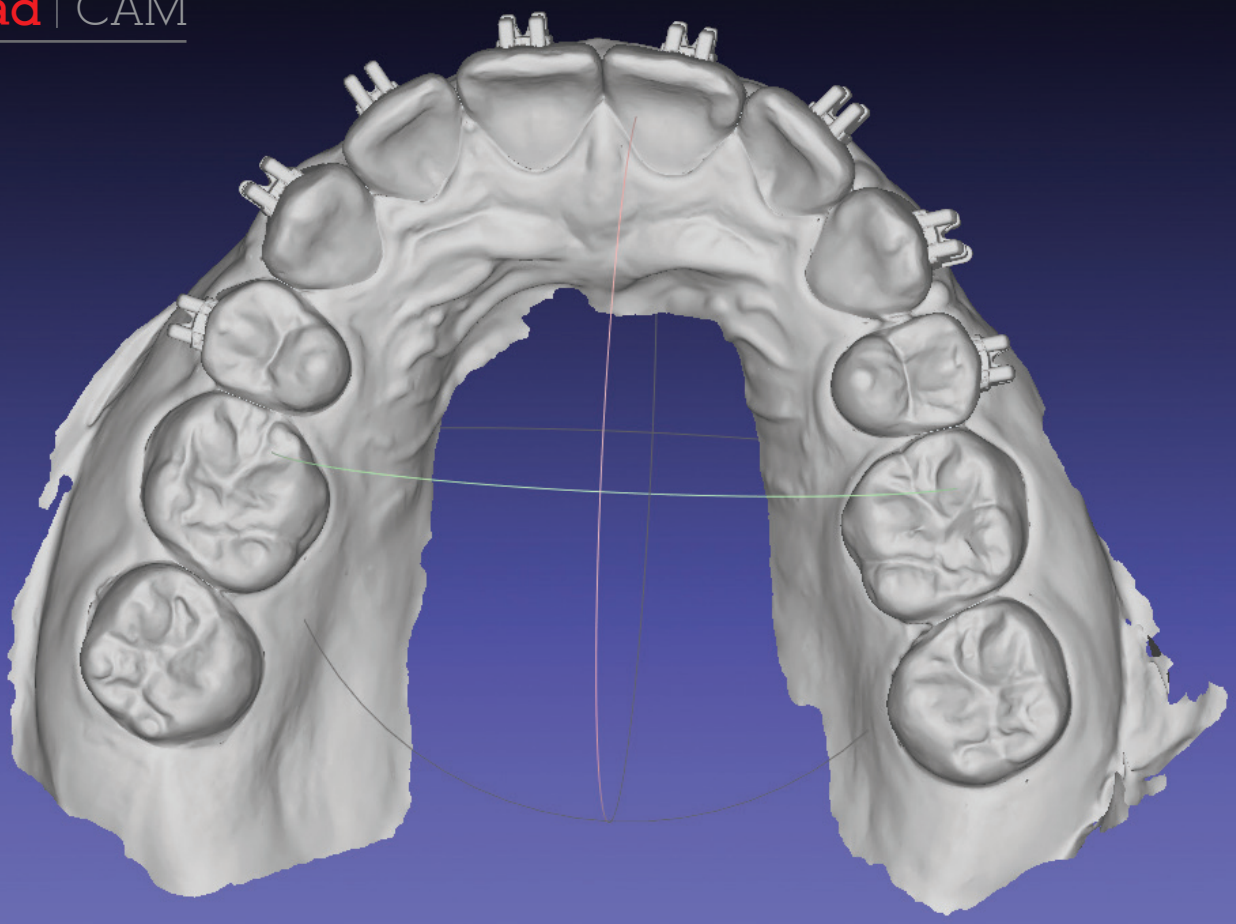

Figure 1. Intraoral scan including brackets in place. For best results, the impression should be taken with arch wires or power chain removed, otherwise you will not get accurate results.

Perfect retention with a Click™

By Terence Whitty

After any orthodontic treatment, retention of teeth is generally vital to the long term success and stability of the treatment. Without a long term retention plan, it is likely the treatment will relapse or at the very least, a partial relapse will occur with the resultant undesirable affects. Teeth are also often naturally mobile over time - from naturally occurring mesial drift, for example. Or, when a tooth is lost and not replaced, movement will occur. When undesired movement needs prevention, the orthodontic retainer is an inexpensive option to hold the teeth in their current position.

Orthodontic retainers resist the tendency of teeth to return to their pre-treatment positions under the influence of periodontal, occlusal and soft tissue forces, as well as, in some cases, continuing dentofacial growth. Great debate exists over the best design for a retainer; there would be little debate, however, in the fact that it is often the type that a patient will wear as prescribed that is best.

Types of retainers

Many types of retainers were described in historic literature such as the Baker Retainer - a vulcanite retainer with stainless lingual arms to hold teeth into position - it even had a labial bow. The most famous, however, is the Hawley Retainer,

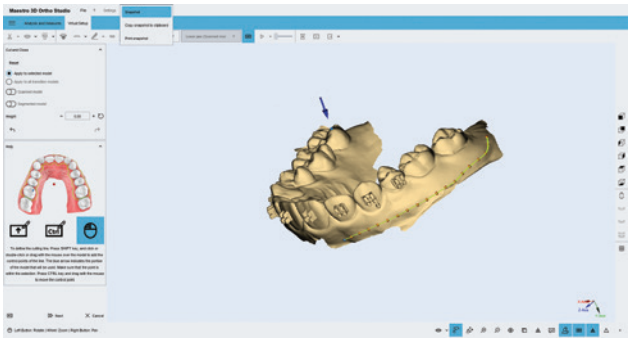

Figure 2. Model being prepared for editing and basing.

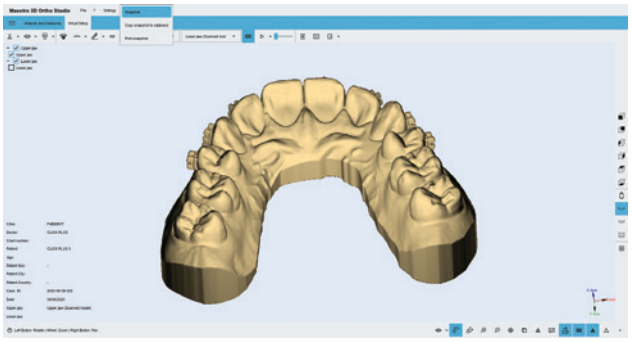

Figure 3. Model based.

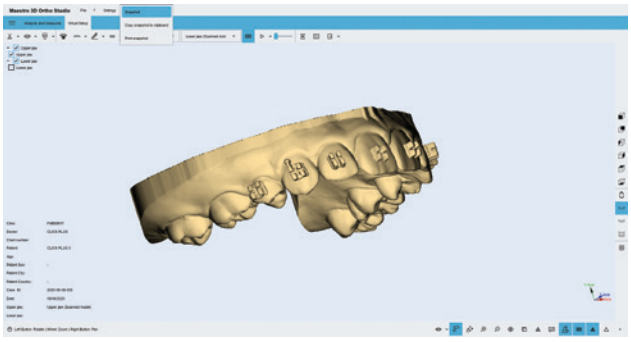

Figure 4. Ready for bracket removal.

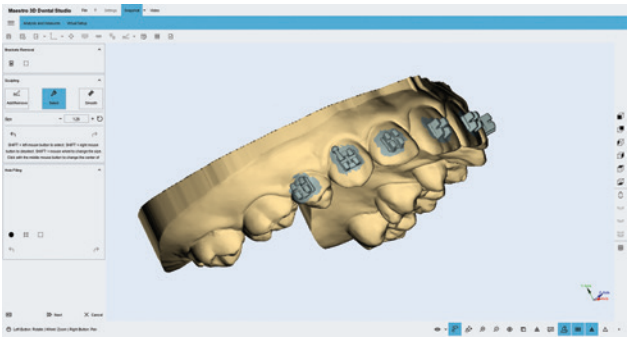

Figure 5. Marking brackets to be removed.

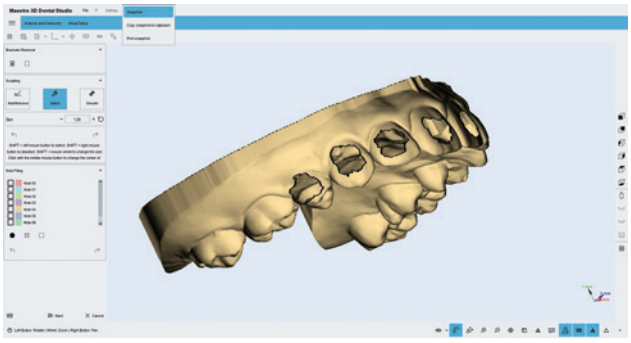

Figure 6. Brackets removed by software.

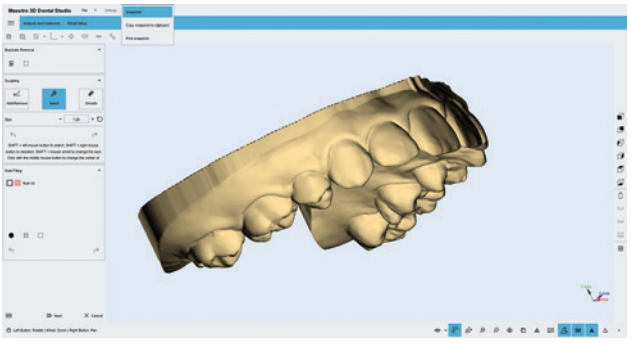

Figure 7. The software will calculate the hole filling needed to restore the model.

described by Charles Hawley in 1919. Today the "Hawley" retainer is a generic name for a wire and acrylic retainer. Often these will include a base pate of acrylic wire clasps to help hold the retainer in place and a labial bow. Lots of designs exist, but all are generically called a Hawley Retainer. The Hawley Retainer will retain well if constructed well; but the disadvantage of the "Hawley" is that they take skill and time to correctly construct and are therefore relatively expensive.

Fixed Retainers or Bonded Retainers are bonded directly to the lingual of the teeth. They come in various designs and materials including cast metal, braided wire and drawn wire. Other new materials include PEEK and ceramics. A recently developed method of fabrication uses robotically bent wire that fits intimately to the lingual surfaces of the teeth.

Fixed retainers must be designed and constructed very carefully so that flossing can still be achieved adequately. There is typically no bite interference on the lower teeth, however the upper bonded retainers can often be difficult. In addition, unless the bonded retainer is absolutely passive when fitted, there can be a tendency for tooth movement due to flexing forces of an active wire. Done well, Bonded Retainers are a good choice for the right patient; done poorly they can be a disaster!

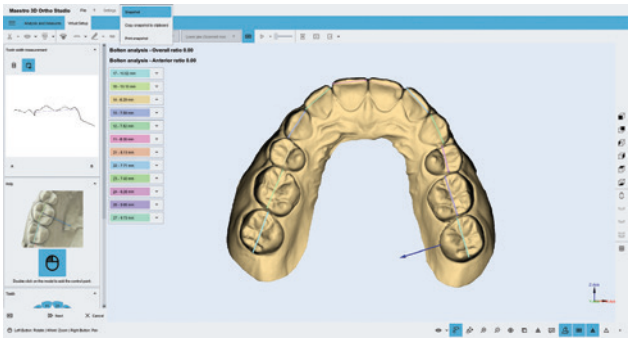

Figure 8. Marking of the teeth.

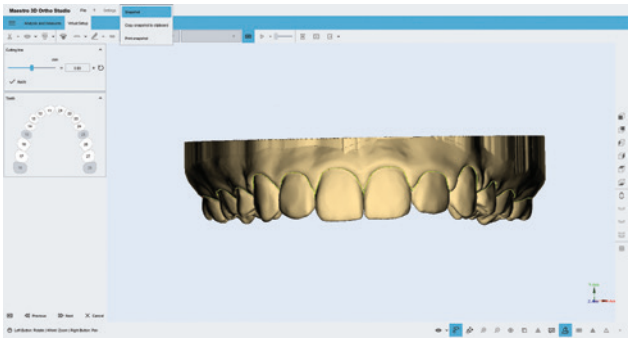

Figure 9. Sectioning of teeth.

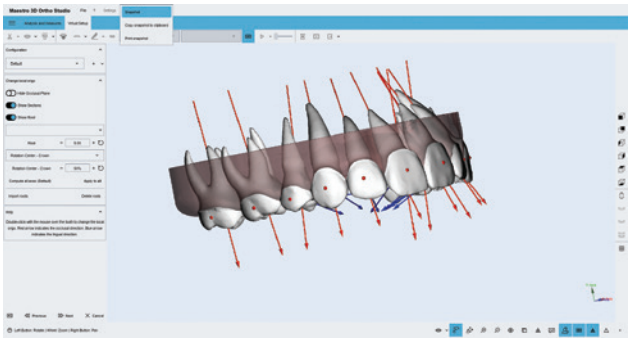

Figure 10. Addition of roots is optional.

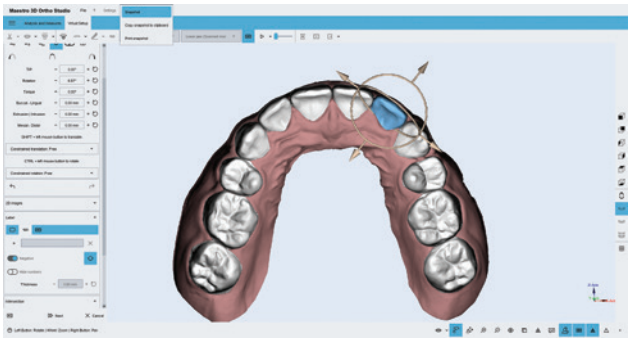

Figure 11. Minor movements can be made.

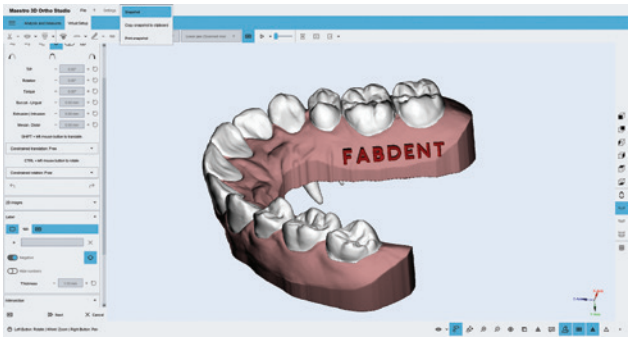

Figure 12. Marking of model prior to printing.

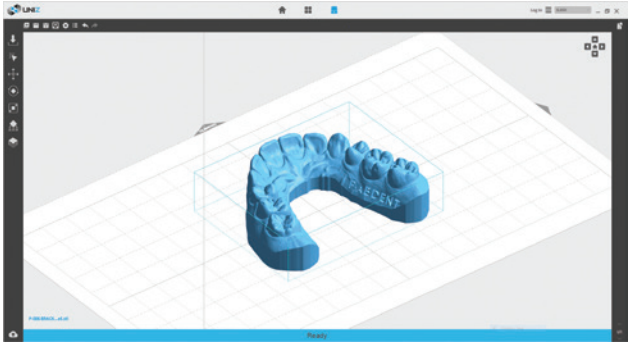

Figure 13. Model in 3D printing software.

The invisible retainer

The Tru-Tain Invisible Retainer is a thermoformed retainer developed over a three year clinical testing period (1973-1975) by Dr Lloyd H. Truax of Rochester, Minnesota, USA. During this time, over 1500 retainers were placed. Various types of materials, thicknesses, shapes and amounts of tooth coverage were used to develop the retainer. Tru-Tain is a thermoformed shell of clear material covering all the teeth. It can also be used for minor tooth movement if the tooth is reset on the model prior to forming, hence the modern concept of aligners was also invented.

The Essix Retainer is a similar product - the same basic concept made from Polycarbonate or Polypropylene. The main disadvantage of any type of Invisible Retainer tends to be the type of material used. Polycarbonate tends to wear and break easily and polypropylene tends to loose its shape and distort over time. In addition, there is considerable difference between Invisible Retainers made by vacuum forming versus pressure forming, the latter being a superior process.

There is a growing movement to place retainers directly after debonding orthodontic brackets, in fact, at the same appointment. Traditionally, this would have been done by taking an impression a week or so from the debonding appointment and after the impression is cast, the model would be painstakingly worked on to manually remove the brackets. After the model is prepared, the retainer is made and delivered to be ready for the debonding appointment. This is not a hyperaccurate method, but up until recently, was essentially the best option available.

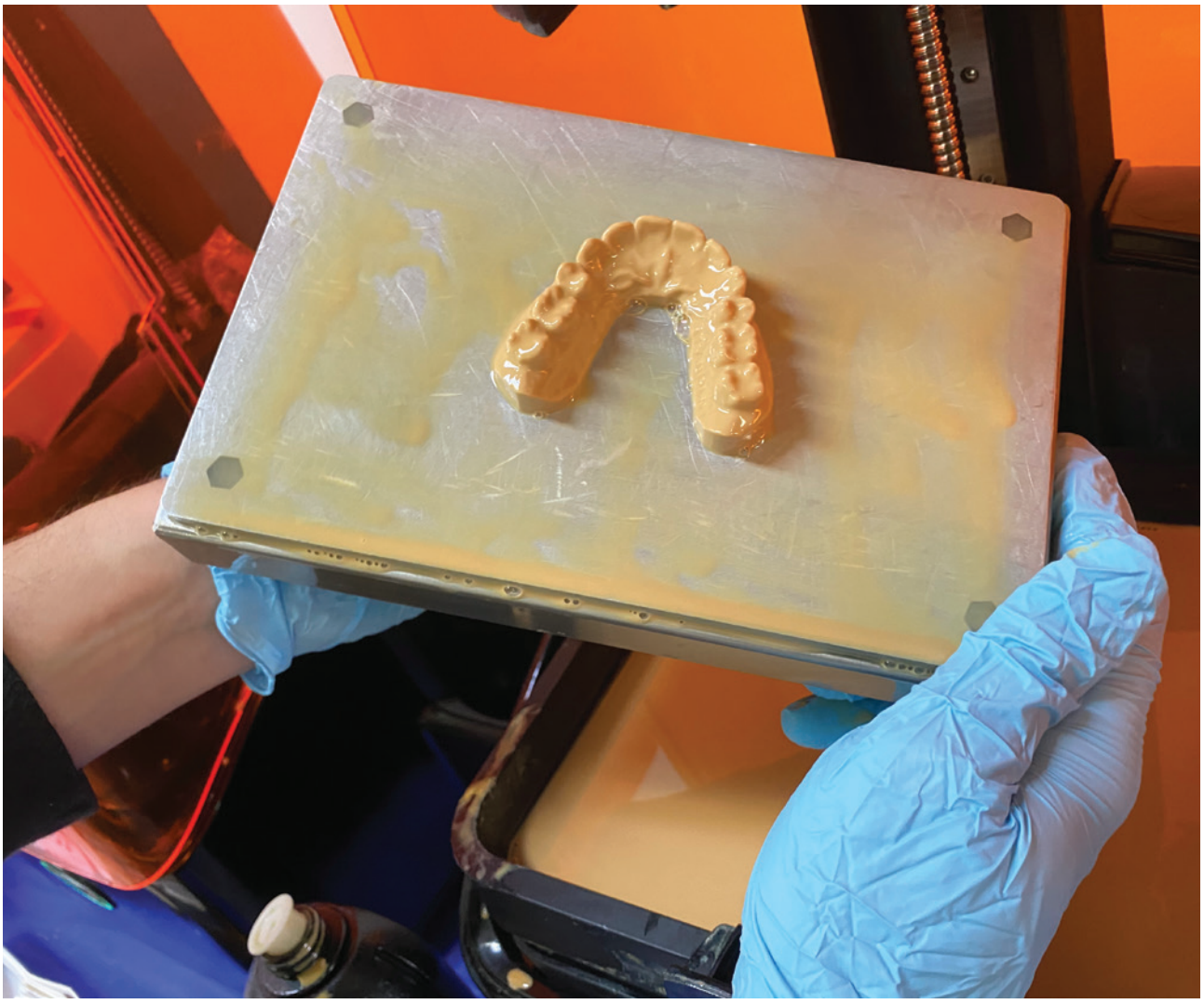

Figure 14. Removing the model from a UNIZ SLASH 2 3D printer.

With widespread use of the intraoral scanning in the orthodontic specialty, it was quick to see a new method for retainer manufacture could be realised using these intraoral scans and some clever software to make the whole process not only quicker and more accurate, but to add features that would be advantageous to the clinician and ultimately the patient.

The method

The scan is taken of the patient prior to the debonding appointment, preferably without the arch wires in place as this will yield a more accurate outcome. The scans are imported into software and the brackets are identified and removed digitally using special algorithms based on surrounding area data to emulate the patient's situation without brackets. If molar bands are present, it does offer a challenge but these can be reasonably successfully removed and smoothed over using the add/remove and smoothing tools. If any areas on the arch need "touching up" this can be done easily with the tools in the software.

Once this inital preparation is completed, the result is a digital 3D model of the dentition without the brackets. This digital model can then be digitally sectioned and and minor movements can be made to the position of the teeth. Care must be taken that the movement is within the limits of what a retainer can achieve. Otherwise, a series of retainers or - more correctly if this is the case - aligners can be used.

Next the digital model is prepared for 3D printing. This may include basing, mesh repair, blocking out major undercuts, adding names and numbers and any other process required prior to printing. The files are then sent to the print software and the models are 3D printed. For this type of work and depending on the printer, a 100 µm layer is sufficient; however, using a 50 µm layer will yield a smoother finish. All 3D printers build up in layers and depending on many factors, you may obviously see the demarcation lines of these layers (looking at any 3D printed model under a microscope will always reveal all).

Once the model is printed, it is post-processed and placed in the curing light for the manufacturer's recommended time.

Figure 15. Cleaned and post-cured model. The UNIZ 3D printing resin requires a 20-second post cure only.

Figure 16. Thermoformed retainer on 3D printed model.

Figure 17. Anterior view of finished retainer.

Figure 18. Finished Click Plus Retainer on 3D printed model.

Retainer materials and manufacture

Choice of retainer material and method of manufacture is important and will influence the final outcome and quality of the retainer. There are a plethora of materials available and range in price from about $1 to $10 per piece. Polycarbonates, Polypropylenes and Polyurethanes make up the majority of the materials available with each brand boasting their advantages over the next. Polycarbonates are a popular choice - it's the cheaper of these materials but some types tend to lose desirable properties during the thermoforming process and this can lead to premature fracture.

Regardless of the material, the thermoforming technique will greatly affect the fit of the retainer. Here we have 3 choices: vacuum forming; instant vacuum forming; and air pressure forming. As you can imagine, the equipment price for thermoforming rises as we move from one technology to the next. A basic vacuum former can be bought for a few hundred dollars and will give you fair results - Not great, but it may get you by. Instant vacuum forming is significantly better, but the Rolls Royce is air pressure forming as it will give the best adaptation of all 3.

Trimming retainers can be done in many ways - including with scissors or a hot knife or a handpiece with a rotating carbide cutter or stone.

Finally, finishing can be done with rubbers or wheels.

When trimming, we cut a smooth straight line just above the gingival margins - the height is personal choice - but we use 1-2 mm. Also, it is best to avoid heavy scalloping as this can lead to areas of weakness where the material will tend to split.

No thermoformed retainer will last forever, but a correctly constructed one has a good chance at a long life. If you have patients that constantly break retainers, check for bruxing and if you're getting cracks, check undercuts and insertion and removal techniques as this often contributes to issues like this.

Figures 1-18 illustrate how we construct our *Click Plus*™ retainer with bracket removal and incorporated small movements directly from intraoral scans.

About the author

Terence Whitty is a well-known dental technology key opinion leader and lectures nationally and internationally on a variety of dental technology and material science subjects. He is the founder and owner of Fabdent, a busy dental laboratory in Sydney specialising in high tech manufacturing. Using the latest advances in intra- and extra-oral scanning, CAD/CAM, milling, grinding and 3D printing, most specialties are covered including ortho, fixed and removable prosthetics, computerised implant planning and guidance, TMD, sleep appliances and paediatrics.