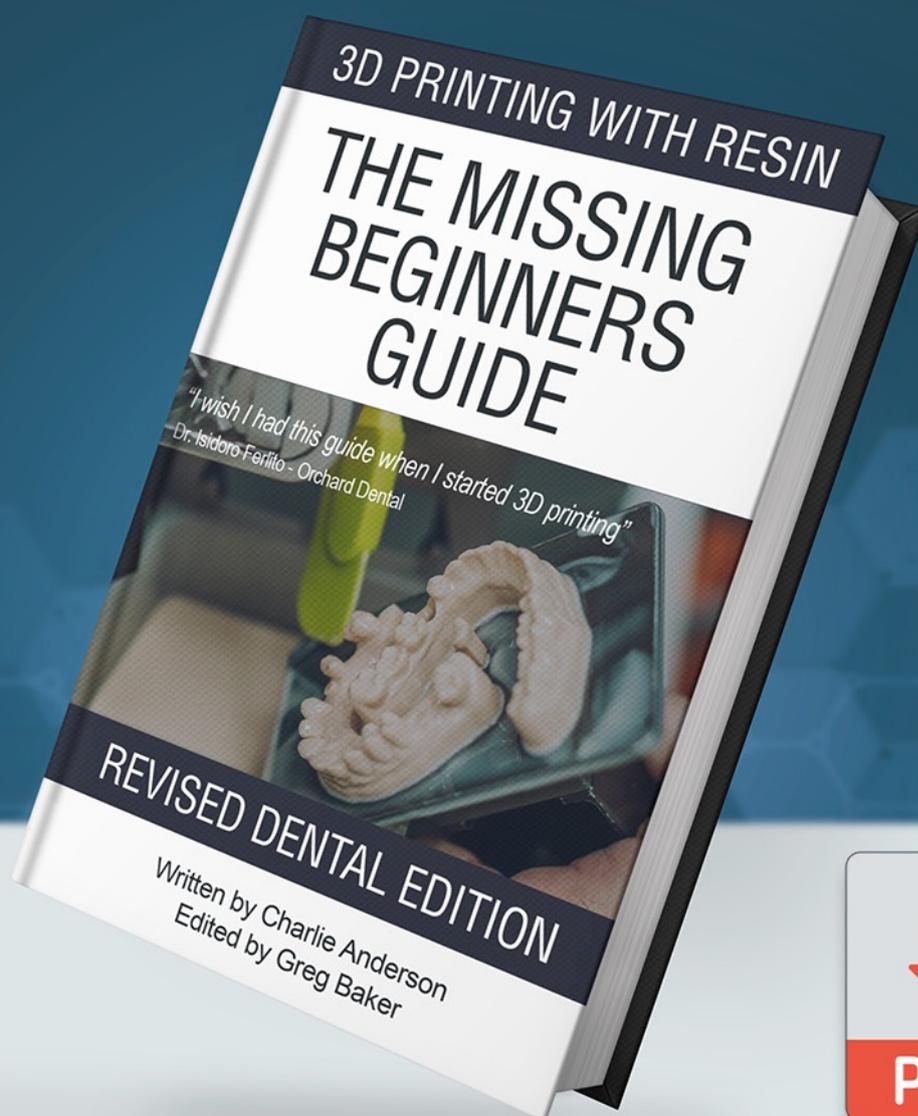


# 3D PRINTING WITH RESIN

## THE MISSING BEGINNERS GUIDE



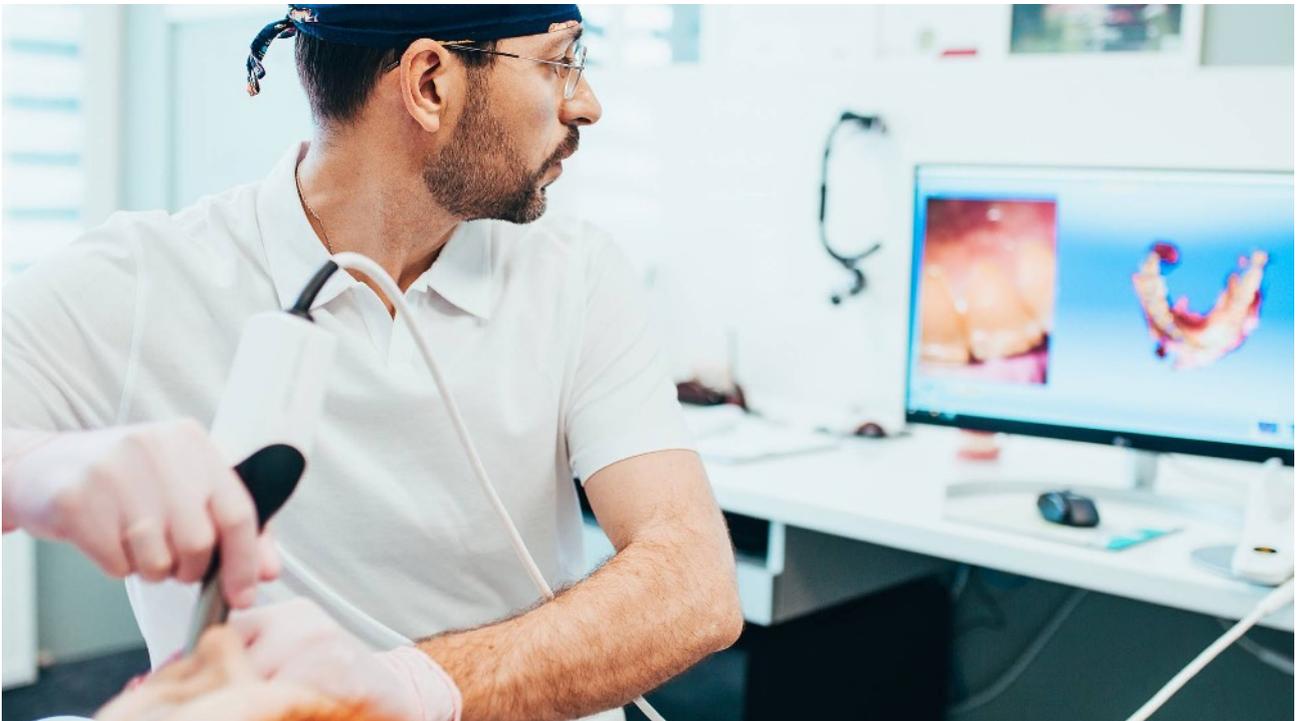
## REVISED DENTAL EDITION

Written by Charlie Anderson  
Edited by Greg Baker



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## 1. Introduction - It's time to hear the truth!

Let me start with what you probably already know but might not want to hear...

3D printers in dentistry are here to stay, and it's not a fad or new technology for the next generation.

Since you are reading this, let me bravely make three assumptions... 1. You are in the field of dentistry 2. You don't use 3D printers in your business. 3. Or you have a 3D printer but haven't embraced the technology. If I'm correct, then well done for downloading this guide because I wrote it for you.

Since writing my original ***beginner's guide for 3d printing with resin*** in 2016 (downloaded over 7000 times), I have been fortunate enough to work with several leading dental lab technicians and 'pioneer' dentists who have helped educate me on the many advantages of 3D printing compared to the traditional methods. One of these dental professionals that I was fortunate to meet was Greg Baker.

Greg is a qualified dental technician and the owner of K-Lab Digital Solutions, a company he founded to provide the highest possible technical support and service to his customers working in the digital dentistry landscape. Greg has serviced clientele throughout Australia and New Zealand in several technical support roles covering all aspects of digital dentistry, including milling, intraoral, and desktop scanning; design software and has a specific focus on 3D Printing. His ability to repair, service, problem-solve and integrate systems enables Greg to offer exceptional client outcomes in a rapidly changing environment. With a passion for maximising efficiency and quality within the dental lab and real-world experience of digital workflows between surgery and laboratory, Greg understands the importance of accurate, replicable and flexible digital solutions.

Greg has been kind enough to be my Dental "fact checker" and consultant for this guide. I wouldn't have been able to do it without him. I thank him for his time and patience.



The 'pioneers' are the lab technicians, dental practitioners and dentists, who have discovered that 3D scanning and printing in-house saves them valuable time (and, therefore, money). With accessibility to lower-cost hardware, local materials, education and support, it's paved the way for dental professionals to embrace this new technology. 'Digital dentistry' is progressively streamlining the often cumbersome traditional processes and changing the industry's future for the better. 3D printing might be the most significant



advancement in dentistry since the local anaesthetic!

This guide aims to educate you on using digital technology in your dental business. Everything from setting up your printing area to which type of 3D printer you should consider and how much it will cost to start. I will delve into the 3D printer setup and resin calibration. However, this guide will not get into technical jargon, specific printer settings, or how to use dental-specific 3D software or interaural 3D scanners. I will leave these topics to the suppliers of those products. Fortunately, you won't need to know those mentioned above to start your 3D printing journey. I aim to teach you how to crawl before you sprint. We are all apprehensive about starting anything new. The fear of the unknown is real, but as long as we all agree that making mistakes is part of any learning process.

Are you ready for another home truth...when you make a mistake in 3D printing, it will cost you a few dollars in materials and twenty minutes of print time. If you accept this, then well done. You are now prepared to take on this new challenge!



The first time I read about 3D printing, a burst of excitement ran through my body, and I remember thinking - how incredible is this...As someone who grew up playing with train sets, building model kits, remote control cars & planes. At school age, I enjoyed wood & metalwork. After that, I moved on to modifying cars and boats. I loved pulling things apart to see how they worked (not always getting them back together). I'm most definitely not an engineer, far from it. I would describe myself as creative with an inquisitive mind. I knew 3D printing was going to change my life forever.

Jumping forward a few years, my experience with 3D printing has been more than most. I decided to help my father in his 35-year established industrial chemical company, Monocure Pty Ltd. The traditional business was developing and manufacturing UV-cured coatings for the printing, label and packaging industries. Before joining the family business, I ended my career as a TV production director after 20 years of working in the industry.



It was apparent that the traditional business needed fresh, innovative products to help propel it into the future. Since the UV-cured coating technology was similar to 3D printing resins, our experienced development chemist, Kevin Jarrett, was able to produce a successful product for use in the first low-cost desktop SLA (stereolithography) 3D printers aimed at consumers, called the Form 1 by a company called Formlabs, that was started on a



crowdfunding website called Kickstarter, and raised over 4 million US dollars.

I was lucky enough to be involved from the early days of Formlabs' first printer, then the introduction of the DLP (Digital Light Processing) 3D printer, when a domestic overhead projector was used to cure the layers. For our development work, I purchased one of the first desktop MSLA (Masked Stereolithography Apparatus) 3D printers from a Chinese company called Wanhao. Incidentally, I visited the company in China in 2018 to meet Mr Gary, who was very welcoming and hospitable but made it clear that an Australian company could never provide resin to a Chinese company - that's a story for another time...



## 2. Preface - Why I wrote this guide.

3D printing is becoming increasingly popular amongst dentists as a time-effective way to produce dental models, guides, prosthetics and other dental products. For time-poor dentists, 3D printing offers a great way to produce customised dental products while saving valuable time.

The cost of 3D printing can be lower than traditional manufacturing methods. 3D printing is also a great way to test new products before investing in large production runs, allowing dentists to experiment with different products and designs without worrying about manufacturing costs.

Resin 3D printing also offers a wide range of materials, allowing dentists to create customised dental products that match their individual needs. 3D printing can also produce dental appliances in small quantities, making it an ideal solution for situations when patients are demanding.

Bear with me while I recite a conversation I had on a recent visit to IDEM (International Dental Exhibition & Meeting) in Singapore with a local woman in the coffee queue. The conversation went something like this...

**Charlie** - *"Hi, what do you do for work?"*

**Woman** - *"I'm a dentist."*

**Charlie** - *"Wow, you look too young to be a dentist" (my poor brain-to-mouth filtering was passed down to me by my father...)*

**Dentist** - *"I have only been practising for a short while as I finished University a couple of years ago."*



**Charlie** - *“When you studied dentistry at university, did you learn about 3D printing processes as part of your course?”*

**Dentist** - *“Yes, it was.”*

**Charlie** - *“Ok, so you must use 3D printers in your practice now?”*

**Dentist** - *“Actually, no, we don’t have any.”*

**Charlie** - *“What? Why not?”* (Sounding confused)

**Dentist** - *“The other dentists in our practice are all older than me and were not trained to use 3D printers.”*

**Charlie** - *“I understand, but do you think you would be more efficient and save time and money if you had access to them?”*

**Dentist** - *“Yes, of course!”*

**Charlie** - *“Well, as a 3D printer resin developer and manufacturer, I would encourage you to show the old dogs some new tricks!”*

**Dentist** - (Laughs)

At this point, her boyfriend was looking over and wondering how this 48-year-old balding Australian guy was making his girlfriend laugh. So I thanked her and left (without my coffee - which, embarrassingly, she pointed out, and I had to go back and get it!)

Thanks for sticking with me. I’m sure you would agree that this conversation was a great in-site into the state of the dental industry and why the uptake of the new technology has been slower than expected. The vast majority of dental professionals have not had any training in the use of 3D printers. Most have learnt the traditional dentistry methods and know nothing about the new digital processes. So it’s understandable why they would be hesitant to learn a whole new way of working when the way they were taught is easy & comfortable for them.

### **3. The Methodology - Work smarter, not harder.**

Here are some common phrases I have heard over the past couple of years from dental lab owners, technicians, dentists and orthodontists...

*“Those 3D printers are expensive, and the material cost is crazy.”*



“Did you hear about that company who spent 150k on a 3D printer that ended up being slower than the traditional methods?”

“Why would I change to a new technology, it’s going to take me ages to learn, and I just don’t have the time.”

“3D printing will never take off, and I prefer the old way of doing things.”

I understand that change is hard for all of us. There is so much misinformation out there and people claiming to be experts who don’t know what they are talking about. Be aware of the salesman telling you that you need to spend 20-50k so that the 3D printer is ‘the only one good enough’ for dental work.

The traditional methods involve manual teeth impressions, then sending them off (using snail mail) to a third-party lab to be processed. Once processed, the models have to be sent back. Ironically the lab will likely turn the impression into a digital file using a 3D scanner anyway! With all the shipping and back and forth, this process can take weeks...Alternatively, embracing the new digital technology that can all be scanned and printed in a matter of minutes...while the patient is waiting in the chair. I mentioned the time saved, but what about the cost?



Let’s look at the cost of 3D printing your models. How many models would you get from a 1ltr bottle (1ltr = 1.1kg specific gravity) of our PRECISE™ dental model resin? Since these materials are considered 100% solid, it means that 1.1kg of liquid resin, once cured, will weigh 1.1kg of solid, printed material. If each model weighs around 20 grams, then a single bottle will produce approximately 50 models. At an RRP of \$145AUD per litre, that works out to be \$2.90AUD per model. Since a clear aligner patient may need 12-36 models printed, you can see why some orthodontists have quickly embraced the technology.

If you are working in dentistry and one of the above-mentioned “slow to adopt” people, don’t worry; you are not alone. I can think of a few reasons for the resistance to transition to the digital age of dentistry in Australia. Since speaking to many newcomers, the main point I often hear is the fear factor. Most are (understandably) concerned about changing the workflows and procedures they were trained in and had been doing every day since they started. Learning a new skill can be daunting, especially when you are a busy dental practitioner. Well, it doesn’t need to be... I have adapted this guide from my original Beginners Guide for 3D printing in resin to help give you the confidence to dive in head first without



having to go back to university or watch hours of training videos. I aim to educate you, so you have the knowledge and skills to set up and start 3D printing for your small dental practice or a large dental lab.

My first piece of advice is to be wary of 3D printer salesmen...Don't be fooled into thinking that the more you spend, the easier it will be! This is usually not the case, with promises of unlimited technical support and "free" on-site setups often broken once you sign on the dotted line.

#### **4. Getting Started - Ask yourself these questions.**

Most 3D resin printers targeted towards dentists can be "over-specified for your needs. In some cases, the cheaper 3D printers being mass-produced for the hobby market can outperform these high-cost printers with better dimensional accuracy, higher resolution and speed. The main three resin-based printing technologies are **SLA, DLP & MSLA**.

Stereolithography (SLA) is an older technology that uses a high-powered laser and tilted mirrors to "colour in" the layers. A Digital Light Processing (DLP) machine uses a UV projector module to cure the entire layer completely. MSLA, short for masked stereolithography apparatus, is a newer, lower-cost process that uses an LCD screen with a powerful LED light array to cure the photosensitive resin selectively.

SLA is said to be more forgiving with specific complex structures. While a DLP and MSLA use an image for each layer slice, they are much faster, especially when you print multiple items simultaneously on the build plate. If you only print one small item, if you load the build plate with multiples of the same thing, it will take the same time to print. This technology might be preferable if you want to mass-produce models rather than print one item at a time.

Make sure you research, as this is probably your most significant decision when choosing a 3D printer.

1. **What is the intended use of my new 3D printer?** - Is it to print the 3D scans that you are currently sending out to a 3rd party, to print models for vacuum forming clear aligners and mouth guards, or to verify the fit of a manufactured appliance like a crown? Or maybe you are planning on 3D printing surgical guides, splints or custom trays using TGA-approved Bio-Compatible resin? Whatever your need(s) for a 3D printer, you should consider all because even if you don't initially plan on doing more than one job, I can guarantee that once you have discovered how easy it is, you will be transitioning most of your traditionally processed work over to digital. One printer could turn into 3-4 very quickly.



2. **Will the consumables, such as resins, vats, FEP sheets, etc be compatible with my new printer?** I suggest you avoid printers that don't support using 3rd party 3D resins and consumables like FEP sheets and LCD screens. Nothing is worse than being locked down into a system where the materials are too expensive or not fit for purpose. Since this is such a new Industry, the technology is constantly updating, and development companies like Monocure 3D are coming up with cutting-edge materials you will want access to.



3. **How much budget should I allocate to this new technology?** Like any new equipment, it's important to work out how much the traditional methods are costing you (make sure you include your/others' time and storage) compared to what it will cost you to do it digitally. Then work out how long it will take to pay back the printer and other equipment needed that I will list below. This will depend on many factors, so it must be tailored to your circumstance. In many cases, 3D printers can replace staff, which is not great for the national employment rate, but

staff are increasingly hard to find and reducing them can be a quick way to increase profits.

4. **Will I get the level of Technical Support that I require?** Since you are reading this guide, I assume you are new to all this, so that a helping hand can be important at the beginning of your 3D printing journey. At this stage, we don't sell 3D printers. There are many options on the market, with a new one appearing every few weeks (it seems). We prefer to ensure that you have the best 3D printer for your needs, so you keep using it and, therefore, keep purchasing our products! If you would like to speak with one of our 3D printing experts, please email us at [support@monocure3d.com.au](mailto:support@monocure3d.com.au) or call us at +61 (0) 2 9738 5340.
5. **Do I have a suitable work area to set this up?** You will need a dedicated area to set up your 3D printers. Remember, it's not just the printer(s) - yes, you will end up with more than one...but you will need room for an ultra-sonic cleaner, a post-curing unit and a few other smaller items that I will discuss in more detail below. If you have running water with a sink, this can be helpful. Although this is not 100% necessary, it will make it a little easier with the cleaning-up process.
6. **How much extra equipment will I need?** As mentioned above, you will need a few extra items to purchase as part of your 3D printing set-up. I will list them individually below with a brief description of each. Some might be obvious, but I have written this guide assuming the person reading it is a newbie.



## 5. Equipment - The A-Z of what you'll need.

**I) 3D Resin Printer (or 2)** - This one is obvious, but the idea of more than one printer is not on most people's minds when they decide to use the technology. With the cost of these becoming lower and lower, the idea of starting with two or more is not bad. Whenever I buy a piece of equipment for my factory, I always consider the redundancy plan if we have an equipment breakdown. Nothing is worse than being in the middle of a job and having a printer malfunction (all equipment breaks down), with no way of completing the job without waiting for spare parts or another printer to arrive. If you are going to go down the lower-cost option, you should get at least two identical printers. You don't need to set both of them up, but have the second one on standby if there is an issue. (You can thank me later for that advice). I can guarantee that you will be unboxing that printer and using it to keep up with demand. When that happens, consider purchasing another one (or two) as a backup if either malfunction.

**II) Ultra-Sonic Cleaner** - As someone who works in the dental industry, this is a piece of equipment you may already have. Unless you are not using it and it is big enough, I suggest you get another one dedicated to 3D printing. You don't need to spend thousands of dollars on a dental-branded version. Jump online and check out the low-cost offerings on eBay or Amazon. Make sure you get one big enough to fit the build-plate and vat of your 3D printer. The capacity will depend on the size of the printer you decide on, don't go too small because when you have four printers, you will need the extra space - seriously.

Make sure you get a full stainless steel one. Avoid the plastic case/lid varieties, as they quickly get destroyed. Most have a digital timer function that can beep to remind you to remove the model from the cleaning bath. Some have also had a heating option. If you use our ResinAway® cleaning solution, since it is not considered flammable, heat can safely help clean the models quicker, especially on those colder days when the resin is slightly more viscous.

I recommend you only take it up to around 28C, as too much heat might cause some resin to soften. Do not use heat if using any alcohol, such as IPA (Isopropyl Alcohol) or Methylated Spirits, as these are highly flammable and could catch fire. I do not recommend using an ultra-sonic cleaner with these solvents (especially if you have purchased a low-cost option, as suggested above). This is not the only reason you should avoid IPA in your 3D printing process. You can read the article on the [Dangers of Isopropyl Alcohol](#) and make up your mind.

**III) Post-curing unit** - An essential part of the 3D printing process is required after the model has been washed in the ResinAway® bath and the excess has been removed with water or compressed air to complete the curing process. The 3D printer (in most cases) will only cure the resin to 70-80%, and the final strength



comes from the post-curing unit. Without completing the cross-linking of the material, you risk the model being too flexible for certain processes and potentially splitting over time. The size of your printer will determine the size of the unit, the number of printers and how many models you will need post-cure at once. There are expensive options for the dental market, but they are not necessary to do the job. The lower-cost versions aimed at the hobby market do the same at a fraction of the cost. Make sure you get one with 405nm UV LED lights, the same wavelength as most 3D printers today.

**IV) Pre-wash Container** - Before the final rinse in the clean(er) ultra-sonic unit, I recommend a pre-wash container full of ResinAway®. This can be a Tupperware from the kitchen drawer (I won't tell if you don't), a bucket, or a plastic tub from the hardware store. Your printer's volume will determine the size. These are essential for cleaning printer vats and build plates. Use a soft brush to help remove the excess resin, and avoid the ultra-sonic cleaner getting saturated too quickly. One of the many advantages of ResinAway® is the ability to be reused over and over without the need to change the pre-wash after multiple washes. Some customers have told me their daily pre-wash has lasted over three months. Without me sounding too much like a used car salesman, IPA will become saturated quickly and cost more in the long run.

**V) Tools** - Here is my list of what to get to make the journey cleaner and easier.

**Metal Paint Scraper** - These come with most printers and are needed for removing the models from the build plate after they have been 3D printed. Make sure it has a nice sharp edge, and remember, never allow it to go anywhere near the FEP film, as you risk puncturing it.

**Plastic Scraper** - These are also supplied with most printers and are handy when mixing the resin in the Vat or removing a failed print. They have a soft rounded edge, which allows them to be safely used in the Vat with the delicate FEP film.

**Soft Paint Brushes** - Not for painting, but great for cleaning excess resin off in the above-mentioned pre-wash. Avoid those with painted handles as the ResinAway® or Alcohol will re-activate the paint, which tends to go everywhere.

**Foil Trays** - Not for the BBQ, but very handy in keeping the mess contained. We use these daily in our 3D Printlab and have them placed strategically in piles so you can easily grab one when needed. Keep some near the printer, the pre-wash container, the Ultra-Sonic cleaner and the Post-Curing Unit. We sell these in packs of ten, and I can't recommend them enough.

**Tongs** - Standard long-handle kitchen stainless steel is perfect for fishing out those dropped models in your prewash container!



**Funnels** - Needed for pouring the unused resin back into the bottle. Get a few different sizes.

**Paper Filters** - After printing, hard resin ‘bits’ can end up floating in the vat, these need to be removed, or you will risk serious damage to your printer. These paper filters with a fine mesh work well. Most printers come with a handful. Alternatively, you can use a small kitchen strainer. Look for a cone-shaped one, as they fit in the funnel better.

**Strainers** - Alternatively, you can use a small kitchen strainer. Look for a cone-shaped one, as they fit in a funnel better.

**Side Cutters** - Some 3D printed Models will require support. Normally these are removed before the post-curing process because they are still soft and easy to remove by snapping off by hand. If the model has been post-cured with supports to keep the model dimensionally accurate, then side cutters will be your best friend for removing the supports from the model. Remember to wear eye protection

**Empty Bottles** - Come in handy when you have excess resin, or some customers like to give their 5ltr bottle a good shake and decant into 5 x 1ltr bottles to save energy for future prints.

**Resin Waste Container** - All labs should have one of these. It can be as simple as a 10kg pail or 20ltr cube with a hole in the top and a funnel to dispose of unwanted resin.

**PPE (Personal Protection Equipment) - Disposable nitrile or reusable kitchen rubber gloves** also handle the models while removing them from the build plate and cleaning and drying them. Some people can be sensitive to the resin on their skin. It’s a good habit to wear gloves, even if you are not sensitive because the day you walk outside with some UV-reactive resin on your hands, you will know about it! The resin can reach up to 70C when curing.

**Safety glasses** should also be an essential item that you wear whenever you are handling resin or cleaning products. From someone who has dropped a model in a pre-wash of IPA, I can tell you (so you don’t need to try) that it stings when it splashes in your eye. Some of the printers also come with a dust or surgical-type mask. This has always confused me a little as to what they are for. To protect from a splash of resin going in your mouth? Or perhaps if you decide to sand your model and don’t want to breathe in the dust? I’m certain they are not included to protect you from fumes. You would need a much more expensive filter to stop chemical fumes. The use of a mask while handling resins is a well-debated topic on the internet on social media groups. I suggest you do your research and make up your mind. Always follow the advice on the SDS of the resin and other materials you are using. Ours is available for download from this [link](#).

## 6. The Terminology - The Resin 3D Printer Components

**1. Printer body** - The central part of the 3D printer includes the UV light source, lifting/lowering mechanism (Z-Axis), power switch, LCD touch Screen and USB/SD Card Slot(s), and cable connections.

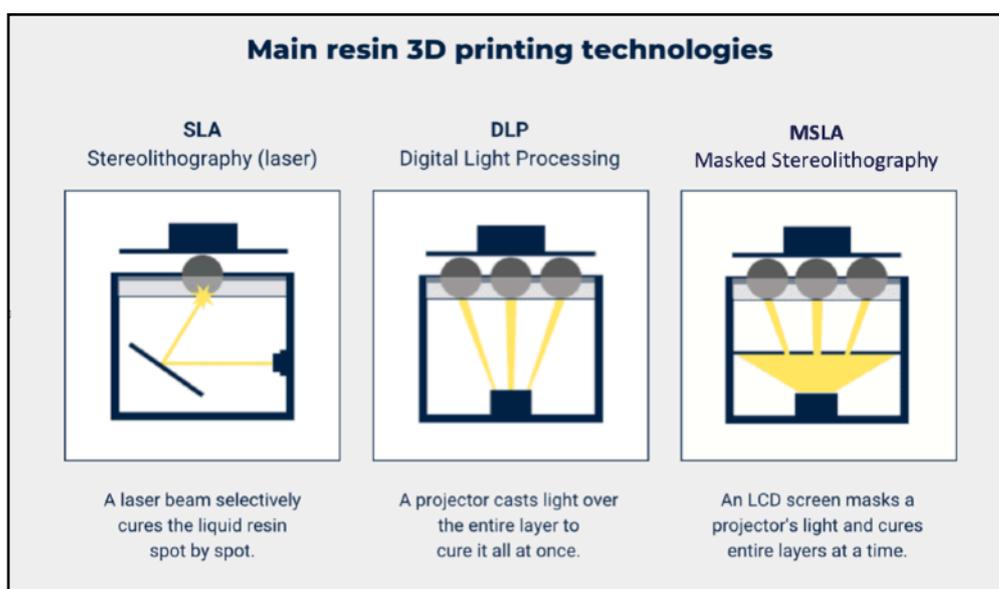
**2. Build Plate** - This is detachable from the central part of the printer and is what the model will adhere to. Most build plates are made from aluminium to ensure they don't suffer from corrosion, and it's a good surface for the UV resin to stick to. If your build plate is smooth, I recommend you give it a light sand with 100G sandpaper, as this gives much better adhesion for the cured resin to stick to.



**3. Resin Vat (AKA Tank)** - Where the resin is poured before printing, and the build plate is lowered. These need to have some way of releasing the printed object from the bottom of the vat. On the original SLA printers, this was usually a PDMS (Polydimethylsiloxane) layer, Sylgard, two-part silicon, the same silicon commonly used in solar panels. More recent MSLA and DLP printers use FEP (Fluorinated ethylene propylene) Teflon release film. This is a flexible film that comes in different thicknesses. Please see the section below on failures to understand why the prints sometimes stick to the bottom of the vat instead of on the build plate.



**4. The LED UV Array, Projector or Laser** - This intelligent part emits UV light to cure the resin.





**5. LCD Screen** - On an MSLA 3D Printer, this will cut the shape for each layer, only allowing the light from the LED Array to pass through the areas that need curing.

## **7. The Setup - A step-by-step walkthrough**

Here is a general list of things to remember when setting up your new 3D resin printer. Most of these instructions concern the "bottom-up" type printer rather than the "top-down" printers. My experience with the top-down type is limited, but there are many more bottom-up printers and a much more widespread technology for the small desktop SLA or DLP printers. If you have a top-down printer and would like some more information, please get in touch with me, and I'll put you in touch with a friend of mine who makes a 3D printer that operates like this.

**1. Find a good place to set up** - (please refer to the "Getting Started" section for more information). Your printer must be on a flat surface away from any UV light source. These include electric lights (especially fluorescent) and windows where natural sunlight can enter. Windows can be covered with a UV filtering material, and these are transparent films that are usually orange or red in colour that can be purchased online.

**2. Connect to a stable power source** - and a cabled internet connection if required for the printer you have purchased.

**3. Choose the right computer** - Originally, resin printers required an HDMI connection from a computer to act as a second screen. Thankfully, the technology moved on quickly. Now a computer is vital for preparing the model for printing. This process is referred to as slicing and, depending on the size and definition of the model, can be slow on an older laptop. Eventually, you will want to create your models using Fusion 360, Rhino or Blender software. These software programs require a decent CPU and Graphics card to work at their best. Intraoral scans need to be refined and processed to have volume and able to be printed. This can be done with dental-specific software like exocad or 3shape. Or general design software like Meshmixer or blender.

**4. Install the slicing software** - This is how you get your 3D file into the printer. Most printers have in-built memory, and files can be loaded directly into the printer using an SD card or USB A thumb drive. Others require a tethered connection with a UBS cable from a laptop computer or Wi-Fi Connection. Some printer manufacturers will supply custom-built software that is comprehensive and easy to use. There are several 3rd party slicers available, and most have free cut-down versions and paid subscriptions for more options.

**5. Connect all the required cables** - Follow the manufactures guide.



**6. Homing the printer** - This is getting the build plate to start at the right spot at the bottom of the vat. Getting the homing right is essential to getting your prints to adhere to the build plate. If the plate is too high, then the projected UV light will not be able to cure the resin through to the build plate, so the model will not stick. Making the build plate too low in the homing procedure will mean that there is not enough resin between the bottom of the vat, and the setting up of the homing of your printer will vary depending on the make and model, so I suggest you follow the recommended method outlined by the manufacturer.

**7. Choose a model to print** - I know you probably have some dental models in mind that you can't wait to print! Take a deep breath because there is plenty of time later for tricky, complicated models. Try to take small steps when starting something new. Keeping it simple will help ensure your printer is set up correctly and build your confidence one print at a time. I have dealt with many people trying to print complex models first and getting frustrated with the process. Unfortunately, they usually blame the resin first and post pics all over Social Media only to prove that the printer wasn't homed or the computer settings were incorrect. I recommend you print our mono matrix. It is only 5mm thick and 50mm wide and is designed to sit flat in the middle of the build plate. This should take approximately 10-15 minutes to print (depending on your resin, printer and settings). Printing this first will outline some fundamental things about your settings, printer and resin. More on this later...

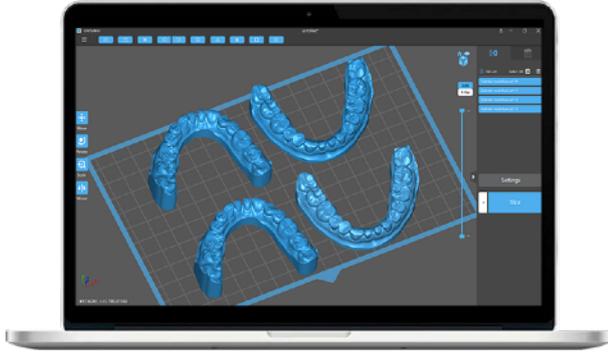


**8. Positioning it on the build plate** - Hopefully, you have followed my advice and downloaded the Mono Matrix from our website. It's time to open up your slicing software and position it on the build plate. Put it flat in the middle of the plate, with no supports or rafts. At this point, it might be necessary to slice the model (this is where the computer will figure out the slices and prepare them for the printer.) Now export the file in the format recommended by the printer manufacturer.

**9. Load the model file into the printer.** This is usually done using a USB flash drive that is required to stay in the printer while it prints or uploads the sliced file to an onboard hard drive inside the printer. USB Flash drives are commonly supplied with most printers, but I recommend you get a decent branded one, as the cheaper unbranded options have been known to fail. This results in your 20-hour print stopping at 15 hours, which can be frustrating! Some offer connecting via a network using an ethernet connection or WiFi. If you have a choice, always choose a hard-wired connection or a USB flash drive to add your sliced print files. Whatever method you choose, make sure you understand what is required. Or are you using a USB drive or SD card? Make sure they are formatted in the correct format for the printer to read.



**10. The Printer Settings** - Most printers come with tailored slicing software or



recommend a free 3rd party option, such as ChituBox or Lychee. The manufacturers usually supply the software for download via the provided USB thumb drive or a website link (QR code) on the instruction manual. All the settings may be done in the slicing software, and some can be changed on the printer's firmware using the LCD touch screen. These settings must be obtained from the

printer's guide, the resin manufacturer or other users who have used your printer and resin combination. We have a comprehensive list of resin printers and the settings for all our resins on [our website](#).

**11. Testing the UV light source** - It's a good idea to ensure the UV light source is working correctly. Most printers have a testing mode, or I recommend starting a print without the resin so you can see the light working correctly and you don't have anything else on the screen. By this, I mean parts of the desktop or anything else other than the intended image.

**12. Choosing the resin** - Some early SLA 3D printers were designed around a resin. This makes it hard for 3rd party resins to work on all printers. The more recent MSLA and DLP printers are designed to be open-sourced for the resin. This gives the consumer many more choices and means that products like our Monocure 3D Resins will work perfectly once you have the printer dialled in correctly. It's not a good idea to start with a fancy flexible, sparkling or casting resin. Instead, choose a simple transparent or semi-transparent colour, as these will give you the best chance of getting a successful print when starting.



**13. Resin Profiles** - These need to be set up depending on your printer and the resin you are using. You can find this information in forums or groups from the printer, resin manufacturer, or other users. Trial and error can make this process lengthy and frustrating. Don't hesitate to contact me, as I'm happy to help if I can or point you where you can get help. Our website has a comprehensive [settings page](#) that covers most of the more popular printers.

**14. Pouring the resin into the vat** - This should be done with the build plate lifted from the floor of the vat to allow the resin to flow across the bottom. Make sure you give the resin bottle a good shake and open it away from UV light. Fill the vat according to the manufactures recommendations, and some vats have level



markings on the inside, so you know not to over-fill. If you over-fill the vat when the build plate lowers into it filled with resin, it can overflow due to displacement (what happens to the water level in a bath when you hop in). Some bubbles may be present on the surface of the resin since it has just been shaken to mix it. These will disperse after a few minutes, but a light blow with a hair dryer will heat the air in the bubbles causing them to pop and speed up the process if necessary.

**15. It's time to start the print** - With the vat now full of resin, your file is loaded, and you have tested the UV light. Let's get this party started! If all is done correctly, when commanding the printer to create, it should engage the motor drive on the Z axis (up & down) and lower the build plate into the resin-filled vat. Now it's time to practice that thing called patience! Not much will happen for a while, as most Resin printers will start with a series of "base layers". As the term suggests, it is the initial layers of the resin onto the build plate. These are the first few printed layers to help with the resin adhesion. During the next 5 -10 minutes, the printer should move up and down as the layers are printed, and the resin is refreshed for each printed slice.

**16. Moment of Truth** - When the print is finished, the build plate should rise so you can see the underside of the build plate. If your print was successful, you would see the Matrix sitting flat on the build plate as you set it up on the slicing software covered in uncured resin. If this is what you see, punch the air and pat yourself on the back. Congratulations, you have successfully printed your first 3D resin print! If you do not see this, and you have nothing on the build plate, or it has not printed as expected, don't worry. It's very common and can be fixed by looking at several factors, which I will discuss later in this guide (see the Trouble Shooting section below).

**17. Remove the Model from the build plate** - We need to remove the printed part from the build plate. The first thing I do is put on gloves; I like thin medical-type, single-use gloves. I use a plastic scraper and push the uncured resin on top of the build plate and, as much as possible, on the underside back into the vat. If you do this carefully, it should all just end up dripping into the vat. Remove the build plate and place it carefully onto a tray. I use disposable foil trays with a cake drying rack so the resin can drip off the build plate and not have to sit in it. Find your metal scraper and carefully slide it under the edge of the print, and try and push and slide it off. On a dental model, if it is not too thin, the heels are the best place to start. Once the scraper is in a good position, it should slide off the plate. If you are having trouble getting the scraper under the part, turn the plate around and try it from the other side. There is usually a weak spot that will lift more quickly than the rest. If you still have issues, pour hot water over the back of the build plate to help soften the resin.

**18. Time to clean the model** - The object that you have printed is now separated from the build plate but still covered in uncured resin. I have an ultrasonic cleaner filled with our [ResinAway® cleaning solution](#). If you don't have an ultrasonic



cleaner or a wash & cure unit, I recommend you use a small container filled with ResinAway® and a soft paintbrush. Try dipping the model in and out of the solution and gently brushing until you can not see or feel any more resin covering the model's surface. Giving it a quick rise in clean water and then back in clean ResinAway® for a few cycles can help complete the process. Use

compressed air to dry to remove the excess water from the surface.

**19. Remove the supports** - If you have just printed the matrix, then you won't have any supports to remove, but if your model is supported, this is an excellent time to remove supports as the resin is still slightly soft before it gets post-cured. Some people recommend small nail scissors or side cutters for this job, be careful if snapping them off by hand, as it can be very disappointing to break part of your model that just took 16 hours to print! Best to use a tool and remember that sanding can always be done once the model is post-cured to remove any support nibs or bases. **PROTIP:** Remember that sanding can always be done once the model is post-cured to remove any support nibs or bases.

**20. Post-Curing** - The model is now clean, so it needs to be post-cured. This process is necessary as the printer will not fully cure the resin. So we need to finish the cure by putting the object under a UV light source at a wavelength similar to your printer (or check the resin you are using as they should have a working range). The sun can be used for post-curing, but it is not recommended as it has a broad range of UV spectrum that can cause the resin to be tainted yellow. Some place the printed parts in a clear, water-filled glass vessel. This does help filter some of the harmful rays, but the water can make the model cloudy, especially if you are printing with clear resin. This is because the uncured resin still on the surface is not water-soluble, so it can make it have a cloudy appearance. I recommend a UV light box with 405nm LED UV lights. The model's duration under the lights will depend on the UV power. Post-curing can take up to 2 hours if you want your material to be as strong as possible. You can tell when the part is completely post-cured as it will no longer have any surface tack (this is the uncured resin). The parts will feel more rigid with a hard, scratch-resistant surface.

**21. Finishing** - You may need fine grit sandpaper or sanding sticks to clean up any support nibs or unwanted cured resin on your completed model.

**22. Cleaning up** - Removing unused resin from the vat between prints is a good idea. This ensures that no floating lumps of cured resin are hidden in the remaining resin. This can lead to show-stopping events. If the build plate lowers and presses



on a hard resin lump, it will damage the LCD screen creating a “dead spot” or worse, cracking it. MSLA printer screens, especially the large 8K monochrome versions, can be expensive. Most printers now come with a cleaning option that cures the thin layer at the bottom, thus capturing any heavy cured resin particles that have sunk to the bottom. I don't recommend that you rely on this method. Pouring and filtering the resin back into the bottle is always safer. A word of warning for resin printer owners, don't remove your Vat if the build plate has any resin on it. Resin dripping onto your LCD screen, glass or mirrors can be disastrous. Remove the build plate, and drain all the resin out of the vat. Any residue can be wiped out with a paper towel dipped in ResinAway®, or the whole vat can be submerged in your ultra-sonic cleaner for a few minutes before being washed in fresh water and dried with a paper towel or compressed air. The build plate and other resin-covered tools can be cleaned using the same method.

**23. Disposing of resin** - I find the best way to dispose of unwanted resin is to tip it into a foil tray and leave it in the sun. Eventually, it will go hard, and you can throw the foil tray with the cured resin in the bin.

**24. How to deal with resin spills** - If you have a resin spill, use plenty of rags and paper towels to clean it up. Depending on the surface you have spilt it on, ResinAway® will work well to finish the job. Please do a test patch first to ensure the ResinAway® is not going to discolour or damage the surface.

## **8. Troubleshooting - Where did it go wrong?**

**i) Stuck to the bottom of the vat** - This can occur because the homing calibration of the build plate was not done correctly, or you did not have long enough for the “base layers” to help the resin stick to the build plate.

**ii) Nothing anywhere** - If you can't see any cured resin on the build plate or stuck on the bottom of the vat, something is wrong. Check that your UV light is working correctly. This can be done by running the print without the resin or vat and seeing what is happening during the print. Large flat areas can cause the model to create suction between it and the bottom of the vat. This causes it to be pulled off the build plate. You may need to reposition your model on an angle, so it avoids this issue.

**iii) The model has been printed but does not look adequately formed.** This can be a result of under or over-curing of the resin. If it is under-cured, you will need to increase the layer times; if it is over-cured, you may need to decrease your layer times. This is possible with most DLP or MSLA printers, so if you are experiencing this with an SLA (which uses a laser diode to cure the resin), the only way is to try a different resin setting to see if it is possible to adjust the laser strength to compensate.



iv) **It's a big over-cured mess.** This is usually caused by the slicer settings being wrong. It can also be caused by extraneous things appearing on the screen in the case of MSLA or DLP, or incompatible resin may have been used.

v) **Why are the base edges lifting off the build plate?** The resin adhesion to the build plate needs to be better. You can fix this by increasing the base-layer duration and the number of transition layers. If you have to print with a raft, it is much better to use rounded edges as they are less prone to lifting. It would help if you considered repositioning the model on the build plate. Alternatively, use our PlateBond™ product for the ultimate adhesion!

vi) **Why did I only get a part of my print?** This can happen if the model is in a weak spot and it snaps off at that point. The rest of your model will be stuck to the bottom of your vat. Make sure you properly clean out the vat before attempting to print again. Use a soft plastic scraper or your fingernail to gently lift the edge of the hard resin from the bottom of the vat.

## 9. Top 10 Resin Printing Tips for Dental



- 1.** Choose your new printer wisely - Research as much as possible using the internet and communicate with others who have already done the hard yards.
- 2.** Prepare your work area so it is 3D resin printing ready, and keep it neat,
- 3.** Join the community. Find an online forum or a social media group with the same printer as yours. Set up your printer according to manufacturers' instructions and listen to others who have already paved the way.
- 4.** Remember, KISS (Keep it simple stupid). Don't be too ambitious. Print something simple. Choose a well-known Resin-friendly model like our Mono Matrix calibration model in the downloads section of our website. No support is needed for this one. It can be positioned flat on the build plate. This will help build your confidence and get you printing your complex designs quickly.
- 5.** Keep your resin vat clean and debris-free to ensure consistent printing quality. Cured resin Particles can cause damage to the printer.



- 6.** Get a post-curing station that matches the resin you are using. Make sure it has a good source of artificial UV light. Some in-mouth-approved resins might require a special post-curing unit.
  
- 7.** Download and learn a professional 3D design program. I use Fusion 360 by Autodesk. There are several excellent choices. Blender is Free and open source, and there are many online help and YouTube tutorials to get you started. Once you can use a 3D design program, you are only limited by your imagination!
  
- 8.** Choose the best resin for your printer. The stock resin that comes with your printer should work, but it's not always the best for your needs.
  
- 9.** Learn from your mistakes - The Art of Troubleshooting.
  
- 10.** Work Smarter, Not Harder. I understand that change is hard for all of us.

Remember, it's not a failure if you have learnt something that will make you better the next time you try!

## **10. The last word.**

I hope you have gained some knowledge from my beginner's guide to 3D resin printing. Please contact me if you have any questions or need help. I welcome any feedback regarding this guide. If there is anything I missed or areas that need more information, please contact me with suggestions on how I can improve it.

At the time of writing this, it was estimated that 5-10% of dental labs and dentists in Australia had taken up digital technology. In the USA, it is said to be 30 - 40% up-take, but many people have moved over in a market that size. As Australians eventually follow the trends of our USA and European comrades, the tidal wave of 3D printing is inevitable! Don't be at the back of the pack struggling to get on the wave...Much better to be one of the leaders gliding smoothly ahead of the wave. (All the paddling was done when there were fewer people to get in your way!)

Please consider our Monocure 3D resin and other products, as I'm confident you will be thrilled with the results and the support we provide.

Cheers,

Charlie

Monocure 3D Founder and 3D Printing enthusiast.



## 11. Disclaimer

This disclaimer governs the use of this guide. By using this guide, you accept this disclaimer in full.

This guide has been written to assist people new to 3D printing with resin.

You must rely on something other than the information in the guide as an alternative to the manufacturer's instructions or advice from an appropriately qualified professional.

You should consult an appropriately qualified professional if you have specific questions.

Without prejudice to the generality of the foregoing paragraph, we do not represent, warrant, undertake or guarantee that the use of the guidance in the report will lead to any particular outcome or result.

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