



# What happens in the lab?



**Ashley Byrne<sup>1</sup>** explains the basics of making a crown using digital dentistry.

A single crown can be constructed using various methods and techniques but in the modern dental lab the days of metal castings are all but gone and stone models are rapidly on the decline. At Byrnes dental laboratory we do still produce metal bonded with ceramic but the sub frame would now be produced using 3D printed metal, which is explained in this article.

## Intra oral scan

The first stage of making a single crown starts with a scan of the mouth, the opposing occlusion and the bite registration. Whereas

in a normal impression this is a three stage process of upper, lower and a silicone occlusal record, digitally this is now a half scan of the preparation arch and a close scan of the prepped tooth, flowing into the half scan of the opposing arch and then straight onto a simple scan of the upper and lower buccal surfaces in occlusion. This method is not only quicker and easier but it is also shown to be preferred by the vast majority of patients.<sup>1</sup>

## IOS scan sent to the laboratory

This process happens via the Cloud and the laboratory will receive the digital scan, patient's details and the restorative prescription often while the patient is still at the practice. The file is then converted into what is known as an .stl file and this file is then used to design and manufacture a crown as well as the digital model. One of the great aspects of using digital files is that both the crown and the model can be designed independently and manufactured at completely different times without affecting one or other of the manufacturing process. In some cases we can now even manufacture the crown using a virtual model and never having an actual model in our hands but this is not

common at this time. If we design the model using model builder software the model is then exported and can be either milled in polyurethane or printed using a resin 3D printer. This model is the true representative of the mouth and preparation and allows us to start the process of making a crown.

The single crown in digital dentistry comes in many forms and materials and every type has its advantages and disadvantages. The two most common ways to produce a crown are full contour all ceramic or cut back metal/ceramic coping and then veneered with ceramic.

## The full contour crown

This type of crown is usually limited to the posterior of the mouth as the aesthetic demands are not as high as an anterior restoration. In this case the model or scan file .stl is imported into the CAD software. The margin is then selected and then a crown is designed virtually on the screen in 2D using the dental specific CAD software. The occlusion and contacts are checked as is the aesthetic position and we can even check the excursive movements if the virtual articulator in the software is used. The crown is then exported as another .stl file which then allows us to mill this in a variety of materials, however, this is most commonly a multi-layer all ceramic. This ceramic material is milled in a soft state then sintered overnight. The ceramic crown is then stained and glazed in the lab by a technician. The initial stain of the darker colours is fired onto the crown

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and then another two layers of lighter stain are added to create a natural looking crown. These stains are fired onto the crown around the 850°C temperature but vary depending on the ceramic stain manufacturer. This crown is then hand polished for a natural surface finish. Once all these stages are complete the crown is checked again for contacts and occlusion on either the milled or the 3D printed model before being sent to the clinician.

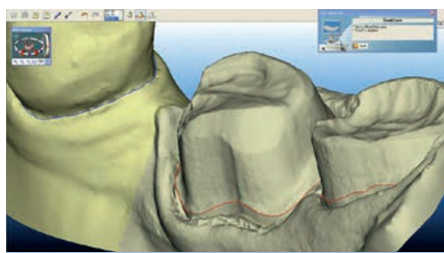


Image 1 - An example of a clear intra oral scan of a preparation



Image 2 - An anterior crown with ceramic bonded onto the metal for optimum aesthetics on a 3D printed model

### Cut back coping and veneered method

There are two groups of materials used in the cut back and veneer method and these restorations are used in both the posterior and anterior regions when a higher level of aesthetics is required. A veneered crown from a dental technician is considered the highest aesthetic option and so always used in the anterior. The digital CAD stages of producing a coping come from an initial full contour crown design; using this method is very similar to the above full contour however at the stage when the full crown is finalised, the crown is virtually cut back to allow porcelain to be added to the coping. This cut back is carefully done by a trained dental technician to ensure the space is large enough for the aesthetics required but also small enough to ensure good ceramic support so the risk of a ceramic fracture is reduced or even eliminated. Once this coping is designed then like the full contour, the coping is exported as an .stl and then milled or printed.



Image 3 - A full contour Zirconia crown stained and glazed on a milled polyurethane model

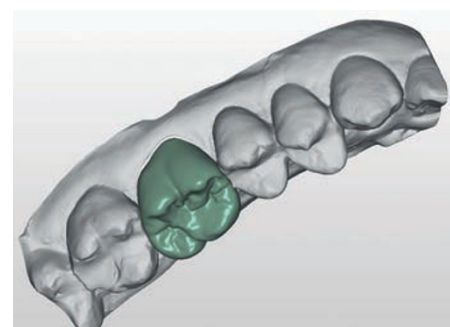


Image 4 - Designing a fill contour crown using lab CAD software

## 'THE SINGLE CROWN IN DIGITAL DENTISTRY

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### Metal coping

The metal coping can be milled from a variety of metals but more commonly we use selective laser melting and Combat Chromium. The metal is effective 3D printed in tiny 25 micron thick layers and then fused together. This technology allows copings to be produced accurately plus the material bond strength to the ceramic is incredibly high which vastly reduces fractures. The copings are printed on tiny legs which are then removed, trimmed and sandblasted ready for the veneering ceramic.

### All ceramic coping

All ceramic copings are milled in the same way as the full contours discussed earlier but they are simply a different shape.

### Veneering the coping

Both all ceramic and the metal 3D printed copings are produced using similar methods but the one main difference is the initial layer. On the metal coping due to its grey

colour, an opaque layer of ceramic is added in the relevant base colour to mask the metal colour. This opaque layer is fired onto the metal at the ceramic manufacturers' recommendation which is usually around 950°C. The all ceramic coping is fired with a liner to aid bonding but this is not used to mask the colour as the all ceramic is already tooth coloured. Both metal and all ceramic is now treated the same way. The coping is then veneered with a variety of porcelain colours which vary in opacity, fluorescence and translucency as well as colour. Dentine is layered on first then enamels and translucent ceramics on top to create a beautiful natural looking tooth which is custom hand-made especially for the patient. After firing the ceramic will shrink so the skill of the technician is used to manage this and add ceramic where needed. This is then trimmed into the shape required as well as on the model to check contacts, occlusion and aesthetics. More ceramic is then added where needed. The crown is fired once more and then again for a final glaze firing. The very last stage is to hand-finish the crown for contacts,

occlusion and to hand polish it for natural surface texture. The veneered crown is now ready for fitting into the mouth.

1. Joda T, Brägger U. Patient-centered outcomes comparing digital and conventional implant impression procedures: a randomized crossover trial. *Clin Oral Implants Res* 2016; 27: e185-e189. doi: 10.1111/clr.12600.
2. Maynard K. 'I wouldn't change this job for anything' *Vital spring* 2012; 24-29.

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<https://www.nature.com/articles/bdjteam201761>



bdjteam2017120