easy-to-use solution of 3D printers, software, and materials that enables professional designers and engineers to innovate every day. Today, Ultimaker is the market leader in desktop 3D printing. From offices in the Netherlands, New York, Boston, and Singapore – plus production facilities in Europe and the US – its global team of over 400 employees work together to accelerate the world's transition to local, digital manufacturing.

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